# TWENTY-THIRD ANNUAL REPORT

OF

# The Connecticut Agricultural Experiment Station

For 1899.

Printed by Order of the General Assembly

The publications of this Station are sent free to every citizen of Connecticut who applies for them. Address, The Conn.

Agricultural Experiment Station, New Haven, Conn.

NEW HAVEN, CONN.: THE TUTTLE, MOREHOUSE & TAYLOR COMPANY 1900

## CONNECTICUT AGRICULTURAL EXPERIMENT STATION.

#### OFFICERS AND STAFF FOR 1899.

#### STATE BOARD OF CONTROL.

77	- C .: -	-
H.X	officio.	

HIS EXCELLENCY GEORGE E. LOUNSBURY, President.

		App	pointed by Connecticut	State Agricultural	Society:	expire
S.	M.		Wethersfield.			July 1, 190

#### Appointed by Board of Trustees of Wesleyan University:

PROF.	W.O. ATW	ATER, Middletow	n.	1900

#### Appointed by Governor and Senate:

EDWIN HOYT, New Canaan.	190
JAMES H. WEBB, Hamden.	190

#### Appointed by Board of Agriculture :

T. S. GOI	D, West Corn	wall, Vice-President.	190

#### Appointed by Governing Board of Sheffield Scientific School:

		Appointed o	by Governing 1	soura of	She your Severity to Severit	
W.	Н.	BREWER,	New Haven,	Secretary	and Treasurer.	1902

#### Ex officio.

S. W. JOHNSON, New Haven, Director.

#### STATION STAFF.

#### Chemists.

S W 10	OHNSON, Director.	T. B. OSBORNE, Ph.D.
F H I	ENKINS, Ph.D., Vice-Dir.	A. W. OGDEN, Ph.B.
	VINTON, PH.B.	G. F. CAMPBELL, Ph.B.
	TITCHELL PHB*	CLIFFORD LANGLEY, PH.B.+

#### Botanist.

#### WILLIAM C. STURGIS, PH.D.

#### Horticulturist.

#### W. E. BRITTON, B.S.

#### Grass Gardener.

#### JAMES B. OLCOTT, South Manchester.

#### Stenographer and Clerk.

#### MISS V. E. COLE.

#### In charge of Buildings and Grounds. CHARLES J. RICE.

#### Laboratory Helpers.

#### HUGO LANGE.

#### WILLIAM POKROB.

#### Sampling Agent.

#### V. L. CHURCHILL, New Haven.

\* Till Sept. 1st, 1899.

+From Sept. 1st, 1899.

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## ANNOUNCEMENT.

THE CONNECTICUT AGRICULTURAL EXPERIMENT STATION was established in accordance with an Act of the General Assembly approved March 21, 1877, "for the purpose of promoting Agriculture by scientific investigation and experiment."

The Station is prepared to analyze and test fertilizers, cattle-foods, seeds, milk, and other agricultural materials and products, to identify grasses, weeds, moulds, blights, mildews, useful or injurious insects, etc., and to give information on various subjects of Agricultural Science, for the use and advantage of the citizens of Connecticut.

The Station does not undertake sanitary analyses of water. The Station makes analyses of Fertilizers, Seed-Tests, etc., for the citizens of Connecticut, without charge, provided—

- I. That the results are of use to the public and are free to publish.
- 2. That the samples are taken from stock now in the market, and in accordance with the Station "Instructions for Sampling."
- 3. That the samples are fully described and retail prices given on the Station "Forms for Description."

The officers of the Station will take pains to obtain for analysis samples of all the commercial fertilizers sold in Connecticut; but the organized coöperation of farmers is essential for the full and timely protection of their interests. Granges, Farmers' Clubs, and like associations can efficiently work with the Station for this purpose, by sending in duly authenticated samples early during each season of trade.

By recent Acts of Legislature it is made the business of this Station to examine commercial cattle feeds and articles used for human food or drink on sale in Connecticut, with reference to their adulterations.

Here it may be stated that, until further notice, the Station will examine only such samples of food and drink as are

collected by its agents or such as shall be taken under its advice, and by the methods it shall prescribe or approve.

All other work proper to the Experiment Station that can be used for the public benefit will be done without charge. Work for the private use of individuals is charged for at moderate rates. The Station undertakes no work the results of which are not at its disposal to use or publish, if deemed advisable for the public good.

Results of analysis or investigation that are of immediate general interest are published in Bulletins, copies of which are sent to each Post Office in the State, and to every citizen of the State who applies for them. The results of all the work of the Station are summed up in the Annual Reports made to the Governor.

It is the wish of the Board of Control to make the Station as widely useful as its resources will admit. Every Connecticut citizen who is concerned in agriculture, whether farmer, manufacturer, or dealer, has the right to apply to the Station for any assistance that comes within its province to render, and the Station will respond to all applications as far as lies in its power.

Instructions and Forms for taking samples, and Terms for testing Fertilizers, Seeds, etc., for private parties sent on application.

Parcels by Express, to receive attention, should be prepaid.

Letters sent to individual officers are liable to remain unanswered in case the officer addressed is absent. All communications therefore should be directed simply to the

#### AGRICULTURAL EXPERIMENT STATION, New Haven, Conn.

and all remittances should be made payable to the undersigned.

Station Grounds, Laboratories, and Office are on Huntington Street, five minutes walk west from Whitney Avenue and 15% miles north of City Hall.

Huntington Street may be reached by Whitney Avenue Electric Cars, which leave the corner of Chapel and Church

Streets five times hourly, viz.: on the striking of the clock and at intervals of twelve minutes thereafter.

The Station has telephone connection and may be spoken from the Central Telephone Office, 118 Court Street, or from Peck & Bishop's Office in Union R. R. Depot, New Haven.

The Grass Garden, in charge of Mr. James B. Olcott, is near South Manchester, five minutes walk from the line of the Manchester Electric Cars, leaving City Hall Square, State Street, Hartford, every half hour. Conductors on this line can direct visitors to the Garden.

S. W. Johnson, Director.

# REPORT OF THE BOARD OF CONTROL.

To His Excellency, George E. Lounsbury, Governor of Connecticut:

The Board of Control of the Connecticut Agricultural Experiment Station herewith submits its Report for the year ending October 31st, 1899:

#### THE FERTILIZER CONTROL.

During the months of April, May and June, Mr. V. L. Churchill, the sampling agent of the Station, visited one hundred and nineteen towns and cities in Connecticut and drew from stock in the hands of dealers or purchasers, five hundred and ninety-six samples of commercial fertilizers. These samples represented all but six of the two hundred and ninety-two brands which were legally entered for sale in the State.

With these six exceptions, being brands which could not be found by our agent, one sample at least of every commercial fertilizer legally sold in the State has been analyzed during this year. A manuscript copy of the analysis has been sent to the manufacturer and to each dealer from whom a sample of the goods analyzed was taken, and the analyses are tabulated for publication in Part I of the Station Report.

Other examinations of commercial fertilizers and manurial waste products bring the total number of fertilizer analyses made within the year up to four hundred and sixty.

These analyses have been executed by Messrs. Winton, Ogden and Mitchell, with the assistance of Mr. Lange.

#### Examination of Food Products.

During the year ending July 31st, 1899, agents of the Station visited twenty-one towns and villages in this State, and bought in each one of them samples of food products for examination. Four hundred and sixteen samples have been subjected to chemical or microscopic examination, as appears

in Part II of the Report of the Station staff. The microscopic work was wholly done by Mr. Winton, the chemical work by Messrs. Winton, Ogden and Mitchell.

#### Examination of Commercial Cattle Feeds.

During the year ending November 1st, 1899, Messrs. Winton, Ogden and Mitchell have analyzed two hundred and fortyone samples of this class of feeds and the results will appear in Part II of the Report.

#### WORK FOR THE DAIRY COMMISSIONER.

All the chemical work required by the Dairy Commissioner has been done in the laboratory of this Station, involving three hundred and twenty-three analyses of butter and oleomargarine, molasses and syrup, vinegar, honey and coffee.

#### OTHER CHEMICAL WORK.

In connection with work on the availability of different kinds of fertilizer nitrogen, the chemists named have made partial analyses of twenty-eight samples of red-top grass, of one hundred and twenty samples of Hungarian grass, of four samples of carnations, and of eighteen of soil.

A large amount of work has also been done in studying analytical methods as well as qualitative methods for the detection of adulterants in food products.

#### STUDY OF PROTEIDS.

During the past year, Dr. Osborne, with the assistance of Mr. Campbell, has made a study of nucleic acid and the phosphorized proteids, nucleins, nucleoproteids and nucleoalbumins. The proteids of the egg-white and also of the egg-yolk have been investigated in detail, and a very thorough study has been made of the proteids of the embryo of the wheat-kernel.

#### HORTICULTURAL AND ENTOMOLOGICAL WORK.

The study of the relative availability of organic nitrogen in various forms has been continued by Messrs. Jenkins and

Britton, with the coöperation of the Station chemists. Sixty-two cultures of red-top grass, forty-eight of oats, ninety-five each of Hungarian grass and of rye, and forty-eight of privet have been made for this purpose, in galvanized iron pots charged with soil to which the several forms of nitrogen have been added.

During the winter, forty-eight comparative cultures of tomatoes, twelve of carnations and ten of lettuce were made on the benches of the forcing houses.

Mr. Britton has also given attention to the grafting of improved varieties of edible chestnuts to determine the proper season and the best method of setting chestnut cions in this State.

The entomological work of the Station has also been done by Mr. Britton. Besides correspondence and the determination of insect species sent to the Station to be identified, much attention has been given to a study of the San José scale; its present distribution in this State, its spread, and the means of abating and stopping its ravages by the use of insecticides.

In response to requests from nurserymen, Mr. Britton has made thirteen inspections of nurseries to determine whether or not dangerous insect or fungus pests were present and in nine cases has been able to give certificates that the nurseries were clear.

#### SEED TESTING.

Two hundred and ninety-one samples of seeds, chiefly of vegetables and garden crops, have been tested as to their germinating power, in the interest of seed growers and purchasers.

#### BOTANICAL WORK.

Dr. Sturgis has made experiments on the effects of shading and applications of lime to prevent the trouble with tobacco known as "Calico," and on fractional fertilization of melons as a preventive of disease. He also contributes to the Report of the Station staff, papers on Further Notes on the Pole Burn of Tobacco, on the Prevention of Raspberry Anthracnose by Cultural Methods and Miscellaneous Notes on Fungous Diseases.

#### FIELD EXPERIMENTS.

Under the supervision of Mr. Jenkins the three experiments on the fertilization of peach orchards, chiefly to study the effects of different amounts of potash salts and of the forms of nitrogen best adapted to the crop, which were begun in 1896, have been continued, and in one of the orchards the first crop of peaches was gathered this year.

#### TOBACCO EXPERIMENTS.

Under the direction of Mr. Jenkins, the curing of wrapper leaf tobacco by artificial heat used to supplement the natural conditions, and the fermentation of this tobacco in bulk instead of in cases, have been studied this year with very gratifying results.

#### STATION PUBLICATIONS.

The twenty-second Report of this Station, for the year 1898, a volume of 341 pages, has been issued in an edition of 7,000 copies. These have been distributed, after satisfying our exchanges, among the farmers of this State in response to applications.

Of the third Annual Report on Food Products, 10,000 extra copies were printed at the expense of the Station, and distributed in our cities and villages to intelligent citizens who are, presumably, interested in pure food, but are not reached by the regular edition that is intended for the use of agriculturists.

Bulletin No. 128, issued in April last, twelve pages, was entitled, "Commercial Feeding Stuffs in the Connecticut Market."

Bulletin No. 129, issued in May last, ten pages, treated of the "Inspection and Care of Nursery Stock."

Five thousand copies of each of these bulletins were printed and distributed and the substance of their contents is reproduced in the Report of the Station Staff for 1899, with appropriate emendations.

#### CORRESPONDENCE.

During the year ending October 31, 1899, more than twenty-eight hundred letters and manuscript reports of fertilizer and other analyses have been written on Station business.

#### CHANGES IN THE STATION STAFF.

Mr. Walter Mitchell, who has for four years served most efficiently as chemist on the Station staff, resigned in September, to accept a more satisfactory position in a large manufacturing establishment. A few weeks later Mr. Clifford Langley was appointed to fill the vacancy.

#### MEETINGS OF THE BOARD.

During the year ending October 31st, the Board of Control has held three meetings.

All of which is respectfully submitted.

WM. H. BREWER, Secretary.

### REPORT OF THE TREASURER.

Wm. H. Brewer, in account with the Connecticut Agricultural Experiment Station for the fiscal year ending September 30, 1899.

#### RECEIPTS.

Balance from 1898,				\$281.38
State Appropriation	, Agricul	ture,		10,000.00
State Appropriation	, Foods,			2,500.00
United States Appr	opriation,	. 118		7,500.00
Analysis Fees,				5,677.00
Miscellaneous,			4.4.5	438.00

#### DISBURSEMENTS.

S. W. Johnson,	Salary	,				\$1,250.00
E. H. Jenkins,	"					2,500.00
W. H. Brewer,	"				. *	499.70
V. E. Cole,						800.00
W. C. Sturgis,	**					1,000.00
T. B. Osborne,						1,775.00
A. L. Winton,						1,775.00
A. W. Ogden,	44					1,675.00
G. F. Campbell,	**					. 1,000.00
W. L. Mitchell,	**					900.03
W. W. Mursick,	"					150.00
C. Langley,	"		. /			30.77
W. E. Britton,						1,175.00
H. Lange,	"			. 100		720.00
J. B. Olcott,	"					800.00
C. J. Rice,	"					600.00
V. L. Churchill,	"	-				600.00
Labor, .				.4		. 1,080.45
Publications,					12.3	567.27
Postage,						125.46
Stationery,						174.75
Telephone and	Telegra	iph,				146.13
Freight and Exp	oress,					95.83
Gas, .						464.93
Coal, .						842.40
Water, .						147.00
Chem. Laborato	ry,					1,209.36

			\$126.60
			119.39
			118.28
			106.83
			512.45
			192.53
			39.90
			280.05
			18.20
			155.46
			423.79
			267.46
*			177.43
7	A Hara	N.	
			263.03
			789.43
			572.65
nt,			128.82
			\$26,396.38
	 		nt,

Memorandum.—The accounts of the Treasurer have been duly audited by the State Auditors of Public Accounts. The Report of the Treasurer for the fiscal year of the United States ending June 30th, 1899, was duly rendered to the Secretary of the Treasury of the United States, and in duplicate to the Secretary of Agriculture.

In the accounts as here presented, the disbursements for "Fertilizers" are exclusive of those used in the special Grass and Tobacco investigations, and those for "Traveling by the Staff" are exclusive of money spent in the sampling of Fertilizers and Foods.

The above classification of Expenditures is in accordance with the requirements of the State laws regarding expenditures of the State appropriations, of the requirements of the Secretary of the Treasury of the United States for the expenditure of the United States appropriation, and with the schedule prepared by the United States Secretary of Agriculture for use by all the Agricultural Experiment Stations of the country.

WM. H. BREWER,

Treasurer.

# COMMERCIAL FERTILIZERS.

During 1898 fifty-four manufacturing firms have entered for sale in this State two hundred and ninety-two distinct brands of fertilizers, viz.:

Special manures for particular crops	109
Other nitrogenous superphosphates	109
Pone manures and "bone and potash"	37
Fish, tankage, castor pomace and chemicals	37
	292

The duties of this Station regarding fertilizers are prescribed by law as follows:

#### THE FERTILIZER LAW OF CONNECTICUT.

The General Assembly, in 1882, passed an act concerning Commercial Fertilizers, which, as amended in 1893, is now in force.

Attention is especially called to the following requirements of the law, the full text of which is printed on pages 3 and 4.

I. In case of *all* fertilizers or manures, except stable manure and the products of local manufacturers of less value than ten dollars a ton, the law holds the SELLER responsible for *affixing a correct label or statement* to every package or lot sold or offered, as well as for the *payment of an analysis fee* of ten dollars for each fertilizing ingredient which the fertilizer contains or is claimed to contain, *unless* the MANUFACTURER OR IMPORTER has provided labels or statements and has paid the fee. Sections 4005 and 4007.

The Station understands "the fertilizing ingredients" to be those whose determination in an analysis is necessary for a valuation, and which are generally Nitrogen, Phosphoric Acid, and Potash. The analysis fees in case of any fertilizer will, therefore, usually be ten, twenty, or thirty dollars, according as one, two or three of these ingredients are contained or claimed to exist in the fertilizer.

2. The law also requires, in the case of every commercial fertilizer, that a sealed sample shall be deposited with the Director of the Station by the MANUFACTURER OR IMPORTER, and that a certified statement of composition, etc., shall be filed with him. Section 4006.

A statement of the percentage of Nitrogen, Phosphoric Acid (P<sub>2</sub>O<sub>5</sub>), and Potash (K<sub>2</sub>O), and of their several states or forms, will suffice in most cases. Other ingredients may be named if desired.

In all cases the percentage of *nitrogen* must be stated. Ammonia may also be given when actually present in ammonia salts, and "ammonia equivalent to nitrogen" may likewise be stated.

The percentage of soluble and reverted phosphoric acid may be given separately or together, and the term "available" may be used in addition to, but not instead of, soluble and reverted.

The percentage of insoluble phosphoric acid may be stated or omitted. In case of Bone, Fish, Tankage, Dried Meat, Dried Blood, etc., the chemical composition may take account of the two ingredients, Nitrogen and Phosphoric Acid.

For Potash Salts give always the percentage of Potash (potassium oxide): that of Sulphate of Potash or Muriate of Potash may also be stated.

The chemical composition of other fertilizers may be given as found in the Station Reports.

- 3. It is also provided that EVERY PERSON in the State, who sells any commercial fertilizer of whatever kind or price, shall annually report certain facts to the Director of the Experiment Station, and on demand of the latter shall deliver a sample for analysis. Section 4008.
- 4. All "CHEMICALS" that are applied to land, such as Muriate of Potash, Kainite, Sulphate of Potash and Magnesia, Sulphate of Ammonia, Nitrate of Potash, Nitrate of Soda, etc.—are considered to come under the law as "Commerical Fertilizers." Dealers in these chemicals must see that packages are suitably labeled. They must also report them to the Station, and see that the analysis fees are duly paid, in order that the Director may be able to discharge his duty as prescribed in Section 4013 of the Act.

It will be noticed that the State exacts no license tax either for making or dealing in fertilizers. For the safety of consumers and the benefit of honest manufacturers and dealers, the State requires that it be known what is offered for sale, and whether fertilizers are what they purport to be. With this object in view the law provides, in Section 4013, that all fertilizers be analyzed, and it requires the parties making or selling them to pay for these analyses in part; the State itself paying in part by maintaining the Experiment Station.

## ACTS CONCERNING COMMERCIAL FERTILIZERS.

Chapter CCLIII of the General Statutes of Connecticut as amended by Chapter CLXXII of the Acts of the General Assembly, Session of 1893.

Section 4005. Every person or company who shall sell, offer, or expose for sale, in this State, any commercial fertilizer or manure except stable manure, and the products of local manufacturers of less value than ten dollars a ton, shall affix conspicuously to every package thereof a plainly printed statement clearly and truly certifying the number of net pounds of fertilizer in the package, the name, brand, or trademark under which the fertilizer is sold, the name and address of the manufacturer, the place of manufacture, and the chemical composition of the fertilizer, expressed in the terms and manner approved and usually employed by the Connecticut Agricultural Experiment Station.

If any such fertilizer be sold in bulk, such printed statement shall accompany every lot and parcel sold, offered, or exposed

for sale.

SEC. 4006. Before any commercial fertilizer is sold, offered, or exposed for sale, the manufacturer, importer, or person who causes it to be sold, or offered for sale, within this State, shall file with the Director of the Connecticut Agricultural Experiment Station two certified copies of the statement prescribed in Section 4005, and shall deposit with said director a sealed glass jar or bottle containing not less than one pound of the fertilizer, accompanied by an affidavit that it is a fair average sample thereof.

SEC. 4007. The manufacturer, importer, agent, or seller of any commercial fertilizer shall pay on or before May I, annually, to the Director of the Connecticut Agricultural Experiment Station, an analysis fee of ten dollars for each of the fertilizing ingredients contained or claimed to exist in said fertilizer: provided, that when the manufacturer or importer shall have paid the fee herein required for any person acting as agent or seller for such manufacturer or importer, such agent or seller shall not be required to pay the fee prescribed in this section.

SEC. 4008. Every person in this State who sells, or acts as local agent for the sale of any commercial fertilizer of whatever kind or price, shall annually, or at the time of becoming such seller or agent, report to the Director of the Connecticut Agricultural Experiment Station his name and brand of said fertilizer, with the name and address of the manufacturer, importer,

or party from whom such fertilizer was obtained, and shall, on demand of the Director of the Connecticut Agricultural Experiment Station, deliver to said director'a sample suitable for analysis of any such fertilizer or manure then and there sold or offered for sale by said seller or agent.

Sec. 4009. No person or party shall sell, offer, or expose for sale, in this State, any pulverized leather, raw, steamed, roasted, or in any form, as a fertilizer or as an ingredient of any fertilizer or manure, without explicit printed certificate of the fact, such certificate to be conspicuously affixed to every package of such fertilizer or manure, and to accompany every parcel or lot of the same.

SEC. 4010. Every manufacturer of fish guano, or fertilizers of which the principal ingredient is fish or fish mass from which the oil has been extracted, shall, before manufacturing or heating the same, and within thirty-six hours from the time such fish or mass has been delivered to him, treat the same with sulphuric acid or other chemicals, approved by the director of said experiment station, in such quantity as to arrest decomposition: provided, however, that in lieu of such treatment such manufacturers may provide a means for consuming all smoke and vapors arising from such fertilizers during the process of manufacture.

SEC. 4011. Any person violating any provisions of the foregoing sections of this chapter shall be fined one hundred dollars for the first offense, and two hundred dollars for each subsequent violation.

SEC. 4012. This chapter shall not affect parties manufacturing, importing, or purchasing fertilizers for their own private use, and not to sell in this State.

SEC. 4013. The Director of the Connecticut Agricultural Experiment Station shall pay the analysis fees received by him into the treasury of the Station, and shall cause one or more analyses of each fertilizer to be made and published annually. Said director is hereby authorized, in person or by deputy, to take samples for analysis from any lot or package of manure or fertilizer which may be in the possession of any dealer.

SEC. 4014. The Director of the Connecticut Agricultural Experiment Station shall, from time to time, as bulletins of said Station may be issued, mail or cause to be mailed two copies, at least, of such bulletins to each post-office in the State.

# OBSERVANCE OF THE FERTILIZER LAW.

Here follows an alphabetical list of the manufacturers who have paid analysis fees as required by the Fertilizer Law, and the names or brands of the fertilizers for which fees have been paid by them for the year ending May 1st, 1900.

#### Firm.

Armour Fertilizer Works, The, Chicago,

Berkshire Mills Co., Bridgeport, Conn.

Boardman, F. E., Little River, Conn.

Bowker Fertilizer Co., 43 Chatham St., Boston, Mass.

Brand of Fertilizer.

Ammoniated Bone with Potash, Grain Grower, All Soluble, Fruit and Root Crop Special.

Berkshire Complete Fertilizer, Potato Phosphate,

Ammoniated Bone Phosphate. 66

Ground Bone,

Columbian Phosphate.

Boardman's Complete Fertilizer for Potatoes and General Crops.

Stockbridge Special Tobacco Manure,

Corn Manure, Grass Top Dressing and Forage

Crop Manure,

Potato and Vegetable Manure,

Bowker's Special Fertilizer, Potato and Vegetable,

Potato Phosphate,

Hill and Drill Phosphate. Farm and Garden or Ammoniated Bone Fertilizer,

Fish and Potash, Square Brand.

Tobacco Starter, Sure Crop Phosphate,

Market Garden Fertilizer, Square Brand Bone and Pot-

ash, Corn Phosphate,

Bone and Wood Ash Fertilizer,

Tobacco Ash Elements, Fertilizer,

Middlesex Special, Early Potato Manure,

Acid Phosphate, Fisherman's Brand Fish and Potash,

Dry Ground Fish,

Nitrate of Soda, Dissolved Bone-black, Firm.

Bowker Fertilizer Co., 43 Chatham St., Boston, Mass.

Bradley Fertilizer Co., 92 State St., Boston, Mass.

Brightman, Wm. E., Gen'l Agent, Tiverton, R. I.

Buckingham, C., Southport, Conn.

Burwell, E. E., New Haven, Conn.

Clark's Cove Fertilizer Co., The, Box 1779, N. Y. City.

Cleveland Dryer Co., The, 92 State St., Boston Mass.

Coe, E. Frank Co., 133-137 Front St., N. Y. City.

Brand of Fertilizer.

Muriate of Potash, Fresh Ground Bone, Tankage, Canada Hardwood Ashes, Castor Pomace.

Bradley's Eclipse Phosphate,
"Dry Fish Guano,
High Grade Tobacco Manure,
Farmers' New Method Fertilizer,
B. D. Sea Fowl Guano,
Triangle A Fish and Potash,
Anchor Brand Fish and Potash,
Circle Brand Ground Bone with Potash,
Fine Ground Bone,
Complete Manure for Corn and Grain,
"Potatoes and
Vegetables.

Potato Manure, Superphosphate, Corn Phosphate, Potato Fertilizer, Tobacco Fertilizer, Niagara Phosphate.

Brightman's Fish and Potash,

"Tobacco Special and Market Garden Fertilizer,

" Ammoniated Bone and Potash,

" Dry Ground Fish.

XX Formula.

Double Sulphate of Potash, Muriate of Potash, Blood and Meat, Dissolved Bone Black, Nitrate of Soda.

Great Planet A., Bay State G. G., Sweepstakes Potato Manure, Potato Fertilizer, King Philip.

Superphosphate, High Grade Complete Manure, Potato Phosphate, Fertilizer.

E. Frank Coe's High Grade Ammoniated Bone Superphosphate,

" High Grade Potato Fertilizer, " Gold Brand Excelsion

"Guano,
Ground Bone and Pot-

Special Potato Fertilizer.

Firm.

Conn. Valley Orchard Co., Berlin, Conn.

Cooper's Glue Factory, Peter, 17 Burling Slip, N. Y. City.

Crocker Fertilizer and Chemical Co., Buffalo, N. Y.

Cumberland Bone-Phosphate Co., State St. and Merchants Row, Boston, Mass.

Darling Fertilizer Co., L. B., Pawtucket, R. I.

Dennis, L. C., Stafford Springs, Conn.

Downs & Griffin, Derby, Conn.

East India Chemical Works, The, H. J. Baker & Bro., Prop's., 100 William St., N. Y. City.

Ellsworth, F., Hartford, Conn.

Frisbie, L. T. Co., The, Hartford, Conn.

Great Eastern Fertilizer Co., Rutland,

Hess, S. M. & Bro., Cor. 4th & Chestnut Sts., Philadelphia, Pa.

Kelsey, E. R., Branford, Conn. Lederer & Co., New Haven, Conn. Brand of Fertilizer.
C. V. O. Co.'s Fertilizer.

Bone Dust.

Crocker's Ammoniated Wheat and Corn
Phosphate,

New England Tobacco and Potato Grower.

" A. A. Complete Manure,
" Special Potato Manure.

Cumberland Superphosphate,

"Concentrated Phosphate,
"Botato Fertilizer

" Potato Fertilizer,

" Fertilizer,
" Hawkeve Fertilizer.

" Extra Fine Ground Bone.

Potato and Root Crop, Tobacco Grower, Blood, Bone and Potash, Dissolved Bone and Potash, Farm Favorite, Fine Bone.

Ground Bone.

Ground Bone.

Complete Tobacco Manure,
"A A" Ammoniated Superphosphate,
Complete Potato Manure,
Harvest Home Fertilizer,
Complete Corn Manure,
Castor Pomace,
Complete for General Use,
Bone.

Shoemaker's Swift Sure Bone Meal. "Superphosphate.

Frisbie's Bone Meal, "Superphosphate.

Garden Special, Vegetable, Vine and Tobacco, Northern Corn Special, General, Grass and Oats.

Potato and Truck Manure, Hess's Tobacco Manure, Keystone Bone Phosphate.

Bone, Fish and Potash.

Pure Ground Bone.

Firm.

Lister's Agricultural Chemical Works. Newark, N. J.

Lowell Fertilizer Co., 44 No. Market St., Boston, Mass.

Ludlam, Frederick, 108 Water St., N. Y. City.

Manchester, E. & Sons, West Winsted, Conn.

Manock, Robert, Rockville, Conn.

Mapes, F. & P. G. Co., The, 143 Liberty St., N. Y. City.

McCormack, W., Wolcott, Conn.

Miles, Geo. W., Agent, Milford, Conn.

Milsom Rendering & Fertilizer Co., 963 William St., East Buffalo, N. Y.

Brand of Fertilizer.

Lister's Standard Pure Bone Superphosphate of Lime,

Animal Bone and Potash. Success Fertilizer.

Potato Manure, Special Potato Fertilizer.

Swift's Lowell Bone Fertilizer.

Animal Fertilizer, Potato Phosphate, Tobacco Manure, Ground Bone, 66 " "

Dissolved Bone and Potash,

Market Garden, Fruit and Vine.

Cecrops Brand, Cereal Brand.

"

Manchester's Formula.

Ground Bone. Potato Manure.

Economical Potato Manure. Complete Manure "A" Brand, Tobacco Starter Improved,
Vegetable Manure or Complete Manure
for Light Soils,
Dissolved Bone, Tobacco Ash Constituents, Manure, Wrapper Brand, Corn Manure, Cereal Brand. Fruit and Vine Manure. Grass and Grain Spring Top Dressing. Average Soil Complete Manure. Seeding Down Manure.

Ground Bone.

I. X. L. Ammoniated Bone Superphos-Fish Guano.

Buffalo Fertilizer. Corn Fertilizer, Potato, Hop and Tobacco Phosphate, Cyclone Pure Bone Meal. Vegetable Bone Fertilizer. Wheat, Oats and Barley Phosphate. Erie King, Buffalo Guano, Connecticut Wrapper. Potato Special. B. B. Guano. Dissolved Bone and Potash.

Firm.

National Fertilizer Co., Bridgeport, Conn.

Niagara Fertilizer Works, The, Buffalo, N. Y.

Olds & Whipple, Hartford, Conn.

Pacific Guano Co., P. O. Box 1368, Boston, Mass.

Packer's Union Fertilizer Co., P. O. Box 1528, N. Y. City.

Peck Bros., Northfield, Conn.

Plumb & Winton Co., Bridgeport, Conn.

Preston Fertilizer Co., Greenpoint, L. I.

Quinnipiac Co., The, 92 State St., Boston, Mass.

Read Fertilizer Co., The, Box 3121, N. Y. City.

Brand of Fertilizer.

Chittenden's Complete Fertilizers, Ammoniated Bone,

Fish and Potash, Market Garden, Potato Phosphate.

Fine Ground Bone.

Niagara Wheat and Corn Producer, Potato, Tobacco and Hop Fertilizer.

Bone Meal, O. and W. Special Phosphate, "Castor Pomace.

Soluble Pacific Guano, Potato Special, High Grade General Fertilizer, Nobsque Guano. Grass and Grain Fertilizer, Fine Ground Bone.

Animal Corn Fertilizer, Potato Manure. Universal Fertilizer, Wheat, Oats and Clover, Gardeners' Complete Manure.

Pure Ground Bone.

Ground Bone.

Potato Fertilizer. Ground Bone.

Quinnipiac Phosphate,

Potato Manure,

" Phosphate, Market Garden Manure, Corn Manure,

Climax Phosphate, Pure Bone Meal,

Fish and Potash, Pequot,

Uncas Bone Meal, Special Potato.

Muriate of Potash. Sulphate of Potash, Nitrate of Soda, Dry Ground Fish, Ammoniated Dissolved Bone, Fish and Potash, Crossed Fishes Brand.

Read's Standard, Bone, Fish and Potash, Vegetable and Vine, High Grade Farmer's Friend.

Leader Guano.

Firm.

Rogers & Hubbard Co., The, Middletown. Conn.

Brand of Fertilizer.

Hubbard's Pure Raw Knuckle Bone Flour, Strictly Pure Fine Bone.

Fertilizer for Oats and Ton Dressing,

Fertilizer for All Soils and All Crops,

Potato Phosphate. Soluble Potato Manure. Fairchild's Formula Corn and General Crops.

66 Soluble Tobacco Manure. Grass and Grain Fertilizer.

Rogers Mfg. Co., The. Rockfall, Conn.

Pure Ground Bone, High Grade Soluble Potato, Complete Potato, Corn, Oats and Top Dressing, High Grade Tobacco Manure, Grass and Grain Manure,

Fish and Potash, All Round Fertilizer.

Russia Cement Co., Gloucester, Mass.

Essex Fish and Potash,

Complete Manure for Potatoes. Roots and Vegetables,

Complete Manure for Corn, Grain and Grass.

Corn Fertilizer, Potato Fertilizer, Tobacco Starter,

Manure, Dry Ground Fish.

Sanderson, L., New Haven, Conn.

Sanderson's Mixed Formula A,

Old Reliable Superphosphate,

Potato Manure,

Special with 10% Potash,

Nitrate of Soda, Muriate of Potash, Dissolved Bone Black, Blood, Bone and Meat,

Fine Ground Bone, Sulphate of Potash, Pulverized Bone and Meat,

Fish. Luce Bros.' Bone, Fish and Potash.

Shay, C. M., Groton, Conn.

Standard Fertilizer Co., Farlow Building, State St., Boston, Mass.

Groton Corn and Grain Manure. Mystic Gilt Edge Potato Manure, Ground Bone.

Standard Fertilizer,

Special for Potatoes.

Guano,

Complete Manure.

Tucker, Henry F. Co., Farlow Building, State St., Boston, Mass.

Wheeler, M. E. & Co., Rutland, Vt.

Brand of Fertilizer.

Tucker's Special Potato Fertilizer, Original Bay State Bone Superphosphate,

Bay State Special Fertilizer, Imperial Bone Superphosphate.

M. E. Wheeler's & Co.'s Superior Truck Fertilizer.

Havana Tobacco Grower, High Grade Potato Manure, High Grade Corn Fertilizer, High Grade Fruit 66 Fertilizer, 66 High Grade Grass and Oats. High Grade Electrical Dissolved Bone. High Grade Pure Ground Bone.

Wilcox Fertilizer Works, The, Mystic, Conn.

Williams & Clark Fertilizer Co., 27 William St., N. Y. City.

Potato, Onion and Tobacco Manure, Complete Bone Superphosphate, Potato Manure, High Grade Fish and Potash, Dry Ground Fish Guano.

Ammoniated Bone Superphosphate Corn Phosphate, High Grade Special, Good Grower Potato Phosphate, Muriate of Potash, Dry Ground Fish, Potato Phosphate, " Manure, Royal Bone Phosphate, Pure Bone Meal, Nitrate of Soda, Kainit. Acid Phosphate, Tankage, Fish and Potash.

#### SAMPLING AND COLLECTION OF FERTILIZERS.

During April, May and June, Mr. V. L. Churchill, the sampling agent of this Station, visited one hundred and nineteen localities in Connecticut to draw samples of commercial fertilizers for analysis. These places were distributed as follows:

Litchfield County	II
Hartford County	
Tolland County	II
Windham County	10
New London County	14
Middlesex County	13
New Haven County	17
Fairfield County	14
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In these places 596 samples were taken, representing all but six of the brands which have been entered for sale in this State.

These six brands, which the sampling agent was unable to find on sale and of which no samples were received from the manufacturers, are the following:

Armour & Co.'s Fruit and Root Crop, Special.

Bowker & Co.'s Stockbridge Tobacco Manure.

"Dissolved Bone Black.

Clark's Cove Fertilizer Co.'s Sweepstakes Potato Manure.

Pacific Guano Co.'s High Grade General Fertilizer.

"Ground Bone.

It has not been possible, therefore, for the Station to make analyses of these six fertilizers.

When several samples of a single brand are drawn in different parts of the State, the analysis is usually performed, not on any single sample, but on a mixture made of equal weights of all of the several samples. Thus, it is believed, the average composition of the goods is more fairly represented than by the analysis of single samples.

The Station agent is instructed in every case to open at least three packages of each brand for sampling, and, if the number of packages is very large, to take a portion from every tenth one, by means of a sampling tube which withdraws a section or core through the entire length of the bag or barrel.

As a rule, the Station will not analyze samples taken—

- I. From dealer's stock of less than one ton.
- 2. From stock which has lain over from last season.

3. From stock which evidently is improperly stored, as in bags lying on wet ground or exposed to the weather, etc.

The Station desires the coöperation of farmers, farmers' clubs and granges in calling attention to new brands of fertilizers, and in securing samples of all goods offered for sale. All samples must be drawn in strict accordance with Station's Instructions for Sampling, and must also be properly certified, if the Station analysis is desired. A copy of these instructions and blank certificates will be sent on application.

#### ANALYSES OF FERTILIZERS.

During the year, four hundred and fifty-nine samples of commercial fertilizers and manurial waste-products have been analyzed. A classified list of them is given on page 21.

On a few of these samples, analyses were made for private parties and charged for accordingly. A few others were analyzed at the request of other experiment stations in order to compare and test analytical methods. Results of the examination of all the samples, with these exceptions, are given in detail in the following pages. When the contrary is not stated, the samples were drawn by an agent of the Station.

Samples are analyzed as promptly as possible in the order in which they are received. As soon as an analysis is completed a copy of it is sent to the party who furnished the sample, and also to the manufacturer, in order that there may be opportunity for correction or protest, before the results are published.

The following "Explanations" are intended to embody the principles and data upon which the valuation of fertilizers is based, a knowledge of which is essential to a correct understanding of the analyses that are given on subsequent pages.

#### EXPLANATIONS CONCERNING THE ANALYSIS OF FERTILIZERS AND THE VALUATION OF THEIR ACTIVE INGREDIENTS.\*

#### THE ELEMENTS OF FERTILIZERS.

The three chemical elements whose compounds chiefly give value, both commercial and agricultural, to fertilizers, are Nitrogen, Phosphorus, and Potassium. The other elements found in fertilizers, viz.: Sodium, Calcium, Magnesium, Iron, Silicon, Sulphur, Chlorine, Carbon, Hydrogen, and Oxygen, which are necessary or advantageous to the growth of vegetation, are either so abundant in the soil or may be so cheaply supplied to crops, that they do not considerably affect either the value or cost of high-priced commercial fertilizers.

NITROGEN in fertilizers is, on the whole, the least abundant of their valuable elements, and is, therefore, their most costly ingredient.

Free Nitrogen is universally abundant, making up nearly four-fifths of the common air, and appears to be directly assimilable by various low vegetable organisms, and with aid of certain bacteria, by leguminous plants (the clovers, alfalfa, peas, beans, lentils, esparsette, lupins, vetches, lathyrus, peanut, yellow locust, honey locust, etc.), and by a few non-leguminous plants, carrying root nodules, viz.: the Oleasters (Eleagnus), the Alders (Alnus), and a single family of coniferous trees (Podocarpus), but not at all, according to present evidence, by the cereals or other field and garden crops.

Organic Nitrogen is the nitrogen of animal and vegetable matters which is chemically united to carbon, hydrogen, and oxygen. Some forms of organic nitrogen, as those of blood, flesh, and seeds, are highly active as fertilizers; others, as found in leather and peat, are comparatively slow in their effect on vegetation, unless these matters are chemically disintegrated. Since organic nitrogen may often readily take the form of ammonia, it has been termed potential ammonia.

Ammonia (NH<sub>3</sub>) and Nitric Acid (N<sub>2</sub>O<sub>5</sub>) are results of the chemical change of organic nitrogen in the soil and manure heap, and contain nitrogen in its most active forms. They occur in commerce—the former in sulphate of ammonia, the latter in nitrate of soda: 17 parts of ammonia, or 66 parts of pure sulphate of ammonia, contain 14 parts of nitrogen: 85 parts of pure nitrate of soda also contain 14 parts of nitrogen.

PHOSPHORUS is, next to nitrogen, the most costly ingredient of fertilizers, wherein it exists in the form of phosphates, usually those of calcium, iron, and aluminum, or in case of "superphosphates," to some extent in the form of free phosphoric acid.

Water-soluble Phosphoric Acid is phosphoric acid (or a phosphate) that freely dissolves in water. It is the characteristic ingredient of super-

phosphates, in which it is produced by acting on "insoluble" (or "citrate soluble") phosphates, with diluted sulphuric acid. Once well incorporated with the soil, it gradually "reverts" and becomes insoluble, or very slightly soluble, in water.

Citrate-soluble Phosphoric Acid signifies the phosphoric acid (of various phosphates) that is freely taken up by a hot strong solution of neutral ammonium citrate, which solution is, therefore, used in analysis to determine its quantity. The designation citrate-soluble is synonymous with the less explicit terms reverted, reduced, and precipitated, which all imply phosphoric acid that was once easily soluble in water, but from chemical change has become insoluble in that liquid.

Recent investigation tends to show that water-soluble and citrate-soluble phosphoric acid are on the whole about equally valuable as plant food, and of nearly equal commercial value. In some cases, indeed, the water-soluble gives better results on crops; in others, the "reverted" is superior. In most instances there is probably little to choose between them.

Insoluble Phosphoric Acid implies various phosphates insoluble both in water and in hot solution of neutral ammonium citrate. The phosphoric acid of Canadian "Apatite," of South Carolina and Florida "Rock Phosphate," and of similar dense mineral phosphates, as well as that of "bone ash" and "bone black," is mostly insoluble in this sense, and in the majority of cases gives no visible good results when these substances, in the usual ground state, are applied to crops. They contain, however, a small proportion of citrate-soluble phosphoric acid, and sometimes, when they are reduced to extremely fine dust (floats) or applied in large quantities, especially on "sour soils" or in conjunction with abundance of decaying vegetable matter (humus), they operate as efficient fertilizers.

Available Phosphoric Acid is an expression properly employed in general to signify phosphoric acid in any form, or phosphates of any kind that serve to nourish vegetation. In the soil, phosphoric acid and all phosphates, whatever their solubilities, as defined in the foregoing paragraphs, are more or less freely and extensively available to growing plants. Great abundance of "insoluble" phosphoric acid may serve crops equally well with great solubility of a small supply, especially when the soil and the crop carry with them conditions highly favorable to the assimilation of plant food.

In Commercial Fertilizers, "available phosphoric acid" is frequently understood to be the sum total of the "water-soluble" and the "citrate-soluble," with the exclusion of the "insoluble."

The "insoluble phosphoric acid" in a commercial fertilizer costing \$20 to \$50 per ton, has very little or no value to the purchaser, because the quantity of it which can commonly go upon an acre of land has no perceptible effect upon the crop, and because its presence in the fertilizer excludes an equal percentage of more needful and much more valuable ingredients.

In Raw Bone the phosphoric acid (calcium phosphate) is nearly

<sup>\*</sup> Prepared and revised by the Director.

insoluble, because of the animal matter of the bones which envelopes it; but when the animal matter decays in the soil, or when it is disintegrated by boiling or steaming, the phosphate mostly remains in an available form. The phosphoric acid of "Basic-Slag" and of "Grand Cayman's Phosphate" is in some soils as freely taken up by crops as water-soluble phosphoric acid, but in other soils is much less available than the latter.

Phosphoric acid in all the Station analyses is reckoned as "anhydrous phosphoric acid," (P<sub>2</sub>O<sub>5</sub>), also termed among chemists phosphoric anhydride, phosphoric oxide, and phosphorus pentoxide.

Potassium is the constituent of fertilizers which ranks third in costliness. In plants, soils, and fertilizers, it exists in the form of various salts, such as chloride (muriate), sulphate, carbonate, nitrate, silicate, etc. Potassium itself is scarcely known except as a chemical curiosity.

Potash signifies the substance known in chemistry as potassium oxide (K<sub>2</sub>O), which is reckoned as the valuable fertilizing ingredient of "potashes" and "potash salts." In these it should be freely soluble in water and is most costly in the form of sulphate, and cheapest in the form of muriate (potassium chloride). In unleached ashes of wood and of cotton-seed hulls it exists mainly as potassium carbonate.

#### VALUATION OF FERTILIZERS.

The valuation of a fertilizer, as practised at this Station, consists in calculating the *retail Trade-value* or *cash-cost* (in raw material of good quality) of an amount of nitrogen, phosphoric acid, and potash equal to that contained in one ton of the fertilizer.

Plaster, lime, stable manure, and nearly all of the less expensive fertilizers have variable prices, which bear no close relation to their chemical composition, but guanos, superphosphates, and similar articles, for which \$20 to \$50 per ton are paid, depend for their trade-value exclusively on the substances, nitrogen, phosphoric acid, and potash, which are comparatively costly and steady in price. The trade-value per pound of these ingredients is reckoned from the current market prices of the standard articles which furnish them to commerce.

The consumer, in estimating the reasonable price to pay for high-grade fertilizers, should add to the *Trade-value of the above-named in-gredients* a suitable margin for the expenses of manufacture, etc., and for the convenience or other advantage incidental to their use.

#### TRADE-VALUE OF FERTILIZER ELEMENTS FOR 1899.\*

The average trade-values or retail costs in market, per pound, of the ordinarily occurring forms of nitrogen, phosphoric acid, and potash in raw materials and chemicals, as found in New England, New York and New Jersey markets during 1898 were as follows:

	Cents per poun	d.
Nitrogen in ammonia salts	15	1/2
organic nitrogen, in dry and fine-ground fish, meat, and blood, in mixed fertilizers		
in fine* bone and tankagein coarse* bone and tankage	IO	
toric acid. water-soluble	4	
of fine* ground fish, bone, and tankage	4	
of coarse* fish, bone, and tankage of cotton-seed meal, castor pomace, and ashe of mixed fertilizers, if insoluble in ammon	es 4	
citrate†	2	
Potash as high-grade sulphate and in forms free from muriate	(or 5	
chlorides)as muriate		1/4

The foregoing are, as nearly as can be estimated, the prices at which, during the six months preceding March last, the respective ingredients were retailed for cash, in our large markets, in those raw materials which are the regular source of supply. They also correspond to the average wholesale price for the six months ending March 1st, plus about 20 per cent. in case of goods for which we have wholesale quotations. The valuations obtained by use of the above figures will be found to correspond fairly with the average retail prices at the large markets, of standard raw materials, such as the following:

Sulphate of Ammonia,
Nitrate of Soda,
Dried Blood,
Azotin,
Ammonite.

Muriate of Potash, Sulphate of Potash, Plain Superphosphates, Dry Ground Fish, Bones and Tankage,

Ground South Carolina Rock.

\*In this report "fine," as applied to bone and tankage, signifies smaller than \$^{1}\_{50}\$ inch; and "coarse," larger than  $^{1}_{50}$  inch. From 1878 on for 10 years, we distinguished five grades of bone, as to fineness. In 1888, one, in 1897, two of the coarser grades were dropped from the list. The smaller grades remain unchanged in dimensions, but "coarse" was for the first 10 years larger than  $^{1}_{50}$  inch, for the next 9 years included all larger than  $^{1}_{12}$  inch, for the next year all larger than  $^{1}_{12}$  inch, and in this year all larger than  $^{1}_{50}$  inch; the former "coarsemedium," "medium," and "fine-medium" having been successively merged in "coarse."

This simply means that the three coarser grades that made up a large share of ground bone twenty years ago have gradually ceased to come into the market, there being no demand for them.

†Dissolved from 2 grams of the fertilizer, previously extracted with pure water, by 100 cc. neutral solution of ammonium citrate, sp. gr. 1.09, in thirty minutes, at 65° C., with agitation once in five minutes. Commonly called "reverted" or "backgone" Phosphoric Acid.

<sup>\*</sup>Adopted at a conference of representatives of the Connecticut, Massachusetts, New Jersey, and Rhode Island Stations held in March, 1899.

VALUATION OF SUPERPHOSPHATES, SPECIAL MANURES AND MIXED FERTILIZERS OF HIGH GRADE

The Organic Nitrogen in these classes of goods is reckoned at the price of nitrogen in raw materials of the best quality,\* 14 cents.

Insoluble Phosphoric Acid is reckoned at 2 cents per pound. Potash is rated at 4¼ cents, if sufficient chlorine is present in the fertilizer to combine with it to make muriate. If there is more Potash present than will combine with the chlorine, then this excess of Potash is reckoned at 5 cents per pound.

In most cases the valuation of the ingredients in superphosphates and specials falls below the retail price of these goods. The difference between the two figures represents the manufacturer's charges for converting raw materials into manufactured articles and selling them. The charges are for grinding and mixing, bagging or barreling, storage, and transportation, commission to agents and dealers, long credits, interest on investments, bad debts, and, finally, profits.

The majority of the manufacturers agree that the average cost of mixing, bagging, handling, and cartage ranges from \$3 to \$4.50 per ton.

In 1899 the average selling price of Ammoniated Superphosphates and Guanos was \$29.54 per ton, the average valuation was \$19.55, and the difference \$9.99, an advance of 51.1 per cent. on the valuation and on the wholesale cost of the fertilizing elements in the raw materials.

In case of special manures the average cost was \$32.64, the average valuation \$21.76, and the difference \$10.88 or 50.0 per cent. advance on the valuation.

To obtain the Valuation of a Fertilizer we multiply the pounds per ton of nitrogen, etc., by the trade-value per pound. We thus get the values per ton of the several ingredients, and adding them together we obtain the total valuation per ton.

In case of Ground Bone and Tankage, the sample is sifted into the two grades just specified (see footnote, page 17), and we separately

compute the nitrogen-value of each grade by multiplying the pounds of nitrogen per ton by the per cent. of each grade, multiplying one-tenth of that product by the trade-value per pound of nitrogen in that grade, and taking this final product as the result in cents. Summing up the separate values of each grade thus obtained, together with the values of each grade of phosphoric acid, similarly computed, the total is the Valuation of the sample of bone.

#### USES AND LIMITATIONS OF FERTILIZER VALUATION.

The uses of the "Valuation" are two-fold:

I. To show whether a given lot or brand of fertilizer is worth, as a commodity of trade, what it costs. If the selling price is not higher than the valuation, the purchaser may be tolerably sure that the price is reasonable. If the selling price is twenty to twenty-five per cent. higher than the valuation, it may still be a fair price; but in proportion as the cost per ton exceeds the valuation there is reason to doubt the economy of its purchase.

2. Comparisons of the valuation and selling prices of a number of similar fertilizers will generally indicate fairly which is the best for the money.

But the valuation is not to be too literally construed, for in some cases analysis cannot discriminate positively between the active and the inert forms of nitrogen, while the mechanical condition of a fertilizer is an item whose influence cannot always be rightly expressed or appreciated.

For the above first-named purpose of valuation, the trade-values of the fertilizing elements which are employed in the computations should be as exact as possible, and should be frequently corrected to follow the changes of the market.

For the second-named use of valuation frequent changes of the tradevalue are disadvantageous, because two fertilizers cannot be compared as to their relative money-worth when their valuations are deduced from different data.

Experience leads to the conclusion that the trade-values adopted at the beginning of the year should be adhered to as nearly as possible throughout the year, notice being taken of considerable changes in the market, in order that due allowance may be made therefor.

#### PERCENTAGE DIFFERENCE BETWEEN COST AND VALUATION.

Among the 109 brands of fertilizers classed in this Report as "Nitrogenous Superphosphates," whose analyses are tabulated on pages 48-61, Nos. 12454 and 12651 stand at the extremes of cost, the retail price of the former being \$45, and that of the latter \$16. The Station Valuation of the former is \$33.19, which is the highest of all these brands and the Station Valuation of the latter is \$10.35, which is the lowest with a single exception. It is easily reckoned that the cost of the first is less than three times that of the second and that the valuation of

<sup>\*</sup>This concession gives the dishonest manufacturer the opportunity to defraud the consumer very easily and very seriously, by "working off" inferior or almost worthless leather, bat guano, and similar materials which "analyze well," containing up to 8 or 9 per cent. of nitrogen, much or all of which may be quite inert. Since the Station has had no practicable means of determining with certainty the amount of worthless nitrogen or the quality of the nitrogen in a mixed fertilizer, and since honest and capable manufacturers generally claim to use only "materials of the best quality," it would be unjust to them to assume that these fertilizers contain anything inferior. Farmers should satisfy themselves that they are dealing only with honest and with intelligent manufacturers. This can be done at little cost by such co-operation as Farmers' Clubs and Granges may practice, sending a competent and trusty agent to visit factories frequently and unexpectedly and take samples of raw materials. Honorable manufacturers will be glad to show all their raw materials and processes to their customers, especially if such inspection is insisted on as a preliminary to business. Cooperation may thus insure satisfactory quality of goods, as well as reduced cost.

the first is more than three times that of the second, but to make a close comparison of these with each other and with the 107 other brands requires a somewhat different calculation.

We obtain a just basis for comparing any number of fertilizers by taking the valuation in each one as 100 and reckoning by "rule of three" the proportionate cost. This calculation is illustrated as follows, with the two fertilizers above noted and three others whose analyses are given in the same table on pages 48-61:

Station No.	Cost.	Valuation.		Difference of Cost and Valuation.	
12380	(\$20)	\$21.24:100	::	1.24:	5.8
12454	(45)	33.19:100	.:	11.81:	35.6
12651	(16)	10.35:100	::	5.62:	54.6
12374	(37)	24.01:100	::	12.29:	54.1
12577	(25)	10.19:100	::	14.81:	145.3

The last terms in the above statements are the percentage differences between cost and valuation.

The first fertilizer, No. 12380, differs from all the others in the Table of Analyses covering pages 48 to 61 inclusive, in the fact that the Valuation is greater than the Cost. Accordingly the percentage difference between cost and valuation is subtracted from 100 to give the cost (at average rates) of 100 cents worth, which is thus found to be 94 cents in round numbers.

In case of the other fertilizers, the cost is greater than the valuation. The cost of 100 cents worth is therefore found by *adding* the percentage difference to 100.

No. 12454 is the highest priced of all the 109 brands whose analyses are printed on pp. 48 to 61, and the percentage difference shows that one dollar's worth sold for \$1.35.

The two fertilizers, Nos. 12651 and 12374, though so unlike in selling price and valuation, closely agree in one respect, viz., that of them both one dollar's worth sold for \$1.54.

Finally, one dollar's worth of No. 12577 sold for \$2.45.

#### AGRICULTURAL VALUE OF FERTILIZERS.

The Agricultural Value of a fertilizer is measured by the benefits received from its use, and depends upon its fertilizing effect, or cropproducing power. As a broad, general rule, it is true that ground bone, superphosphates, fish scraps, dried blood, potash salts, etc., have a high agricultural value which is related to their trade-value, and to a degree determines the latter value. But the rule has many exceptions, and in particular instances the trade-value cannot always be expected to fix or even to indicate the agricultural value. Fertilizing effect depends largely upon soil, crop, and weather, and as these vary from place to place, and from year to year, it cannot be foretold or estimated except by the results of past experience, and then only in a general and probable manner.

# CLASSIFICATION OF FERTILIZERS ANALYZED.

RAW MATERIALS. No. of Sam	ples.
1. Containing Nitrogen as the Chief Valuable Ingredient.	
Nitrate of Soda	
Dried Blood	
Cotton Seed Meal 35	
Castor Pomace 7	
2. Containing Phosphoric Acid as the Chief Valuable Ingredient.	
Dissolved Bone Black	
Dissolved Bolic Black  Dissolved Rock Phosphate	
Dissolved Rock I Hospitale Valuable Ingredient	
3. Containing Potash as the Chief Valuable Ingredient.	
High Grade Sulphate of Potash	
Double Sulphate of Potash and Magnesia 3	
Muriate of Potash	
Kainit I	
4. Containing Nitrogen and Phosphoric Acid.	
Bone Manures 51	
Tankage 13	
Fish 12	
MIXED FERTILIZERS.	
Bone and Potash 6	
Nitrogenous Superphosphates121	
Special Manures	
Home Mixtures 8	
MISCELLANEOUS FERTILIZERS AND MANURES.	
Cotton Hull Ashes	
Unleached Canada Ashes	
Leached Ashes	
Total459	

#### DESCRIPTION AND ANALYSES OF FERTILIZERS.\*

The samples referred to in the following pages, unless the contrary is stated, were drawn by an agent of the Station.

# I. RAW MATERIALS CHIEFLY VALUABLE FOR NITROGEN. NITRATE OF SODA OR SODIUM NITRATE.

Nitrate Soda is mined in Chili and purified there before shipment. It contains about 16 per cent. of nitrogen, equiva-

<sup>\*</sup>This chapter has been prepared for publication by Dr. Jenkins. The analyses of fertilizers have all been made by Messrs. Winton, Ogden, and Mitchell, chemists of the Station, with the assistance of Mr. Lange.

lent to 97 per cent. of pure sodium nitrate. The usual guarantee is "96 per cent." of sodium nitrate, equivalent to 15.8 per cent. of nitrogen.

In rare cases cargoes have been found to contain sodium perchlorate, which, even in small amount, is very injurious to vegetation.

Eight analyses of nitrate of soda are given in a following table. The percentage of nitrogen ranges from 15.52, equivalent to 94.2 per cent. of nitrate,—to 16.00. All the samples are therefore of fair to good quality.

The price ranged from \$40 to \$45 per ton.

The cost of nitrogen in nitrate of soda has ranged from 12.6 to 14.5 cents per pound, the average cost being 13.9 cents, a fraction of a cent higher than in the previous year.

#### ANALYSES OF NITRATE OF SODA.

Station No.	Sold by	Sampled from Stock of	Nitrogen.	Equivalent Nitrate.	Cost per ton.	Nitrogen costs cents per pound.
12283	E. E. Burwell, New	E. E. Burwell, New				
	Haven		15.84	96.2	\$40.00	12.6
12305	Bowker Fertilizer Co., Boston, Mass	F. B. Northam, East	TE EO	04.0	42.00	TO 5
12366	Read Fertilizer Co.,	Adams & Canfield.				
	New York City	Winnipauk	16.00	97.1	45.00	14.1
12284	L. Sanderson, New Haven	L. Sanderson, New		-60		
12304	Rogers & Hubbard Co.,	A. E. Kilbourne, East	15.94	90.8	45.00	14.1
	Middletown	Hartford	15.60	94.7	45.00	14.4
12626	Williams & Clark Fer-	J. G. Schwink, Meri-				
	City	den	15.53	94.3	45.00	14.5
12303	Quinnipiac Co., Bos-	Olds & Whipple, Hart-				
	ton, Mass	ford	15.52	94.2	45.00	14.5
12174		Orange	T	010		
		Orange	15.52	94.2		

#### DRIED BLOOD.

This consists of slaughter-house blood which has been dried by superheated steam or hot air. It is a finely pulverized, nearly odorless substance, red or nearly black in color, and rich in nitrogen that is quickly available to vegetation. 12294. Dried Blood, sampled by Station agent from stock of E. E. Burwell, New Haven.

This sample contained 13.68 per cent. of nitrogen (equivalent to 16.6 per cent. of "ammonia"), and 0.32 per cent. of phosphoric acid. It cost \$37.00 per ton. The nitrogen cost 13.1 cents per pound.

#### COTTON SEED MEAL.

This material is of two kinds, which are known in trade respectively as undecorticated and decorticated. In their manufacture cotton seed is first ginned to remove most of the fiber, then passed through a "linter" to take off the short fiber or lint remaining, then through machines which break and separate the hulls. The hulled seed is ground and the oil expressed. The ground cake from the presses is used as a cattle food and fertilizer. The hulls are burned for fuel in the oil factory, and the ashes, which contain from 20 to 30 per cent. of potash, are also used as a fertilizer. In case of undecorticated meal, the hulls and the ground press-cake are mixed together.

The only samples received for analysis this year have represented clear, decorticated meal.

In the table, page 24, are given the percentages of nitrogen in thirty-two samples. The percentage of phosphoric acid in cotton seed meal ranges from 2.69 to 3.44, and that of potash from 1.64 to 2.00, the average being 3.15 and 1.90, respectively. The cost per pound of nitrogen is determined in each case by deducting from the ton price \$4.42—the valuation of the phosphoric acid and potash,—and dividing the remainder by the number of pounds of nitrogen in the ton of meal.

The average cost of cotton seed meal has been about \$22.80 per ton. The percentage of nitrogen has ranged from 6.72 to 7.63 and has averaged 7.14. The cost of nitrogen per pound has ranged from 11.9 to 14.6 cents, averaging 12.9 cents per pound, nearly a cent and a half per pound more than last year, but still the cheapest form of quickly available organic nitrogen in our market.

#### CASTOR POMACE.

This is the ground residue of castor beans from which castor oil has been extracted. The nitrogen which it contains is quickly available to plants, but the pomace is extremely poisonous to animals, which often eat it greedily when the opportunity offers

Dealer,	Sampled by	Per Cent. of Nitrogen.	Cost per ton.	Nitrogen cost cents per pound,
	W. H. Prout, Suffield	7.17	\$21.25	11.7
	Horatio J. Lathrop, Suffield	6.92	21.00	12.0
	Clark Brothers, Poquonock	7.27	22.00	12.1
wick, Mass	ohn B. Cannon, West Suffield	7.18	22.00	12.2
	Ernest N. Austin, Suffield	7.50	22.75	12.2
	G. A. Douglass, Thompsonville	7.45	22.75	12.3
	Lester, W	7.10	22.00	12.3
Ira B. Barnard, Tariffville	W. R. Holcomb, Tariffville	7.12	22.00	12.4
rd	W. R. Holcomb, Tariffville	7.49	23.00	12.4
	Ernest N. Austin, Suffield	7.36	22.75	12.5
Olds & Whipple, Hartford		7 45	23 00	. 12.5
E Perkins, Suffield	. B. Hatheway, Windsor Locks	6.83	21.50	12.5
W. W. Cooper, Suffield	5. S. Seymour, Windsor Locks	7.32	23.00	12.7
C. H. Dexter & Sons, Windsor Locks	ان	6.79	21.75	12.7
	A. E. Miskill, Broad Brook	7.30	23 00	12.7
Cruttenden, Kockville	Andrew Kingsbury, Coventry	7.14	22.50	12.7
	. b. Drew, Shelton	7.03	24.00	12.8
S. Cruttenaen, Kockville	Andrew Kingsbury, Coventry	66.9	22 50	12.9
	. b. Farker, Poquonock	7.20	23 00	12.9
		06.9	22.25	12.9
Mass	L. H. Brewer, Hockanum	717	23.00	13.0
Bowker Fermizer Co., Boston, Mass.	J. Dewey, Buckland	7.02	23.00	13.2
	. W. Lester, Hayden Station	7.16	23 50	13.3
Pouleur, Windsor	August Pouleur, Windsor	7.04	23.60	13.6
		7.07	23.60	13.6
	***************************************	7.04	23.60	13.6
	" " " " " " " " " " " " " " " " " " " "	6.97	23.60	13.8
	***************************************	6.98	23.60	13.8
	Station Agent	6.72	24.00	14.5
	John Leonard, Burnside	7.04	25.00	14.6
& Co., Boston, Mass	H. K. Brainard, Thompsonville	7.16*		
"	ii ii	1 1/4		

12611. Stock of Olds & Whipple, Hartford. Sampled by

W. E. Treat, Silver Lane. 12299. Stock of Olds & Whipple, Hartford. Sampled by

E. P. Brewer, Silver Lane. 12354. Stock of Bowker Fertilizer Co., Boston. Sampled

by L. H. Brewer, Hockanum. 12036. Oil Seeds Pressing Co., New York City. Sampled

by C. H. Eno, Simsbury.

12302. Stock of Bowker's Branch, Hartford. Sampled by

Station agent.

12301. Made by H. J. Baker & Bro., N. Y. City. Stock of Olds & Whipple, Hartford. Sampled by Station agent.

12488. Stock of Hartz Bros. Sampled by John Leonard, Burnside.

#### ANALYSES.

12611	12299	12354	12036	12302	12301	12488
Nitrogen 6.05	6.19	5.43	5.44	5.00	5.47	5.03
Phosphoric Acid	1.85	2.15	1.79	2.53	1.79	
Potash	1.02	1.10	1.06	1.18	0.86	
Cost per ton\$19.00	\$20.00	\$19.00	\$19.00	\$19.00	\$20.00	\$19.00
Nitrogen costs						
cents per pound* 13.5	14.1	14.9	15.1	15.8	16.2	16.3

The percentage of nitrogen in these samples has ranged from five to over six and nitrogen has cost from 13.5 to 16.3 cents per pound. It is the most expensive form of organic nitrogen in the market and is used only by certain tobacco growers who have the impression that its effect on the quality of wrapper leaf is superior to that of cotton seed. Five years careful tests and observation at the experiment field at Poquonock failed to show any such superiority.

<sup>\*</sup>Allowing four cents per pound for phosphoric acid and five cents for potash.

#### II. RAW MATERIALS OF HIGH GRADE CONTAINING PHOS-PHORIC ACID AS THE CHIEF VALUABLE INGREDIENT.

#### DISSOLVED BONE BLACK.

Bone black, made by subjecting bone to a red heat without access of air, is used in sugar refineries to decolorize sugar solutions. The waste bone black, dried and treated with oil of vitriol, makes a "superphosphate" of high grade which does not cake together on standing, but remains as a fine powder suitable for application to the land.

In the following table are given analyses of three samples of this material.

The cost of available phosphoric acid in dissolved bone black has ranged from 5.9 to 7.0 cents per pound.

This material is becoming very scarce in market, because much less bone black is used in sugar refineries, and at present prices dissolved bone black is not an economical fertilizer.

#### Analyses of Dissolved Bone Black and (AE)

12519 L 12288 L 12313 Q 12521 Q	. Sanderson, New Haven†  Sanderson, New Haven Quinnipiac Co., Boston	E. E. Burwell, New Haven  L. Sanderson, New Haven Olds & Whipple, Hartford Olds & Whipple, Hartford
12519 L 12288 L 12313 Q 12521 Q	E. E. Burwell, New Haven	L. Sanderson, New Haven Olds & Whipple, Hartford
12519 L 12288 L 12313 Q 12521 Q	E. E. Burwell, New Haven	L. Sanderson, New Haven Olds & Whipple, Hartford
12519 L 12288 L 12313 Q 12521 Q	. Sanderson, New Haven†  Sanderson, New Haven Quinnipiac Co., Boston	L. Sanderson, New Haven Olds & Whipple, Hartford
12288 L 12313 Q 12521 Q	4. Sanderson, New Haven Quinnipiac Co., Boston	L. Sanderson, New HavenOlds & Whipple, Hartford
12313 Q 12521 Q	Quinnipiac Co., Boston	Olds & Whipple, Hartford
12521 Q 12171 B	Quinnipiac Co., Boston+	Olds & Whipple, Hartford
	Dissolved Rock Phosphate.	De ha puritation of the profit
6- D	Berkshire Mills Co., Bridgeport	Berkshire Mills Co., Bridgepor by S. E. Curtis, Stratford
12207 D	Bowker Fertilizer Co., Boston,	
	Mass.	F. T. Bradley, Saybrook
	M. E. Wheeler, Rutland, Vt.*	W. H. Baldwin, Cheshire
12312 W	Williams & Clark Fertilizer Co., N. Y. City	J. G. Schwink, Meriden
12412 L	. Sanderson, New Haven	Theodore Fowler, North Guilford
	Read Fertilizer Co., New York	
	City	Adams & Canfield, Winnipauk
12311 B	Bowker Fertilizer Co., Boston,	D D M II D III
12176	Mass.	F. B. Northam, East Hampton S. D. Woodruff & Sons, Orange

<sup>\*&</sup>quot; Electrical Dissolved Bone." † Sampled by W. H. Brewer, Silver Lane.

#### DISSOLVED ROCK PHOSPHATE OR ACID ROCK.

This material, made by treating various mineral phosphates with oil of vitriol, is the most common source of the phosphoric acid of factory-mixed fertilizers.

In the following table are given eight analyses of dissolved rock phosphate. The composition of the samples is by no means uniform.

The cost of available phosphoric acid ranges from 3.7 to 6.1 cents per pound, the average of seven samples being 4.6 cents.

12624. "Electrical Dissolved Bone," sold by M. E. Wheeler & Co., is simply dissolved mineral phosphate.

#### OF DISSOLVED ROCK PHOSPHATE.

	Рноѕрн	ORIC ACID.		Cost per ton,	"Available Phosphoric	
Soluble.	Reverted.	Insoluble.	Total.	Cost per ton.	Acid costs cents per, pound.	
TT 0.						
11.84	4.74	0.83	17.41	\$20.00	5.9 6.3	
16.21	3.05	0.24	18.49	23.00	0.3	
16.78	0.22	0.08	16. <b>6</b> 1 17.16	24.00	6.7 7.0	
17.02	0.08	0.00	17.10	24.00	7.0	
12.58	2.77	0.50	15.85	11.50	3.7	
9.76	3.70	1.38	14.84	12.00		
5.00	10.52	1.30	16.56	15.00	3.9 4.7	
9.65	5.28	1.18	16.11	13.00	4.2	
6.74	8.59	2.00	17.33	15.00	4.6	
4.80	8.09	2.77	15.66	15.00	5.4	
9.12	3.51	1.22	13.85	16.00	6.1	
12.42	2.80	0.50	15.72			

#### RAW MATERIALS OF HIGH GRADE CONTAINING POTASH.

#### HIGH GRADE SULPHATE OF POTASH.

This chemical should contain over 90 per cent. of pure potassium sulphate (sulphate of potash) or about fifty per cent. of potassium oxide, the same quantity as is supplied by muriate, and should be nearly free from chlorine.

A single sample sent by a manufacturer was found to contain 8.67 per cent. of chlorine, which explained the considerable percentages of chlorine found in a tobacco fertilizer of which this potash salt was one of the ingredients.

Another firm made up a small lot of fertilizer which was brought into the State and guaranteed free from chlorine. Analysis, however, showed the presence of a considerable amount.

The manufacturer states that a lot of fifty tons of potash salts, bought for high grade sulphate and billed as such, contained over forty per cent. of chlorine.

In the table, on pages 30 and 31 are given two analyses of high grade sulphate, both of fair quality.

#### DOUBLE SULPHATE OF POTASH AND MAGNESIA.

This material is usually sold as "sulphate of potash" or "manure salt," on a guarantee of "48-50 per cent. sulphate," which is equivalent to 25.9-27.0 per cent. of potassium oxide. Besides some 46-50 per cent. of potassium sulphate, it contains over 30 per cent. of magnesium sulphate, chlorine equivalent to 3 per cent. of common salt, a little sodium and calcium sulphates, with varying quantities of moisture.

The three analyses given in the table on pages 30 and 31 show the usual percentage of potash, and from 1.88 to 2.45 per cent. of chlorine.

#### MURIATE OF POTASH.

Commercial muriate of potash contains about 80 per cent. of muriate of potash (potassium chloride), 15 per cent. or more of common salt (sodium chloride), and 4 per cent. or more of water.

It is generally retailed on a guarantee of 80 per cent. muriate. which is equivalent to 50.5 per cent. of potassium oxide.

The percentages of potash in the eight samples whose analvses appear in the tables, pages 30 and 31, range from 52.80 to

45.56, and average 50.83 per cent.

12615 was sent for analysis by C. J. Dewey, who stated that it was sold as muriate of potash and drawn with special care from stock of the Bowker Branch, Hartford. It contained 23.28 per cent. of potash, and as it contained much magnesia and sulphuric acid is evidently not muriate but probably double sulphate of potash and magnesia of poor quality. The price quoted was \$40 per ton.

#### KAINIT.

Kainit is less uniform in composition than the other potash salts. It contains from 11 to 15 per cent. of potash, more than that quantity of soda, and rather less magnesia. These "bases" are combined with chlorine and sulphuric acid. Unless "calcined" it contains more water than occurs in sulphate or in muriate of potash. It is usually sold on a guarantee of 12 to 15 per cent. of potash, or 23 to 25 per cent. "sulphate of potash." It is not properly called, or claimed to be, a sulphate of potash, since it contains more than enough chlorine to combine with all the potash present, and there are sound reasons for believing that its potash exists chiefly as muriate and to a much less extent as sulphate. Its action and effects are unquestionably those of a muriate rather than of a sulphate.

A single analysis of kainit appears in the table, pages 30 and 31.

In 1899, the cost of potash in the samples of high grade sulphate of potash analyzed at this Station was about 5 cents per pound.

The cost of potash in the "low grade" or double sulphate of potash and magnesia ranged from 5.2 to 5.9 cents per pound, slightly higher than in the high grade sulphate.

In seven samples of muriate of potash, the cost per pound of potash ranged from 3.8 to 4.9 cents per pound, and averaged 4.2 cents, this being the cheapest source of water-soluble potash in the market.

The cost of potash in the sample of kainit was 5.1 cents per pound.

#### ANALYSES OF (A)

		0.000 5.00%
Station No.	Sold by	Sampled from Stock of
	High Grade Sulphate of Potash.	
12359	H. J. Baker & Bro., New York	Ernest N. Austin, Suffield
12310	City	F. B. Northam, East Hampton
	Double Sulphate of Potash and Magnesia.	
12620	E. E. Burwell, New HavenL. Sanderson, New Haven	L. Sanderson, New Haven
12309	Quinnipiac Co., by Olds & Whip- ple, Hartford	Olds & Whipple, Hartford
	Muriate of Potash.	
al in		Berkshire Mills Co., by S. E. Curtis, Stratford
12300	Williams & Clark Fertilizer Co. N. Y. City	J. G. Schwink, Meriden
12285	L. Sanderson, New Haven E. E. Burwell, New Haven	L. Sanderson, New Haven
2308	Bowker Fertilizer Co., Boston,	F. B. Northam, East Hampton
2307	Quinnipiac Co., by Olds & Whip-	
2365	ple, Hartford	Olds & Whipple, Hartford
	City	Adams & Canfield, Winnipauk
2175		S. D. Woodruff & Sons, Orange
	Kainit.	
2553	Williams & Clark Fertilizer Co. New York City	J. G. Schwink, Meriden

#### POTASH SALTS.

Chlorine.	Per cent. of Potash.	Equivalent Sulphate of Potash.	Equivalent Muriate of Potash.	Cost per ton.	Potash costs cents per pound.
			•		
trace	49.30	91.2		\$48.00	4.9
1.66	50.00	92.5		51.00	5.1
		Ser establish			
1.88	27.09	50.1		28.00	5.2
2.30	27.06	50.0		28.00	5.2
2.45	27.13	50.2		32.00	5.9
					•
Not					
determin'd	52.26		82.8	40.00	3.8
	51.59		81.7	40.00	3.9
"	52.80		83.6	42.50	4.0
	49.29		78.1	41.00	4.2
"	51.79	3	82.0	44.00	4.2
"	51.73		81.9	45.00	4.3
"	45.56		72.2	45.00	4.9
44	51.65		81.8	43	1.7
				-	
**	12.78		20.3	13.00	5.1
	-2.70	1177	20.3	13.00	3.1

# IV. RAW MATERIALS CONTAINING NITROGEN AND PHOS-PHORIC ACID.

#### BONE MANURES.

The terms "Bone Dust," "Ground Bone," "Bone Meal," and "Bone" applied to fertilizers, sometimes signify material made from dry, clean, and pure bones; in other cases these terms refer to the result of crushing fresh or moist bones which have been thrown out either raw or after cooking, with more or less meat, tendon, and grease, and—if taken from garbage or ash heaps—with ashes or soil adhering; again they denote mixtures of bone, blood, meat, and other slaughter-house refuse which have been cooked in steam tanks to recover grease, and are then dried and sometimes sold as "tankage"; or finally, they apply to bone from which a large share of the nitrogenous substance has been extracted in the glue manufacture. When they are in the same state of mechanical subdivision the nitrogen of all these varieties of bone probably has about the same fertilizing value.

The method adopted for the valuation of bone manures, which takes account of their mechanical condition as well as chemical composition, is explained on page 18.

#### 1. Bone Manures Sampled by Station Agents.

In the table, pages 34 and 35, are given thirty-one analyses of samples of this class.

The price printed in full-face type in the column showing cost per ton is the one used in calculating the percentage difference between cost and valuation.

The average cost of these bone manures is \$29.84 per ton; the average valuation \$22.36; showing that the Station valuation has been lower than is justified by the average selling price of ground raw bone in Connecticut. It must however be remembered that boiled and steamed bone, quite finely ground, are put on our Connecticut market by large manufacturing establishments at prices much lower than can be quoted by our small local manufacturers for ground raw bone.

#### Analyses requiring special mention.

The analysis of Hubbard's Strictly Pure Fine Bone, 12414, page 35, was unsatisfactory to the manufacturers in that the percentage of phosphoric acid found, 20.74, was stated by them to be lower than had ever before been found during the last twenty years.

Further samples were accordingly drawn and analyzed with the results given in analysis 12810, page 35, which shows 22.23

per cent. of phosphoric acid.

The analysis of Bone made by the Rogers Manufacturing Co., 12418, page 35, was made on a sample of a small lot of two tons and is stated by the manufacturers to unfairly represent the general quality of the regular brands made by them.

#### Bone Manures. Sampled by (

-		
Station No.	Name or Brand,	Manufacturer.
12619 12893 12618	Pure Bone Meal	L. T. Frisbee Co., Hartford Rogers Mfg. Co., Rockfall Berkshire Mills, Bridgeport
12561	Pure Flour Bone	M. E. Wheeler, Rutland, Vt.
12290 12371	Ground Bone	L. Sanderson, New Haven
12563	Fine Ground Bone	L. B. Darling, Pawtucket, R. I
12415 12421 12810	Ground Bone Bone Meal Hubbard's Strictly Pure Fine Bone* Hubbard's Raw Knuckle Bone	Downs & Griffin, Derby M. L. Shoemaker & Co., Phila Rogers & Hubbard Co., Middle-town
12416	Hubbard's Raw Knuckle Bone Flour	Rogers & Hubbard Co., Middle-
12418	Bone* Bone Meal	Rogers Mfg, Co., RockfallQuinnipiac Co., Boston, Mass
12558 12557	Uncas Bone Meal Pure Fine Ground Steamed Bone Meal	
12564	Ground Bone Extra Fine Ground Bone	Bowker Fertilizer Co., BostonCumberland Bone Phosphate Co.
	Bone Dust	P. Cooper's Glue Factory, N. Y. C.
	Cyclone Bone Meal	Buffalo, N. V.
12554	Ground BoneFine Ground Bone	East India Chem. Works, N. Y. C
12617	Hubbard's Strictly Pure Fine Bone*	Robert Manock, Rockville
12368	Pure Ground Bone	Lederer & Co., New Haven

#### STATION AGENT. ANALYSES.

	orice	on.	and	Cher	nical lysis.	Mech Ana	anical lysis.
Dealer.	Dealers' cash price per ton.	Valuation per ton	Percentage difference between cost and valuation.	Nitrogen,	Phosphoric Acid.	Finer than 1-50 inch.	Coarser than 1-50 inch.
City Coal&Wood Co., N. Brit'n	\$26.00	\$25.50	1.9	3.50	23.43	75	25
Manufacturer	32.00 28.00	28.97 24.81	10.5	3.82	26.04	81 67	19
- F Llinman (,())[[[[]]]	30.00	****		****			100
	30.00	26.31	14.0	2.30	29.82	71	29
F Strong (Olchestel	27.00	23.30	15.9	2.68	26.23	59	41
	29.00	24.53	18.2	2.17	28.29	68	32
H. A. Bugbee, Willimantic	30.00	****		2772	****	**	**:
D. Beaslee, Ellington	29.00	2.00.0	****	****	****		
Manufacturer	28.00	23.35	19.9	3-35	25.10	52	48
Manufacturer	28.00	22.97	21.9	3.95	23.10	47	53
N Ray Greenwich	28.80					14.4	35
W. W. Cooper, Suffield F. S. Bidwell, Windsor Locks	30.00	24.49	22.5	2.78	25.36	71	29
F. S. Bidwell, Windsor Locks	28.00			1000		20	
J. B. Parker, Jr., Poquonock	26.00		E	1222	****	**	
Manufacturer	30.00	23.61	27.I	2.28	27.66	62	38
Gault Bros., Westport	36.00	27.85	29.3	5.51	23.92	52	48
Strong & Tanner, E. Winsted W. O. Goodsell, Bristol	31.00	00.00		4.00			20
W. C. Bulkley, Forestville	30.00	23.13	29.7	4.08	22.23	50	50
H. W. Andrews, Wallingford	32.00 33.00	25.97	30.9	3.76	25.39	63	37
ar in second, waning lord	34.00			****			
D. W. Spencer, Centerbrook	32.00	24.45	30.9	1.92	25.93	86	14
C. Buckingham, Southport G. W. Williams Co., New London	28.00	21.13	32.5	2.89	22.16	58	42
C. Buckingham, Southport	32.00	T 9 70	20.5		2222	ć-	**
	25.00	18.73	33.5	2.42	19.73	61	39
Olds & Whipple, Hartford	30.00	21.65	38.6	1.14	29.81	58	42
B. Northam, E. Hampton	26,00	18.61	39.7	2.54	23.33	37	63
Kahn Brothers. Yantic	27.00	19.19	40.7	2.68	19.77	59	41
	30.00	21.01	42.8	1.35	31.92	40	60
Charles H. Davis, Guilford	30.00	21.00	42.9	2.79	22.00	60	40
Manufacturer Sault Brothers, Westport Saxton & Strong Bristol	*****	22.35	43.1	3.63	22.93	49	51
Saxton & Strong, Bristol O. Jelliff & Co. Southpart	32.00		.6.				-
C. O. Jelliff & Co., Southport	35.00	23.91	46.4 46.8	3.79	23.44	56	44
annoin, New		20.44	40.0	2.94	21.22	56	44
H. W. Andrews, Wallingford	32.00	00.40	47.0	470	20 7		**
	29.00	20.40	47.0	4.14	20.74	33	67
Manufacturer W. H. Scott &	30.00	16.99	47 T	2.05	T8 07	T.4	86
P. I Ball & Co., Peguabuck	28.00	18.46	47.I 51.7	3.95 4.18	18.97	14 12	88
	28.00	10.40	32.7	4.10	21.00	12	00
Cadwell & Jones, Hartford F. S. Atwater, Plantsville	32.00	21.03	52.2	3.14	23.90	43	57
T. B. Atwater, Plantsville E. A. Platt, New Haven	32.00	20.81	53.8	2.86	21.77	58	42
F. S. Platt, New Haven E. A. Buck, Willimantic	35.00	20.93	67.3	2.65	24.29	50	50
THIIIIantic	30.00	17.45	71.9	4.17	20.47	8	92

† Purchaser, not a dealer.

#### Bone Manures. Sampled by ( )

Station No.	Name or Brand.	Manufacturer.
	Sampled by Manufacturers.	
12173 12807 14021		Robert Manock, Rockville William McCormack, Wolcott William McCormack, Wolcott
	Sampled by Purchasers.	
12280	Ground Bone	Preston Fertilizer Co., Brooklyn,
12282	Bone Meal	Milsom Rendering and Fertilizer Co., Buffalo, N. Y
12118	Screenings from bone used in tempering steel	
12612	Ground Bone	Hartford Fertilizer Co., Hartford-
	Western Ground Bone	
	Eastern Ground Bone	Geo. F. Taylor & Co., N. Y. City-

#### 2. Bone Manures Sampled by Manufacturers and by Purchasers.

In the table just above are given analyses of seven samples of bone, which were sent by purchasers, and of two samples deposited by manufacturers representing brands which were not found in market by our sampling agent.

The Station is responsible for the correct subdivision and analysis of the small samples placed in its possession, but not for the accuracy with which those samples represent the several articles specified,—though it requires that a certificate be filed by the person drawing the sample, stating that it has been fairly drawn according to the printed directions furnished by the Station.

The valuation of 12807, Mad River Bone, made by Wm. McCormack, was so low that the manufacturer asked to have a second sample analyzed, which was accordingly done. The second sample, 14021, was like the first in mechanical condition, but contained smaller percentages of both nitrogen and phosphoric acid.

Sample 12118 represents screenings from bone prepared for

#### MANUFACTURERS AND PURCHASERS.

	price	ton.	difference cost and	Chemical Analysis.		Mechanical Analysis.	
Sampled by	Dealer's cash price per ton.	Valuation per ton.	Percentage diff between co- valuation.	Nitrogen.	Phosphoric Acid.	Finer than r-50 inch.	Coarser than
Manufacturer	\$25.00 28.00 28.00	\$23.45 18.51 16.20	6.6 51.3 72.8	4.39 3.98 3.59	20.81 20.41 17.20	2 2I 22	98 79 78
O. G. Beard, Shelton	25.00	20.77	20.4	3.15	24.92	36	64
G. W. Barnes, Poquonock.	28.00	21.37	31.0	3.18	20.72	62	38
Charles H. Wells, Suffield		16.04		2.92	16.75	39	61
C. J. Dewey, Buckland				2.81	26.35		1
A. E. Plant, Branford		26.74		3.29	25.98	75	25
A. E. Plant, Branford A. E. Plant, Branford		23.63		2.43 3.77	28.57	55	45

use in tempering steel. It was a small lot bought for "from ten to twelve dollars" per ton.

On the Quantity of Fat in Several Brands of Bone Manures.

Determinations of fat have been made by Mr. Langley in a number of samples of bone manures, whose analyses are given in the table on pages 34-35, with the following results:

	1	Percentage
Station No.	Brand.	of Fat.
12371	Plumb & Winton's Bone Fertilizer	-10.96
12414	Hubbard's Strictly Pure Fine Bone	- 9.34
12419	Rogers Mfg. Co.'s Pure Ground Bone	- 9.24
12424	Peck Bros. Pure Ground Bone	- 3.82
12559	Shay's Pure Bone Flour	- 3.62
12617	Manock's Ground Bone	- 3.44
12555	Dennis' Pure Ground Bone	
12421	Shoemaker's Bone Meal	
12315	Bowker's Ground Bone	- 1.46
12619	Frisbee's Pure Bone Meal	- I.37
12893	Rogers Mfg. Co.'s Raw Bone Flour	- 0.73
12415	Downs & Griffins Ground Bone	
12418	Rogers Mfg. Co.'s Bone	- 0.46
12416	Hubbard's Raw Knuckle Bone Flour	- 0.42
12368	Lederer & Co.'s Ground Bone	- 0.31

The three samples which contain over nine per cent. of fat probably represent butchers' bone with considerable adhering grease which has not been separated by boiling or steaming.

Of the four samples containing between three and four per cent. of fat, one at least is claimed by the manufacturer to be raw (untreated) bone.

Of those bones which have between one and two per cent. of fat, two samples at least have been subjected to treatment. Shoemaker's bone is treated by benzine, and Frisbee's is boiled or steamed to remove grease.

Of the five samples which contain less than one per cent. of fat, most have probably been steamed or boiled, but Hubbard's Raw Knuckle Bone Flour is claimed to be the refuse, trimmings and dust from selected hard raw bone used in the manufacture of articles of bone.

The quantity of grease in a raw bone, as these figures show, depends in the first place on the nature of the bone. The hard firm thigh and shin bones, from which the marrow has been

#### GROUND TANKAGE ( )

Station No.	Name or Brand.	Manufacturer or Dealer.
	Sampled by Station Agent.	Carlos sus su sucre
12560		Williams & Clark Fertilizer Co., N. Y. City
12316	Tankage	Bowker Fertilizer Co., Boston, Mass.
12293	Blood, Bone and Meat	L. Sanderson, New Haven
	Sampled by Purchasers.	
12268	Tankage	Berkshire Mills Co., Bridgeport-Bowker Fertilizer Co., BostonL. Sanderson, New Haven
12520 12522 12177		Quinnipiac Co., Boston, Mass L. Sanderson, New Haven

removed, may contain as little grease as much of the steamed or boiled butchers' bone. Softer bones, less carefully selected, with some adhering tissue, contain much more fat and raw, wet butchers' bone as it is collected from the market may contain, as appears on page 41 of the Report of this Station for 1898, over twenty per cent.

#### TANKAGE.

After boiling or steaming meat scrap, bone, and other slaughter-house waste, fat rises to the surface and is removed, the soup is run off, and the settlings are dried and sold as tankage. As analyses show, tankage has a very variable composition. In general, it contains more nitrogen and less phosphoric acid than bone.

In the table below, are given eleven analyses of this material, five drawn by a Station agent and six by purchasers.

These analyses show the usual differences in chemical composition.

#### ANALYSES AND VALUATIONS.

	n price	ton.	difference cost and	Chen Anal		Mechanical Analysis.	
Sampled from Stock of	Dealer's cash pr per ton.		Percentage di- between co valuation,	Nitrogen.	Phosphoric Acid.	Smaller than 1-50 inch.	Larger than
G. Schwink, Meriden	\$22.00	\$24.75	11.1*	7.43	8.56	69	31
F. B. Northam, East Hamp-		(-	6.4	0	-0		-0
. Sanderson, New Haven	24.00	25.63	6.4*	5.58	18.05	62	38
- Sanderson New Harron	30.00	24.99 24.26		6.33	13.69	65 66	35
E. E. Burwell, New Haven	29.00	24.20	23.7	10.65	2.46		34
		31.8					
S. E. Curtis, Stratford	21.00	23.37	10.1*	6.38	12.91	53	47
heodore Family	23.00	24.65	6.7*	7.82	9.30	53	47
Guilford North	28.00	25.43	IO.I	6.70	13.11	64	36
W. H. Brewer, Silver Lane W. H. Brewer, Silver Lane	28.00	24.96	12.2	5.58	17.37	60	40
W. H. Brewer, Silver Lane B. D. Woodruff & Sons, Orange	28.00	24.48	14.4	5.32	16.78	65	35
range		24.39		7.60	12.46	38	62

<sup>\*</sup> Valuation exceeds cost.

No. 12291, though tabulated with the samples of tankage, is, as the analysis indicates, largely composed of dried bloo or meat with little bone.

#### DRY GROUND FISH.

This residue from the manufacture of fish oil is men sprinkled with diluted oil of vitriol, to check putrefacion, whereby the fish bones are softened and to some extent dissolved.

Eleven analyses of this article are given in the following table. With a single exception the percentage of nitrogen is well above the guarantee. In all but three cases the valuation exceeds cost; which indicates that dry fish has been, during the last season, a cheap source of available nitrogen and phosphoric acid.

#### DRY GROUND FISH. ANALYSES (

Manufacturer or Wholesale Dealer.	Sampled from Stock of	esto necibilidadida
Wilcox Fertilizer Works, Mystic I Sanderson New Haven	Wholesale Dealer	\$28.00
		30.00
		Jido
		28.00
Williams & Clark Fertilizer Co.,		3010
	Daniels Mills Co., Hartford	T.00
	F. A. Beckwith, Niantic	28.00
Wilcox Fertilizer Works, Mystic	C. M. Smith, East Hartford.	1100
	ville	700
		3000
Bowlet I dimiser out, Boston-1	Soundi o Branon, Frantion	March
		2,00
		1200
	Wilcox Fertilizer Works, Mystic L. Sanderson, New Haven Russia Cement Co., Gloucester, Mass. W. E. Brightman, Tiverton, R. I. Geo. W. Miles, Agent, Milford Williams & Clark Fertilizer Co., New York L. Sanderson, successor to Luce Bros Wilcox Fertilizer Works, Mystic  Bowker Fertilizer Co., Boston  Bradley Fertilizer Co., Boston	Wilcox Fertilizer Works, Mystic L. Sanderson, New Haven Russia Cement Co., Gloucester, Mass

#### MIXED FERTILIZERS.

BONE AND POTASH.

Six samples of this material have been analyzed with the results given in the following table, page 42.

12813, made by the Milsom Co., and 12656, made by Lister's Agricultural Chemical Works, branded as bone and potash, are mixtures of dissolved phosphate and potash salts, but are not "bone and potash," in the usual proper acceptation of the term, and are therefore misbranded articles.

Samples 12375 and 12808 are the only ones which are not superphosphates, and appear to be mixtures of bone dust and potash salts. The phosphoric acid in 12375 is therefore valued as in bone.

12452. Dissolved Bone and Potash, made by the Darling Fertilizer Co., Pawtucket, R. I. Sampled from stock of J. S. Warner, Glastonbury, and Hotchkiss & Templeton, Waterbury.

#### AND VALUATIONS.

2	ence id	Nitrogen.					PHOSPHORIC ACID.						
Valuation per Ton.	Differations of the contract o		Or-	Total N	itrogen.				Tota	al.	Availa	ble.	
	Percentage Difference between Cost and Valuation.	Nitrogen as Ammonia.	Nitrogen. C	Found.	Guaran- teed.	Soluble.	Reverted.	Insoluble,	Found.	Guaran- teed.	Found.	Guaran- teed,	
\$30.65 32.77 32.71	Valuation exceeds cost. 8.6 8.4	0.12	8.96 8.48 8.27	9.08 9.38 8.27	7.4 8.0	0.78 1.01 0.64		2.27 1.13 4·37	7.54 8.35 14.03	9.0 II.0	5.27 7.22 9.66		
29.72 29.65	5.8 5.6	0.44	8.09 8.01	8.53 8.66	7.4 6.6	0.90		I.3I 0.70	7·73 6·75	7.0	6.42	8.0	
28.27	4.5	0.38	8.02	8.40	7.4	0.74	4.43	1.15	6.32	7.0	5.17		
28.88 30.56	3.0 1.8	1.88	6.12 9.02	8.00 9.02	8.2 8.5		6.18 4.80		7.95 7.49	6.0	7.09 5.57	4.0	
			2555			272							
30.09	O.3 Cost exceeds valua- tion.	0.67	8.15	8.82	8.0	0.64	5.35	1.01	7.00	6.0	5.99		
28.87	0.5	0.31	8.05	8.36	7.4	0.67	5.06	1.87	7.60	7.0	5.73		
27.56	16.1	0.34	7.89	8.23	7.4	0.56	4.36	1.14	6.06	7.0	4.92		

12625. Circle Brand Bone and Potash, made by Bradley Fertilizer Co., Boston. Sampled from stock of C. L. Comstock, Danbury.

12375. Square Brand Bone and Potash, made by Bowker Fertilizer Co., Boston. Sampled from stock of H. B. Sherwood, Southport, E. W. S. Pickett, Fairfield, and Hubbell & Bradley, Saugatuck.

12813. Bone and Dissolved Potash, made by the Milsom Fertilizer Co., East Buffalo, N. Y. Sampled from stock of C. H. Davis, Guilford.

12656. Animal Bone and Potash, made by Lister Agricultural Chemical Works, Newark, N. J. Sampled from stock of J. E. Leonard & Son, Jewett City.

12808. Bone and Potash, made by the E. F. Coe Fertilizer Co., N. Y. City. Sampled by the manufacturer.

#### Analyses and Valuations of Bone and Potash.

	12452	12625	12375	12813	12656	12808
Nitrogen as ammonia	0.24	0.10				
Nitrogen, organic		2.47	1.80		4-	3.03
Nitrogen, total		2.57	1.80			3.03
Nitrogen, guaranteed	1.50	1.85	1.50			
Phosphoric acid, soluble		1.91		6.01	5.00	
Phosphoric acid, reverted.	9.69	8.30		4.41	3.98	
Phosphoric acid, insoluble	0.28	5.80		0.51	1.91	
Phosphoric acid, total Phosphoric acid guaran-	15.19	16.01	11.09	10.93	10.89	19.84
teed	13.00	10.00	12.00	11.00	10.00	
Available phosphoric acid found	14.91	10.21	6.00	10.42	8.98 -	
				9.00	9.00	1177
Potash as muriate	7.67	2.32	2.21	1.34	4.90	0.89
Potash as sulphate						1.88
Potash, total	7.67	2.32	2.21	1.34	4.90	2.77
Potash, guaranteed	7.00	2.00	2.00	1.65	5.00	
Cost, per ton		30.00	25.00	18.00	23.00	27.00
Valuation, per ton	\$24.76	19.87	13.97	10.28	12.61	22.96
Percentage difference be- tween cost and valuation	37.3	51.0	79.0	75.1	82.4	
con cost and variation	31.3	51.0	79.0	75.I	82.4	

## NITROGENOUS SUPERPHOSPHATES AND GUANOS.

Here are included those mixed fertilizers containing nitrogen, phosphoric acid, and in most cases, potash, which are not designed by their manufacturers for use on any special crop. "Special Manures" are noticed further on.

#### 1. Samples drawn by Station Agents.

In the tables on pages 48 to 61 are given analyses of 117 samples belonging to this class, arranged according to the percentage differences between their cost prices and valuations.

#### GUARANTEES.

Of the one hundred and seventeen analyses of nitrogenous superphosphates given in the tables, eighteen are below the manufacturer's minimum guarantee in respect of one ingredient and ten in respect of two ingredients. Nearly one-fourth of the whole number therefore failed in some respect to come up to the claims of the manufacturer.

It should be said, however, that a deficiency of one ingredient is sometimes attended with a marked excess of another, indicating that failure to correspond with the guarantee has been caused by incomplete mixing of the materials, of which the superphosphate is made up.

#### COST AND VALUATION.

#### Cost.

The method used to ascertain the retail cost price of the superphosphates is as follows:

The sampling agents inquire and note the price at the time each sample is drawn. The analysis, when done, is reported to each dealer from whom a sample was taken, with an enclosed postal card addressed to the Station, and a request to note on it whether the retail cash price is correctly given and to mail to the Station.

From the data thus obtained the average prices are computed.

#### Valuation.

The valuation has been computed in all cases in the usual manner as explained on page 18.

Percentage difference given in the table shows the percentage excess of the cost price over the average retail cost of the nitrogen, phosphoric acid, and potash contained in the fertilizer.

This information enables the purchaser to estimate the comparative value of different brands and to determine whether it is better economy to buy the commercial mixed fertilizers of which so many are now offered for sale, or to purchase and mix for himself the raw materials.

Which plan is preferable can only be determined by each individual farmer, who should know best what his soil and crops need and what his facilities for purchase and payment are.

In case a fertilizer has sold at two or more different prices, the *manufacturer's price*, when known, has been used in calculating percentage difference.

Otherwise an average, or nearly average price, forms the basis of comparison between cost and valuation. The price thus employed is printed in heavy-faced type.

The average cost of the nitrogenous superphosphates is \$29.54. The average valuation is \$19.55 and the percentage difference 51.1.

Last year the corresponding figures were:

Average cost \$29.22, average valuation \$19.30, percentage difference 51.4.

These valuations, it must be remembered, are based on the assumption that the nitrogen, phosphoric acid, and potash in each fertilizer are of good quality and readily available to farm crops. Chemical examination shows conclusively whether this is true in respect of potash and phosphoric acid, but gives little or no clue as to the availability of the organic nitrogen of mixed goods. This Station has been for some years, and is still, engaged in a study of methods for determining approximately the relative availability of nitrogen.

Since various inferior or agriculturally worthless forms of nitrogen are in the market and are known to be used in compounding fertilizers, and cannot as yet be detected with certainty by analysis, the only security of purchasers of mixed fertilizers is in dealing with firms which have the highest reputation and are able to satisfy their customers that they use the best raw materials, and in avoiding "cheap" goods offered by irresponsible parties.

In the tables the various brands of nitrogenous superphosphates are arranged according to the percentage excess of selling price over valuation; those brands being given first in which valuation approaches nearest to cost.

The assertion of interested parties that valuation is useless because little or no clue to the availability of the organic nitrogen of mixed goods can be found by chemical analysis, may be briefly noticed.

That the valuation always shows the fair selling price of fertilizers is expressly disclaimed by the Station.

But it is true that the valuation sums up in a single statement certain facts which are shown in the chemical analysis by a considerable number of figures, and enables the purchaser to make a comparison of the *probable values* of any number of fertilizers which otherwise defy all attempts at comparison.

To illustrate: Below are given the average composition and valuation of the nineteen superphosphates (the number on the first manuscript page of the table) which begin the table on pages 48 to 61 which we may call lot A, and also seventeen analyses (the number on the last manuscript page but one of the table) which are near the foot of the table, numbers 12587 to 12643, and which we may call lot B.

As it happens, the average cost price of both lots is the same and the valuations differ by about \$7.50.

## AVERAGE COMPOSITION OF NITROGENOUS SUPER-PHOSPHATES.

#### LOT A AND LOT B.

	" Lot A."	"Lot B."
Nitrogen as nitrates	. 0.48	0.13
" ammonia	. 0.18	0.01
" organic	. 2.45	1.74
Soluble phosphoric acid	. 5.88	5.43
Reverted " "	3.42	3.71
Insoluble " "	. I.0I	1.78
Potash as muriate	. 3.93	1.94
" sulphate	. 2.10	0.36
Cost per ton		\$28.15
Valuation per ton	. 23.31	15.88

Now unless some of the firms whose brands are included in lot A are dishonestly selling inferior forms of nitrogen, while all of those whose brands are included in lot B are using only

the good, readily available forms of nitrogen, the relative value of these two lots of fertilizers is fairly expressed by the figures 23.31 and 15.88.

A mixture containing the same quantities of nitrogen, available phosphoric acid and potash as the average of lot A could be made of 61 pounds of nitrate, 17 of sulphate of ammonia, 700 of cotton seed meal, 1330 of acid phosphate, 158 of muriate and 90 of high grade sulphate of potash.

Calling the ton cost of these articles, \$45 for nitrate, \$70 for sulphate of ammonia, \$23.00 for cotton seed meal, \$15.00 for acid phosphate, \$42.50 for muriate and \$50 for high grade sulphate of potash (higher figures than have been paid by retail purchasers of these articles during the last season), we find that the mixture, weighing 2,356 pounds and costing \$25.60, contains the same amount of available plant food as the factory mixture weighing 2,000 pounds and costing, mixed and bagged, \$28.15. Evidently at the prices quoted for fertilizer-chemicals, these particular factory-mixed goods will be a little cheaper than the home-mixed if the latter is made from the materials named.

On the other hand, 17 pounds of nitrate of soda, 500 of cotton seed meal, 1,300 of acid phosphate, 78 of muriate of potash and 15 of sulphate of potash will contain as much available plant food as two thousand pounds, like the average of lot B.

The total weight will be 1,910 pounds and the cost of the goods unmixed \$17.88.

The relative value of the two lots of fertilizers as reckoned from the average valuations is 100 to 68: as calculated from the cost of raw materials necessary to furnish the same quantities of plant food, the relative value is 100 to 70.

It does not follow that one fertilizer is more economical than another because its valuation is a dollar or two higher or the percentage difference between cost and valuation slightly lower, but it is a fact that when costly fertilizers are made of the best materials, the valuations fairly express their *relative commercial values*, and are the best and only safe guide that the purchaser can employ.

It requires no argument to make plain that while it is very possible or even probable that a fertilizer may be worth less than the Station valuation, it is extremely improbable that it can be worth more than that valuation, except as a result of a considerable advance in the cost of raw materials or of labor, subsequent to the time of determining trade values, in March of each year.

On the other hand, the consumer can always guard his own interests by refusing to purchase those articles which show a great percentage difference between cost and valuation.

#### Analyses Requiring Special Notice.

12454, Fairfield's Formula for Corn and General Crops, is a mixture of nitrate of soda, bone and muriate of potash and not a nitrogenous superphosphate. It contains 55 per cent. of bone graded as "fine," *i. e.*, passing a sieve with circular holes <sup>1</sup>/<sub>50</sub> inch in diameter, and 45 per cent. of bone which does not pass the sieve.

12351. Shoemaker's Swift Sure Superphosphate. This analysis was unsatisfactory to the manufacturers, because it showed 0.4 per cent. less of nitrogen, a quarter of one per cent. less of potash and a per cent. and a half more of available phosphoric acid than their own tests led them to believe the goods contained. But more important that this, the manufacturers claim to use *only* high grade sulphate of potash, whereas our analysis showed some muriate. Two other samples of the goods were accordingly drawn and analyzed with the result given on pages 52 and 53 of the table. The composition of these samples is about what was claimed by the manufacturer.

12577. Erie King, made by the Milsom Rendering & Fertilizer Co., Buffalo, N. Y. As the analysis of this sample did not correspond with the manufacturer's guarantee, the Station was asked to draw and analyze other samples, but was unable, after the request was made, to find the brand on sale in the State.

12603. Bay State Special, made by H. F. Tucker Co., Boston. The manufacturer stated that the analysis did not represent the average quality of this brand and asked that samples be drawn from stock of other dealers. The sampling agent could not find the goods on sale at the time by any one except the dealer from whom this sample had been taken.

But at the request of the manufacturer a second sample was drawn from the stock of Mr. Schneider and analyzed, with the results given on page 55, No. 12799.

## NITROGENOUS SUPERPHOSPHATES. SAMPLED BY THE STATION.

#### Analyses and Valuations.

				1	1
		A SURFICIAL COMPANY		price	7.
		/			tor.
No	Name of Brand.	Manufacturer.	Dealer.	cas l	per
Station No.		distribution of the		Dealer's cash per ton,	Valuation per ton.
tati				eale	luat
S		•		De	$V_{a}$
228	Dana Fish and Da	D D F 1 D C 1			
2300	ash	E. R. Kelsey, Branford	F. H. Rolf, Guilford Samuel Foote, Branford	\$20.00	\$21.2
2349	XX Formula	C. Buckingham, South	- E. B. Clark Co., Milford	20.00	
		port	Manufacturer	30.00	27.
2579	Manchester's For-	E. Manchester & Sons		3	
2425	mula C. V. O. Co's Fertil	- Conn. Valley Orchard	d	29.00	25.4
	izer	Co., Berlin E. E. Burwell, Nev	I. I. Watrous Meriden	26,00	22.7
		Haven F. E. Boardman, Little	Manufacturer	28.00	24.0
		River	Manufacturer	28.00	23.4
2034	Bone, Fish and Pot	- L. Sanderson, New Ha	M. A. Tucker, Chester-		
	Mark Mark Control	Bros., Niantic	field	25.00	20.
2497	A. A. Complete Ma	- Crocker Fert. & Chem	. C. F. Tallard & Son,	-5.00	20.
	nure	Co., Buffalo, N. Y	Broad Brook	32.00	24.4
	AND EXCEPT OF RE		S. E. Dowd, Clinton	28.00	
2575	Complete Manure_	Standard Fertilizer Co.	No. 10 Part Annual Control	30.00	
		Boston	R. E. Hyde, Ellington	30.00	24.4
2309	Middlesex Special .	Boston	Baldwin's Mills, Meriden		
2035	I. X. L. Ammoniated			25.00	20.2
	Bone Superphos	Geo. W. Miles, Agent,		and ed a	
2400	phate	Milford	Manufacturer	22.00	17.8
2400	ash	Russia Cement Co.,	E. N. Pierce & Co.,		
	, 4311	Gloucester, Mass	A. R. Manning & Co.,	28.00	21.8
			Vantic	27.00	
2581	Market Garden	Lowell Fertilizer Co.,	H. A. Bugbee, Willi-	-/.00	
608	"Ceres" Special	Boston	mantic	34.00	26.8
.000	Complete Ferti-	G. W. Miles, Agent,	ewirst Assistance		
	lizer	Milford	Manufacturer	30.00	23.5
597	Berkshire Complete	Berkshire Mills Co.,		30.00	23.5
	rertilizer	Bridgeport Mapes F. & P. G. Co.,	Manufacturer	30.00	23.4
		New York	ford	29.00	22.6
633	Frisbie's Superphos-	L. I. Frisbie Co., Hart-	City Coal and Wood	29.00	22.0
	nhate	tord	Co., New Britain	33.00	25.6
009	An Kound Ferninzer	Rogers Mfg. Co., Rock-fall	Manufacturer		0
435	Bowker's Market	Bowker Fertilizer Co.,	A. L. Hitchcock, Plain-	23.00	17.8
	Garden Fertilizer	Boston	ville	34.00	24.7
			H. B. Sherwood, South-	3.	
48T	Blood. Bone and	L. B. Darling Fertilizer	W W Cooper Sugald	32.00	
70.	Potash	Co., Pawtucket, R. I.	Hotchkiss & Templeton	34.00	25.9
		, , , , , , , , , , , , , , , , , , , ,	Waterbury	36.00	
			, , , , , , , , , , , , , , , , , , , ,	30.00	

	op.		NI	TROGE	N.				Potash.							
	difference cost and				Tot	al gen				Tot	al.	Avail	able.	Fou	nd.	
Station No.	Percentage dif between co valuation.	Nitrogen as Nitrates.	Nitrogen as Ammonia,	Nitrogen Organic.	Found.	Guaran- teed.	Soluble.	Reverted.	Insoluble.	Found.	Guaran- teed.	Found.	Guaran- teed.	As Muriate.	Total.	Guaranteed.
2380	5.8*		0.69	3.34	4.03	3.1	3.55	2.35	0.39	6.29	4.0	5.90		0.73	4.69	4.0
2349	9.1	1.67		2.44	4.11	5.0	6.46	3.76	1.37	11.59	10.0	10.22	5.0	3.43	7.63	8.
12579	14.1 14.5	0.64		3.26 2.48	3.90 4.19	3.5 4.1	6.03 5.20	2.47 4.33	0.54 1.69	9.04 11.22	7.5	8.50 9.53	9.0	2.7I 3.I3	7.46 3.13	3.0
12474	16.5	1.82		1.53	3.35		5.94	1.43	0.31	7.68		7.37		1.09	8.75	
12500	19.3			2.80	2.80	2.5	6.38	2.03	0.20	8.61		8.41	8.0	9.65	9.65	10.
12634	21.7		0.90	2.44	3.34	3.0	2.33	3.26	0.31	5.90	4.0	5.59		0.53	6.27	4.
2497	22.5			3.36	3.36	3.3	6.64	3.79	1.38	18.11		10.43	8.0	5.97	6.41	7.
2575	23.0	0.66		2.94	3.60	3.3	6.24	3.43	0.90	10.57	9.0	9.67	8.0	6.82	6.82	7.
2509	23.2	0.26		2.05	2.31	2.1	6.59	3.07	0.46	10.12	8.0	9.66		6.27	6.27	6.
2035	23.5	0.14	0.75	1.96	2.85	2.1	5.89	1.11	4.32	11.32		7.00	8.0	2.13	2.13	2.
12400	23.5	0.32		2.55	2.87	2.1	7.04	5.80	1.87	14.71	12.0	12.84		2.58	2.58	2.
12581	26.4		0.35	4.54	4.89	4.1	7.01	0.69	0.13	7.83	8.0	7.70	7.0	0.48	6.29	6.
12608	27.7	0.69	0.49	1.95	3.13	3.3	5.28	3.74	0.92	9.94	10.0	9.02	8.0	0.53	6.81	7.
12597	27.9	0.75		1.81	2.56	2.5	8.64	2.88	1.20	12.72	10.0	11.52	8.0	0.44	6.02	6.
12314	28.3			3.08	3.08	2.1	7.71	8.43	0.76	16.90	12.0	16.14				
12633	28.5	0.16		3.70	3.86	3.3	6.82	2.84	0.68	10.34	11.5	9.66	II.O	7.35	7.35	8.
2669	28.6			1.67	1.67	1.6	5.41	6.08	1.17	12.66	10.0	11.49		3.53	3.53	2
2435	29.6	0.30		2.45	2.75	2.3	5.30	3.14	1.67	10.11	7.0	8.44	6.0	10.75	10.75	10
12481	31.2	0.82	0.24	2.98	4.04	4.1	5.97	3.20	0.16	9.33	8.0	9.17	7.0	8.01	8.01	7

<sup>\*</sup> Valuation exceeds cost.

## NITROGENOUS SUPERPHOSPHATES. SAMPLED BY THE STATION.

#### ANALYSES AND VALUATIONS—Continued.

				93	- 1		1 ce		N	ITROGE	EN.				Рноз	SPHORIC	ACID.			Potash.		
No.	Name of Brand.	Manufacturer.		sh price	r ton,		ference st and				To	tal ogen.				Tot	al.	Avail	able.	Fou	nd.	
Station N			Dealer.	Dealer's cash per ton.	Valuation pe	Station No.	Percentage diffe between cost valuation.	Nitrogen as Nitrates.	Nitrogen as Ammonia.	Nitrogen Organic.	Found.	Guaran- teed.	Solúble.	Reverted.	Insoluble.	Found.	Guaran- teed.	Found.	Guaran- teed.	As Muriate,	Total,	Guaranteed.
12426	and all crops	Middletown	H. W. Andrews, Wal lingford Wells & Dean, Bloom field	\$28.00	1	12426	32.0	1.00		1.79	2.79	2.3	7.89	3.57	1.31	12.77	12.0	11.46	10.0	3.79	3.79	3
12329	or complete Ma.	New York	Birdsey & Foster, Mer-iden							711												
	nure for Light Soils		Mapes Branch, Hart- ford	40.00	-9.10	12329	33.7	2.57	.67	2.23	5.47	4.9	2.46	4.87	1.25	8.58	8.0	7.33	6.0	1.13	8.04	(
12464	Ammoniated Bone with Potash	Armour Fertilizer Works, Chicago	C. J. Benham, New Haven	26.00	20.92	61	33.8			3.17	3.17	2.5	2.72	5.67	4.11	12.50	8.0	8.30	6.0	0.83	3.53	
			E. A. Buck & Co., Willimantic	30.00		12464	33.0			3.27	3	-5		3.47							3 00	
2644	Potash	ton	A. I. Martin, Walling-	28.00	76.00					d alti	20											
2033	Complete	G. W. Miles, Agt., Milford	Manufact		16.39 22.30	12644	34.2						150			313111				2.00		10
454"	for Corn and General Crops	Rogers & Hubbard Co.	H. W. Andrews, Wal-	45.00	33.19	12033	34.5	.71	MAN	100						9.39					5.66	1
	ciai Ciops		W. C. Buckley, Forest-	45.00	μ 	22434	33.0	3.27		2.01	5.20	35					10.00		In a	1.33	133	
	All Soluble	Works Chicago	Manufacturer C. J. Benham, New Haven	45.00			7															
2451	Farm Favorite	L. B. Darling Fertilizer	J. S. Warner, Glaston- bury	32.00	23.59	12510	35.7					7	100			0.00		UTW		0.11		1
			Hotchkiss & Templeton, Waterbury	30.00		12451	35.7		.18	2.20	2.38	2.1	7.79	2.99	.49	11.27	9.0	10.78	7.0	, 5.10	5.10	
333	Average Soil Com-	Mapes F. & P. G. Co., New York	Birdsey & Foster, Meri- den	34.00	24.21	12333	36.3	2.88		T 57	1.15	11	1.15	2.88	.76	8.00	8.0	7.33	7.0	0.96	6.14	
2594	High Grade Fish	Wilcox Fertilizer	Mapes Branch, Hart- ford Lewis Ford, Norwich	33.00			30.3	2.00		1.57	4.43	4	4.43	2.00	.,,	0.09	0.0	7.55				
	and Potash	Works, Mystic Great Eastern Fertilizer	Manufacturer	30.00	20.51	12594	36.5		.30	3.62	3.92	3.3	3.84	2.07	.46	6.37	6.0	5.91	5.0	4.91	4.91	
	Gardeners Com-	Co., Rutland Packer's Union Ferti-	Silas Finch, Greenwich O. S. Rogers, Essex Nelson Dayton, New	<b>32.00</b> 36.00	23.21 25.33	12538	37.9 38.2	.44		3.05 1.92	3.49 2.78	3.3	4.90 7.38	2.40 1.50	.89	8.19 9.36				8.09		
391	Concentrated Phosphate	Cumberland Bone- Phosphate Co., Boston	London Kahn Bros., Yantic D. C. Spencer, Saybrook	35.00	23.48	12391	38.4	.75		2.53	3.28	3.3	5.84	3.36	1.64	10.84	10.0	9.20	8.0	6.95	6.95	
373	Ammoniated Bone Phosphate	National Fertilizer Co., Bridgeport	ManufacturerAnsonia Flour and Feed	35.00 <b>32.50</b>	20.86	12373	39.0		.36	1.73	2.09	1.9	2.11	7.83	1.18	11.12	9.0	9.94	7.0	2.42	2.42	
			Co., Ansonia	30.00 28.00 <b>29.00</b>	=======================================					,				inv					31.766			

<sup>\*</sup> See page 47.

# NITROGENOUS SUPERPHOSPHATES. SAMPLED BY THE STATION.

#### ANALYSES AND VALUATIONS—Continued.

			-	o			d de		N	ITROGE	N.				Phos	PHORIC	ACID.			Potash.		
		1		price	ton.		feren st an				To Nitro	tal				Tota	al.	Availa	able.	Fou	nd.	
Station No.	Name of Brand.	Manufacturer.	Dealer,	Dealer's cash per ton.	Valuation per	Station No.	Percentage diffe between cost valuation.	Nitrogen as Nitrates.	Nitrogen as Ammonia.	Nitrogen Organic.	Found.	Guaran- teed.	Soluble.	Reverted.	Insoluble.	Found.	Guaran- teed.	Found.	Guaran- teed.	As Muriate.	Total.	Guaranteed.
2592	Soluble Potato and General Crop	Rogers Mfg. Co., Rock-fall	R. H. Hall, East Hamp	¢				70	47	2.46	2 65	25	T 62	6 50	T 74	0.05	0.0	8.21		.93	9.89	8.
2404		M. E. Wheeler & Co	D. G. Chesebro, Center	38.00	\$27.28	12592	39.3							1021								
			J. F. Blakeslee, North		22.71	12404	40.9	.20		2.88	3.08	3.3	4.93	3.15	1.46	9.54		8.08	7.0	7.78	7.78	8.
2816	Chittenden's Fish and Potash	National Fertilizer Co., Bridgeport	E. Hartford.	38.00	21.11	12816	42.I			2.89	2.89	3.0	5.95	2.67	1.23	9.85	6.0	8.62		.27	5.07	4
	High Grade Far- mer's Friend	New Vork	Manufacturer T. A. Tillinghast,				40.0			0.16	2.46	2.2	2.02	2.40	T 24	7.66		6.42	50	11.39	11.20	70
	Superphosphate	M. L. Shoemaker & Co.,	Olds & Whipple, Hart-	36.00	25.31 24.58	12641	42.4											Uthern		1.76		
0201	Sure Superphos- phate	M. L. Shoemaker & Co., Philadelphia	Olde & Whipple II-	35.00	24.46	12628	43.1	.93		2.07	3.00	2.5	8.40	4.15	1.75	14.30		12.55	9.0	.71	4.86	4
209	Standard Complete Manure	Standard Fertilizer Co., Boston	stock	34.00	00 70	12200	43.3	.24		2.08	3.22	2.2	6.40	1.88	1.21	9.49	9.0	8.28	8.0	8.28	8.28	2
386	Market Garden Manure	Quinnipiac Co., Boston	G. W. Williams Co., New London	38.00	23.72	12386	44.2									10.58	i	9.26	Aller			1
			C. Buckingham, South- port	30.00			7	A CHO														
	and Potash	Bradley Fertilizer Co.,	C. S. Gillette, Cheshire	35.00	19.37	12578	44.6	.20	.13	1.67	2.00	2.0	2.13	4.34	3.74	10.21	6.0	6.47		8.13	8.13	3
		Haven	Manufacturer	28.00	19.33	12632	44.9	.14		2.73	2.87	2.5	2.20	6.04	3.96	12.20	10.0	8.24	7.0	3.47	3.47	
36	Animal Brand Fer- tilizer	Lowell Fertilizer Co., I	A. B. Morse, Guilford. F. S. Bidwell, Windsor Locks	30.00	19.31	12536	45.0			2.58	2.58	2.5	7.81	1.40	.77	10.07	10.0	9.30	8.0	4.19	4.19	
		J	D. Beasley, Ellington Balch & Platt. W.	28.00																		
ALC: NO SHAPE		Bradley Fertilizer Co., V Boston	117 3 - 4 - 1	33.00	18.54	12517	45.6	.31		1.77	2.08	1.0	5.81	5.22	2.50	13.53	12.0	11.03	10.0	2.81	2.81	1
		York Ludiam, New S	A. Smith, Clinton-	34.00	23.31	12599	45.9	Min	of his	1973						9.59		8.37				
1 100	Shoemaker's Swift M	Boston I. L. Shoemaker & Co., E	Center	35.00	23.99	12574	45.9	.75		2.59	3.34	3.3	5.30	3.46	2.01	10.77	9.0	8.76	8.0	7.67	7.67	
	Sure Superphos- phate	Filladelphia	ford Bros., Westport	33.00	23.78	12351+	47.2	.89		1.89	2.78	2.5	9.23	3.56	2.01	14.80		12.79	9.0	3.29	4.79	
04	High Grade Special W	Villiams & Clark Fer-B	F Pinney Ellington	35.00 35.00	23.76	12494	47.3	.73		2.69	3.42	3.3	4.93	4.23	1.68	10.84	9.0	9.16	8.0	6.95	6.95	
6	Great Planet A. A. C	lark's Cove Fertilizer H		37.00	23.64	12646	48.1	.75	.38	2.28	3.41	3.3	3.87	5.06	1.64	10.57	9.0	8.93	8.0	7.12	7.12	
200	Complete Bone W	Co., New York	ewis Ford Norwich	35.00 28.00	23.04	12593	48.7									12.15	10	0.00				

+ See page 47.

† See page 47.

## NITROGENOUS SUPERPHOSPHATES. SAMPLED BY THE STATION.

#### ANALYSES AND VALUATIONS-Continued.

							1 ce		1	Nitrog	EN.				Рноѕ	PHORIC	ACID.			Potash.		
		1		price	ton.		feren t and			1	To	tal ogen.	TO S			Tot	al.	Availa	ble.	Fou	nd.	
Station No.	Name of Brand.	Manufacturer.	Dealer.	Dealer's cash price per ton.	Valuation per	Station No.	Percentage dif between cos valuation.	Nitrogen as Nitrates.	Nitrogen as Ammonia.	Nitrogen Organic.	Found.	Guaran- teed.	Soluble.	Reverted.	Insoluble.	Found.	Guaran- teed.	Found.	Guaran- teed.	As Muriate.	Total.	Guaranteed.
12338	Formula A	L. Sanderson, New Haven	Manufacturer †Sidney B. Smith, East	\$35.00	\$23.49	12338	49.0	1.02		2.71	3.73	3.1	4.03	3.73	2.08	9.84	10.0	7.76	6.0	6.95	6.95	6.0
12542	Complete for General Use	East India Chemical Works, H. J. Baker & Bros., New York	Haven C. F. Tallard & Son, Broad Brook	33.00		12542	50.7	.32	.73	1.71	2.76	2.2	5.73	2.93	.96	9.62	9.0	8.66	8.0	7.34	7.34	6.0
12635	Special with 10 per cent. Potash	L. Sanderson, New Haven	A B Morse Guilford	35.00		12635	51.6			2.79	2.79	2.5	2.93	4.39	2.41	9.73	9.0	7.32	5.0	9.60	9.60	10.0
2629	Americus High	Williams & Clark Fer-		35.00		12629	51.8	.63	.68	2.19	3.50	3.3	1.13	7.90	1.87	10.90	9.0	9.03	8.0	6.90	6.90	7.0
2348	Grade Special Fisherman's Brand Fish and Potash	Bowker Fertilizer Co.,	Gault Bros., Westport J. F. Buckhout, Green- wich Bowker's Branch, Hart-	<b>36.00 26.00</b>	23.71 16.45	12348	52.0		.17	2.29	2.46	2.3	3.50	1.66	1.42	6.58	6.0	5.16	4.0	5.27	5.27	5.0
2491	Square Brand Fish and Potash	Bowker Fertilizer Co., Boston	City Coal & Wood Co	25.00		12491	52.3		.42	2.10	2.52	2.3	3.26	3.46	1.28	8.00	8.0	6.72		4.37	4.37	4.0
2664	Gold Brand Excel-	E. Frank Coe Co., New	E. F. Miller, Ellington - W. D. Wanzer, Lanes	26.00	1	12664	52.4	-33		2.24	2.57	2.0	5.62	2.29	1.87	9.78	9.0	7.91	8.0	.60	7.01	6.0
2799	sior Guano* *Bay State Special	ton	ville	33.00	21.66	12799	52.8	.68	.11	2.32	3.11	3.3	5.28	4.41	1.90	11.59	11.0	9.69	8.0	6.27	6.27	7.0
2814	Market Garden Fer- l	National Fertilizer Co.,	bury	32.00 35.00		12814	52.9		.60	2.18	2.78	2.5	4.40	4.63	1.11	10.14	9.0	9.03	7.0	5.80	5.80	6.0
	tilizer	Bridgeport National Fertilizer Co., Bridgeport	Manufacturer	32.00	20.93	12374	54.1	HALL OF	13.3	1			1 TOTAL		1777	9.57	SIMIA					10.0
2603	*Bay State Special I Fertilizer	H. F. Tucker Co., Boston	wichC. I. Goodale Glaston-	<b>37.00</b>	24.01	12603	54.1	.72		2.46	3.18	3.3	5.96	3.15	1.70	10.81	9.0	9.11	8.0	6.42	6.42	7.0
2651	B. B. Guano	Milsom Rend. & Fert.		35.00		12651	54.6		.13	2 1.73	1.85	1.8	1.79	2.70	1.25	5.74	6.0	4.49	5.0	1.03	1.03	2.0
2537	Reystone Bone	M. Hess & Bro.	E. A. Halladay, Suffield M. S. Treat, Woodmont C. I. Pheeland, W. Suf-	16.00	10.35	12537	54.7			- 1.12	1.14	0.8	1.07	9.22	1.29	11.58		10.29	9.0	1.04	1.04	1.0
2486	Vegetable Bone Fer- tilizer	Milsom Rend. & Fert. Co., East Buffalo, N. Y.	G. W. Barnes, Poquo-	25.00	22.56	12486	55.1			. 3.81	3.81	4.1	5.60	2.31	2.11	10.02	9.0	7.91	8.0	4.89	4.89	5.0
396		Rogers Mfg. Co., Rock-	Chas. H. Davis, Guilford A. J. Palmer, Branford D. W. Spencer, Center-	35.00	14	12396	55.9		.31	5 3.03	3.39	3.3	.64	3.77	3.44	7.85	6.0	4.41		4.02	4.02	3.
2511	Bowker's Hill and E	Bowker Fertilizer Co.,	B. Sherwood, South	28.00		12511	56.7	.38		. 2.2	2.66	2.3	7.06	3.75	1.60	12.41	12.0	10.81	9.0	2.15	2.15	2.
	Americus Ammoni- V	Villiams & Clark Fer-	port	30.00	19.15	12469	58.0	.21		2.4	2.62	2.5	5.62	4.40	1.88	11.90	10.0	10.02	9.0	2.06	2.06	2.0
2659	Standard Pure Bone L	ister's Agricultural	J. G. Schwink, Meriden R. B. Witter, Brooklyn	29.00	18.36	12659	58.1		3	4 1.8	2.15	2.4	7.80	2.70	2.45	12.95	12.0	10.50	10.0	1.72	1.72	I.
	Superphosphate of Lime	Chemical Works, Newark, N. J.	A. N. Clark, Milford	28.00	17.71																	

<sup>†</sup> Consumer, not a dealer.

<sup>\*</sup> See page 47.

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#### NITROGENOUS SUPERPHOSPHATES. SAMPLED BY THE STATION.

#### cash Name of Brand. Manufacturer. No. Dealer. 12411 A. Brand Manure \_ Mapes F. & P. G. Co., Southington Lumber & New York ..... Feed Co., Southington \$31.00 \$20.60 W. C. Bulkley, Forestville -----Birdsey & Foster, Meriden .... 33.00 12492 Harvest Home Phos- East India Chemical Carlos Bradley, Ellingphate\_\_\_\_\_ Works, H. J. Baker ton... 22.00 15.02 & Bros., Props., New York F. S. Platt, New Haven 30.00 24.00 ----12463 Universal Fertilizer Packer's Union, New Nelson Dayton, New York London 25.00 15.53 J. P. Little, Columbia ... 26.00 12346 Patent Superphos-Bradley Fertilizer Co., C. O. Jelliff & Co., phate\_\_\_\_\_ Boston \_\_\_\_ Southport \_\_\_\_ 30.00 18.56 Kinsella & Smallhorn, New Canaan D. L. Clark, Milford ... 30.00 12667 Ammoniated Bone W. E. Brightman, Tiver- William Crane, Broad and Potask ..... ton, R. I. ..... Brook ..... 30.00 18.48 12467 General Fertilizer \_\_ Great Esstern Fertilizer T. E Greene, Plainfield 26.00 15.30 Co., Rutland, Vt.... H. S. Harvey, Windham 25.00 12543 Hawkeye Fertilizer\_ Cumberland Bone-Phosphate Co., Boston ..... Kahn Bros., Yantic.... 20.00 12.13 12657 Success Fertilizer \_\_ Lister's Agric Chem. Works, Newark, N. J. A. N. Clark, Milford --25.00 15.14 12448 Farmers' New Meth- Bradley Fertilizer Co., D. L. Clark, Milford. 28.00 16.88 od Fertilizer Boston ..... Wilson & Burr, Middletown -----28.00 12508 Bone and Wood Ash Bowker Fertilizer Co., A. L Hitchcock, Plain-Fertilizer \_\_\_\_\_ Boston \_\_\_\_ ville \_\_\_\_ 26.00 15.61 12385 Phosphate ...... Quinnipiac Co., Boston Gault Bros, Westport 32.00 18.51 G. W. Williams Co., New London 31.00 12601 Royal Bone Phos-Williams & Clark Fer-14.84 12210 Standard Fertilizer - Standard Fertilizer Co., Boston ----- H. F. Child, Woodstock 28.00 16.62 12507 Bowker's Sure Crop Bowker Fertilizer Co., H. E. Kelsey, West-Phosphate Boston brook 25.00 14.73 12661 Bay State G. G. .... Clark's Cove Fertilizer Co., Boston \_\_\_\_ E. Bishop, New London 28.00 16.48 12583 Original Bay State Bone Superphos- H. F. Tucker Co., Bos- J. F. Lester, Norwich... 16.39 phate ..... Nathan Lanz, Rockville 30.00 28.00 12431 A. A. Ammoniated East India Chemical F. S. Platt, New Haven 40.00 20.41 Superphosphate\_\_ Works, H. J. Baker & Bros., Prop., New Saxton & Strong, Bristol 31.50 York ..... 35.00 ----

#### ANALYSES AND VALUATIONS-Continued.

			NI	TROGE	N.	- 1			PHOSE	HORIC	ACID.			Po	TASH.	1
	ence	1	1	1	Tot	al gen.	1			Tota	al.	Availa	ole.	Foun	id.	
Station No.	Percentage difference between cost and valuation.	Nitrogen as Nitrates.	Nitrogen as Ammonia.	Nitrogen, Organic.	Found.	Guaran- teed.	Soluble.	Reverted.	Insoluble.	Found.	Guaran- teed.	Found.	Guaran- teed.	As Muriate.	Total.	Guaranteed.
12411	59.5	.46	.30	2.16	2.92	2.5	3.12	8.14	1.84	13.10	12.0	11.26	10.0	2.97	2.97	2.5
12492	59.8	.26		1.32	1.58	0.8	4.59	4.14	1.25	9.98	9.0	8.73	8.0	3.21	3.21	2.0
12463	61.0			1.14	1.14	0.8	6.69	2.11	1.10	9.90		8.80	8.0	4.93	4.93	5.0
12346	61.6	-35	.12	2.25	2.72	2.5	6.02	3.33	2.45	11.80	11.0	9.35	7.0	2.30	2.30	2.0
12667	62.3	.10		2.21	2.31	2.1	7.26	2.83	1.40	11.49	9.0	10.09	8.0	3.17	3.17	3.0
12467	63.4			1.09	1.09	0.8	7.17	2.22	1.19	10.58		9.39	8.0	4.16	4.16	4.
12543			~	1.20	1.20	0.8	5.36	2.61	1.61	9.58	9.0	7.97	7.0	1.43	1.43	I.
12657	65.1			1.48	1.48	1.2	6.58	3.14	2.10	11.82	11.5	9.72	9.5	2.04	2.04	2.
12448	65.9	.38		1.66	2.04	1.7	5.01	3.85	2.44	11.30	10.0	8.86	8.0	3.19	3.19	3.
12508	66.5	.79		1.16	1.95	.1.5		7.46	5.77	13.23		7.46	6.0	1.01	2.25	2.
12385	67.5	.56	.12	2.08	2.76	2.5	6.80	2.99	1.49	11.28	10.0	9.79	9.0	1.92	2.11	2.
1260	68.5			1.51	1.51	1.0	6.02	2.72	2.19	10.93	8.0	8.74	7.0	2.51	2.51	2.
1221	REAL PROPERTY.	.30	)	1.91	2.21	2.0	5.52	3.22	2.66	11.40	10.0	8.74	8.0	2.25	2.25	2.
1250	TOTAL STREET	.12	2	93	3 1.05	0.8	6.10	4.08	1.73	11.91	11.0	10.18	9.0	2.81	2.81	2
1266	69.9		.16	1.80	2.05	1.9	5.6	4.08	1.94	11.60	10.0	9.75	8.5	1.85	1.85	2
1258	3 70.8	.26	5	_ 1.86	5 2.12	2.1	5.00	3.99	2.18	11.20	5 11.0	9.08	9.0	2.22	2.22	2
1243	71.5	-52	2 1.00	1.4	4 2.96	5 2.5	8.0	3 2.62	.90	11.60	0 11.0	10.70	10.0	2.76	2.76	2

#### NITROGENOUS SUPERPHOSPHATES. SAMPLED BY THE STATION.

Station No.	Name of Brand.	Manufacturer.	Dealer.	Dealer's cash price per ton.	Valuation per ton.
12587		Lowell Fertilizer Co., Boston	F. S. Bidwell, Windsor Locks	\$28.00	\$16.84
			Manchester	30.00	
12337		Bowker Fertilizer Co., Boston	Linsley & Lightbourn, New Haven	35.00	16.13
			H. B. Sherwood, South-	28.00	
12477	Imperial Bone	H. F. Tucker Co., Bos-	E. B. Clark Co., Milford C. J. Goodale, Glaston-	24.00	
	Superphosphate	ton	L. A. Fenton, Norwich	28.00	16.08
12576	Superphosphate	Cleveland Dryer Co.,	C. M. Holbrook, Willi-	28.00	
		Boston Fred'k Ludlam, New York	mantic	30.00	17.17
12516	Niagara Phosphate	Bradley Fertilizer Co.,	P. Schwartz, Chester-	23.00	13.16
		Boston	field	22.00	12.54
12330	Octoar Brand 11111	New York	den	27.00	15.31
12482	B. D. Sea Fowl	Bradley Fertilizer Co., Boston	A. N. Clark, Milford W. W. Cooper, Suffield F. S. Bidwell, Windsor	30.00	16.92
. 2572		E. Frank Coe Co., New	Locks	30.00	
25/3		York	J. R. Babcock, Mystic -	31.00	17.39
12501		Olds & Whipple, Hart-	Manufactures		
12389	Superphosphate	Cumberland Bone- Phosphate Co., Bos-	Manufacturer	34.00 27.00	18.96
		ton	ville	30.00	
12588	Bone Fertilizer	Lowell Fertilizer Co., Boston	mantic	28.00	15.58
			C. W. Lines, New Brit-	28.00	
2650	Soluble Pacific Gu-	Pacific Guano Co., Bos-	A. A. Snow, Clinton	28.00	
	Fish, Bone and Pot-	ton	Saxton & Strong, Bristol	33,00	18.35
12343	Ammoniated Bone	New York Berkshire Mills Co.,	W. J. Warner, Gilead.	29.00	15.97 15.4 <sup>1</sup>
	Phosphate	Bridgeport	Manufacturer		
	all Crops	Standard Fertilizer Co., Boston	H. F. Child, Woodstock	25.00	13.66
43		New York	Lewis Ford, Norwich.	25.00	13.60

# ANALYSES AND VALUATIONS-Continued.

		THE I	NI	rroge:	N.	1			PHOS	PHORIC .	ACID.			Po	TASH.	
	and	1	1	1	Tot	al	1		1	Tota	al.	Availa	ble.	Foun	d.	
Station No.	Percentage difference between cost and valuation.	Nitrogen as Nitrates.	Nitrogen as Ammonia.	Nitrogen, Organic.	Found.	Guaran- teed.	Soluble.	Reverted.	Insoluble.	Found.	Guaran- teed.	Found.	Guaran- teed.	As Muriate.	Total.	Guaranteed.
2587	72.2			2.16	2.16	1.7	3.23	6.69	1.15	11.07	10.0	9.92	9.0	2.43	2.43	2.0
12337	73.6	.29		1.59	1.88	1.6	6.67	3.02	1.62	11.31	11.0	9.69	9.0	2.21	2.21	2.0
12477	74.1	.79		1.16	1.95	1.3	6.30	3.01	1.74	11.05	11.0	9.31	9.0	2.44	2.44	1.9
12576	74.7			2.20	2.20	2.1	6.74	3.15	1.94	11.83		9.89	9.0	1.93	1.93	2.0
12600	74.8	.20		.76	.96	0.8	6.16	3.96	2.07	12.19	10.0	10.12	8.0	1.16	1.16	I.0
12516	75.4			1.20	1.20	0.8	5.73	2.68	1.82	10.23	8.0	8.41	7.0	1.35	1.35	I
12350	76.4			2.00	2.00	1.7	1.92	5.75	1.66	9.33	8.0	7.67	6.0	3.20	3.20	3.
12482	77.3			2.18	2.18	2.1	6.48	3.67	1.93	12.08	10.0	10.15	8.0	1.51	1.51	I.
12573	78.3		.20	1.80	2.00	1.9	7.55	2.24	1.38	11.17	11.0	9.79	9.0	.30	2.65	2.
12501	79.3	.73		2.12	2.85	2.5	6.21	4.06	1.18	11.45	10.0	10.27	9.0	.40	1.94	2.
12389	79.5	.24		1.74	1.98	2.1	4.86	4.12	2.41	11.39	10.0	8.98	8.0	2.09	2.09	2.
12588	79.7			1.85	1.85	1.7	4.29	4.07	1.11	9.47	9.0	8.36	8.0	3.34	3.34	3.
12650	79.8			2.60	2.60	2.3	4.92	2 5.59	1.79	12.30	10.5	10.51	8.5	1.71	1.71	2.
12642	81.6			2.59	2.59	2.5	3.48	3 1.86	1.55	6.89	)	5.34	4.0	4.09	4.09	4
12343	81.7			1.15	1.15	0.8	6.29	3.42	3.22	12.93	3 10.0	9.71	8.0	-35	2.55	2
12211		N 200		1.30	1.30	) I.O	6.23	2 2.29	2.03	3 10.54	1 10.0	8.51	8.0	2.09	2.09	2
12643				1.2	1.2	0.0	5.2	5 3.57	1.66	10.48	8.0	8.82	7.0	2.31	2.31	2

#### NITROGENOUS SUPERPHOSPHATES. SAMPLED BY THE STATION.

				Dealer's cash price per ton.	on.
No.	Name of Brand.	Manufacturer.	Dealer.	ısh	Valuation per ton.
				s cz	I uo
Station				aler er to	ıati
Stz				Dea	Valu
					-
12640	Guano for all Crops	Standard Fertilizer Co.,			
72402	Standard Sunan	Boston	F. J. Newton, Branford		\$14.11
12402	phosphate	New York	Lewis Ford, Norwich F. L. Dimmock, New	28.00	15.00
12602	Fish and Potash	Williams & Clark Fer-	T. B. Atwater, Plants-	28.00	
	Oli Di i	tilizer Co., New York	ville	32.00	16.79
12408	Climax Phosphate.	Quinnipiac Co., Boston	J. P. Lathrop, Plainfield	28.00	14.52
12580	Fertilizer for all	Cleveland Dryer Co.,	S. V. Osborn, Branford	28.00	
	Crops	W. E. Brightman, Tiver-	I. T. Peckham, Norwich	28.00	14.42
		ton, R. I.	Brook	28.00	14.34
12654	Buffalo Fertilizer	Milsom Rend. & Fert.			-4.24
T2620	Fertilizer	Co., E. Buffalo, N. Y.	J. R. Gilbert, Gilead J. W. Howe & Son., So.	26.50	13.52
12039	r crimizer	Roston	Glastanhur		
12636	Columbian Phos-	Berkshire Mills Co	J. W. Palmer, Stamford	34.00	17.06
	phate	Bridgeport	P. Schwartz, Chester-	26.00	12.24
			field	21.00	
			L. Mullaly, Windsor	28.00	::::
12408	Buffalo Guano	Milsom Rend. & Fert.	C H Davis Cuilford	25.00	
12490	Bunaro Guano	Co., E. Buffalo, N. Y.	A. L. Anderson & Son,	25.00	13.44
			Tolland	30.00	
12660	King Philip Alka-	Clark's Cove Fertilizer	J. M. Burke, So. Man-	27.50	
12648	Nobsque Guano for	Co., Boston Pacific Guano Co., Bos-	J. O. Fox & Co., Put-	28.00	12.75
	all Crops	Milsom Rend & Fert.	nam	32.00	14.04
3,,,			L. B. James, Scotland	25.00	10.19

‡ See page 47.

# 2 and 3. Nitrogenous Superphosphates. Sampled by Manufacturers and Purchasers.

12809. Fish and Potash. Anchor Brand, made by the Bradley Fertilizer Co., Boston. Sample deposited with the Director of the Station by the manufacturer.

12326. Conn. Valley Orchard Co.'s Fertilizer, made for the Conn. Valley Orchard Co., Berlin. Sampled by Earl Cooley, Berlin.

12584 and 12586. Special Mixtures. Sampled and sent by A. E. Plant, Branford.

#### ANALYSES AND VALUATIONS—Continued.

	eo		N	TROGE	EN.				Рно	SPHORIC	ACID.			P	OTASH.	
	fferen it and	-			To Nitro	tal ogen.				Tot	al.	Avail	able.	Fou	nd.	
Station No.	Percentage difference between cost and valuation.	Nitrogen as Nitrates.	Nitrogen as Ammonia.	Nitrogen, Organic.	Found.	Guaran- teed.	Soluble.	Reverted.	Insoluble.	Found.	Guaran- teed.	Found.	Guaran- teed.	As Muriate.	Total.	Guaranteed.
12640	84.3			1.43	1.43	1.0	5.72	2.68	2.07	10.47	10.0	8.40	8.0	2.34	2.34	2.0
12402	86.7			1.06	1.06	0.8	6.90	2.24	1.24	10.38	9.0	9.14	8.0	4.15	4.15	4.0
12602	90.6	.14	0.30	1.87	2.31	2.1	2.78	3.61	1.90	8.29	6.0	6.39	4.0	4.88	4.88	4.0
12468	92.8			1.44	1.44	1.0	6.43	2.33	1.90	10.66	9.0	8.76	8.0	2.45	2.45	2.0
12580	94.2	.II		1.40	1.51	1.0	4.59	4.21	2.46	11.26	8.0	8.80	7.0	2.05	2.05	2.0
12668	95.3		0.40	1.64	2.04	2.1	1.84	4.36	3.07	9.27	7.5	6.20	6.0	2.55	2.55	2.0
12654	96.0			1.93	1.93	1.9	4.59	2.81	1.60	9.00	9.0	7.40	8.0	1.29	1.29	1.5
12639	99.3		0.15	2.09	2.24	2.0	5.06	4.78	1.68	11.52	10.0	9.84	8.0	2.02	2.02	2.0
12636	104.2						2.55	7.85	3.21	13.61	12.0	10.40	10.0	.23	2.41	2.0
12498	104.6			.90	.90	0.8	6.15	2.22	1.01	9.38	9.0	8.37	8.0	3.76	3.76	4.0
12660	119.6			1.07	1.07	I.I	6.16	2.03	1.86	10.05	9.0	8.19	8.0	2.18	2.18	2.0
12648	127.9			1.33	1.33	1.2	6.22	2.46	2.02	10.70	9.0	8.68	8.0	2.28	2.28	2.0
12577‡	145.3			.96	.96	0.8	4.02	2.19	1.31	7.52	9.0	6.21	7.0	1.89	1.89	2.0

‡ See page 47.

#### ANALYSES AND VALUATIONS.

	12809	12326	12584	12586
Nitrogen as nitrate		1.72		
" ammonia			0.47	0.76
" organic	3.58	2.60	3.21	3.08
Nitrogen, total	3.58	4.32	3.68	3.84
Soluble phosphoric acid	3.92	5.70	0.61	3.07
Reverted phosphoric acid	2.48	3.57	9.19	2.82
Insoluble phosphoric acid	1.60	1.73	1.75	0.51
Total phosphoric acid	8.00	11.00	11.55	6.40
Potash as muriate	3.37	3.09	8.70	10.18
Potash as sulphate				
Potash, total	3.37	3.09 ·	8.70	10.18
Cost per ton	\$28.00	\$25.00		
Valuation per ton	19.03	22.89	26.40	24.77
Insoluble phosphoric acid Total phosphoric acid Potash as muriate Potash as sulphate Potash, total Cost per ton	1.60 8.00 3.37  3.37 \$28.00	1.73 11.00 3.09  3.09	1.75 11.55 8.70  8.70	0.51 6.40 10.18 

#### SPECIAL MANURES.

Here are included such mixed fertilizers, chiefly nitrogenous superphosphates, as are claimed by their manufacturers to be specially adapted to the needs of particular crops.

## I. Samples Drawn by Station Agent.

In the table on pages 64 to 79 are given analyses of one hundred and eight samples drawn by the Station agents and representing one hundred and five brands.

#### GUARANTEES.

Of the one hundred and eight samples analyzed, twenty-one do not fulfill the manufacturer's minimum guarantee in respect of one ingredient, and nine are each deficient in respect of two ingredients.

Six were deficient in nitrogen, twenty-four in potash, and nine in phosphoric acid.

#### COST AND VALUATION.

The average cost per ton of the one hundred and eight samples examined was \$32.64, the valuation \$21.76 and the percentage difference 50.0.

In 1898 the corresponding figures were: Average cost, \$33.11; average valuation, \$21.72, percentage difference 52.4.

#### Analyses Requiring Special Notice.

The Rogers Mfg. Co.'s High Grade Grass and Grain Manure, 12627, Mapes' Seeding Down Manure, 12476, Hubbard's Grass and Grain Manure, 12811 and 12456, and Hubbard's Oat and Top Dressing Manure, 12455, analyses of which appear on pages 65, 67 and 69 of the table, are mixtures of bone with chemicals.

The mechanical analyses of the bone in these fertilizers, are as follows:

#### 12627 12476 12811 12456 12455

Per cent. fine, smaller than 1/50 inch	81	85	53	50	54
Per cent. coarse, larger than 1/50 inch	19	15	47	50	46
10	00	100	100	100	100

The manufacturers objected that the analyses of Hubbard's Grass and Grain Manure, 12456, given on page 68, did not fairly represent their goods, as it showed more nitrogen and

considerably less phosphoric acid and potash than this brand was made to contain. At the request of the Rogers & Hubbard Co., another sample was drawn, 12811, and analyzed with the results given on page 67. This last analysis conforms to the manufacturer's guarantee.

The Milsom Rendering Co. objected that the analysis of their Potato, Hop and Tobacco Phosphate, 12483, page 79, was very low in potash and in available phosphoric acid.

They asked that other samples be drawn and analyzed, but the sampling agent was not able to find it on sale any more.

The Quinnipiac Co. requested another analysis of their Potato Manure, because the one first reported, 12353, showed a deficiency of potash. Accordingly another sample was drawn, 12812, the analysis of which appears on page 69 of the table, and shows a very different composition as well as different ingredients, the one containing a considerable quantity of nitrate, while the other contains none.

The sample of Brightman's Tobacco Special and Market Garden Fertilizer, 12666, was stated to have been drawn from stock left over in the dealer's warehouse from the season of 1898. A second sample of the same brand, from goods made in the fall of 1899, was therefore drawn, 14029 and analyzed with the results given on page 67.

Neither of these analyses, however, represent the goods sold in Connecticut in the spring of 1899, which were guaranteed to be free from chlorine. The manufacturers stated that 14029 was made in the fall of 1899, and that the potash used was from a lot bought for and billed to them as high grade sulphate. After receiving the analysis, investigation showed that the 50 ton lot sold to them as sulphate was largely muriate.

The Cleveland Dryer Co. requested another analysis of their Potato Phosphate, 12665, page 69, because of a deficiency of nitrogen and potash as shown by the analysis of this sample.

It was impossible to find the goods on sale in the State after the request was made.

on No.	Name of Brand.	Manufacturer.	Dealer.	Dealer's cash price per ton.	Valuation per ton.
Station				Dealer	Valuati
12627	High Grade Grass	Rogers Mfg. Co., Rock	Manufactures	0	
12466	Complete for Pota- toes, Roots and	Russia Cement Co.,	Manufacturer E. N. Pierce, Plainville C. A. Young & Co.,	\$37.00	\$33.50
12493	Vegetables Special Tobacco Manure	Russia Cement Co., Gloucester, Mass.	Danielson G. W. Pomeroy, East Granby	35.00	
			H. C. Aborn & Son., Ellington	43.00	34.85
12539		L. B. Darling Fertilizer Co., Pawtucket, R. I.	Loomis Bros Granhy	38.00	07.0
12598	Huic	S. M. Hess & Bro., Philadelphia Pa	Joseph Amstead, Wind-	33.00	31.24 26.00
12476*	nure	New York	Mapes Branch, Hart-	37.00	
12514	Bowker's Tobacco Ash Elements	Bowker Fertilizer Co.,	Bowker's Branch	Military.	29.17
12595	Potato, Onion and Tobacco Manure	Wilcox Fertilizer	I. W. Dennison, Mystic- C. M. Smith, E. Hart-	30.00	23.29 26.49
12352	Economical Potato Manure	Mapes F. & P. G. Co., New York	ford	36.00	
			Henry F. Quintard, Sound Beach Mapes Branch, Hart-	30.00	23.28
12480	Tobacco Manure	Mapes F. & P. G. Co.,	C. K. & H. T. Hale,	33.00	
12335	Wrapper Brand Hubbard's Soluble	New York	W. W. Cooper, Suffield H. W. Andrews Wal	<b>44.00</b> 46.00	33.02
	Tobacco Manure_	Middletown	A. E. Kilbourn, East	42.00	31.50
12378	Potato Phosphate	Lowell Fertilizer Co.,	HartfordG. C. Ingham, Saybrook	42.00	22.45
2637	Mystic Gilt Edge	Boston	A. A. Snow, Clinton	33.00	
12334	Hubbard's Soluble	C. M. Shay, Groton Rogers & Hubbard Co.,	Manufacturer	30.00	22.36
	Potato Manure	Middletown	A. E. Kilbourn, East	38.00	28.23
2471	Tobacco Ash Con-	Mapes F. & P. G. Co., New York	Hartford C. K. & H. T. Hale,	38.00	
	Stituonis		Gildersleeve	32.00	22.29
2591	High Grade Soluble Tobacco Manure	Rogers Mfg. Co., Rock-fall	N. H. Root, New Mil-	30.00 42.00	31.19
			ford	42.00	

# Analyses and Valuations.

	e		NIT	rroge	N.				Рноя	PHORIC	ACID.			P	OTASH.	
	feren t and				To	tal gen.		way.		Tota	d.	Availa	ble.	Fou	nd.	
Station No.	Percentage difference between cost and valuation.	Nitrogen as Nitrates.	Nitrogen as Ammonia.	Nitrogen Organic.	Found.	Guaran- teed.	Soluble.	Reverted.	Insoluble,	Found.	Guaran- teed.	Found.	Guaran- teed.	As Muriate.	Total.	Guaranteed.
12627* 12466	10.2		.70	2.79 3·34	2.79 4.04	2.5 3.7	5.68	5.60	1.25	19.61 12.53	16.5 9.0	11.28		14.12 .29	14.12 8.92	12.5
12493	20.5		1.24	3.46	4.70	4.5	5.34	4.20	•54	10,08	8.0	9.54		.33	13.10	12.0
12539	21.6		2.66	2.78	5.44	4.9	4.70	1.81	.22	6.73	8.0	6.51	7.0	1.08	9.87	10.0
12598	26.5		.56	3.45	4.01	3.3	5.54	2.26	1.56	9.36		7.80	8.0	1.39	7.54	7.
12476*	26.8	1.40		1.08	2.48	2.5				18.55	18.0			10.65	10.65	10.
12514	28.8 32.I	-95	•55	2.55	4.05	3.3	.13 4.70	7.76 4.52		11.05	8.0	7.89 9.22	6.0 7.0	1.32 .25	15.90 7.04	15. 6.
12352	33.2	1.15		2.37	3.52	3.3	1.44	3.94	1.20	6.58	6.0	5.38	4.0	1.44	9.05	8.
12480	33.3	3.50	1.28	1.72	6.50	6.2	.26	5.09	.53	5.88	4.5	5.35		2.23	11.43	10.
12335	33.3	1.38		3.78	5.16	5.0	1.46	6.80	2.70	10.96	10.0	8.26	7.0	.60	9.73	10.
12378	33.6		.29	2.63	2.92	2.5	6.96	1.72	1.00	9.68	9.0	8.68	8.0	.08	6.19	6.
12637	34.2	.67	.30	2.04	3.01	3.0	5.18	5.06	1.92	12.16	9.0	10.24	8.0	5.40	5.40	5.
12334	34.6	1.66		3.70	5.36	5.0	1.14	6.34	2.54	10 02	10.0	7.48	7.0	1.00	6.75	5.
			r													
12471	34.6			.73	.73	0.5		5.09	1.20	6.29	5.7	6.29		3.25	16.19	15.
12591	34.7	1.44	.32	3.17	4.93	5.0	2.30	5.88	1.86	10.04	8.0	8.18		.85	10.37	II

<sup>\*</sup> See page 62.

# ANALYSES AND VALUATIONS—Continued.

				0					1	NITROG	EN.				Phosi	PHORIC	ACID.			P	OTASH.	
				price	ton.		erenc				To	otal ogen,	H			Tot	al.	Availa	able.	Fou	ind.	
Station No.	Name of Brand.	Manufacturer.	Dealer.	Dealer's cash per ton.	Valuation per	tation No.	Percentage differences to a valuation.	Nitrogen as Nitrates.	Nitrogen as Ammonia.	Nitrogen Organic.	Found.	Guaran- teed.	Soluble.	Reverted.	Insoluble.	Found,	Guaran- teed.	Found.	Guaran- teed.	As Muriate	Total.	Guaranteed
12811	Hubbard's Grass	Rogers & Hubbard Co.,	Strong & Tanner, East			0.	-															
12606	Oats and Top Dress-	Rogers Mfg. Co., Rock- fall	Strong & Tanner, East Winsted Manufacturer D. W. Spencer, Center	\$38.00	\$28.22 30.99	12811†	34·7 35·5	trace 4.88		9 2.18	2.57 6.65	2.5 6.3	1.76	5.73	1.53	9.02	9.0	7.49		8.30		
12655	Tobacco Manure	Lowell Fertilizer Co.,	brook	40.00																		
12450	Grain Grower	Armour Fertilizer	Thos. Lee, Brookfield C. J. Benham, New	40.00	29.35	12655	36.3	1.74	139.77	The state of the s		111111111111111111111111111111111111111		1 1 1 1 1	No.	6.74	. 3	1000		•45		
		works, Chicago	Haven E. A. Buck & Co., Wil-	23.00	17.49	12450	37.2			- 1.92	1.92	1.7	3.50	6.43	2.67	12.60	10.0	9.93		•37	2.80	2.0
12589	Fruit and Vine	Lowell Fertilizer Co.,	limanticG. C. Ingham, Saybrook	25.00 24.00 32.00			20 T		2	0 2 4	3 2.78	2.2	5.76	2.30	.73	8.88	0.0	8.15	8.0	.85	6.00	6.0
	Charles land	Boston	H. A. Bugbee, Willi-	35.00	23.89	12589	30.1		.3	3.4	3.7	33	5.,		13							1,463
12604	Complete Corn	Rogers Mfg. Co. Rock-	Thos. Lee, Brookfield N. H. Root, New Mil-	34.00 33.00													100					
		fall	ford	35.00 35.00	25.21	12604	38.8	1.24		2.40	3.73	3.6	4.78	5.19	1.66	11.63	8.0	9.97		7.09	7.09	7.0
12541	Corn Manure	East India Chemical Works, H. J. Baker		33.00																		
12330	Potato Manure	York	Wm. Stevenson, South Glastonbury Mapes Branch, Hart-	35.00	25.16	12541	39.1	.70	1.4	7 2.0	3 4.25	4.0	5.30	1.81	.58	7.69	7.0	7.11	6.0	7.92	7.92	7.0
		New York	fordBirdsey & Foster, Meri-	36.00	25.69	12330	40.1	1.78	1.5	.5	3.84	3.6	3.04	5.52	1.48	10.04	8.0	8.56	8.0	1.41	7.63	6.0
704FF	Hubband's Osta and	D	den	37.00 38.00					P1021													
124551	Top Dressing	Middletown	H. W. Andrews, Wallingford W. O. Goodsell, Bristol	49.00	34.94	12455†	40.2	7.49		. 1.3	2 8.81	8.8				8.46	7.9		1000	9.17	9.17	8.4
12409	Complete for Pota-	Bradley Fertilizer Co	Manufacturer	49.00							9 (14, 24)						0.73			(8) (8) p		17:50
	toes & Vegetables	Boston	Southport J. M. Todd, Forestville	32.00 35.00	23.51	12409	40.4	.73		2.6	3.33	3.3	4.91	3.93	1.83	10.67	9.0	8.84	8.0	7.19	7.19	6.0
14029‡	Tobacco Special and Market Garden Manure	W. E. Brightman, Tiverton, R. I.	William Crane, Broad Brook	33.00	24.88	14029‡	40.7	1.68		1.8	1 3.52	3.3	4.48	4.68	1.84	11.00	9.0	9.16	8.0	3.28	7.51	7.0
12515	Bowker's Tobacco	Bowker Fertilizer Co.,	Bowker's Branch Hart-			12515			10													
12473	Potato Manure	BostonL. Sanderson, New	A. B. Morse, Guilford	40.00	28.4I 21.24	12473	40.8	3.12		. 2.9	3.23	3.0	3.33	6.98 4.53	5.06	12.22	9.0		5.0		5.86	
12453	Potato and Root I Crop Manure	L. B. Darling Fertilizer	Hotchkiss & Templeton,	30.00 <b>34.00</b>	24.04	12453	41.4	.52	.2	20 2.2	3.00	2.9	7.23	2.93	•35	10.51	10.0	10.16	7,0	7.96	7.96	7.0
			J. S. Warner, Glaston-	35.00																		
12518	Complete Tobacco I	East India Chemical Works, H. J. Baker	bury	35.00																		
		Bro., Props., New York	Wm. Stevenson, South Glastonbury	42.00	29.62	12518	41.8	.43	2.9	1.3	2 4.66	4.5	4.13	1.37	.93	6.43		5.50	4.0	.73	11.03	10.0

Station No.	Name of Brand.	Manufacturer.	Dealer.	Dealer's cash price per ton.	Valuation per ton.
12817	tato and lobacco	Chemical Co., Buf-	C. F. Tallard & Son, Broad Brook Latimer & Williams, So. Coventry William Orr, Southing-	\$30.00	\$20.
12392	tato and Tobacco	Crocker Fertilizer and Chemical Co., Buf- falo, N. Y	S. E. Dowd, Clinton Haley & Chesebro, Stonington	30.00 32.00 38.00	20.
12428 12456	Grain and Grass_	Gloucester, Mass.	E. N. Pierce, Plainville_ J. M. White, Bristol Manufacturer	30.00 40.00 43.00 38.00	27.
12347	Bowker's Early Po-	Middletown	John Bransfield, Port- land	37.00	
	tato Manure	Boston	wich	35.00	23.
			ford	35.00 33.00 32.00	
2812†	Potato Manure	Quinnipiac Co., Boston		34.00	
2512	Stockbridge Top Dressing	Bowker Fertilizer Co., Boston	New London	31.00	21.
2433	Complete for Corn and Grain	Bradley Fertilizer Co., Boston.	Conn. School for Boys, Meriden	37.00	25. 22.
2429	Potato Fertilizer	Russia Cement Co.,	S. J. Stevens, Glaston- bury	33.00	ŵ
		Gloucester, Mass	Yantic	<b>32.00</b> 43.00	21.
2449	Hubbard's Potato Phosphate	Rogers & Hubbard Co., Middletown	G. W. Dennison, Say-	30.00	20.
2395		M. E. Wheeler & Co.,	G. C. Ingham, Saybrook D. G. Chesebro, Center	30.00 24.00	17.
			Groton Dwight Gallup, Old	28.00	
2479	Essex Tobacco Starter	Russia Cement Co., Gloucester, Mass	Mystic W. W. Cooper, Suffield J. B. Parker, Jr., Po- quonock	<b>26.00</b> 34.00	22.0
2665†	Potato Phosphate	Cleveland Dryer Co., Boston		31.00 32.50 26.00	17.

#### † See page 63.

# ANALYSES AND VALUATIONS-Continued.

1	0		NI	FROGE	N.				PHOS	PHORIC .	ACID.			Po	TASH.	
	erenc	1		1	Tot	al		1		Total		Availal	ble.	Four	nd.	
Station No.	Percentage difference between cost and valuation.	Nitrogen as Nitrates.	Nitrogen as Ammonia.	Nitrogen Organic.	Found.	Guaran- teed.	Soluble.	Reverted.	Insoluble.	Found.	Guaran- teed.	Found.	Guaran- teed.	As Muriate.	Total.	Guaranteed.
12817	43.6			3.16	3.16	3.3	3.18	4.26	1.93	9.37		7.44	6.0	2.40	5.36	5.4
12392	44.0			3.35	3-35	3.3	3.41	3.86	1.66	8.93		7.27	6.0	1.87	4.92	5.4
12428	44.I	1.00	.38	2.60	3.98	3.7	4.13	5.21	1.65	10.99	9.5	9.34		9.74	9.74	9:
12456†	45.4			3.10	3.10	2.5			-4	16.08	16.5			10.63	10.63	12
12347	45.5	1.10		2.32	3.42	3.0	5.95	2.79	1.23	9.97	9.0	8.74	7.0	7.09	7.09	7.
12812†	45.7			3.13	3.13	2.5	3.26	3.19	3· <b>7</b> 7	10.22	7.0	6.45	6.0	6.50	6.50	5.
12512	46.3	2.60		2.22	4.82	4.8	6.51	1.78	.32	8.61	6.0	8.29	4.0	6.07	6.07	6.
12433	46.5	.30	.42	2.15	2.87	3.3	4.18	7.28	1.41	12.87	13.0	11.46	12.0	5.12	5.12	3.
12429	46.6	.52		1.83	2.35	2.0	4.88	6.61	2.79	14.28	11.0	11.49		5.42	5.42	5
12449	47.3	.70		1.21	1.91	2.0	8.99	3.16	.60	12.75	10.0	12.15	9.0	5.13	5.13	5
12395	47.4						5.84	5.43	2.00	13.27		11.27	10.0	8.33	8.49	8
12479	47.7	1.46	5	1.54	1 3.00	2.5	4.91	6.88	2.31	14.10	12.0	11.79	)	.05	3.21	2
12665	48.0			1.9	7 1.9	7 2.1	6.44	3.72	2.23	12.39		10.16	8.0	2.80	2.80	3

+ See page 63.

		The participation of the			
Λο.	Name of Brand.	Manufacturer.	Dealer.	Dealer's cash price per ton.	Valuation per ton.
Station No.				r's c	tion 1
Stat				Deale	Valuat
12331	Fruit and Vine Ma	- Mapes F. & P. G. Co	., Birdsey & Foster, Meri-		
	nure	New York	den	\$38.00	\$24.9
12666	Tobacco Special &	W. E. Brightman, Tiv	ford - William Crane, Broad	37.00	
12432	Market Garden. Complete Potato	East India Chemica	Saxton & Strong Bris-	35.00	23.5
	Manure	& Co., Props., Nev	r tol v John Hartz, Burnside	<b>39.00</b> 40.00	26.2
12652	Conn. Wrapper	Milsom Rend. & Fertz	G. W. Barnes, Poquon-		
12336	Stockbridge Potato	Bowker Featilizer Co.	, E. B. Clark Co., Milford Bowker's Branch, Hart-	<b>35.00</b> 34.00	23.55 24.80
12638	Groton Corn and		ford	36.00 <b>37.00</b>	
12658	Grain	C. M. Shay, Groton Lister's Agric. Chem.	Manufacturer	25.00	16.7
12332	Grass and Grain	Works, Newark, N. J. Mapes F. & P. G. Co.	A. N. Clark, Milford Birdsey & Foster Mari	34.00	22.68
	Spring Top Dress-	New York	den	39.00	25.34
12485	Tobacco Fertilizer	Bradley Fertilizer Co., Boston	Mapes Branch, Hartford S. J. Stevens, Glaston-	38.00	
			W. W. Cooper, Suffield.	32.00 38.00 <b>34.00</b>	22.58
12605	Complete Potato & Vegetable	Rogers Mfg. Co., Rock-fall	F. S. Bidwell, Windsor Locks		
			Manufacturer R. H. Hall, East Hamp-	<b>32.00</b> 32.00	21.13
12379	Vegetable and Vine	Read Fertilizer Co.,	Adams & Canfield,	31.00	
		New York	Winnipauk Albert Bender, Glen-	30,00	18.43
2662	Special Potato Ma-	Crocker Fertz. & Chem.	F. M. Loomis, North	28.00	
	nure	Co., Buffalo, N. Y	Granby	25 50	23.24
2534	Northern Corn Special	Great Eastern Fertilizer Co., Rutland, Vt	Strong & Tanner, East	35.50	18.96
2596	Potato Manure		Winsted	29.00	
3,-			Lewis Ford, Norwich Manufacturer	29.00	17.55
2400	Tobagas Start I		I W Dennison Myetic	25.00	
2403	proved	Mapes F. & P. G. Co., New York	Mapes Branch, Hartford Southington Lumber &	33.00	21.37
			Feed Co., Southington	33.00	

#### ANALYSES AND VALUATIONS—Continued.

	9		NI	TROGE	N.				PHOS	PHORIC	ACID.			I	POTASH.	
	ferend t and				Tot	al gen.				Tota	d.	Availa	able.	For	und.	
Station No.	Percentage difference between cost and valuation.	Nitrogen as Nitrates.	Nitrogen as Ammonia.	Nitrogen Organic.	Found.	Guaran- teed.	Soluble.	Reverted.	Insoluble.	Found.	Guaran- teed.	Found.	Guaran- teed.	As Muriate.	Total.	Guaranteed.
233 <sup>I</sup>	48.2	-55	(200) (100)	1.63	2.18	1.7	3.15	3.81	.93	7.89	7.0	6.96	5.0	1.94	13.05	10.0
2666†	48.4	.70		2.84	3.54	3.3	5.24	3.49	1.89	10.62	9.0	8.73	8.0	6.60	6.60	7.0
2432	48.4	.77	1.28	1.64	3.69	3.0	4.94	1.85	.58	7.37	6.0	6.79	5.0	7.22	10.84	10.0
12652 12336	48.8 49.2	1.02	.18	4.03 2.48	4.2I 3.50	4.I 3.2	5.11 5.21	2.42 2.85	2.22	9·75 8.89	9.0	7.53 8.06	8.0	5.02 9.42	5.02 9.42	5.0
			1000							VIENEG						
2638	49.5		.12	2.57	2.69	1.8	3.61	3.15	.96	7.72	9.0	6.76	8.0	3.54	3.54	2.
2658	49.9		.74	2.61	3.35	3.7	6.17	1.89	1.54	9.60	8.5	8.06	7.5	6.44	6.44	7.
12332	50.0	1.66	.71	2.83	5.20	4.9	2.90	2.23	1.07	7.20	6.0	5.13	5.0	7.44	7.44	7.
12485	50.6	.56	.36	2.43	3.35	3.3	6.86	2.08	.57	9.51	10.0	8.94	8.0	5.97	6.13	4.
12605	51.4	.49		1.87	2.36	2.3	7.14	4.54	1.16	12.84	10.0	11.68	1	4.87	4.87	5.
12379	51.9			1.82	1.82	1.7	5.48	1.72	.46	7.66	7.0	7.20	6.0	8.05	8.05	8.
12662	52.8		01	4.00	4.00	3.7	6.03	2.86	.70	9.59	2	8.89	8.0	4.75	4.75	5.
12534	53.0	.56		2.54		3.0	6.86	2.51	1.20	10.57		9.37	8.0	2.10	2.10	2.
12596	53.8	.49		2.04	2.53	2.0	2.90	3.73	2.13	8.76	7.0	6.63	6.0	4.91	4.91	4:
12403	54.4	1.51	.68	2.17	4.36	4.1	2.03	6.06	1.97	10.06	8.0	8.09	6.0	0.85	2.13	I.

+ See page 63.

† See page 63.

# ANALYSES AND VALUATIONS—Continued.

				0			e ce		N	ITROGE	EN.				Pнos	PHORIC	ACID.			I	OTASH.	
ć	Name of Brand.	1		cash price	ton.		ference t and				Nitro	tal ogen.				Tot	al.	Availa	able.	For	ind.	
Station No.	Name of Brand.	Manufacturer.	Dealer.	Dealer's casl	Valuation per	Station No.	Percentage diffe between cost valuation.	Nitrogen as Nitrates.	Nitrogen as Ammonia.	Nitrogen, Organic.	Found.	Guaran- teed.	Soluble,	Reverted.	Insoluble.	Found.	Guaran- teed.	Found.	Guaran- teed,	As Muriate.	Total.	Guaranteed.
12328	Corn Manure	Mapes F. & P. G. Co. New York	Birdsey & Foster, Meri- den	\$34.00	\$20.57	12328	55.6	.77	.18	1.56	2.51	2.5	3.63	5.60	1.58	10.81	10.0	9.23	8.0	6.29	6.29	6.
12815	Potato Phosphate	National Fertilizer Co. Bridgeport	ford Gault Bros., Westport Ansonia Flour & Feed Co., Ansonia		20.51	12815	56.0		.50	1.77	2.27	2.0	4 <b>.1</b> 1	2.42	1.91	8.44	8.0	6.53	6.0	9.00	9.00	8.
12490	Special Potato Fer-	H. F. Tucker Co., Bos-	G. & A. H. Williams, E. Hartford			12490	56.7	.61		1.65	2.26	2.0	4.53	2.85	2.14	9.52	9.0	7.38	8.0	6.80	6.80	6
12436			bury L. A. Fenton, Norwich Town Bowker's Branch, Hart-	30.00	19.15	12490	30.7							Kara t								
÷	Starter	Boston	City Coal & Wood Co		21.67	12436	56.9	.38		2.30	2.68	2.3	7.63	3.91	1.16	12.70	12.0	11.54	8.0	.92	3.96	3
12465	Potato Phosphate	Quinnipiac Co., Boston	New Britain J. P. Lathrop, Plainfield C. A. Young & Co., Danielson		17.82	12465	57.1	.21		2.06	2.27	2.1	4.90	3.93	3.16	11.99	9.0	8.83	8.0	3.19	3.19	3
Market 1	manule	unizer Co., New York	J. P. Kingsley, Plain-	28.00	17.82	12631	57.1	.29		1.88	2.17	2.1	5.93	2.97	2.51	11.41	9.0	8.90	8.0	.40	3.17	5
	tilizer	Chem. Works, New-	J. E. Leonard & Son, Jewett City	26.00	16.45	12590	58.1			1.86	1.86	1.7	6.08	3.16	1.84	11.08	9.0	9.24	8.0	2.94	2.94	ŝ
	manufo	Boston	W. O. Goodsell, Bristol City Coal & Wood Co.,	26,00 <b>37.00</b>	23.40	12427	58.1	.68		2.64	3.32	3.0	7.39	2.06	.49	9.94	10.0	9.45		6.84	6.84	(
2621	Grass and Oat Fer-	M. E. Wheeler & Co.,	New Britain  E. F. Strong, Colchester	38.00		12621	58.2					10	6.99	4.00	1.45	12.44		10.99	II.O	2.28	2.28	2
		gammpiae Co., Boston	C. Buckingnam, South-		12.01	12647	59.2			1.43	1.43	1.2	4.19	2.81	1.53	8.53	7.0	7.00	6.0	5.24	5.24	3
2408	High Grade Potato Manure	Packer's Union Fertilizer Co., New York.	O S Dogges Fa	<b>24.00</b> 34.00	15.08 19.92	12408	60.6		322	2.23	2.23	2.1	7.39	1.80	-55	9.74		9.19	8.0	6.32	6.32	6
2344	Vegetable, Vine and C	Great Eastern Fertilizer Co., Rutland, Vt	A. S. Bennett, Cheshire	32.00 32.00 35.00 29.00	19.84	12344	61.3			2.27	2.27	2.1	7.20	2.04	.75	9.99		9.24	8.0	5.97	5.97	6
2405 I	Potato Manure	M. E. Wheeler & Co., Rutland, Vt	Mystic	39.00	18.29	12405	61.3			2.41	2.41	2.1	6.50	2.94	1.05	10.49		9.44	8.0	3.43	3.43	ن
			Groton	28.00																		
2533 F	Potato and Truck S Manure	. M. Hess & Bro., Philadelphia, Pa.	C. I. Phelan West	29.50 33.00 34.00	20.36	12533	62.1		-55	2.10	2.65	2.5	4.26	4.41	1.13	9.80		8.67	8.0	5.90	5.90	0

No.	Name of Brand.	Manufacturer.	Dealer.	ash price	oer ton.
Station No.				Dealer's cash per ton.	Valuation per ton.
12377	Potato Phosphate	Williams & Clark Fer- tilizer Co., New York		\$32.00	\$18.31
12393	Potato Fertilizer	Bradley Fertilizer Co. Boston	J. G. Schwink, Meriden P. Schwartz, Chester- field	30.00	17.6
12388	Potato Fertilizer	Cumberland Bone- Phosphate Co., Bos-	D. L. Clark, Milford Kahn Bros., Yantic Thos. McLyman, Green-	<b>29.00</b> 27.00	17.63
		ton	D. C. Spencer, Saybrook	30.00 30.00 <b>29.00</b>	
		tilizer Co., New York	F. L. Dimmock, New London	29.00	17.02
12401	Corn Fertilizer	Russia Cement Co., Gloucester, Mass.	E. N. Pierce, Plainville A. R. Manning & Co.,	34.00	20.02
		o postipulla, Post	Yantic	32.00 35.00	
	Potato Fertilizer_	E. Frank Coe Co., New York	P I Bolan Waterhury	33.00 30.00 35.00	17.94
12499	Potato Fertilizer	Clark's Cove Fertilizer	E. Bishop, New London J. M. Burke, So. Man- chester	28.00	18.24
12513	Bowker's Potato and Vegetable	Boston, Mass.	Bowker's Branch, Hart- ford	30.50	19.65
12353*	Potato Manure	Quinnipiac Co., Boston, Mass.	C. Buckingham, South- portOlds & Whipple, Hart-	28.00	18.39
22406	Corn Fortilizor	M E WI 1 2 G	ford	33.00 <b>31.00</b>	
12400	Corn Fertilizer	M. E. Wheeler & Co., Rutland, Vt	G. C. Ingham, Saybrook Dwight Gallup, Old Mystic	25.00	15.37
12212	Standard Special for	Standard Fertilizer Co.,	D. G. Chesebro, Center Groton	26.00	
2345	Potatoes	Boston	H. F. Child, Woodstock D. L. Clark, Milford Kinsella & Smallhorn, New Canaan	<b>30.00</b> 30.00	17.45 17.9 <sup>2</sup>
2495	Havana Tobacco Grower	M. E. Wheeler & Co., Rutland, Vt		32.00	22.18
		, , ,	E. E. Pitney, Ellington	40.00 37.00 <b>38.50</b>	22.10

#### ANALYSES AND VALUATIONS—Continued.

	e		N	TROGI	EN.				Рно	SPHORIC	ACID			I	POTASH.	
	fferen st and				To Nitro	tal ogen.		1		To	tal.	Avail	able.	Fou	ind.	
Station No.	Percentage difference between cost and valuation.	Nitrogen as Nitrates.	Nitrogen as Ammonia.	Nitrogen, Organic.	Found.	Guaran- teed.	Soluble.	Reverted.	Insoluble.	Found.	Guaran- teed.	Found.	Guaran- teed.	As Muriate.	Found.	Guaranteed.
2377	63.8	.71	1777	1.86	2.57	2.5	3.04	4.49	2.21	9.74	7.0	7.53	6.0	4.83	4.83	5
2393	64.3	.26		1.90	2.16	2.7	5.65	3.33	2.80	11.78	11.0	8.98	9.0	3.30	3.30	3
2388	64.5	.15		1.89	2.04	2.0	6.91	3.01	2.00	11.92	i1.0	9.92	9.0	2.97	2.97	3
2394	64.5	.32		2.00	2.32	2.0	5.84	3.24	2.38	11.46	10.0	9.08	9.0	2.14	2.14	I
2401	64.8	.40	22	2.10	2.50	2.0	3.84	6.93	3.20	13.97	11.0	10.77		3.36	3.36	3
2430	67.2		.30	1.45	1.75	1.7	7.02	2.20	1.97	11.19	10.0	9.22	8.0	.40	4.17	4
2499	67.2	.26		1.95	2.21	2.1	6.59	3.32	2.12	12.03	9.0	9.91	8.0	3.16	3.16	3
2513	67.9	.38		2.18	2.56	2.3	7.57	2.36	.89	10.82	11.0	9.93	9.0	4.16	4.16	4
2353*	68.6	.68		1.94	2.62	2.5	3.18	4.37	2.33	9.88	7.0	7.55	6.0	4.67	4:67	5
					- 1											
2406	69.2			1.80	1.80	1.6	6.72	2.44	.95	10.11	8.0	9.16	8.0	2.29	2.29	2
2212	71.9	-35		1.83	2.18	2.1	5.38	3.16	3.23	11.77	9.0	8.54	8.0	3 28	3.28	3
<sup>2</sup> 345	73.0	.68		1.82	2.50	2.0	3.89	2.45	2.49	8.83	8.0	6.34	6.0	5.48	5 48	5
2495	73.6			3.17	3.17	2.9	4.99	2.57	1.02	8.58		7.56	6.0	3.33	6.84	7

\* See note, page 63.

<sup>\*</sup> See note, page 63.

# ANALYSES AND VALUATIONS—Continued.

							0	T A	NI	TROGE	N.				Phos	PHORIC	ACID.			Pe	OTASH.	
	for the second	,		price	ou.		and				Tot	al gen.				Tota	al.	Availa	ble.	Four	id.	
Station No.	Name of Brand,	Manufacturer.	Dealer.	Dealer'e cash per ton.	Valuation per t	Station No.	Percentage diffication.	Nitrogen as Nitrates.	Nitrogen as Ammonia.	Nitrogen, Organic.	Found.	Guaran- teed.	Soluble.	Reverted.	Insoluble.	Found.	Guaran- teed.	Found.	Guaran- teed.	As Muriate.	Total.	Guaranteed
	phate	Great Eastern Fertilizer Co., Rutland, Vt E. Frank Coe Co., New	H. S. Harvey, Windham	\$20.00	\$11.50	12540	73.9					Revise V	4.37			12.28	S-1			1.90	1.90	2.0
	Fertilizer	York	J. O. 2 01 C OO, 1 UI	38.00	21.80	12663	74.3			10 10 20 00 0	HIN THEO			11 3 V 1 19	ATT THE REAL PROPERTY.	10.04	ALOSSON TO	0.1000	K CONTROL	.17	6.57	6.5
12370	Phosphate		brook Lewis Dowd, Madison_	30.00	16.80	12376	77.6	.15		1.74	1.89	1.5	7.76	2.84	1.36	11.96	10.0	10.60	8.0	2.18	2.18	2.0
12434	Corn Phosphate	Bradley Fertilizer Co., Boston		30.00 31.00	16.87	12434	77.8			2.15	2.15	2.1	6.50	3.22	2.19	11.91	10.0	9.72	9.0	1.81	1.81	1.5
12390	Animal Corn Fertilizer	Packer's Union Fertilizer Co., N. Y	O. S. Rogers, Essex Nelson Dayton, New London		17.58	12390	79.2			2.58	2.58	2.5	6.50	2.83	.98	10.31		9.33	8.0	2.19	2.19	2.0
12410	Bowker's Potato and Vegetable Phos- phate	Bowker Fertilizer Co., Boston		30.00 31.50 34.00	16.63	12410	80.4	,20		1.67	1.87	1.5	7.10	3.17	1.68	11.95	11.0	10.27	9.0	2.18	2.18	2.0
12607	Potato Phosphate	Berkshire Mills Co., Bridgeport		35.00 30.00 32.00 32.00	17.71	12607	80.7			2.07	2.07	1.6	3.10	3.90	4.85	11.85	8.0	7.00	6.0	4.78	4.78	4.0
12496	Ammoniated Corn Phosphate		Manufacturer F. M. Loomis, North Granby C. F. Tallard & Son, Broad Brook	34.00	17.15	12496	80.8			2.08	3 2.08	2.0	7.36	3.75	1.22	12.33		. 11.11	10.0	1.43	1.43	1.6
12478	Special Potato Fer- tilizer	Milsom Rend. & Fert. Co., E. Buffalo, N. Y.	ock	31.00	16.77	12478	84.9			_ 1.6	4 1.64	. I.C	6 4.58	3 2.58	3 1.41	8.57	10.0	7.16	8.0	6.40	6.40	8.0
	Phosphate	Williams & Clark Fer- tilizer Co., New York Milsom Rend. & Fert. Co., E. Buffalo, N. Y.	S. G. Brown, Norfolk C. H. Davis, Guilford G. W. Barnes, Poquon-	28.00 28.50	15.10 15.92	12582 12484	85.4 86.9	1		- I.4 - 2.4	5 1.45	i I	2 4.72 5 5.10	2 2.55	5 1.42	8.60	7.0	7.27	6.0		4.92 2.01	
12470	Corn Manure	Quinnipiac Co., Boston	S. V. Osborne, Branford R. B. Witter, Brooklyn	31.00 29.75 32.00	17.07	12470	87.5	.38	8	- 1.9	4 2.32	2 2.	0 5.8	7 3.5	7 2.62	2 12.06	5 10.0	9.4	4 9.0	1.76	1.76	1.5
	Manure	Bradley Fertilizer Co., Boston	Loomis Bros., Granby	45.00	23.90	12535	88.3		3.9	7 1.8	5 5.8	2 5.	8 1.2	5 4.5	3 1.81	7.59	9 6.0	5.7	8 5.0	1.58	3 10.48	10.0
12472	Special for Potatoes	Standard Fertilizer Co.,	W. B. Chamberlain & Son, Colchester J. W. Howe & Son, So.		17.67	12472	B. 19530 000	Marie Control	011/	1	D. L. W.	100		- 10-	SE NOW	1000	1000			3.38	3.38	3.0
12645	Grass and Grain Fer- tilizer	Pacific Guano Co., Boston	Glastonbury Carlos Bradley, Elling- ton	34.00 24.00	12.47	12645	92.5	5		1.1	7 1.1	7 0.	8 5.4	2 2.8	5 1.7	3 10.0	0 8.	0 8.2	7 7.0	1.58	8 1.58	3 I.I

Station No.	Name of Brand,	Manufacturer.	Dealer,	Dealer's cash price per ton.	Valuation per ton.
12447	Wheat and Corn Producer	Niagara Fertilizer Works, Buffalo, N. Y.	W. R. Atwell, Durham. H. A. Kinne, So. Glas-	\$28.00	\$14.3
12407	Oats and Clover Fertilizer	Packer's Union Fertili-	O. S. Rogers, EssexA. S. Bennett, Cheshire	28.00 24.00 21.00	II.2
12630 12483†	Potato, Hop and	Milsom Rend. and Fert. Co., E. Buffalo, N. Y. Milsom Rend. and Fert.	Bloomfield	31.50	15.8
	Tobacco	Co., E. Buffalo, N. Y.	G. W. Barnes, Poquon- ock	32.00	15.5
12653	Wheat, Oats and Barley Phosphate	Milsom Rend. and Fert. Co., E. Buffalo, N. Y.	J. R. Gilbert, Gilead	31.00	12.28
12649	Potato Special	Pacific Guano Co., Bos-	J. O. Fox & Co., Put-	25.00	
12446	Potato, Tobacco and	Niagara Fertilizer	H. A. Kinne, So. Glas-	36.00	17.58
	Hop Fertilizer	Works, Buffalo, N. Y.	W. R. Atwell, Durham	33.00	14.66

+ See page 63.

#### 2. Sampled by Private Individuals.

12281. Ten Per Cent. Potato Fertilizer, made by the Preston Fertilizer Co., Brooklyn, N. Y. Sampled and sent by O. G. Beard, Shelton.

12445. Tobacco Ash Elements, made by the Bowker Fertilizer Co., Boston, Mass. Sampled and sent by H. M. Rose, West Suffield.

## ANALYSES AND VALUATIONS-Continued.

	0		NI	TROGE	N.				Phos	PHORIC	ACID.			P	OTASH.	
	erenc and		DE SE		Tot	al ogen.				Tot	al.	Avail	able.	Fou	nd.	
Station No.	Percentage difference between cost and valuation.	Nitrogen as Nitrates.	Nitrogen as Ammonia.	Nitrogen, Organic.	Found.	Guaran- teed.	Soluble.	Reverted.	Insoluble.	Found.	Guaran- teed.	Found.	Guaran- teed.	As Muriate.	Total.	Guaranteed.
12447	94.6			1.56	1.56	1.2	4.82	3.88	1.87	10.57		8.70	8.0	2.15	2.15	2.2
12407	94.9						4.96	6.13	1.20	12.29	-,	11.09	11.0	1.71	1.71	2.0
12630	98.4		.12	1.94	2.06	2.1	4.28	3.26	1.15	8.69	9.0	7.54	8.0	3.73	3.73	4.0
12483†	99.6			2.06	2,06	2.1	4.86	2.55	1.51	8.92	9.0	7.41	8.0	3.24	3.24	4.0
12653	103.6			1.29	1.29	1.2	4.88	2.88	1.34	9.10		7.76	8.0	1.69	1.69	-2.0
12649	104.8	.24		2.00	2.24	2.0	4.32	4.42	3.53	12.27	9.0	8.74	8.0	2.99	2.99	3.0
12446	125.1			1.67	1.67	1.6	4.80	3.31	.85	8.96	8.0	8.11	8.0	3.14	3.14	2.7

+ See page 63.

#### ANALYSES AND VALUATIONS.

the state of the s	12281	12445
Nitrogen as nitrates	0.34	
" organic	1.89	
" total	2.23	
Soluble phosphoric acid	4.13	trace.
Reverted phosphoric acid	6.36	8.57
Insoluble phosphoric acid	3.68	2.52
Total phosphoric acid	14.17	11.09
Potash as muriate	9.24	1.80
Potash, total	9.24	15.13
Cost per ton	\$30.00	\$30.00
Valuation per ton		22.73

#### HOME MIXTURES. FORMULAS AND

			FORM	ULAS.	Poun	DS PER	ton (	of Mi	XTURE.	
Station No.	Made by	Nitrate of Soda.	Tankage.	Blood, Bone and Meat.	Dry Ground Fish.	Bone.	Dissolved Bone Black.	Dissolved Rock Phosphate.	Sulphate of Potash.	Muriate of Potash.
12298 12341 12342 12372 12462 12568	S. D. Woodruff & Sons, Orange A. C. Innis, Stratford	100 150 167	1200 833 750 1400 800	666		167 800	200	833 750 200 650	200	300 400 334 200 400 400 334 400

#### HOME MIXTURES.

In the table just above, are given the analyses and valuations of eight mixtures made by farmers according to formulas given in the table from fertilizer chemicals bought by them. The cost does not include the outlay for mixing these chemicals, which is usually estimated at two or three dollars per ton. The average cost per ton is \$26.55, or, including mixing, \$29.50 at the most. The average valuation is \$26.61 per ton, and the percentage difference between cost, mixing included, and valuation is 10.9.

The mixing is often a rainy day job that employs labor otherwise idle and thus has the quality of "a penny saved" which "is twopence earned."

#### MISCELLANEOUS FERTILIZERS AND MANURES.

#### COTTON HULL ASHES.

In the table, pages 82 to 83, are given analyses of thirty-six samples of cotton hull ashes; which are extensively used as a source of potash for fertilizing tobacco lands where "Connecticut Havana" wrapper leaf is raised, in the Connecticut River valley.

These analyses show the usual wide range of composition.

#### ANALYSES AND VALUATIONS.

			Anal	YSES.			Philippin .	COST (UNI	MIXED) AND ATION.
Nitrogen as Nitrates.	Organic Nitrogen.	Total Nitrogen.	Soluble Phosphoric Acid.	Reverted Phosphoric Acid.	Insoluble Phosphoric Acid.	Total Phosphoric Acid,	Potash.	Cost per ton.	Valuation per ton.
0.78 1.60 0.14 0.80  1.21 0.98	3.11 3.38 2.62 2.64 5.35 2.08 2.87 3.20	3.89 4.98 2.76 3.44 5.35 3.29 3.85 3.54*	5.06 1.87 3.01 4.08 1.25 5.01 3.89 0.38	3.52 5.41 5.82 3.31 3.60 3.34 5.45 8.80	2.58 5.27 3.71 2.87 2.39 1.95 2.28 1.57	11.16 12.55 12.54 10.26 7.24 10.30 11.62 10.75	7.36 11.31 9.93 7.96 11.15 10.49 7.49 8.82	\$26.00 35.00 20.00 22.00 35.00 23.55 27.00 25.20	\$25.32 31.19 24.98 23.71 29.43 25.73 25.63 25.49

<sup>\* 0.34</sup> per cent. of nitrogen as ammonia.

The highest percentage of water-soluble potash found was 30.94, the lowest 11.10 (excluding this, the lowest is 16.96) and the average, 22.62, slightly lower than in the previous year, (23.3.)

Allowing 4½, 4 and 2 cents per pound respectively for water-soluble, citrate-soluble and insoluble phosphoric acid, the water-soluble potash has cost from 4.2 cents to 7.3 cents per pound, or 6.7 cents per pound on the average, a little less than in the previous year, (7.1).

Purchasers are urged to insist on a guarantee of water-soluble potash. Samples often contain from one to five per cent. of potash insoluble in water and presumably but slowly available to plants.

In seven of the samples received, the total potash as well as water-soluble potash was determined with the following results:

Percentages of Water-Soluble and of Total Potash in Samples of Cotton Hull Ashes.

Water-Soluble Potash.	Total Potash.	Potash.Insoluble in Water.
24.34	26.92	2.58
21.98	25.02	3.04
21.18	24.20	3.02
19.70	22.20	2.50
22.90	24.18	1.28
19.14	22.48	3.34
20 =0	25.82	5.24
	Potash.  24.34  21.98  21.18  19.70  22.90	Potash. Total Potash.  24.34 26.92  21.98 25.02  21.18 24.20  19.70 22.20  22.90 24.18  19.14 22.48

#### COTTON HULL ASHES.

No.	Dealer or Purchaser.	Supplied by
Station		
Sta		
12670	C. C. Fuller, New York	Comstock, Ferre & Co., Wethers-
	011 0 3771: 1 77 .6 1	field
12042	Olds & Whipple, Hartford	
12272	American Cotton Oil Co., New	
	Vork Olds & Whipple, Hartford	
12277	Arthur Sikes, Suffield	
12444	Olds & Whipple, Hartford	
12271	Olds & Whipple, Hartford, by H.	
2/92	C. Aborn & Son, Ellington	
12323	W. F. Fletcher, Southwick, Mass.	John B. Cannon, W. Suffield
12381	Arthur Sikes, Suffield	G. A. Douglass, Thompsonville.
12187	" "	Chas. H. Wells, Suffield
12182	W. W. Cooper, "	Alanson Hoffman, West Suffield.
2358	Althui Dikes,	Ernest N. Austin, Suffield
12043	Olds & Whipple, Hartford, by T. P.	
	Kinney, Windsor	Station Agent
12186	Ariel Mitchelson, Tariffville	Alfred H. Griffin, Granby
12529	VI 1 0 1 1 0 0	C. Dwyer, Bloomfield
12363	Humphreys, Goodwin & Co.,	C A Vant Sagald
	Memphis, Tenn	
12031		
12530	P. I. Spencer Suffield	F. B. Hatheway, Windsor Locks
12505	Olds & Whinnle Hartford	W. S. Pinney, Suffield
12362	Chas. L. Spencer	E. S. Seymour, Windsor Locks
12319	J. C. Eddy, Simsbury	
12458	Planters' Cotton Seed & Crushing	
	Ass'n, Greenville, Miss.	
10857	Edmund Halladay, Suffield	
12164	Loomis Bros., Granby	
12475	W. W. Cooper, Suffield	
2459	W. S. Pinney, "	
12382		
12027	Arthur Silves Suffield	Chas. C. Bissell, Suffield Edward Austin, Mapleton
12185	Wm Pinney "	C. D. Woodworth, Thompsonville
12506	Olds & Whipple, Hartford	Station Agent
12517	" " " " " " " " " " " " " " " " " " "	F. L. Chandler, South Windsor.
12364	W. W. Cooper, Suffield	
12028		Chas. C. Bissell, "
12383	C. C. Fuller, New York	" "
0 0		

#### ANALYSES.

Station No.	Soluble Phosphoric Acid.	Reverted Phosphoric Acid.	Insoluble Phosphoric Acid.	Total Phosphoric Acid.	Potash Soluble in Water.	Cost per ton.	Valuation per ton.	Potash costs cents per pound.
	6.0					ф 6 o	фта 16	4.0
12670	.04 2.96	2.48 8.17	.84	3.36	30.94	\$11.60 40.00	\$13.46 40.23	4.2 5.0
	4.27	7.45	.69	12.41	29.72	40.00	39.80	5.0
12272	4.26	7.54	-57	12.37	29.14	40.00	39.23	5.1
12277	2.62	6.02	-55	9.19	24.34	32.50	31.74	5.2
12444	3.70	5.50	.73	9.93	27.32	40.00	35.34	5.9
72702	1.12	5.46	.62	7.20	28.23	40.00	33.86	6.1
12792	1.23	6.24	.65	8.12	24.40	36.00	30.76	6.1
12381	2.82	6.73	.70	10.25	21.98	35.00	30.18	6.1
12187	1.74	6.15	.87	8.76	21.18	32.50	28.02	6.1
12182	1.25	7.44	.71	9.40	26.16	40.00	33.52	6.2
12358	1.50	7.05	1.01	9.56	19.70	32.50	27.09	6.4
12043	1.86	7.91	.76	10.53	24.20	40.00	32.50	6.5
12186	.61	7.84	.70	9.15	22.08	36.00	29.18	6.5
12529	1.39	4.44	.16	5.99	25.04	38.00	29.90	6.6
12363	.66	5.72	-55	6.93	22.28	35.00	27.67	6.6
12031	2.00	7.24	.97	10.21	24.12	40.00	32.10	6.6
12530	.74	7.64	.28	8.66	23.24	38.00	30.13	6.
12505	1.02	7.37	.53	8.92	24.38	40.00	31.41	6.8
12320	1.02	6.26	1.19	8.47	20.63	35.00	27.04	6.0
12362	1.23	8.25	1.01	10.49	22.56	40.00	30.67	7.
12319	1.73	6.78	.76	9.27	22.90	40.00	30.18	7.
12458	1.23	5.23	.93 .	7.39	20,56	35.00	26.22	7.
10857	.54	8.06	.75	9.35	21.26	38.00	28.50	7.
12164	1.38	8.74	.95	11.07	20.36	38.00	28.97	7.
12475	.91	6.25	.52	7.68	22.00	38.00	28.03	7.
12459	1.36	8.45	.86	10.67	21.84	40.00	30.16	7.
12382	1.31	8.36	.78	10.45	21.48	40.00	30.18	7.
12027	1.33	10.13	.46	11.92	20.70	40.00	24.94	7.
12185	1.04	5.52	1.10	7.66	19.14	40.00	28.32	7.
12506	.94	7.46	.90 I.03	9.30 8.83	20 58	40.00	27.26	8.
12317	.30	7.50 5.18	.76	6.42	21.42	40.00	26.29	8.
12364	.48	5.10	.87	6.90	18.72	40.00	23.94	9.
12028	·45 ·50	8.41	.77	9.68	16.96	40.00	24.45	9.
12383	-75	8.24	.71	9.70	18.54		26.09	

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#### WOOD ASHES.

In the following table are given analyses of twelve samples of wood ashes.

Sample 14010 is from the pits in the smoke house of the Hoyt Provision Co. of New Haven.

Sample 12061 represents wood ashes from the furnaces of a Waterbury Brass Mill.

Sample 14020 was analyzed in due course, but the form containing the description of the sample, with name and address of the sender, could not be found when the analysis was completed. It is hoped that this may meet the eye of the person who sent it and explain to him our failure to make prompt report to him of the analysis.

The eight analyses of "Canada Ashes" given in the table contain on the average 4.63 per cent. of water-soluble potash. 1.54 per cent. of phosphoric acid and 33.57 per cent of lime, or about 59.5 per cent. of carbonate of lime.

The lime contained in ashes is often their most valuable ingredient for agricultural purposes. A ton of unleached wood ashes, calculated from the average of the analyses given above, contains 671 pounds of lime, 93 pounds of potash, and

#### Sources, Analyses and Cost of

Station No.	Dealer or Purchaser.	Sampled or sent by
	Unleached Ashes.	
10856	Bowker Fertilizer Co., Boston	N. D. Platt, Milford
12457	Bowker Fertilizer Co., Boston, by H. B. Sherwood, Southport	to the last the first of the second states
12616	Bowker Fertilizer Co., Boston, by Sim-	
	eon Pease, Greenfield Hill	H. C. C. Miles, Milford
12300	Geo. Munroe, Oswego, N. Y	Conn. Valley Orchard Co. Deep River
12327	Geo. Munroe, Oswego, N. Y., by Conn. Valley Orchard Co., Berlin	
12531		Earl Cooley, Berlin
33-	ell St. John, Simsbury	Station Agent
12502	Warren Woolen Co., Stafford Springs,	Station rigonitization
	by Chas. Sikes, Jr., Ellington	Station Agent
12793		S. R. Woodward, Bethany
14020		
		Elm City Nursery Co., New Haven
12061	"Brass Mill"	The Everett B. Clark Co. Milford
	Leached Ashes.	
10855	B. A. Jackson, South Norwalk	Geo S. Jennings, Southport

3 pounds of phosphoric acid, costing \$9.41. Allowing 5 cents per pound each for potash and phosphoric acid, the pure lime (calcium oxide) in the nine samples has cost forty-eight cents for 100 pounds.

Ashes are sometimes sold with a guarantee of 5.0 per cent. of "potash." This Station, as a rule, determines only the notash soluble in water; for the reason that only potash which is freely soluble can be regarded as immediately available to vegetation. Green sand marl, feldspar, and glass all may contain considerable quantities of "potash," but in forms which vield it up to the roots of plants extremely slowly.

Sample 12793 contained only 3.84 per cent. of water-soluble potash and 0.53 per cent. of potash insoluble in water, but dissolved by strong acids; making the total potash present 4.37 per cent.

In the table is given a single analysis, 10855, of leached wood ashes, having the usual composition, 0.15 per cent. of watersoluble potash, 0.87 per cent. of phosphoric acid, 43 per cent. of carbonate of lime and nearly 30 per cent. of water. Mr. Jennings states that this was bought for unleached ashes for \$7.00 per ton with a guarantee of 4-5 per cent. of potash.

WOOD ASHES.

Potash Soluble in Water,	Phosphoric Acid.	Lime, Calcium Oxide.	Carbonic Acid.	Sand and Soil.	Charcoal.	Cost per ton
			y hite	11		Ti Visi
4.78	1.97	40.17	27.93	9.13	1.23	\$
4.65	1.59	28.48	19.95	11.82	1.61	10.00
4.35	1.57	29.42	19.88	12.08	1.45	10.00
4.98	1.34	31.40	21.67	10.65	1.23	9.50
4.66	1.28	31.56	18.78	10.38	1.44	10.00
5.90	1.36	29.14	17.54	12.89	2.09	10.00
3.85	1.79	46.88	20.57	4.09	1.86	7.00
3.84	1.39	31.52	20.57	10.96	1.86	7.00
1.04	.54 .	48.57	23.94	3.16	2.03	
4.93	.92	33.28	24.03	10.21	6.66	
4.32	2.83	42.60	24.77	5.68	1.15	
0.15	0.87	23.67	19.70	8.36	2.36*	

<sup>\*</sup> Also contains 29.74 per cent. water.

#### REVIEW OF THE FERTILIZER MARKET.

For the Year Ending October 31, 1899.

By E. H. JENKINS.

NITROGEN.

#### Nitric Nitrogen.

The wholesale New York quotation of nitrogen in form of nitrate of soda was 9.9 cents per pound in November, 1898. It rose gradually to 10.7 cents in April, 1899, fell again to 10.4 in August and rose to 10.9 cents in October.

The average of the monthly quotations for a number of years—from November 1st to November 1st, has been as follows:

Year \_\_\_\_\_ 1899 1898 1897 1896 1895 1894 1893 1892 Average quotation, cents

per pound for nitrogen,

Nitrate nitrogen has sold at *retail* in the State for from 12.6 to 14.5 cents per pound, or from \$40 to \$45 per ton for nitrate of soda.

#### Ammonic Nitrogen.

The wholesale New York quotation of nitrogen in sulphate of ammonia was 12.6 cents per pound in November, 1898.

It rose gradually to 15.3 cents in June, 1899, and fell again to 14.3 cents in October. The average of the monthly quotations for the year, November 1st to November 1st, has been 14 cents per pound.

The corresponding averages of previous years have been:

per pound for nitrogen,

wholesale----------- 14.0 11.9 10.5 11.1 14.3 17.3 15.7 14.5

Scarcely any sulphate of ammonia is bought by farmers in this State in unmixed goods, because with the high and fluctu-

ating prices it is not thought to be so economical to use as nitrate of soda or organic forms of nitrogen.

#### Organic Nitrogen.

The wholesale New York quotations of nitrogen in the forms of red blood, black or low grade blood and concentrated tankage are given in the table on page 91, and show only slight fluctuations.

Dried blood has not been largely sold at retail in the Connecticut market. The single sample analyzed, page 23, contained 13.68 per cent. of nitrogen, which cost 14.1 cents per pound.

Low grade tankage, fish, bone and especially cotton seed meal are the forms most popular with those who buy fertilizer materials unmixed at retail. Dry fish has been a cheap form of organic nitrogen during the past year.

In cotton seed meal nitrogen has cost at retail 12.9 cents per pound.

#### PHOSPHATIC MATERIALS.

The wholesale price of ground bone and bone meal have advanced during the year by \$1.75 and \$2.50 per ton respectively. Charleston rock has risen by about twenty-five cents per ton, while bone black has fallen slightly.

The wholesale quotation of acid phosphate remained the same through the year until October.

The figures given on page 27 show that at retail, available phosphoric acid has cost in dissolved bone black from 5.9 to 7.0 cents per pound and in dissolved rock phosphate from 3.7 to 6.1 cents per pound.

#### POTASH.

The prices of potash salts, which are regulated by the German Kali Works, show little fluctuation.

#### Muriate of Potash.

Potash in this form cost, at wholesale, in New York, 3.64 cents per pound in October, 1898, and is now quoted at 3.58 cents.

The average retail price in Connecticut, during the year covered by this review, has been 4.2 cents per pound.

Double Sulphate of Potash and Magnesia.

At wholesale in New York, potash in this form cost 4.11 cents per pound in November, 1898, and it is now quoted at 3.91 cents.

Its retail cost in Connecticut has been about 5.5 cents.

#### High Grade Sulphate of Potash.

At wholesale, in New York, potash in this form cost 4.09 cents in November, 1898, and it has since fallen to 4.07 cents.

The retail cost of potash in this form has been about five cents per pound.

There are two other forms of potash, much used on tobacco lands, which are worth the attention of all farmers. Cotton hull ashes, when of good quality, contain over twenty per cent. of potash, *chiefly in form of carbonate*, and eight to ten per cent. of phosphoric acid. At present prices actual potash costs more in this material than in the Stassfurt Salts, but as the ashes are strongly alkaline their use may be found very profitable on lands which have been dressed for some time with chemical fertilizers, and on meadows having acid soils.

The second form of potash fertilizers is tobacco stems, which contain eight per cent. or more of potash together with two per cent. of nitrogen and one per cent. of phosphoric acid.

#### EXPLANATIONS OF MARKET QUOTATIONS.

The following explanations will help in the examination of the market quotations, and will also show the basis on which they have been interpreted in this review:

Phosphate rock, kainit, bone, fish-scrap, tankage, and some other articles, are usually quoted and sold by the ton. The seller usually has an analysis of his stock, and purchasers often control this by analysis at the time of the purchase.

Sulphate of ammonia, nitrate of soda and the potash salts are quoted and sold by the pound, and generally their wholesale and retail rates do not differ very widely.

Blood, azotin, and concentrated tankage are quoted at so much "per unit of ammonia." To reduce ammonia to nitrogen, multiply the per cent. of ammonia by 14 and divide that product by ply the per cent. of ammonia" is one per cent., or 20 pounds per 17). A "unit of ammonia" is one per cent., or 20 pounds per ton. To illustrate: if a lot of tankage has 7.0 per cent. of nitrogen, equivalent to 8.5 per cent. of ammonia, it is said to contain equivalent to 8.5 per cent. of ammonia, it is said to contain 18½ units of ammonia, and if quoted at \$2.25 per unit, a ton of it will cost  $8\frac{1}{2} \times 2.25 = $19.13$ .

The term "ammonia" is *properly* used only in those cases where the nitrogen actually exists in the form of ammonia, but it is a usage of the trade to reckon all nitrogen, in whatever form it occurs, as ammonia.

To facilitate finding the actual cost of nitrogen per pound from the cost per unit of ammonia in the market reports, the following table is given:

Ammonia at \$3.00 per unit is equivalent to nitrogen at 18.2 cts. per lb.

Illinoina	ac 45.00				STATE OF STREET	T.
66	2.90	"	"	66	17.6	66
44	2.80	. 66	"	"	17.0	"
"	2.70	"	"	"	16.4	"
"	2.60	"		"	15.8	"
66	2.50	"	"	66	15.2	66
"	2.40	"	"	44	14.6	"
"	2.30	"	"	66	14.0	
66	2.20	"	"	"	13.4	66
66	2.10	40	"	"	12.8	"
"	2.00			" .	12.2	"
"	1.90	"	"	***	11.6	"
**	1.80	"	"	"	11.0	
"	1.70	"	"	"	10.3	"
"	1.60	"	"	"	9.7	"
"	1.50	"	"	"	9.1	"

Commercial sulphate of ammonia contains about 20.8 per cent. of nitrogen, though it varies somewhat in quality. With that per cent. of nitrogen (equivalent to 25.25 per cent. of ammonia),

If quoted at 2.6 cents per pound, Nitrogen costs 12.5 cents per pound.

***		Per pound,	TAILLOSCII	COSTS	14.7	COLLEG	her ho
"	2.5	ei .	"	"	12.0		"
**	2.4	"	"	66	11.5		46
66	2.3	"	66	66	II.I		66
66	2.2	a a	"	66	10.6		"
66	2.1	"	"	66	10.1		66
	2.0	"	"	"	9.6		"
	7				9.0		

Commercial nitrate of soda averages 95 per cent. of pure sodium nitrate, or 16 per cent. of nitrogen.

If quoted at	2.5 cents	per pound,	Nitrogen	costs	15.6 cents	per po-
"	2.4	"	80	66	15.0	"pound.
"	2.3	"	- 44	"	14.4	"
"	2.2	"	p- 11	"	13.8	**
"	2.I	"	"	"	13.2	"
"	2.0	"	"	"	12.5	**
"	1.9	4	"	"	11.9	"
"	1.8	"	"	"	11.3	"
66	1.7	"	"	66	10.6	"
"	1.6	"	"	"	10.0	"
"	1.5	"	"	"	9.4	"

Commercial Muriate of Potash usually contains 50½ per cent. of "actual potash," or potassium oxide.

If quoted at 2.20 cen	ts per pound,	Potassium oxide	costs 4.35	cents per 1b.
-----------------------	---------------	-----------------	------------	---------------

66	2.15	"	"	"	4.25	" 1
"	2.10	"	"	"	4.15	"
"	2.05	"	"	66	4.06	"
"	2.00		"		3.96	"
66	1.95	"	"	"	3.86	"
"	1.90	"	"	"	3.76	"
"	1.85	"	"	"	3.66	66
"	1.80	"	"	"	3.56	"
"	1.75	"	"	"	3.46	"
"	1.70	**	66	"	3.36	"

High Grade Sulphate of Potash, as it is found in the Connecticut market, contains about 49.2 per cent. of actual potash.

If quoted at 2.50 cents per pound, Potassium oxide costs 5.1 cents per lb.

quoted	at 2.50	cents per pound,	T Otassiani	Ozride copie	5	· · · ·
"	2.45	"	"	"	5.0	66
"	2.40	"		"	4.9	"
66	2.35	. "	"	"	4.8	66
"	2.30	"	"	"	4.7	"
"	2.25	"	"	"	4.6	"
66	2.20	**	66	"	4.5	66
"	2.15	"	"	"	4.4	"
"	2.10	"	"	"	4.3	"
"	2.05	"	"	"	4.2	"
"	2.00	"	"	"	4.I	

The Double Sulphate of Potash and Magnesia has about 26½ per cent. of potassium oxide.

If quoted at	1.00 cents	per pound,	Potassium	oxide costs	3.77 cents	per 1b.
If quoted a		"		"	3.90 4.15	"
46	1.10	"	"	"	4.34	"
"	1.20	"	"	"	4.53	"
	1.25	"	"	"	4.72	"
"	1.30	***	"		4.90	

The following table shows the fluctuations in the wholesale prices of a number of fertilizing materials in the New York market, since November, 1894. The price given for each month is the average of the four weekly quotations for that month. Sulphate of ammonia is assumed to contain 20.8 per cent. and nitrate of soda 16.0 per cent. of nitrogen, muriate of potash 50½ per cent., high grade sulphate 49.2 per cent., and double manure salt 26.5 per cent. of actual potash.

#### WHOLESALE PRICES OF FERTILIZING MATERIALS.

		Cost	of Nitr	ogen at	wholesa	le in	Cost	of Pota olesale	sh at	in ock.
		Dried	Blood.	age.		ia.		1	te	horic Acid in Carolina Rock
		Red. Cents per pound.	Black or low grade. Cents per pound.	Concentrated Tankage.	Nitrate of Soda. Cents per pound.	Sulphate of Ammonia Cents per pound.	Muriate of Potash. Cents per pound.	Double Manure Salt. Cents per pound.	High Grade Sulphate of Potash.	Available Phosphoric Acid in Dissolved South Carolina Roc
1895.	November	11.7	9.9	12.3	11.6	12.0	3.60 3.60	4.32 4.32	4·34 4·34	2.0
1896.	January	II.O	9.8	12.3	10.8	11.6	3.60	4.32	4.34	2.0
	February	10.8	9.8	12.3	10.7	11.3	3.55	3.99	4.13	2.
	March	10.8	9.8	12.3	10.7	11.5	3.53	3.87	4.05	2.
	April	10.8	9.8	12.3	10.7	II.I	3.60	3.94	4.10	2.
	May	10.7	9.9	12.3	10.9	10.8	3.60	3.94	4.10	2.
	June	10.5	9.8	12.3	10.8	10.8	3.60	3.94	4.10	2.
	July	10.5	9.8	12.6	10.8	10.8	3.60	3.94	4.10	2.
	August	10.5	9.8	11.4	10.8	10.7	3.60	3.94	4.10	2.
	October	10.2	9.I 9.0	9.5	11.3	10.5	3.60	3.94	4.10	2.
	November	11.0	10.1	9.4	11.6	10.8	3.59	3.94	4.10	2.
	December	11.2	10.8	9.5	12.1	10.4	3.59	3.94	4.10	2.
897.	January	10.7	10.1	9.4	12.1	11.0	3.59	3.94	4.10	2.
	February	10.6	10.0	9.4	11.9	II.O	3.59	3.94	4.10	2.
	March	10.5	10.1	9.4	11.9	10.9	3.59	3.94	4.10	2.
	April	10.5	9.9	9.4	12.3	10.8	3.60	3.97	4.10	2.
	May	10.3	9.7	9.9	11.5	10.7	3.64	4.09	4.10	2.
	June	10.1	9.7	9.9	11.0	10.3	3.64	4.09	4.10	2.
	JulyAugust	10.7	10.1	9.9	10.6	9.7	3.64	4.09	4.10	2.
	September	11.8	11.3	11.5	10.5	10.4	3.64	4.09	4.10	2.
	October	12.0	11.8	II.7	10.5	10.5	3.64	4.09	4.10	2.
	November	11.0	10.3	11.7	IO.I	10.9	3.64	4.09	4.10	2.
	December	11.7	10.5	11.7	10.3	11.3	3.64	4.09	4.10	2.
898.	January	11.7	10.5	11.7	11.3	11.5	3.64	4.09	4.10	2.
	February	11.6	10.4	11.6	10.3	12.4	3.64	4.09	4.10	2.
	March	10.0	10.2	11.4	II.I	12.1	3.64	4.09	4.10	2.
	April	10.8	10.5	11.5	11.9	11.4	3.64	4.09	4.10	2.
	May	10.9	10.6	11.7	17.1	11.5	3.64	4.09	4.10	2.
	June July	10.8	10.8	11.7	9.9	12·I 12·I	3.64	4.09	4.10	3.
	August	10.8	10.5	11.7	9.9	12.3	3.64	4.09	4.10	3.
	September	10.8	10.5	11.7	9.1	12.6	3.64	4.09	4.10	3.
	October	10.8	10.5	11.7	9.6	12.3	3.64	4.09	4.10	3.
	November	10.8	10.5	11.7	9.9	12.6	3.64	4.11	4.09	3.
	December	10.7	10.5	11.7	10.4	12.7	3.64	4.11	4.09	3.
1899.	January	10.8	10.5	11.7	10.2	13.1	3.64	4.11	4.09	3.
	February	10.8	10.5	11.7	10.5	12.9	3.58	3.98	4.06	3.
	March	10.8	10.5	11.7	10.6	13.1	3.52	3.85	4.03	3.
	April	II.O	10.7	11.1	10.7	13.6	3.56 3.58	3.90	4.06	3.
	June	12.0	11.4	11.1	10.0	15.3	3.58	3.91	4.07	3.
	July	11.8	11.4	II.I	10.4	15.2	3.58	3.91	4.07	3.
	August	11.7	11.4	II.I	10.4	15.1	3.58	3.91	4.07	3.
	September	11.4	11.4	II.I	10.5	14.8	3.58	3.91	4.07	3.
	October	II.I	II.I	10.9	10.9	14.3	3.58	3.91	4.07	3.

#### FOURTH

# REPORT ON FOOD PRODUCTS.

To His Excellency, George E. Lounsbury, Governor of Connecticut:

As required by law, I herewith submit the fourth annual Report of the Connecticut Agricultural Experiment Station on Food Products, for the year 1899.

Very respectfully,

S. W. JOHNSON, Director.

#### THE CONNECTICUT FOOD LAW.

#### CHAPTER CCXXXV.

Public Acts, January Session, 1895, Entitled

An Act regulating the Manufacture and Sale of Food Products, amended by Chapter XXII, Public Acts, January Session, 1897, entitled An Act amending an Act Regulating the Manufacture and Sale of Food Products.

(The amended Sections are in italics.)

Be it enacted by the Senate and House of Representatives in General Assembly convened:

Section I. It shall be unlawful for any person, persons, or corporation within this State to manufacture for sale, offer or expose for sale, have in his or their possession for sale, or to sell, any article of food which is adulterated or misbranded within the meaning of this act.

SEC. 2. The term food, as used in this act, shall include every article used for food or drink by man, horses, or cattle. The term misbranded, as used in this act, shall include every article of food and every article which enters into the composition of food, the package or label of which shall bear any statement purporting to name any ingredient or substance as not being contained in such article, which statement shall be untrue in any particular; or any statement

purporting to name the substance or substances of which such article is made, which statement shall not give fully the names of all substances contained in such article in any measurable quantity.

SEC. 3. For the purposes of this act, an article shall be deemed adulterated:

First, if any substance or substances be mixed or packed with it so as to reduce or lower or injuriously affect its quality or strength;

Second, if any inferior substance or substances be substituted wholly or in part for the article;

Third, if any valuable constituent of the article has been wholly or in part abstracted;

Fourth, if it be an imitation of or sold under the name of another article;

Fifth, if it is colored, coated, polished, or powdered whereby damage is concealed, or if it is made to appear better or of greater value than it is;

Sixth, if it contains poisonous ingredients which may render such article injurious to the health of a party consuming it, or if it contain any antiseptic or preservative not evident and not known to the purchaser or consumer;

Seventh, if it consists, in whole or in part, of a diseased, filthy, decomposed, or putrid substance, either animal or vegetable, unfit for food, whether manufactured or not, or if it is in any part the product of a diseased animal, or of any animal that has died otherwise than by slaughter;

*Provided*, that an article of food product shall not be deemed adulterated or misbranded within the meaning of this act in the following cases.

- (a) In the case of mixtures or compounds which may be now or from time to time hereafter known as articles of food under their own distinctive names, and not included in definition fourth of this section;
- (b) In the case of articles labeled, branded, or tagged, so as plainly or correctly to show that they are mixtures, compounds, combinations, or blends;
- (c) When any matter or ingredient is added to a food because the same is required for the protection or preparation thereof as an article of commerce in a fit state for carriage or consumption and not fraudulently to increase the bulk, weight, or measure of the food, or to conceal the inferior quality thereof;
- (d) When a food is unavoidably mixed with some extraneous matter in the process of collection or preparation.
- SEC. 4. The Connecticut Agricultural Experiment Station shall make analyses of food products on sale in Connecticut, or kept in Connecticut for export, to be sold without, the State, suspected of being adulterated. Samples of food products for analysis shall be taken by the duly authorized agents of the Station, or by the Dairy Commissioner or his Deputy, at such times and places and to such an extent as in

the judgment of the officers of said Experiment Station and of the Dairy Commissioner shall seem expedient. The Dairy Commissioner or his Deputy shall have full access at all reasonable hours to any place wherein it is suspected that there is kept for sale or for export, as above specified, any article of food adulterated with any deleterious or foreign ingredient or ingredients, and said Dairy Commissioner or his Deputy, upon tendering the market price of such article, may take from any person, firm, or corporation samples of the same. The said Experiment Station may adopt or fix standards of purity, quality, or strength, when such standards are not specified by law.

Sec. 5. Whenever said Experiment Station shall find by its analysis that adulterated food products have been on sale in the State, or kept in the State for export, for sale without the State, it shall forthwith transmit the facts so found to the Dairy Commissioner, who shall make complaint to the proper prosecuting officer, to the end that violators of the law relating to the adulteration of food products shall be prosecuted.

SEC. 6. The said Station shall make an annual report to the governor upon adulterated food products, in addition to the reports required by law, which shall not exceed one hundred and fifty pages, and said report may be included in the report which said Station is already authorized by law to make, and such annual reports shall be submitted to the general assembly at its regular session.

SEC. 7. To carry out the provisions of this act, the additional sum of twenty-five hundred dollars is hereby annually appropriated to said Connecticut Agricultural Experiment Station, which sum shall be paid in equal quarterly installments to the treasurer of the board of control of said Station, upon the order of the comptroller, who is hereby directed to draw his order for the same.

SEC. 8. Any person who, either by himself, his agent, or attorney, with the intent that the same may be sold as unadulterated, adulterates any food products for man, or horses, or cattle, or, knowing that the same has been adulterated, offers for sale or sells the same as unadulterated, or without disclosing or informing the purchaser that the same has been adulterated, shall be fined not more than five hundred dollars, or imprisoned not more than one year.

Sec. 9. No action shall be maintained in any court in this State on account of any sale or other contract made in violation of this act.

SEC. 10. All acts and parts of acts inconsistent herewith are hereby repealed.

Approved, June 26, 1895.

The General Assembly in 1899 also passed an act regulating the Sale of Concentrated Commercial Feeding Stuffs, which, as regards these materials, places on the Station further duties than those imposed by the Pure Food Law just cited. The text of this Act is as follows:

# THE CONNECTICUT LAW REGARDING COMMERCIAL FEEDING STUFFS.

#### CHAPTER CCXIX.

Public Acts, January Session, 1899.

An Act concerning the Regulation of the Sale of Concentrated Commercial Feeding Stuffs.

Be it enacted by the Senate and House of Representatives in General Assembly convened:

Section I. Every lot or parcel of concentrated commercial feeding stuff, as defined in section three of this act, used for feeding domestic animals, sold, offered, or exposed for sale within this State, shall have affixed thereto in a conspicuous place on the outside thereof, a legible and plainly printed statement, clearly and truly certifying the number of net pounds of feeding stuff contained therein, the name, brand, or trademark under which the article is sold, the name and address of the manufacturer or importer, and a statement of the percentage it contains of crude fat and of crude protein, allowing one per cent. of nitrogen to equal six and one-fourth per cent. of protein, both constituents to be determined by the methods adopted at the time by the Association of Official Agricultural Chemists of the United States.

SEC. 2. The term concentrated commercial feeding stuff as herein used shall not include hays and straws, the whole seeds nor the unmixed meals made directly from the seed of wheat, rye, barley, oats, Indian corn, buckwheat, or broom corn.

SEC. 3. The term concentrated commercial feeding stuff as herein used shall include linseed meals, cotton seed meals, pea meals, cocoanut meals, gluten meals, gluten feeds, maize feeds, starch feeds, sugar feeds, dried brewers grains, malt sprouts, hominy feeds, cerealine feeds, rice meals, oat feeds, corn and oat chop, corn and oat feeds, ground beef, or fish scraps, mixed feeds, provenders, bran, middlings, and mixed feeds made wholly or in part from wheat, rye, or buckwheat, and all materials of a similar nature not included in section two of this act.

Sec. 4. Each and every manufacturer, importer, agent, or seller of any concentrated commercial feeding stuff shall, upon request, file with the Connecticut Agricultural Experiment Station a certified copy of the statement named in section one of this act.

SEC. 5. Each and every manufacturer, importer, agent, or person selling, offering, or exposing for sale in this State any concentrated commercial feeding stuff, as defined in section three of this act, without the statement required by section one of this act, and stating that said feeding stuff contains substantially a larger percentage of either of the constituents mentioned in section one than is contained therein, or in relation to which the provisions of all of the foregoing sections

have not been fully complied with, shall be fined not exceeding one hundred dollars for the first offense and not exceeding two hundred dollars for each subsequent offense.

SEC. 6. The Connecticut Agricultural Experiment Station is hereby authorized to have collected a sample not exceeding two pounds in weight, for analysis from any lot, parcel, or package of concentrated commercial feeding stuff as defined by section three of this act, or unmixed meals, brans, or middlings named in section two of this act, which may be in the possession of any manufacturer, importer, agent, or dealer, but said sample shall be taken in the presence of said party or parties in interest or their representatives, and taken from a number of parcels or packages which shall be not less than five per cent. of the whole lot inspected, and shall be thoroughly mixed, divided into two samples, placed in glass vessels, carefully sealed, and a label placed on each stating the name or brand of the feeding stuff or material sampled, the name of the party from whose stock the sample was taken. and the time and place of taking the same, and said label shall be signed by said chemist or his deputy, and by the party or parties in interest or their representatives present at the taking and sealing of said sample; one of said samples shall be retained by said chemist or his deputy and the other by the party whose stock is sampled. Said Connecticut Agricultural Experiment Station shall cause at least one sample of each brand of feeding stuff collected as herein provided to be analyzed annually by or under the direction of said chemist. Said analysis shall include determinations of crude fat and crude protein and such other determinations as may at any time be deemed advisable. Said Connecticut Agricultural Experiment Station shall cause the analysis so made to be published in station bulletins, together with such other additional information in relation to the character, composition, and use thereof as may seem to be of importance, and issue the same annually, or more frequently, if deemed advisable.

SEC. 7. It shall be the duty of the Dairy Commissioner to attend to the enforcement of this act, and when any evidence is submitted by the Connecticut Agricultural Experiment Station that the provisions of this act have been violated, he shall make complaint to the proper prosecuting officer, to the end that the violator may be prosecuted.

SEC. 8. The term importer for all the purposes of this act is intended to apply to such person or persons as shall bring into or offer for sale within this State, concentrated commercial feeding stuffs manufactured without this State.

SEC. 9. This bill shall not apply to feed ground from whole grain and sold directly from manufacturer to consumer.

Sec. 10. All acts or parts of acts inconsistent herewith are hereby repealed.

SEC. II. This act shall take effect on and after July first, 1899.

Approved, June 20, 1899.

# DUTIES OF THE STATION UNDER THE FOOD LAW AND THE LAW REGULATING THE SALE OF COMMERCIAL FEEDING STUFFS.

The fourth, fifth, and sixth sections of the Food Law lay certain duties upon this Station as follows:

- 1st. To make analyses of food products suspected of being adulterated.
- 2d. Whenever it shall find by its analyses that adulterated food products have been on sale, it shall forthwith transmit the facts so found to the Dairy Commissioner.
  - 3d. The Station shall make an annual report.

The law also provides that the Station may adopt or fix standards of purity, quality, or strength, when such standards are not specified or fixed by statute.

The sixth section of the law, regulating the Sale of Commercial Feeding Stuffs, requires the Station,

- 1st. To determine crude fat and crude protein annually in at least one sample of each brand of feeding stuff which it may have collected.
- 2d. To publish these analyses in Station Bulletins, at least annually, with such additional information as to the character, composition and use of commercial feeds as may seem to be of importance.

The Station is also authorized to collect samples of commercial feeding stuffs for analysis from any manufacturers, importers, agents or dealers, and they are required to give the Station, if requested by it, a certified copy of the statement described in section one of the law.

#### SAMPLES EXAMINED BY THE STATION.

During the year beginning Aug 1, 1898, authorized agents of the Station have visited twenty-one towns and villages of this State and purchased samples of food products for examination at this Station.

These places were distributed as follows:

	No. o	f Places.
Litchfield Co		0
Hartford Co		2
Windham Co		2
Tolland Co		0
New London Co		3
Middlesex Co		2
New Haven Co		7
Fairfield Co		5
Tannota Jo		-
		21

COLLECTION OF FOOD PRODUCTS.

In all there have been bought by the Station three hundred and forty-three samples, of the following names or kinds:

No.	of Samples.
Coffee	88
· Coffee substitutes	2
Soda water syrups	92
Bottled syrup	23
Fruit juices	5
Bottled carbonated drinks	90
Peanut butter	2
Food Preservatives	31
Borax	7
Banana flour	3
Total	343

The State Dairy Commissioner is now charged by statute with the enforcement of laws regulating the sale of butter, vinegar, molasses and concentrated commercial feeds.

From the time when the office of Dairy Commissioner was established, 1886, this Station has done at its own cost all the chemical work desired by the Commissioner and has given needful expert evidence in court.

Under the amendment to the Food Law, passed at the session of the General Assembly in 1899, the Commissioner is also empowered to collect samples of food products, the Station is required to report to him all cases of adulteration, and he is required to make complaint to the prosecuting officer.

During the twelve months ending August 1st, 1899, the Station has received from the Commissioner and examined 323 samples, as follows:

C	TOT	7	ES
- 3			L

선생하면 되었는데 하는 것이 되었다. 나는 이 사람이 없는데 없었다.	No.	of Samples.
Butter and imitation butter	 	2
Molasses and syrup	 	213
Vinegar	 	45
Honey		
Coffee	 	61
		-
		323

Three samples of vinegar and forty-three samples of milk and cream, not collected by the Station agent or Dairy Commissioner, have been examined.

In studying the chemical composition and microscopical structure of spices, twenty-five samples of genuine spices, taken from imported packages, and two samples of spice adulterants have also been analyzed, making the total number of examinations seven hundred and thirty-nine.

# THE CHEMICAL COMPOSITION OF AUTHENTIC SAMPLES OF SPICES AND SPICE ADULTERANTS.

By A. L. WINTON, A. W. OGDEN AND W. L. MITCHELL.

In the report of this Station for 1898 are given analyses of one hundred and one samples of whole spices drawn by a representative of the Station from the original packages of importers at New York and Boston; also, of twenty-four samples of spice adulterants. These analyses were made to secure data for fixing standards of composition of the spices used in the United States, and to learn how their composition is affected by the addition of adulterants.

During the present year, twenty-five additional samples of whole spices, representing for the most part grades which were not analyzed in 1898, and two samples of adulterants, have been secured through the courtesy of Messrs. Bennett, Simpson & Co., London and New York.

Analyses of these samples, made by the methods described in the report for 1898, will be found in Table I, pp. 102 to 103.

#### DESCRIPTION OF SAMPLES.

9805. Mangalore black pepper. The corns are unusually large for black pepper. Their exterior is deep black, the interior yellow green in color. The powder is greenish black. This pepper is not likely to be found in our market.

9819. Singapore shot pepper. In the preparation of this pepper, which is not used for grinding, the corns are washed, dried and oiled. By these operations the appearance is im-

proved, at the expense of quality.

9806. Malabar black pepper. This pepper is said to be grown in groves of mango and bread-fruit trees. The berries are hand picked and sun dried.

9807. Coriander or Alleppy white pepper. This variety is prepared in imitation of coriander, by paring off from the end of each corn a piece of the outer hull, thus exposing an inner layer of darker color.

9818. Tellicherry white pepper. Is one of the best grades in our market. The corns are of large size and of a uniform

light color.

9826. Paprika or Hungarian pepper. The dried pods are from seven to ten cm. long and (flattened) from three to seven cm. wide.\* The surface is shiny and of a dark red color. When held to the light the color is a fine claret red. The stems, which have not been detached, are from three to five cm. long and constitute seven per cent. by weight of the sample. This pepper is milder than the closely related varieties of cayenne pepper and has a sweet taste.

9820. Chili Colorado. A mild pepper grown in Mexico. The pods in the sample are of a dull brick color, and from seven to ten cm. long and (flattened) from two to four cm. wide.\* The stems and calyxes are absent.

9861. Natal or Durban cayenne pepper. The dark red pods (from one to two cm. broad and five to ten cm. long\*) are free from stems and calyxes.

9809. Nepaul cayenne pepper. A pepper grown in Hindostan, with pods three to six cm. long and one to one and a half cm. wide,\* of brown yellow color.

<sup>\*</sup>The centimeter (cm.) is approximately 4/10 inch and the millimeter (mm.) 4/100 inch.

TABLE I.—ANALYSES OF PURE WHOLE AND SPICE ADULTERANTS.

			gle		Ash,		
Station No.		Weight of 1 litre in grams.	Weight of 100 single kernels or specimens in grams.	Moisture.	Total.	Soluble in water.	Insoluble in HCI.
-0	Black Pepper:				PART	Little Control	
9805 9819 9806	Singapore Shot	574. 530. 570.	8.57 5.25 5.74	11.61	4.23 3.70 3.45	2.19 1.42 2.26	0.10
	White Pepper:					100	- 5
9807 9818		588. 650.	4.21 6.67	9.47 11.13	1.05 0.97	0.25 0.22	0.04
	Paprica:		35/12		Jibn F	1-11	
9826	Hungarian		621.	8.77	6.45	5.05	0.11
	Cayenne Pepper:		States		100		
9820			180.	15.96	6.19	15.13	0.04
861	Natal		112.	13.58	5.51	4.57	0.07
809	Nepaul		50.8	5.71	6.07	4,54	0.05
810	Zanzibar		4.45	5.18	6.13	4.29	0.15
	Ginger:				100		
812	Bleached Jamaica (limed)			9.72	5.28	2.60	0 24
811	Washed Jamaica			10.11	3.18	2.24	0.15
813	Bleached Cochin (limed)		101131	9.14	4.99	3.52	0.09
	Cinnamon:		19616				
815	Ceylon, extra fine			6.54	5.23	1.62	0.07
	Cassia:						
823	Penang	tell av I	3.84				0.08
822				7.04 8.06	4.53	2.03	0.00
821	Malabar			8.57	5.72 4.80	1.79	0.03
		TAIL .	Mary 3	0.57	7.00	2.79	
825	Cloves: Penang						- 4
824	Bençoolen		10.78	7.91	5.44	3.30	0.04
			9.88	6.73	6.00	3.80	0.03
	Nutmeg:						
814	Brown Penang, 54's		944.	7.69	1.85	0.85	0.04
831	Brown Penang, 80's		572.	9.40	1.88	0.76	0.00
	Mace:						
808	Hand Picked			10.71	1.56	0.87	0.02
829	Penang.			9.41	1.67	0.02	0.03
828	Banda			7.82	1.74	1.00	0.00
827	Batavia			8.89	2.49	1.26	0.21
	Adulterants:		377				
816	Exhausted Cubebs	100	11.00	r 60	TO 28	6.00	0.77
817	Exhausted Cubebs		-3	5.60	10.38	6.32	0.00
				7.09	4.50	2.59	0,3

	ETHER EXTRACT.			by cal-			er er	NITRO	OGEN.	e e	+i
Lime. (CaO.)	Volatile,	Non-volatile,	Alcohol extract.	Reducing matters by direct inversion calculated as starch.	Starch by diastase method.	Crude fiber.	Total N. less N. in non-volatile ether extract, x 6¼.	Total.	In non-volatile ether extract.	Parts of N. in 100 parts non-volatile ether extract.	Cold water extract.
	1.50 1.44 1.04	9.08 7.49 <b>6.10</b>	9.97 8.54 6.94		34.93 33.19 44.83	10.00 10.58 <b>9.68</b>	11.87 12.06 12.56	2.24 2.21 2.26	0.35 0.25 0.24	3.46 3.29 3.86	
	o.55 o.64	7.28 6.68	8.05 7.55		57.60 60.41	<b>4.54</b> 3.94	12.44	2.31 2.24	0.31	4.25 4.18	
	1.12	7.74	21.24		3.93	22.59	14.56	2.33			
  	0.36 0.85 0.85 0.56	15.45 16.00 20.46 15.63	30.42 24.95 23.78 19.92		1.38 1.46 1.46	13.93 19.12 24.25 27.65	11.94 16.81 14.87 14.62	1.91 2.69 2.38 2.34			
1.33 0.13 1.61	1.25 0.97 1.60	2.47 2.58 3.61	3.31 2.61 3.53		61.76 56.31 64.18	2.72 2.43 3.42	9.19 11.12 6.06	1.47 1.78 .97			14.57 15.85 7.72
	1.94	1.73	16.73	22.86		33.26	4.56	.73			
	5.84 4.18 3.25	3.07 1.14 1.30	6.07 12.02 11.97	23.76 22.05 23.22		20.09 20.69 22.27	4.75 4.25 4.50	.76 .68 .72			
	19.71	5.12 5.14	15.92 15.23		2.25 2.62	8.74 9.60	6.31 6.12	1.01			
	5.03 2.64	31.26 34.80	10.49		30.09 26.16	2.40 2.70	6.19 7.12	.99			
	5.79 8.65 10.80 13.03	23.30 21.23 23.82 22.00	24.72 26.04 27.02 27.07		24.19 31.61 27.17 22.68	2.57 3.22 3.10 4.01	5.87 6.06 6.81 7.87	.94 .97 1.09 1.26			
	1.32	8.58 6.07	10.82		8.55	27.64	11.25	1.80			

9810. Zanzibar cayenne pepper. This sample is of fine quality, containing neither stems nor calyxes. The pods (0.5 to 1 cm. long and from 0.3 to 0.5 cm. wide\*) are brick red in color.

9812. Bleached or limed Jamaica ginger.

9811. Washed Jamaica ginger

9813. Bleached or limed Cochin ginger.

The three samples of ginger are made up of large and selected roots.

9815. Ceylon cinnamon, extra fine. The composite quills are but four to five mm.\* in diameter.

9823. Penang cassia. One of the best of the cassias. Bark from one-half to two mm.\* thick.

9822. Travencore cassia. The bark, which has been scraped, is of a light brown color and varies in thickness from two to four mm.\* Like Batavia cassia, the ground bark forms a glutinous mass when stirred up with water.

9821. Malabar cassia closely resembles Batavia cassia. The bark is from one-half to three mm.\* in thickness.

9825. Penang cloves.

9824. Bencoolen cloves. A variety which is said to be often sold for Penang.

9814. Brown Penang nutmegs, fifty-four to the pound. Kernels two and eight-tenths to three and a half cm. long and two to three cm.\* wide.

9831. Brown Penang nutmegs, eighty to the pound.

Like 9814, but of smaller size.

9808. Hand picked mace. Large perfect blades selected by hand.

9829. Penang mace.

9828. Banda mace.

9827. Batavia mace.

9816. Exhausted cubebs. Sold for two cents per pound, as an adulterant for black pepper.

9817. Exhausted allspice. Sold for four cents per pound for use as an adulterant.

#### NOTES ON THE ANALYSES.

Black and white pepper. In the report for 1898 the conclusion was reached that determinations of non-volatile ether-extract and of the nitrogen therein, furnish the best means of detecting adulterants of vegetable origin. This conclusion is confirmed by the results reported herewith.

In the sample of Malabar pepper, No. 9806, the percentages of non-volatile ether-extract, and of alcohol extract are un-

usually low.

Paprika. This pepper contains a much lower percentage of non-volatile ether-extract than other varieties of capsicum which have been examined. It also has a sweeter taste and, therefore, presumably, a higher percentage of sugar. Because of these differences, paprika should be classed apart from cayenne pepper.

Cayenne pepper. The varieties examined, although widely different in appearance, have essentially the same composition.

Ginger. The cold-water extract in No. 9813 is abnormally low, indicating perhaps that the sample has been soaked in water.

Cassia. The sample of Penang cassia has about the same composition as the samples of Saigon cassia examined last year. Travencore, Malabar and Batavia cassia are not only much alike in physical properties, but also in composition.

Cloves. One of the most valuable means of detecting adulteration in cloves is the determination of volatile ether-extract. The minimum percentage of this extract obtained in the analyses of genuine samples, during the past two years, is 17.82.

Nutmeg. The two samples of brown Penang nutmeg have practically the same composition as the limed Singapore nutmegs examined in 1898.

Mace. The percentages of ash, non-volatile ether-extract, alcohol extract and "starch" do not vary greatly in the varieties of true mace, and determinations of these ingredients are of great value in detecting Bombay mace and other adulterants.

<sup>\*</sup>The centimeter (cm.) is approximately  $\frac{4}{10}$  inch and the millimeter (mm.)  $\frac{4}{100}$  inch.

#### COFFEE.

#### By A. L. WINTON.

When the food law went into operation (1896), the cheaper grades of coffee, both ground and unground, which were sold in Connecticut were extensively adulterated.

Of forty-nine samples, bought in that year by Station agents for twenty-five cents or less per pound, not one was pure coffee.

During the past four years there has been a marked decrease in the number of adulterated "coffees" sold in this State, as appears in the following statement.

TABLE II.—PERCENTAGE OF SAMPLES OF COFFEE FOUND ADULTERATED.

		Perce	ntage number adul	
Year.	Number Examined.	Whole Coffee.	Ground Coffee.	Both Whole and Ground,
1896	109	25.0	89.2	63.3
1897	71	7.I	86.6	57.7
1898	40	8.7	40.9	24.4
1899	149	1.5	18.8	10.3

This decrease in the percentage of adulterated samples cannot be attributed to change from year to year in the place or price of purchase.

The agents have each year sought to buy the cheaper grades of coffee in a considerable number of cities and towns.

The average prices paid in these years for the samples have been as follows:

TABLE III.—AVERAGE PRICES OF COFFEE BOUGHT BY STATION AGENTS.

	Ground Coff		Ground Coffe	e, Adulterated.
Year.	No. Samples.	Average price per pound.	No. Samples.	Average price per pound.
1896	7.	37.0	58	24.5
1897	6	26.0	41	25.0
1898	13	26.8	II	24.5
1899	66	26.7	14	22.4

The marked decrease in the sales of adulterated coffee in this State, thus indicated, is no doubt largely due to the work of this Station.

During the last twelve months one hundred and forty-nine samples have been examined, classified as follows:

	Unground.	Ground.	Total.
Number of samples not found adulterated	68	66	134
Number of samples found adulterated	I	14	15
Number of Samples		_	
Total	69	80	149

Particulars regarding these samples are given in Tables IV and V, pages 108 to 111.

All labels other than the retailer's name and address that were found on packages of coffee are copied in the Table.

Samples put up in paper bags without labels are specified as "sold in bulk."

Of the whole number of coffee samples collected, sixty-one were bought by the Dairy Commissioner and eighty-eight by the Station.

Coffee Compounds and Substitutes. Two samples have been examined as follows:

No. 11471. "Combination Coffee." Bought of Russell Bros., State and Court sts., New Haven, 20 cents per pound. Contained coffee, chicory and imitation coffee made from wheat middlings.

No. 11434. "Hayward & Co., French Breakfast Coffee Compound, manufactured by Dwinell, Wright & Co., Boston." The word "Compound" was inconspicuous. Bought of Daniel Sullivan, Putnam, 10 cents per pound package. Consisted chiefly of ground peas and cereals. No real coffee was found.

## TABLE IV.—COFFEE NOT FOUND ADULTERATED.

	Zo.		August 1997 State of the State	
	n I	PRAND	Deliver	2.96
	atic	BRAND.	DEALER.	pe, ct
	St			rice
11455	Tay of the	Hagrand Coffee		Pod
11455		2	, W II D	
11454			Ansonia. W. H. Bronson, 234 Main St.	
11454			P. W. Fogarty, II High St.	
11457			Geo. E. May & Son, Maple and High Sta	
11458   " " "   "   "   "   "   "   "   "		************	Geo. McCabe, 19 High St.	
11458   " " "   "   "   "   "   "   "   "	0		New York Grocery Co., 134 Main St.	
11459   11459   1459   1459   1459   1459   1450   1460   1460   1460   1460   1460   1460   1460   1460   1460   1460   1460   1460   1460   1460   1460   1460   1460   1460   1460   1460   1460   1460   1460   1460   1460   1460   1460   1460   1460   1460   1460   1460   1460   1460   1460   1460   1460   1460   1460   1460   1460   1460   1460   1460   1460   1460   1460   1460   1460   1460   1460   1460   1460   1460   1460   1460   1460   1460   1460   1460   1460   1460   1460   1460   1460   1460   1460   1460   1460   1460   1460   1460   1460   1460   1460   1460   1460   1460   1460   1460   1460   1460   1460   1460   1460   1460   1460   1460   1460   1460   1460   1460   1460   1460   1460   1460   1460   1460   1460   1460   1460   1460   1460   1460   1460   1460   1460   1460   1460   1460   1460   1460   1460   1460   1460   1460   1460   1460   1460   1460   1460   1460   1460   1460   1460   1460   1460   1460   1460   1460   1460   1460   1460   1460   1460   1460   1460   1460   1460   1460   1460   1460   1460   1460   1460   1460   1460   1460   1460   1460   1460   1460   1460   1460   1460   1460   1460   1460   1460   1460   1460   1460   1460   1460   1460   1460   1460   1460   1460   1460   1460   1460   1460   1460   1460   1460   1460   1460   1460   1460   1460   1460   1460   1460   1460   1460   1460   1460   1460   1460   1460   1460   1460   1460   1460   1460   1460   1460   1460   1460   1460   1460   1460   1460   1460   1460   1460   1460   1460   1460   1460   1460   1460   1460   1460   1460   1460   1460   1460   1460   1460   1460   1460   1460   1460   1460   1460   1460   1460   1460   1460   1460   1460   1460   1460   1460   1460   1460   1460   1460   1460   1460   1460   1460   1460   1460   1460   1460   1460   1460   1460   1460   1460   1460   1460   1460   1460   1460   1460   1460   1460   1460   1460   1460   1460   1460   1460   1460   1460   1460   1460   1460   1460   1460   1460   1460   1460   1460   1460   1460   1460   1460   1460   1460   1460			New York Grocery Co., 134 Main St.	
1995   Magnolia Blended. Bennett,   Sloan & Co., New York   Sold in bulk.   Danbury.   McGraw & Baldwin, qI White St.   Union Pacific Tea Co., 253 Main St.   32   Main Ist.   32   Main Ist.   32   Main Ist.   33   Main Ist.   34   Main Ist.   34   Main Ist.   34   Main Ist.   35   Main Ist.   36   Main Ist.   36   Main Ist.   36   Main Ist.   37   Main Ist.   38   Main Ist.   38   Main Ist.   38   Main Ist.   39   Main Ist.   39   Main Ist.   39   Main Ist.   39   Main Ist.   30   Main Ist.	the second secon		J. D. Welch & Co., Main St.	
Magnolia Blended. Bennett,   Sold in bulk.   Danbury. McGraw & Baldwin, 9t White St.   Sold in bulk.   Union Pacific Tea Co., 253 Main St.   1125			J. D. Welch & Co., Main St.	
Sloan & Co., New York		Magnelia Planded Pennett	Briageport. Osborne Bros., Noble Ave. & Jane St.	
Manila Coffee	9995		D	-3
Manila Coffee	TTTOS		Danbury. McGraw & Bardwin, 91 White St.	32
Sold in bulk		Manila Coffee	Devise C. W. Comments of Elicitation St.	
11462   " "			Versel's Person II.	
11462   " " " " " " " " " " " " " " " " " "			Lamas Makrarray	
11031			Now York Crosser C. M. C.	38
Hartford. J. C. & Co., 558 Asylum St.   20			Custom C S Avery of Thomas Ct.	25
R. S. Kennedy, 1040-46 Main St.   20			Hartford I C & Co TTO A column St.	
11085   " "			P S Kennedy 1040 46 Main St.	
11085		" "	Middletory American Too Co. too Main St.	
11087   " " "   Winterich & Kirby, 218 Main St		" " "	S. T. Camp. 224 Main St.	
11089   " " "			Winterich & Kirby and Main Ct	
			Portland C. H Rell Main St.	
11100			New Britain Home Tea Co. 160 Main St.	
Chas. Baum, 295 Oak St.   20		44 44 45	New Haven S S Adams 745 Grand Ave	
Cedar Hill Exchange, 1132 State St.   25		46 66 66	Chas Baum 205 Oak St	
11469   " " " "   Conn. Tea Co., Grand Ave. & Franklin St.   25	11146		Cedar Hill Exchange Tree State St	
11479   " " " Geo. W. Cooper, Grand Ave. & Artizan St.   25	11167		G. M. Clark 258 Congress Ave	
11473	11469		Conn. Tea Co. Grand Ave. & Franklin St.	
11404	11473	" " "	Geo. W. Cooper Grand Ave & Artigan St.	
Daniel Dore, 579 Grand Ave.   30	11164	" " "	C. F. Curtiss, 054 State St	
Manage   M	11466	" " "	Daniel Dore, 570 Grand Ave	
Sold in bulk	9592	Diamond B. Wm. Boardman	2 dans 2 dans 2170.2.2 2	3-
11470   Sold in bulk		& Sons Co., Hartford	Gibbons Bros., State & Pearl Sts	30
Harry Leigh Co., 354–6 State St. 35  F. J. Markle, Olive & State Sts. 24  Hermon Mosca, 177 Hamilton St. 15  E. E. Nicholss, 378 State St. 25  Russell Bros., State & Court Sts. 30  J. L. Stevens, 255 Congress Ave. 28  W. E. Waterbury, 774 State St. 20  R. Zeidler, 768 Grand Ave. 30  I1047 " " New London. Daboll & Freeman, 148 State St. 21  I1401 " " Daboll & Freeman, 148 State St. 22  I1410 " " Donovan, 135 Main St. 36  I1410 " " Donovan, 135 Main St. 36  I1411 " " Donovan, 135 Main St. 36  I1411 " " A. E. Foster, 120 Main St. 30  I1413 " " A. E. Foster, 120 Main St. 30  I1406 " " M. Joseph, 145 Main St. 30  I1405 " " Mohican Grocry Co., State St. 14	11470	Sold in bulk	Johnson & Bro., 411 State St.	
Hermon Mosca, 177 Hamilton St.			Harry Leigh Co., 354-6 State St.	
Hermon Mosca, 177 Hamilton St.   15			F. J. Markle, Olive & State Sts.	
11474			Hermon Mosca, 177 Hamilton St.	15
Russell Bros., State & Court Sts.   30		***************************************	E. E. Nichols, 378 State St.	25
J. L. Stevens, 255 Congress Ave.   25		***************************************	Russell Bros., State & Court Sts.	30
W. E. Waterbury, 774 State St.   20			L. Stevens, 255 Congress Ave.	
R. Zeidler, 768 Grand Ave.   30			W. E. Waterbury, 774 State St.	
New London, Daboll & Freeman, 148 State St.   22   11412	The second secon		R. Zeidler, 768 Grand Ave.	
D. Donovan, 135 Main St.   30	The second secon		New London. Daboll & Freeman, 148 State St.	
Daboll & Freeman, 148 State St.   22   23   24   25   25   25   26   27   27   27   27   27   27   27			D. Donovan, 135 Main St.	30
D. Donovan, 135 Main St.   30		***************************************	Daboll & Freeman, 148 State St.	22
D. Donovan, 135 Main St.   20		" " "	D. Donovan, 135 Main St.	30
D. Donovan, 135 Main St.   39	The state of the s	" "	D. Donovan, 135 Main St.	
A. E. Foster, 120 Main St. 30  11408 " " A. E. Foster, 120 Main St. 20  11406 " " M. Joseph, 145 Main St. 30  11405 " " Mohican Grocery Co., State St. 14	-	16 16 11	D. Donovan, 135 Main St.	30
11408 " " " A. E. Foster, 120 Main St. 20 11406 " " " M. Joseph, 145 Main St. 30 11405 " " " J. N. Miner, Main St. 30 11405 " " " Mohican Grocry Co., State St. 14		" "	A. E. Foster, 120 Main St.	30
11406 " " " J. N. Miner, Main St. 36  11406 " " " M. Joseph, 145 Main St. 36  J. N. Miner, Main St. 36  Mohican Grocery Co., State St. 14		" " "	A. E. Foster, 120 Main St.	
Mohican Grocery Co., State St. 14		" "	M. Joseph, 145 Main St.	36
Monican Grocery Co., State St.		4. 44 44	J. N. Miner, Main St.	30
John Kollo, of Main St		" " "	Monican Grocery Co., State St.	
			John Kollo, oo Main St.	13)

# TABLE IV .- COFFEE NOT FOUND ADULTERATED-Continued.

	BRAND.	DEALER.	Price per
_	Unground Coffee—Continued.		
	Blend, Ross W. Weir		
7	er Co N. Y.	Norwalk. W. & E. Osterbank, 53 Main St	2
	sold in bulk	Norwich. Hong Kong Tea Co., 210 Main St	2
0	" "	E. W. Phillips, 47 Shetucket St.	]
6		W. A. Smith, 135 Main St.	2
9	" " "	Waterbury. Brooklyn Co-operative Store, 875	
7		Bank St.	2
6	" " "	A. W. Brumaghim, 844 Bank St.	2
6	White House Mocha & Java.		
4	Dwinell Wright & Co., Boston	J. A. Edmundson, 415 So. Main St.	1
6	Sold in bulk	Willimantic. S. E. Amidon, 877 Main St	]
7	" " "	S. E. Amidon, 877 Main St.	199
4	" " "	F. P. Casey, 81 Jackson St.	2
3	" " "	C. R. Hibberd, 22 North St.	
I	4 44 45	Frank Larrabee, Church St.	
4		Purrington & Reade, Main St.	
I	***************************************	Burt Thompson, 798 Main St.	
0	Lion Coffee. Woolson Spice Co., Toledo, Ohio	Burt Thompson, 798 Main St	
	Part of the Part of the Part of the	Butt Thompson, 790 Main St	
	Ground Coffee.	Austria Car E Mars & Car Marsla & III at Car	
3	Sold in bulk	Ansonia. Geo. E. May & Son, Maple & High Sts.	
5		Bridgeport. Belknap Tea Co., 511 Main St	
6		Columbia Tea Co., 534 Main St.	
9	***************************************		
4		Derby. S. Z. D. Durand, 193 Main St.	
2		New York Cash Store, Main St.	
6			
5	" " "		
4	Olympia. The Edmunds Cof-	H. E. Hills & Son, 1143 Main St.	
	fee Mills, Boston	Peckham Bros., 8 Ford St	
2	Royal Arms. International	1 ccknam bros., 8 Pord St	
	Coffee Co., N. Y. & London	Union Grocery, 1026 Main St.	
5	Sold in bulk	Meriden. Boston Grocery, 17 Colony St.	
9	" " "	Grant's Tea Store, State & Main Sts.	
8		E. J. Stoddard, 300 E. Main St.	
7	Gold Brand Java. Brownell	E. J. Stoddard, 300 E. Main St.	
	& Field Co., Providence	Middletown. G. E. Burr, 136 Main St	1
2	Sold in bulk	New Britain, A B Goodrich 7 Franklin Square	
3		H. Oldershain, 236 Park St.	
6	" "	New Haven. S. S. Adams, State & Court Sts.	
2	16 16 66	Conn. Tea Store, 722 Grand Ave.	
7	Victor. Shapleigh Coffee Co	, , , , , , , , , , , , , , , , , , , ,	
I	Boston	Mrs. Gerner, State & Clark Sts	:
1	Crescent Mills, John P. Augur	,	
I	LIEW Harren	P. J. Lyons, 419 Congress Ave.	
6	Sold in bulk	F. A. Peck, 719 State St.	:
3	10wer New Haven	H. M. Tower, 379 Congress Ave	
	Stoddard, Gilbert	717 5008	
2	W CO New Haven	William & Franklin	
	Arms. International		1
3	Coffee Co New Vork	New London. Frank Caracausa, State St	3
9	Arms International		
	Coffee Co.	Frank Caracausa, State St	3

#### TABLE IV.—COFFEE NOT FOUND ADULTERATED—Concluded.

No.			-
Z			r ts.
Station	BRAND.	DEALER.	Price per pound, cts.
stal			ice
0.			Pr
	Ground Coffee—Continued.		_
9599	Back Bay. G. P. Champlin,	New London-Continued	
9599	Boston	M. Wilson Dart, Bank & Howard Sts	
11415	Sold in bulk	Wm. A. Holt, 50 Main St,	25
11049	" " "	Keefe & Davis, 125 Bank St.	26
9600	Star Java. Brownell & Field		25
9000	Co., Providence, R. I	W. M. Lucy, 191 Bank St.	
11407	Sold in bulk	J. N. Miner, Main St.	35
11404	61 66 66	Mohican Grocery Co., State St.	36
11050	" " "	S. Prottas, 45 Bradley St.	14
9978	Autocrat Java, Brownell &		18
,,,	Field Co., Providence	J. E. St. John, 265 Bank St.	2 =
11007	Sold in bulk	Norwalk. William M. Betts, 15 Main St	25 25
9982	Silver Quarter. Swain, Earle	[일본 [일본 ]	~5
	& Co., Boston	Norwich. Appely & Jordan, 88 W, Main St	25
11061	Sold in bulk	E. A. Fitch, 62 Broadway	20
11068		E. Robinson, 264 Main St.	25
9983	Golden Cup. C. H. Russell,		
	Boston	Russell Bros., 110 Main St.	23
9988	Regal. The E. S. Kibbe Co.,		
	Hartford	Portland. P. Sullivan, Main St.	30
11435	Sold in bulk. Java and Mocha	Putnam. N. J. Bartlett	36
11436	" " "	N. J. Bartlett	36
11430	46 46 46	N. H. Mansfield & Co.	26
11431	***************************************	N. H. Mansfield & Co.	30
11428	· Java	Edward Mullan	36
11429	. Java and Mocha	771 176 11	
	blend	Edward Mullan	36
11437	· Iriple blend	A. C. Stetson	30
11433		James Sullivan	26
11432		James Sullivan	36
11008	" " "	So. Norwalk. F. D. Lawton & Co., 22 Main St.	25
11009	Princess. O'Donahue Coffee	New York Grocery Co., Washington St	25
9957	Princess. O'Donahue Coffee Co., New York	Chas. E. Seymour, 33 Washington St.	25
11001	Sold in bulk	Stamford. G. A. Ferris, 184 Main St.	20
11000	" " "	A. G. Weed, I Atlantic Square.	25
11000		Walling ford. A. J. Martin, 29 Main St.	35
11020		Union Tea Company, 7 Hall Ave.	25
11418		Willimantic. S. E. Amidon, 877 Main St.	26
11419	" "	Daintor & Johnstone, 931 Main St.	36
11070	" "	Grand Union Tea Co., 725 Main St.	25
11072	" "	E. C. Hall, 15 Union St.	25
11426	" "	Frank Larrabee, 24 Church St.	36
11427	" " "	Frank Larrabee, 24 Church St.	18
11073		Purrington & Reade, 719 Main St.	22
11425		Purrington & Reade, 719 Main St.	20
9985	Yale. Howard W. Spurr Coffee		11 1
	Co., Boston	Burt Thompson, 800 Main St.	25
11422	Sold in bulk	Burt Thompson, 800 Main St.	36

TABLE V.—COFFEE FOUND ADULTERATED.

oN noitsti	Brand.	Dealer.	Price per pound, cents.	. Adulterants,
1100	Unground Coffee.  Itoo Sold in bulk		13	13 Peas, 2 per cent.
1127 1124 1129 1463	1124 " " " " " " " " " " " " " " " " " " "	Sold in bulk	25 20 20 20 20 20 20 20 20 20 20 20 20 20	Chicory, imitation coffee.* Chicory, imitation coffee.* Chicory, imitation coffee.*
1032	9973 French Mixture Hotel Coffee, C. H. Russell, Boston	Hartford. C. H. Russell, gog Main St	15 20 20	000.
1005	2 2 3	Norwalk. W. R. Bates, 49 Main St.  Norwich. Thomas Wilson, 76 Franklin St.	0 0 0 0 0 0 0 0	Chicory, peas. Chicory, pea hull pellets.† Chicory, imitation coffee.*
1115	3 3 3 3	Waterbury. Greater New York Lea Co., 1/2 E. Main St. New York & China Tea Co., 181 S. Main St. J. F. Phelan, 41 E. Main St. W. H. Wright, 42 E. Main St.	0 0 0 0	Chicory, imitation coffee.* Pea hull pellets,† chicory. Imitation coffee,* chicory.

\* Brown lumps made from wheat middlings to resemble coarsely crushed roasted coffee. † Made of pea hulls and middlings resembling roasted coffee.

# CARBONATED, NON-ALCOHOLIC BEVERAGES ("TEMPERANCE DRINKS," "SUMMER DRINKS") AND FRUIT FLAVORS.

By A. L. WINTON, A. W. OGDEN AND W. L. MITCHELL.

Water, variously flavored and charged with carbonic acid, commonly called "soda water," may be said to be the national summer drink of the United States. Although statistical proof is not obtainable, it is doubtless true that the consumption of the various carbonated non-alcoholic beverages (not including mineral waters) within our border is greater both per capita and in toto than in any other country.

In Connecticut nearly all of the five hundred apothecaries have soda fountains, and in some cases soda water, during the summer months, is a more important source of revenue than drugs. Soda fountains are also maintained by many confectioners and some of the department stores.

Bottled soda water, ginger ale and similar beverages are sold in large quantities for family use and for consumption in saloons, restaurants, fruit-stands and "Wheelmen's Rests."

## SODA WATER, SOLD BY THE GLASS.

Apparatus for Dispensing Soda Water. In stores where soda water is drawn for consumption from faucets, the "fountains," which are the metal cylinders in which it is stored, are kept in the cellar and from these, pipes lead to and through a box packed with ice at the dispensing counter. This box, which is commonly, but erroneously, known as the "fountain," also contains reservoirs for the various flavoring syrups and is usually cased in polished marble, with nickel faucets and trimmings.

The pressure of the carbonic acid gas in the cylinder forces the carbonated water through the pipes to the faucets, which are so arranged that a large or a fine stream can be drawn, the latter being used to mix and froth the drink.

Besides the flavoring and sweetening matters added in form of syrups, "Cream" is added to chocolate, coffee, vanilla and

some other flavors, and frothed eggs, "acid phosphate" and various other materials are used in the preparation of special drinks.

Preparation of Carbonated Water. Formerly each fountain was charged by connecting with apparatus in which carbonic acid gas was set free by the action of sulphuric acid on marble dust or other carbonate, but now carbonic acid, either made from acid and carbonates or derived from mineral springs, is liquified by pressure and supplied in small steel cylinders.

Some retailers make their own carbonated water, but this work is usually done by local manufacturers, who deliver the fountains ready charged. The operation of charging is, however, a simple one and can be easily carried out by any one provided with the necessary apparatus. The "fountain" is nearly filled with cold water and placed on its side in a cradle. The cock at its end is connected by means of a stout rubber hose with the cylinder of liquid carbonic acid and the gas that freely escapes from the latter is allowed to enter the fountain, where its absorption by the water is aided by constant agitation. This is continued until the water is saturated at about 170 pounds pressure,\* as shown by a gauge.

Soda Water Syrups. The syrups used in soda water consist of sugar syrup (12 to 15 pounds of granulated sugar in 1 gallon of water) mixed with fruit juices, or other flavoring materials, and frequently with gum arabic, soap bark, senegal, or some other substance, to produce foam. The most popular syrups are vanilla, lemon, orange, strawberry, raspberry, chocolate, coffee, ginger, sarsaparilla and pineapple, but there are many others which have a more or less extensive sale. A pamphlet issued by a well known house gives a list of 333 different syrups, which can be made from the materials they supply.

The syrups dispensed at soda fountains are made on the premises, or bought ready for use. In either case, they may be good or poor, pure or adulterated. Some retailers prepare their syrups from genuine fruits or fruit juices and other materials of the best quality, while others use artificial "fruit extracts," coal-tar dyes, chemical preservatives and other objectionable materials, and the same may be said of the manufacturers of syrups on a large scale.

<sup>\*</sup>Also known as "Soda" and more appropriately as "Carbonated Water."

<sup>\*</sup>Mineral waters and root beer are charged at a lower pressure.

For the convenience of those who wish to make their own syrups, but do not care to handle the fruits, many kinds of genuine fruit juices and crushed fruits are now on the market in sealed bottles, jugs and jars. These preparations are sent out sterilized, or otherwise treated to prevent spoiling, and will generally keep until opened. For use they are mixed with sugar syrup and a little citric or tartaric acid, to bring out the flavor.

In justice to the trade it should be stated that those who have built up a flourishing business, use, as a rule, good materials and dispense beverages which are both wholesome and delicious. Syrups containing artificial flavoring and coloring matters are not acceptable to the better class of trade and are dispensed chiefly in the tenement districts, at shore resorts, etc.

All artificial flavoring substances cannot, however, be regarded as adulterants. Oil of wintergreen and vanillin (the valuable constituents of the vanilla bean) are now prepared by purely chemical means, and, although not considered quite so delicate in flavor as the genuine, still the difference is really a matter of quality rather than of purity.

But the artificial extracts made to imitate strawberry, raspberry and some other fruit juices or flavors belong in another category, as they are, in many cases, quite unlike the flavoring matters of the true fruits in chemical composition, as well as in flavor, and when taken in ice cream or soda water are apt to produce unpleasant consequences; indigestion and diarrheea. Often within a half hour after taking them, their artificial nature becomes very evident to the senses of taste and smell.

The following recipes of J. H. Maisch, for the preparation of artificial extracts, given by Allen,\* illustrate the complex nature of some of them.

"The number given indicates the number of measures of the ethers, etc., to be added to each 100 measures of rectified spirit.

\* \* To make the essences of orange and lemon, 10 parts of the respective essential oils must be employed in addition to the ingredients given in the Table."

	ple.		erry.	rry.	t.						t.				
	Pine-apple.	Melon.	Strawberry.	Raspberry	Currant.	Grape.	Apple.	Pear.	Cherry.	Plum.	Apricot.	Peach.	Orange.	Lemon.	Banana
	-	_	_	-	-		-		-	-	-	-	-	-	-
Chloroform	I					2	I				I		2	I	
	I	2		I	I	2	2			5		2	2	2	
Methyl salicylate			I	I		I							I		
Ethyl nitrite			I	I			I							I	
" formate		I	I	I		2				1		5	I		
" acetate			5	5	5		I	5	5	5		5	5	IO	
" butyrate	5	4	5	I						2	IO	5	I		I
" valerate		5									5	5			
" pelargonate				I	I	IO			I		I				
" benzoate				I	I				5				I		
" sebate		IO		I								I			
Amyl alcohol											2	2			-
" acetate			3	I				2					I		I
" butyrate	IO		2	I							I				-
" valerate							IO								
Tartaric acid				5	5	5					I		I	IO	
Oxalic acid								I							
Succinic acid				I	I	3								I	-
Benzoic acid					I				I						
Glycerin		3	2	4		IO	4	2	3	8	4	5	IO	5	-
Benzoic aldehyde										4		5			

The use of coal-tar dyes is also objectionable, as some of them are believed to be injurious to health.

The use of preservatives has been discussed in a preceding report.\* Salicylic acid is not infrequently added to "keep" both the genuine and spurious fruit juices. The addition of this substance to food is prohibited in certain European countries because of its injurious physiological effects.

Some of the leading manufacturers of fruit juices now guarantee their goods to be entirely free from all preservatives.

#### BOTTLED CARBONATED BEVERAGES.

These, like "soda water," which is only sold by the glass, are water charged with carbonic acid and variously colored, flavored and sweetened.

Of this class of "temperance drinks," "ginger ale," put up usually in two-third pint round-bottomed bottles, is perhaps the most popular.

In addition to ginger extract and sugar it may contain a little lemon juice or citric acid and lemon oil. Sometimes capsicum is used in place of a part or all of the ginger extract.

<sup>\*</sup>Commercial Organic Analysis. 2d Edition. Vol. I, p. 163.

<sup>\*</sup> See also pp. 139-141 of this Report.

Other kinds of bottled effervescent beverages are "sarsa-parilla"; also lemon, orange, raspberry and cream (vanilla) "soda," which differ from each other only in the flavors and coloring matters which they contain.

The above list is only a partial one, but includes those which are most in demand.

The cheap grades are commonly of local manufacture and are sold either in quart or half pint bottles, with corks or patent stoppers. The bottling of soda water is done by a machine, which adds a measured quantity of syrup and carbonated water to each bottle and inserts the stopper.

# Examination of Samples from the Connecticut Market.

The samples of soda water syrups and bottled carbonated beverages represent the different grades in the market, from the cheapest to the highest priced. The bottled fruit syrups are sold for the most part by grocers for family use, but are practically the same in composition as the soda water syrups bought at soda fountains. Bottled grape juice, lime juice and some other fruit juices are often kept on soda water counters for use in carbonated drinks and are also sold to some extent for family use. Five samples were examined.

Detailed descriptions of all these samples are given in the tables on pages 117 to 128. Those in which artificial flavors, artificial dyes, preservatives and glucose were not detected are classed as not found adulterated, and the others, whether found to contain one or more of these materials, are classed as adulterated.

Partial quantitative chemical analyses of these samples and of twelve samples of pure fruit juices from manufacturers, and of five samples prepared in the laboratory, are given in Table XIV, pp. 134 to 137, and are of interest chiefly to food chemists.

Following is a classified list of samples not found adulterated and of those found adulterated, together with the names of the foreign materials detected: where boric acid was found no attempt was made to determine whether it existed free or in form of borax.

VI—SUMMARY OF RESULTS OF EXAMINATION OF FRUIT SYRUPS

	Not found Adulterated.	Adulterated.	Total.	Adulterants detected.
	Ad	Ad		
Soda Water Syrups:				
Soda Water Syrups. (Sold at Soda Fountains.)	0	2	2	Artificial coloring matter.
	0	2	2	Coal-tar dyes.
Mint	I	5	6	Coal-tar dyes, salicylic acid, glucose.
Mint	5	I	6	Glucose.
Orange	15	17	32	Artificial flavoring, coal-tar dyes, sali cylic acid, glucose.
Strawberry	10	26	36	Artificial flavoring, coal-tar dyes, sali cylic acid, glucose.
Miscellaneous	5	3	8	Coal-tar dyes.
Total	36	56	92	
Bottled Syrups:				
Orange	2	2	4	Coal-tar dyes.
Pineapple	0	2	2	Salicylic acid.
Raspberry	3	4	7	Artificial flavoring, coal-tar dyes, sal cylic acid, benzoic acid, glucose.
Strawberry	2	3	5	Coal-tar dyes, cochineal, salicylic acid benzoic acid.
Miscellaneous	I	4	5	Coal-tar dyes, salicylic acid.
Total	8	15	23	
Fruit Juice:				
Grape Miscellaneous	0	3	3	Salicylic acid, benzoic acid.
	0	2	2	Salicylic acid.
Total	0	5	5	
Bottled Carbonated Drinks:				
Dirch Reer	7	I	8	Salicylic acid.
Cream Soda	6	I	7	Salicylic acid.
Ginger Ale Lemon Soda	14	9	23	Salicylic acid, boric acid.
Orange C-1	7	2	9	Salicylic acid, boric acid.
Nont Da	o	7	7	Coal-tar dyes, salicylic acid.
Strawherry	8	Í	9	Salicylic acid.
	0	5	5	Artificial flavoring, coal-tar dyes, sal
Sarsaparilla				cylic acid.
Sarsaparilla Miscellaneous	14	2	16	Salicylic acid, boric acid.
Miscellaneous	Ī	5	6	Artificial flavoring, coal-tar dyes, sal cylic acid.
Total			-	- Cylin dold.
Total, syrups, juices and drinks	57	33	90	
Ps, Juices and drinks	TOT	100	210	

The samples examined, with seven exceptions, were sweetened with cane sugar, but in many cases, owing, doubtless, to the presence of organic acids and the process of sterilization employed, this cane sugar had been converted wholly or in part into "invert sugar." This change is not objectionable, as the sweetening matter of most fruits is "invert sugar," and the cane sugar added to fruits in the preparation of preserves, jellies, etc., is partially converted into "invert sugar" during the process.

The sweetening of one sample of bottled syrup, No. 11027, was glucose syrup.

Two samples of bottled syrup and five samples of soda water syrup contained glucose, together with cane and invert sugar. Sweeteners other than sugar were not found.

Of the 71 adulterated syrups, sold at fountains and in bottles, 24 contained artificial flavoring matter; 45, coal-tar dyes; 7, cochineal; 19, salicylic acid, and 2, benzoic acid. Four samples of fruit juices contained salicylic acid, and one benzoic acid. Of the 33 adulterated carbonated drinks (sold in bottles), 6 contained artificial flavoring matter; 15, coal-tar dyes; 16, salicylic acid, and 4, boric acid.

Among the coal-tar dyes identified were magenta, acid magenta, eosine, tropæolin, ponceau, Bordeaux red and anilin green. The quantity in a glass of soda water (250 cc.) or in the syrup for a glass of soda water was, in many cases, sufficient to dye a six-inch square of white woolen cloth (Nun's veiling) a most brilliant color,—scarlet, magenta, crimson, orange, or green, according to the dye.

Tests were made for formaldehyde and sulphurous acid, but neither of these chemical preservatives was detected.

TABLE VII.—SODA WATER SYRUPS NOT FOUND ADULTERATED.

Sold Sold	l for	· Dealer.
9904 Coca-Cola 11093 Cycler's Ai 11097 Fruitina 9783 Neapolitan Orange 11053 Pineapple "" 11075 11076 9905 Neapolitan Outlier of the color o	Phosphate	Willimantic. C. E. Whittemore, 759 Main St.  Bridgeport. —, Fairfield Ave. & Water St.  Danbury. D. A. David, 292 Main St.  Hartford. Condos & Co., 226 Asylum St.  Williams, 975 Main St.  New Britain. E. W. Thompson & Co., 181 Main St.  New London. Moon's Pharmacy, 477 Bank St.  C. M. Rogers, 9 Main St.

# TABLE VIII—ADULTERATED

Caratan		THE I
Station No.	Sold for	Dealer.
11143	Cherry	New Haven. R. Ginzberg, 610 Grand Ave
9992	Cherry Ripe	Waterbury, Anthony Dec. 84 Const Co.
11004		
11084		
11042		
9969	Miner's Iced Mint	Meriden W H Thompson To W M
11121	Orange	Meriden. W. H. Thompson, 75 W. Main St.  Danbury. T. C. Casassa, 3 White St.
III22	"	Danbury. T. C. Casassa, 3 White St.
11030	"	Maridan I E Dall OF M.
11010		Meriden. J. F. Dooley, 48 E. Main St.  South Norwalk. Lane's Bakery, 51 Washington St.  Waterbury. Anthony Dec. 84 Canal St.
9991	"	Waterbarn And Description St.
11046	Pineapple	Waterbury. Anthony Deo, 84 Canal St.  New London. Anthony & Traggis, 186 State St.  Bridgeport. — 610 F. Main St.
11152	Raspberry	
IIII9		
11040		
11158		
11044	"	11. Diock, /2 Telliple of.
11095		- Laur Weitel, /3/ Wall St
11092	. "	J. E. Bunny, Main and W. Main Sts
11142		Nosasco & Curroni, 271 Main St
11133		New Haven. Bakery, 657 Grand Ave.
11148	"	C. I. Hollings, 014 State St.
11139	**	S. I lekus, 40 Oak St.
11003		M. L. Shorr, 787 Grand Ave.  Stamford. Parker & Ward, 185 Main St
11107		
11109		Waterbury. M. K. Lillian, 143 E. Main St.
11023	"	Wallingford. J. F. Cassin, 38 Center St.
11022	"	Wallingford. J. F. Cassin, 38 Center St.
11149		Shortell's Pharmacy, 72 Center St.  West Haven. Putman's Restaurant, Beach St
	Strawberry	
11043	"	
11159	"	
11154	"	J. Katz, 215 Front St.
11157		
11082		Middletown. Buel & Blatchley 246 Main St
11083	"	
1096	"	John Tosillo, 280 Main St.  New Britain. J. F. Burns, 365 Main St.
1001	••	
1131		Rosasco & Caroni, 271 Main St.  New Haven. Cedar Hill Exchange 1700 Steel St.
1138	"	
1134		Klondike Candy Kitchen, 459 State St.
1144		Schultz Grocery, 802 Grand Ave.
1132	"	Smoleroff Branch, 603 Grand Ave.
1140	"	M. Smoleroff, 932 State St.
1135		John Spires, 696 Grand Ave.
1137	"	— , 794 Grand Ave. — , 885 Grand Ave.
II5I	"	- r6 Oals St
1063		Norwich. James Costandi, 263 Main St.
1062		B. A. Herrick Broadway and Main St.
1085	"	B. A. Herrick, Broadway and Main St
1002	"	
9993	"	
1108		
IIIO	"	G. T. Geddes, 826 Bank St. Waterbury Candy Kitchen, 128 S. Main St.
1150	"	West Haven. Fred's Quick Lunch, Savin Rock Grove
1147	" Violetene_	West Haven. Fred's Quick Lunch, Savin Rock Grove
		Congress Ave.

# WATER SYRUPS.

Flavoring matter.	Coloring matter.	Preservative.	Sugar.
			Cane sugar *
	Artificial		"
	Artificial		"
	Artificial		"
			**
	Green coal-tar dye  Green coal-tar dye		
	0 1 1 1 1		Cane sugar and glucose
	Orange coal-tar dye		Cane sugar and glucose
		0.11 11 11	Calle sugar and grucose
	Orange coal-tar dye	Salicylic acid	Cane sugar."
	Orange coal-tar dye		16
		1	Cane sugar and glucose
	Magantak		Cane sugar.*
	Crimson coal for dye		"
Artificial	Crimson coal-tar dye	Solicylic acid	
			"
Artificial	1		
	Crimson coal-tar ave		"
	Cochineal		
4: Goial	Violet dve		6
Affilicial	Crimson coal-tar dye		16
Artincial	Red coal-tar dye		Cane sugar and glucose
	Red Coal-tar dye		Cane sugar *
Artificial	Acid magenta		Cane sugar.
Artificial	Crimson coal-tar dve		
	Red coal-tar dve	Salicylic acid	
		Salicylic acid	
	Crimson coal-tar dye	Salicylic acid	
		Salicylic acid	**
	Magenta†		
A C 1	Cochineal		
Artincial	Cocnineal		"
Artificial	Crimson coal-tar dye		
	Magenta†		"
Artificial	Crimson coal-tar dve		
Artificial	Magentat		
Artificial	Crimson coal-tar dye		"
	Magenta†		"
	Crimson coal-tar dye		"
	Crimson Coar-tar dyc		"
A reic	Magenta†		
Articial	Eosine		"
altincial	Crimson coal-tar dve		
artificial	Fosinet		Cane sugar and glucos
artificial	Crimson coal-tar dve		Cane sugar."
Tuncial	Cochineal		
Artificial	Cochineal		**
	Carriet and to don		"
Artificial	Scarlet coal-tar dye		"
THEIRI	Red coal-tar dye		
	Crimcon coal tar dye	And the form of the second of	
attificial	Scarlet coat-tar dive		
		Salicylic acid	"
	Scarlet coal-tar dye	Salicylic acid	"
	Ded and ton des	Salicylic acid	
Artificial	Red coal-tar dye	Salicylic acid	
aucial	Red coal-tar dye Crimson coal-tar dye	0.11 11	-
Articial	3.5		
Hilficial	Cochineal		_ · · · · · · · · · · · · · · · · · · ·
			- 11
	Green coal-tar dye		- "

Cane sugar and glucose.

acid

Benzoic

Scarlet coal-tar dye

91

25

Philip J. Ritter Conserve Co., Phila Pa.

2966

11026

Cochineal

6

61

Joseph Campbell Preserve Co., Camden, N. J.

Wild Cherry:
No-Tox Wild Cherry Phosphate, E.
S. Burnham Co., New York

9949

9944

9943

No sugar.

Scarlet coal-tar dye

9

\* Partially inverted.

COAL-TAR

SYRUPS CONTAINING PRESERVATIVES OR

X-BOTTLED FRUIT

TABLE

SYRUPS NOT FOUND ADULTERATED. -BOTTLED FRUIT TABLE IX.

Sugar.	Cane sugar.*	ä	3	a	3		Scarlet coal-tar dye _ Benzoic acid Cane sugar and glucose.	Glucose.	Cane sugar.*	,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,	3	79	
Preservative.	Salicylic acid (	Salicylic acid	1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1		Salicylic acid	- Salicylic acid	Benzoic acid	1	Salicylic acid Cane sugar.*	Salicylic acid	Salicylic acid	Salicylic acid	
Coloring matter.	Crimson coal-tar dye Salicylic acid Cane sugar.*	16 Claret	71/2 Orange coal-tar dye.	16 Yellow dye	Pineapple	Pineapple	Scarlet coal-tar dye -		Raspberry	Crimson coal-tar dye Salicylic acid		Scarlet coal-tar dye - Salicylic acid	
Quanti in bottle	91	91	71/2	91	-1	91	16	6	91	91	91	91	
Price per bottle cents cents in bottle in bottle ounce	25	255	20	25	30	25	25	IO	30	25	25	25	
Dealer.	New Haven: Johnson & Bro., Court and State Sts.	Johnson & Bro., Court and State Sts	Stamford: G.A.Ferris, 184 Main St. New Haven:	Johnson & Bro., Court and State Sts	E. E. Hall & Son, 381 State St.	Johnson & Bro., Court and State Sts	Bridgeport: Osborne Bros., Noble Ave. and Jane St	Boston Grocery, 17 Colony St.	E. E. Hall & Son, 381 State St.	Johnson & Bro., Court and State Sts.	Johnson & Bro., Court and State Sts	Johnson & Bro., Court and State Sts.	Dridgeport.
n/ Brand.	Shrub, J. Hunger-Rochester, N. Y		Orange: The Crystal Conserve Co., New York	True fruit Orange Shrub, J. Hunger- ford Smith Co., Rochester, N. Y	Pineapple: Concent, Pineapple Lemonade, Bain & Chapman Mfg, Co., St. Louis, Mo.	True fruit Pineapple Shrub, J. Hungerford Smith Co., Rochester, N.Y.	Raspberry: Philip J. Ritter Conserve Co., Phil- adelphia, Pa.	Raspberry	Bain & Chapman Mfg. Co., St. Louis,	True fruit Raspberry Shrub, J. Hungerford Smith Co., Rochester, N.Y.	Root	Stra	
atic No.	125	37	51	40	069	139	196	527	589	941	446	943	

9939

9590

1566 9940

9937

1966

11027

6886 9941

	ne .
No.	
on I	Brand,
Station No.	
S	
	Birch Beer.
9966	Mohican Spring Water Co., Bridgeport Wait Everett's Birch Beer, New Haven
9936	Wait Everett's Birch Beer, New Haven  J. Wahrenberger's Birch Beer, New Haven
9579	C M 0- C NT TT
9574	Stor Dottling Wanter M. II
992 <b>2</b> 9912	I C Cassill Name II
9555	Gilhuly & Bohen, New Haven  Cream Soda, (Vanilla).
9555	Cream Soda (Vanilla)
1034	Crystal Spring Sade Washer Marile
9586	Crystal Spring Soda Works, Meriden  Crystal Springs Cream Soda, Howard & Co., New York  Wait Everett's Cream Soda New Haven
9932	Wait Everett's Cream Soda, New Haven Chas, Clair's Cream Soda, New Haven
9578	Chas. Clair's Cream Soda, New Haven Star Bottling Works New Haven
9921	Star Bottling Works, New Haven
9916	J. C. Scoviii, New Haven
9964	
9904 9960	Mohican Ginger Ale, Fairfield Spring Water Co., Bridgeport Fairfield Ginger Ale, Aero Distilled Water Co., Bridgeport Royal Belfast Ginger Ale, W. A. Boar & Son, J.
9976	Royal Belfast Ginger Ale, W. A. Ross & Sons Limited, Ireland
9975	Aromatic, M. Bacon, Hartford
1033	Civstal Spring Soda Works, Meriden
9931	wait Everett's Ginger Ale., New Haven
9581	1. Wanrenberger, New Haven
9572	G. Mosca & Co., New Haven
9919	No label
9538 9591	Cantrell & Cochrane, Dublin & Belfast, Ireland.
9910	Hygeia Distilled Water Co., New York J. C. Scovill, New Haven
9528	Glenbrook Spring Ginger Ale, Eagle Bottling Works, Glenbrook
1011	Gray Bros., New Canaan
	Lemon Soda.
9935	Wait Everett's Lemon Soda, New Haven
9582	C. Clair's Lemon Soda, New Haven
9920	Star Bottling Works, New Haven
9918	No label
9553	G. Mosca & Co., New Haven J. C. Scovill, New Haven
9557	Glinuly & Bonen, New Haven
9906	Moxie Nerve Food. Moxie Nerve Food Co., Boston, Mass.
	Koot Beer.
9587	Imperial Brand Root Beer, Franklin Packing Co.
9930	Walt Everett's Koot Beer, New Haven
9923	Star Bottling Works. New Haven
9556	J. C. Scovill, New Haven
575	Gilhuly & Bohen, New Haven J. Wahrenberger's Root Beer, New Haven
981	Improved Root Beer, The Chas. E. Hires Co., Phila., Penn.
980	Famous Root Beer, Geo. A. Berry & Co., Concord, N. H.
	Sursapartita.
965	Mohican Spring Water Co., Bridgeport
031	Crystal Spring Soda Works, Meriden Crystal Springs Sarsaparilla, Howard & Co., New York Wait Everett's Sarsaparilla, New Horse
585	Weit Everett's Sarsaparilla, Howard & Co., New York
933	Wait Everett's Sarsapailia. New Haven
580	Cliquot Club Bottling & Extract Co., Millis, Mass.  J. Wahrenberger, New Haven
573	G. Mosca & Co, New Haven
917	No label
928	Hygeia Distilled Water Co., New York
913	1. U. SCOVIII New Haven
558	Gilhuly & Bohen, New Haven Delatour Extra, Ackley C. Schuyler, New York
598	Delatour Extra, Ackley C. Schuyler, New York H. G. & G. S. Grumman, Norwalk
014	

Dealer.	Price per bottle, cents.	Quantity in bot- tle, pints.
Lectors. R. T. Whiting, 345 Main St.	10	2/3
Brids F. I B Chandler 7 Shelton Ave	IO	2
Vew Hatting City Bottling Works, 745 Dixwell Ave.	7*	2
State & Clark Sts	10	2 2
H. Grau, 15 Dixwell Ave	10 5*	1/2
C. B. Vandine, 894 State St.	10	2
Meriden, 37 State St	5	1/2
	5	2/3
I. B. Chandler, 7 Shelton Ave Elm City Bottling Works, 745 Dixwell Ave	7*	2
H. Grau, 15 Dixwell Ave.	10	2
J. C. Scovill, 171 Kimberly Ave	10	2
Bridgeport. The Coe & White Co., 560 Main St.	10	2/3 2/3 2/3 2/3 1/2 2
OSDOTHE BIOS., Noble Ave. & Jane St.	5 13	7/3 2/3
G. C. Loeffler, 705 Main St.	10	2/3
Mariden - 37 State St	5	1/2
New Haven, I. B. Chandler, 7 Shelton Ave.	3*	2
Elm City Bottling Works, 745 Dixwell Ave, 858 State St.	5	1/2
H. Grau, 15 Dixwell Ave.	5	2/3
Howe & Stetson, 767 Chapel St.	10	2/3
W. S. Prindle, Church & George Sts	10	2/3
J. C. Scoville, 171 Kimberly Ave	3* 10	3/2
Sparks & Co., 850 Chaper St	5	1/2 1/2 2/3 2/3 2/3 3/4 1/2
New Haven. I. B. Chandler, 7 Shelton Ave	10	2
Elm City Bottling Works, 745 Dixwell Ave.	3*	2 /2
H. Grau, 15 Dixwell AveH. Grau, 15 Dixwell Ave	5	2/
—, State & Clark Sts.	10	2
J. C. Scovill, 171 Kimberly Ave.	3*	1/2
C. B. Vandine, 894 State St.	10	2
J. Coburn, College & Chapel Sts	25	
S. S. Adams, Court & State Sts	5	2/2
H. Grau, 15 Dixwell Ave.	10	2
J. C. Scovill, 171 Kimberly Ave.	3*	1/2
C. B. Vandine, 894 State St.	7*	2 2
J. Wahrenberger, 745 Dixwell Ave	10	11
Steiner's Pharmacy, Main & Shetucket Sts	20	2
Bridgeport. R. T. Whiting, 345 Main St.	10	2/1
Meriden. I. Dondero, 306 E. Main St.  New Haven. S. S. Adams, Court & State Sts.	5	2
I. B. Chandler, 7 Shelton Ave.	10	2
C. F. Curtiss, 950 State St.	10	3,
Elm City Bottling Works, 745 Dixwell Ave	7*	2
	5	2
H. Grau, 15 Dixwell Ave		2/2/1
J. C. Scovill, 171 Kimberly Ave	3*	
O T) 17 1: 0- ( Ctate Ct	10	2
New London. Downey & Kinney, 134 State St.  So. Norwalk. Daniel L'Homedieu, Washington St.	5	11/
Wormala Daniel L'Homedieu Wachington M		1

TABLE XII—SODA WATER AND OTHER CARBONATED BEVEN

Station No.	Brand.	Dealer.
	Birch Beer:	New Hayen
9565	John Clancey, New Haven	New Haven: Gibbons Bros., State and Pearl Sts.
9934	Wait Everett, New Haven	2. D. Chandier, / Sherton Ave
9545	John Clancey, New Haven	David Ringerman, 13 Lawrence c.
9562	John Clancey, New Haven	Globons Bros., State and Pearl Sta
9927	Star Bottling Works, New Haven Ginger Ale:	Star Bottling Works, 24 Dow St.
9571	Crystal Springs Ginger Ale, Howard	
9938	& Co., New York Delatour Extra, Ackley C. Schuyler	S. S. Adams, 412 State St.
9530	New York Sparkling, Vartray Water Co., Buffalo	
9536	N. Y.  Arethusa Spring Water Co., Seymout	Hauff Bros., Church and Chanel St.
9584	Countess, Hygeia Ice and Water Co. New Haven	Heublein & Bro., Court and Church o.
9540	Naugatuck Diamond, Diamond Bot- tling Co., Waterbury	E. Hewitt & Co., 744 Chapel St
9534	Naugatuck Diamond, Diamond Bot- tling Co., Waterbury	Harry Leigh & Bronson Co., 354 State &
955 <b>2</b> 9956	John Clancey, New Haven Cliquot Club Bottling and Extract Co., Millis, Mass.	J. J. Sullivan, Nash and Eagle Sts.
9570	Lemon Soda: Lemonade, Arethusa Spring Water Co., Seymour	
9546	John Clancey, New Haven	David Kligerman, 13 Lawrence St
9929	Orange Phosphate, Wait Everett, New Haven	I. B. Chandler, 7 Shelton Ave.
9576	J. Wahrenberger, New Haven	Elm City Bottling Works, 745 Dixwell Av.
9955	Blood Orange, Cliquot Club Bottling and Extract Co., Millis, Mass	F. D. Lawton & Co., 22 Main St.
9583	C. Clair, New Haven	New Haven: Elm City Bottling Works, 745 Dixwell Av.
9925 9550	Star Bottling Works, New Haven Blood Orange Phosphate, John Clan-	H. Grau, 15 Dixwell Ave.
	cey, New Haven	J. J. Sullivan, Nash and Eagle Sts.
9559	Phosa:	C. B. Vandine, 894 State St.
9597	Rumford Chemical Works, Providence, R. I.	New London:, 56 Main St
0565	Raspberry:	New Haven:
9561	Root Beer:	C. B. Vandine, 894 State St.
9564	Sarsaparilla:	Gibbons Bros., State and Pearl Sts.
9569 9952	Naugatuck Boy Brand, Diamond Bot-	
	tling Co., Waterbury	H. A. Smith, 41 Main St
9563	John Clancey, New Haven	Gibbons Bros State and Pearl Sts.
9924	Star Bottling Works, New Haven J. C. Scovill, New Haven	H Gran Is Dixwell Ave
9554	G. Mosca & Co., New Haven	J. C. Scovill, 171 Kimberly Ave. ————————————————————————————————————
1013	H. J. and G. S. Grumman, Norwalk	Daniel L'Homedieu, Washington St

ANTISEPTICS, ARTIFICIAL DYES OR FLAVORS.

lies.	Quant. in bottle. Pints.	Flavoring matter.	Coloring matter.	Preservative.	Sugar.
20	0			Salicylic acid	Cane Sugar.*
	2				"
	2				
	2				"
	2	Vanilla			"
	2		Red coal-tar dye		
	2/3	Ginger		Salicylic acid	"
	2/3			Salicylic acid	"
ı		"		Salicylic acid	"
	2/3 2/3	"		Boric acid	"
	2/3	"		Boric acid	
	2/3	"		Salicylic acid	
	<sup>2</sup> / <sub>3</sub>	"		Salicylic acid Salicylic acid	
	3/4			Salicylic acid	
	2/	T		Boric acid	"
	2/3 2	Lemon		Salicylic acid	
	2	Orange	Orange coal-tar dye		
	2	"	Crimson coal-tar dye		
	3/4		Scarlet coal-tar dye		
	1/2 2	"	Orange coal-tar dye		
	2	"	Acid magentat	Salicylic acid	"
	2	"	Acid magenta		
	2/3			Salicylic acid	66
	2	Artificial	Acid magenta		
	2			Salicylic acid	"
	2/3			Boric acid	"
	2/3			Salicylic acid	"
	2	Artificial	Acid magenta		"
	2	Artificial	Scarlet coal-tar dye		
	1/2 2	Artificial	Crimson coal-tar dye		- "
					"

† A coal-tar dye.

PRESERVATIVES. CHEMICAL CONTAINING JUICES FRUIT XIII.

	ar				
Sugar.	Invert sug		3	3	3
Preservative.	Salicylic acid	Salicylic acid	Benzoic acid	Ave. & Com-	Salicylic acid
Quantity in bot- tle, ounces.	91	17	13	, 4	28
Price per bottle, cents,	20	25	7, 7,	? .	9
Dealer,	Meriden. Russell Bros., W. Main & Colony Sts.	New Haven. Mendel & Freedman, 772 Chapel St. 25 17 Salicylic acid	D. M. Welch, Congress Ave. & Com-	D. M. Welch, Congress Ave. & Com-	, 726 Main
Brand.	Grape Juice.  Grape Juice.  Goncord Snow Grape Juice Co Penn Yan, N. Y. Russell Bros., W. Main & Colony Sts. 20 16 Salicylic acid Invert sugar	9566 Welch Grape Juice Co., Westfield, N. Y	9907 Philip J. Ritter Conserve Co., Phila., Penn.	Montego Lime Juice. 9909 Jamaica, West Indies	Raspberry Juice. 9986 Hance Bros. & White, Phila., Penn
Station No.	0266	9956	2066	6066	9866

1

#### METHODS OF EXAMINATION.

A carbonated beverage is transferred to a flask and shaken at intervals during several hours. The liquid, which is then nearly free from carbonic acid, is used for the examination. Syrups, of course, do not require this preliminary treatment. All samples are kept on ice until

Solids. 2 grams of syrup, or 10 grams of carbonated beverage, are evaporated on a water bath and the residue is heated for 2 hours at 100° C. The drying is completed at 110° C.

Acids. A weighed quantity of the material is diluted with water, boiled, if carbonic acid be present, and titrated with standard barium hydrate solution, phenolphthalein being used as an indicator. The results are calculated as citric acid.

Polarization. The normal quantity for polariscopic test (26.048 grams), or, in the case of some of the syrups, one-half the normal quantity, is dissolved in water and clarified when necessary with Icc. each of alum-cream and basic lead acetate solution. After making up the volume to Ioocc. and filtering, the solution is "polarized" in a 200mm. tube.

50cc. of the solution are inverted by heating at 68° to 70° for ten minutes with 5cc. of strong hydrochloric acid. The inverted solution is polarized in a 220mm. tube, at the same temperature employed in the direct observation and, if glucose is present, again at 86° C.

The polariscopic readings in the table are calculated in all cases to the normal quantity.

The following formulae were used for calculating the sucrose and invert sugar from the polariscopic readings:

Let S=per cent. of sucrose,

I=per cent. of invert sugar,

a=direct reading in sugar degrees, with+sign when right-handed and-sign when left-handed.

b=reading in sugar degrees after inversion, always with + sign.

t=temperature C.

Then 
$$S = \frac{100 (a+b)}{144 - \frac{t}{2}}$$
 (Clerget's formula)

$$I = 1.0526 \left( \frac{100 \text{ b}}{44 - \frac{t}{2}} - S \right) \text{ or } I = \frac{105.26 \text{ (S-a)}}{44 - \frac{t}{2}}$$

The first of the two formulae for calculating invert sugar was derived by the writers from well known data, the latter from a formula given by Tuchschmid\* for calculating grams of invert sugar. In Robb and Veley's English edition of Landolt's Handbook of the Polariscope, London, 1882, p. 189, Tuchschmid's formula, without change, is erroneously given for calculation of percentage of invert sugar.

<sup>\*</sup>Jour. prakt. Chem. (2), 2, 235.

In the presence of any considerable amount of glucose or other optically active matter the formulae are not applicable. Tartaric acid, malic acid, some salts of organic acids, lemon oil and other substances contained in fruits, or added separately to soda water, are optically active, but the specific rotation of most of these is much less than of the sugars and they are present usually in very small amount.

In grape and quince juice, as will be seen by referring to the analyses, the sum of the sucrose and invert sugar, as calculated by formulae, is greater than the percentage of solids. This is due to some body, present in these juices, which polarizes to the left at 86° C. The fruit juices used in the kinds of soda water and syrups examined, give as a rule, a zero reading at 86°, and in these the results calculated by the formulae are not far from correct.

It is evident that the method only gives approximately the quantity of sugar, but indicates whether or not glucose is present.

Arata's Wool Test for Coal-tar Dyes.\* 100cc. of soda water, or 50cc. of syrup diluted to 100cc, are boiled for 10 minutes with 10cc of 10 per cent. solution of potassium bisulphate and a piece of white wool, or woolen cloth, which has been previously heated to boiling in a very dilute solution of sodium hydrate, and thoroughly washed in water. After removal from the solution, the wool is again washed in boiling water and dried between pieces of filter paper. If the coloring matters are entirely from fruit, the wool will either be uncolored, or will take on a faint pink or a brown color, which is changed to green by ammonia and is not restored by washing in water; but acid magenta, tropeolin, ponceau and various azo-colors are fixed on the wool and the color of the latter is either not changed by ammonia, or, if changed, is restored on washing.

Care should be taken to determine whether the wool is dyed, or merely coated with the color. For example, chlorophyl from green coloring preparations of vegetable origin, is deposited on wool, together with fat and resin, but the color, unlike the coal-tar dyes, rubs off on the fingers and is readily washed out with soap and water.

The dye present may often be identified by noting the color of the wool after addition of enough concentrated sulphuric acid to thoroughly moisten the fibres and again after dilution of the acid. In doubtful cases, however, the wool should be treated with dilute tartaric acid solution to remove vegetable colors, washed in water and dried between sheets of filter paper. It is then transferred to a test tube and saturated with concentrated sulphuric acid. After standing 5 or 10 minutes, water sufficient to make 10cc is added and the wool is removed. The solution after neutralizing with ammonia and cooling is shaken with 5 to 10cc. of pure amyl alcohol, to which a few drops of ethyl alcohol are added, to facilitate the separation. The alcoholic extract is

separated, evaporated to dryness, and the residue tested according to the scheme of Witt,\* Weingaertner,† Dommergue,‡ or Girard and Dupré.§

Amyl Alcohol Test, Alkaline Solution. 25cc. of the liquid to be tested, made alkaline with ammonia, are shaken cautiously for some minutes in a separatory funnel, with pure amyl alcohol. If the clear alcoholic layer, when separated from the aqueous solution, is colored, or if addition of acetic acid develops a magenta color (fuchsine), a portion of it, together with an equal bulk of water and a thread of wool, is heated on a water bath, the water lost by evaporation being replaced from time to time.

The presence of a coal-tar dye should not be affirmed until the color has been fixed on wool and the wool has been washed in boiling water, dried and tested. When fuchsine is present, the color which appears on adding acetic acid to the alcohol extract is changed to yellow by hydrochloric acid.

Amyl Alcohol Test, Acid Solution. 25cc. of the liquid, to which have been added a few drops of hydrochloric acid, are shaken with amyl alcohol, and dyeing tests are made as described in the preceding section.

A colored amyl alcohol does not prove the presence of a coal-tar color, as we have found that red coloring matters are extracted by this solvent from acid solutions of fruit juices. These solutions, however, do not dye wool, when treated as above described.

Girard's Test for Acid Fuchsine (Acid Magenta).\*\* If a bright magenta color is fixed on wool by Arata's test and if ordinary fuchsine has been proved to be absent, test should be made for acid fuchsine.

To rocc. of the liquid are added 2cc. or more of 5 per cent.-solution of potassium hydrate. The strongly alkaline liquid is mixed with 4cc of 10 per cent.-solution of mercuric acetate and filtered. The filtrate should be alkaline and colorless. If addition of a slight excess of dilute sulphuric acid produces a violet red coloration and other dyes have not been found by the amyl alcohol test, the presence of acid fuchsine may be affirmed.

Test for Cochineal.†† If amyl alcohol extracts from the liquid after acidifying, an orange color which has not been found to be of coal-tar origin, test is made for cochineal.

The alcohol is washed several times with water and divided into two portions. To one portion is added a solution of uranium acetate, drop by drop, with shaking. In the presence of cochineal the aqueous

<sup>\*</sup>Ztschr. anal. Chem. 28, 639. See also Borgman, Anleitung chem. Anal. d. Weines, Wiesbaden, 1898, p. 91. Koenig, Untersuchung landw. u. gewerb. wich. Stoffe, Berlin, 1898, 577.

<sup>\*</sup>Ztschr. anal. Chem. 26, 100.

<sup>†</sup>Ibid., 27, 232.

<sup>‡</sup>Ibid., 29, 369.

<sup>§</sup>Analyse des Matières Alimentaires et Recherche de leurs Falsification, pp. 583-593.

Ibid., 167, 582.

<sup>\*\*</sup>Girard et Dupré, Analyse des Matières Alimentaires et Recherche de leurs Falsification, p. 169.

<sup>††</sup>Ibid., p. 580.

solution acquires an emerald green color. As a confirmatory test, the other portion is made alkaline with ammonia, which changes the orange color of cochineal to purple.

Vegetable Colors are tested for by the methods described by Girard and Dupré.

Salicylic Acid and Benzoic Acid. Twenty-five to 50cc. of the liquid are thoroughly shaken in a tube of suitable size with an equal bulk of ether. The ethereal solution is carefully decanted into a flat procelain dish and the ether evaporated at a gentle heat. The residue is taken up with absolute alcohol and the solution allowed to evaporate to dryness at the room temperature. The presence of salicylic acid is indicated by the appearance of characteristic fibrous crystals, and that of benzoic acid by shining crystalline scales. The residue is further tested as follows:

Salicylic Acid. A portion of the residue is dissolved in absolute alcohol and tested with ferric chloride solution.

To further confirm the presence of salicylic acid, another portion of the crystalline residue is heated with methyl alcohol and a few drops of sulphuric acid. Methyl salicylate, formed by this treatment, is recognized by its characteristic odor.

Benzoic Acid. A portion of the residue is cautiously heated and if fumes of this acid are given off they are collected on a cool surface. The crystalline sublimate is demonstrated to be benzoic acid by the following tests:

(1.) The melting point is determined.

(2.) Some of the crystals are dissolved in ammonia and the solution evaporated to dryness to remove excess of the alkali. The residue is dissolved in water and divided into two portions. To one portion neutral solution of ferric chloride is added, which gives the flesh-colored precipitate of ferric benzoate. Addition of strong hydrochloric acid decomposes this precipitate with separation of benzoic acid.

(3.) The other portion of the aqueous solution of ammonium benzoate (prepared according to 2) is mixed with an equal bulk of absolute alcohol and a few drops of copper sulphate are added dropwise. A light blue precipitate of cupric benzoate is thus obtained.\*

Boric Acid and Borates. A few cc. of the soda water or syrup are mixed with some drops of strong hydrochloric acid and a piece of delicate turmeric paper is moistened with the liquid. In the presence of boric acid the paper acquires, on drying, a peculiar red color, which is changed by ammonia to a dark blue-green, but is restored by acid.

Sulphurous acid and sulphites. 100cc. of the liquid are mixed with 10cc. of a 5 per cent. solution of phosphoric acid and distilled until 10cc. of liquid are carried over. The distillate is boiled with bromine water, to oxidize sulphurous to sulphuric acid, which is detected by addition of barium chloride solution.

Formaldehyde. 100 to 200 cc. of the solution are distilled until 10 to 200c. of distillate are obtained. The latter is tested as follows:\*

1. One cc. is mixed in a test tube with 5cc. of pure milk; and an equal volume of 94 per cent. sulphuric acid containing a trace of ferric chloride is added in such a manner that the two do not mix. In the presence of formaldehyde a blue ring forms at the juncture of the liquids.

2. A mixture of 2cc. of the distillate, with 1occ. of milk, 5cc. of concentrated hydrochloric acid and 1 drop of ferric chloride solution, is heated with constant agitation. Formaldehyde causes a violet coloration.

3. Rimini test.† 5cc. of the distillate, diluted to 15cc., are mixed with 1cc. phenylhydrazine hydrochloride solution (4:100), 4 drops of freshly prepared sodium nitroprusside solution (1:200) and enough concentrated solution of sodium hydrate to make the mixture strongly alkaline. Formaldehyde is indicated by the appearance of a blue, or in dilute solutions green, coloration, which changes to red on standing. When formaldehyde is absent, only the red color appears.

Saccharine. The liquid to be tested is shaken for some minutes in a separatory funnel with an equal bulk of ether. The ethereal solution is separated and evaporated to dryness. If an appreciable amount of saccharine is present, the residue will have an intensely sweet taste.

<sup>\*</sup>See Horn, Zeitschr. anal. Chem. 30, 732.

<sup>\*</sup>For other tests see Jorissen, J. pharm. de Liege, 4, 257 (Abstract

Ztschr. Unters. Nahr. Genuss, 1, 356.)
Also Wallace and Drescher, N. Y. Dairy Commissioner, Rep. 1898,

<sup>†</sup>Anal. di Farmacol, 1898, 97. (Abstract Ztschr. Unters. Nahr. Genuss, 1, 858.)

			Acids	1	1		POLARI	ZATION.	
Station No.		Solids.	other than carbonic calculated as citric acid.	Cane Sugar.	Invert Sugar.	Direct.	After Inversion.	No. 35 y	After inversion, Reading at 86°C.
	Soda Water Syrups not found Adulterated.			,					- 0.
9904	Coca-Cola	57.95	0.4	8.1	42.0	- 5.0	-15.7	22.5	
11093	Cycler's Aid	60.75	.45	8.6	40.8	- 4.0	-15.4	23.	
11097	Fruitina	54.05	.17	45.7	0.0	46.8	-13.2	25.4	
	Neapolitan Phosphate	56.40	1.14	8.9	42.I	- 4.0	-15.8	23.4	
	Orange	56.14	.14	50.11	0.0	50.4	-15.4	25.4	
	Pineapple	65.56	.65	46.62	8.3	44.0	-18.o	22.	
1098	, , , , , , , , , , , , , , , , , , , ,	51.38	.17	40.53	5.1	39.0	-14.3	25.	
1059		58.84	.20	39.15	8.9	36.8	-15.0	25.4	
1076		66.98	.14	57.37		57.6	-18.5	22.7	
	Queen Sherbet	59.82	.23	50.27	4.2	49.0	-17.6	23.	
1018	Raspberry	56.17	·57	18.37	42.2	6.0	-18.0	26.5	
1123	·	61.00	1.14	0.0	53.6	43.4 —16.0	-15.2	22.6	
11120	46	64.46	.74	1.3	54.9	-16.0 $-15.2$	-16.0 $-16.0$	25.2	
1024		55.20	.23	42.83	5.5	41.2	-15.0	24.8 25.6	
1801		59.85	.62	5.4	52.8	-10.8	-15.0 $-18.0$	23.2	
1086	"	68.84	.17	35.43	20.7	29.0	-18.0	22.7	
1141		62.04	.40	26.35	24.2	19.2	-15.4	25.5	
1145	"	56.44	.28	23.6	27.3	15.6	-15.2	26.5	
1054	"	40.41	.40	36.1	0.0	36.2	-11.0	26.4	
1055	"	68.06	.57	40.5	21.1	34.2	-18.9	25.5	
1065		61.68	.26	56.6	0.0	56.4	-18.7	22.5	
1064		54.27	.34	43.1	0.0	43.2	-13.9	22.5	
IIII	1.	53.71	.57	41.3	7.0	39.2	-15.0	25.4	
1077	"	60.74	•34	46.2	2.0	45.6	-15.4	24.	
	Strawberry	59.90	.23	22.9	22.3	16.0	-14.3	23.	
1118	"	58.50	.57	47.8	90	50.0	-13.4	22.6	
1039	"	61.60	.23	53.6		40.8	-16.3	25.5	
1041	"	58.15	.65	18.1	30.6	8.6	-15.4	25.6	
1094		65.98	.34	49.7		50.0	-15.4	25.	
1057	"	61.21	.05	38.4	14.7	34.0	-16.5	25.	
11056	***	63.56	.23	53.3	0.3	53.2	-16.7	25.5	
1058	"	65.64	.14	36.4	19.3	30.6	-17.2	25.	
1080	"	50.41	•37	42.2	0.6	42.0	-13.9	22.8	
1078		66.12	.14	38.2	16.1	33.2	-17.6	22.3	
	Soda Water Syrups Adulterated.								
	Cherry Ripe	70.36	.14	54.97	6.7	53.0	-18.9	26.4	
9992	Cherry	47.56	.74	32.4	1.3	32.0	-11.0	22.7	
	Fruit Nectar	61.98	.60	7.9	44.7	- 6.0	-16.5	22.5	
	Kolafra	47.56	.68	4.7	38.6	- 7.0	-13.2	24.3	
ALCOHOLD STATE OF THE	Mint	61.57	.09	40.96	17.0	36.0	-17.6	26.3	
9969	Orange	65.75	.68	3.6	59.0	-14.0	-18.7	25.	- 0
1122	Orange	66.57	.14			61.4	-11.7	25.5	5.0
	Orangeade	69 41	.17	58.8		66.0	- 9.9	27.0	7.0
	Orange		.28	47.47		60.0	-17.6 -11.2	24.8 26.4	
9991	"	46.60	.68	47.47		34.0	-14.3 $-11.9$	20.4	
	Pineapple	74.67	.34			50.8	<b>-</b> 9.0	27.0	9.0
	Raspberry	41.71	•34	37.6	1111	38.0	-11.4	25.2	1
11119	"	56.81	.03	55.9		56.6	-17.2	24.0	
1040		61.24	.17	27.1	31.9	17.6	-18.0	25.4	
11158		46.87	.28	38.2	2.9	37.4	-12,1	29.0	
11044		67.69	.23			34.4	-11.7	22.9	
1095	"	57.00	.17	46.2	0.7	46.0	-15.4	22.	
1094		53.71 66.24	.03	24.61	29.6	15.8	-16.5	25.5	
11142				39.51	19.3	33.8	-18.0	25.8	

TABLE XIV.—CHEMICAL EXAMINATION OF FRUIT SYRUPS, FRUIT JUICES AND BOTTLED BEVERAGES—Continued.

1			•   Ac	Acids			POLARIZATION.				
station No.				other than carbonic calculated as citric acid.	Cane Sugar.	Invert Sugar.	Direct.	After Inversion.	Temp. C°.	After inversion. Reading at 86°C.	
-	1		38.63	.14	34.35		35.0	-10.0	26.		
1148	Raspberry		50.30	.00	46.13		46.6	-13.6	27.		
1139	"		60.58	.51	39.07	II.I	35.6	-16.3	22.3		
1003	"		71.53	.45	4.0	65.9	-16.0	-21.3	24.		
1107	"		63.25	.31	45.62	14.6	41.2	-18.9	24.5		
1109	"		57.75	.14	45.55		45.4	-14.5	25.		
1023			62.09	.62	34.26	22.8	27.6	-17.2	26.5		
1022	"		43.73	.II	35.03	3.7	34.0	-11.4 - 8.1	29.3		
1149	Strawberr	y	29.46	.26	26.20	1.4	25.8 16.0	- 6.6	25.6		
1043			23.27	.23	17.22	4.1	17.8	- 4.4	29.		
1159	"		18.79	.00	17.14		24.4	- 5.3	29.		
1154			30.42	.03	29.70		30.0	- 8.8	26.5		
1157	"		57.36	.23	41.78	5.7	40.0	-15.4	22.8		
1082	"		56.49	.40	49.01	0.0	49.0	-15.4	25.2		
1083			60.69	.48	50.38	4.1	49.2	-16.7	26.4		
1096	"		55.21	.II	48.51		49.0	-14.7	25.4		
11091	"		46.23	.06	38.93	3.1	38.0	-13.0	26.		
11131	"		52.90	.06			55.4	- 0.7	26.4	12.0	
11138	"		20.92	.00	19.57		21.0	- 4.6	26.4		
11134	"		56.02	.00	23.20	26.5	15.4	-15.0	26.		
11132	"		59.86	.03	56.61		57.6	-16.7	25.5		
11140			52.84	.45	34.65	12.5	310	-14.3	26.5		
11135	"		29.85	.06	26.54		27.0	-7.7 $-9.2$	26.		
11137	"		37.23	.03	33.13		34.2 18.6	- 5·3	26.		
11151			21.45	.03	18.24		56.0	-16.5	22.4		
11063			58.66	.03	54.59 48.31	2.4	476	-15.8	25.5		
11062			10	.51	26.44	35.1	16.0	-18.7	25.5		
11005			66,54	.20	52.0	8.0	49.6	-18.7	25.2		
9993	**		45.07	.14	39.77		41.0	-11.8	22.5		
11108	44		1 12 2	.65	32.2	8.7	29.6	-12.8	24.8		
IIIIo	"		67.49	.II	60.90	I.I	60.6	-19.8	24.		
11150			56.85	.40	50.77	1.4	50.4	-15.4	28.8		
11147	Violeten	e		.06	14.48	0.0	14.4	- 4.4	28.4		
	Bottled	Fruit Syrups									
001-		d Adulterated.			0 -	.06	720	-14.1	28.		
				1.93	.85	48.6	-13.0 $-6.0$	and the second state of the second	0		
9959				1.65	8.9	52.4	-18.0				
		у	58.06	.74	29.7	21.9	23.2	201			
9958	"	y	62.12	.85	1.2	62.5	-16.0		0		
9953				-45	4 I	62.5	-13.6	-18.9	28.4		
9990	Strawber	ry	56.97	.57	22.24	30.0	136				
9954	"		67.21	.40	5.6	60.2	-11.4	-18.7	28.4		
		Fruit Syrups									
9942	Cherry	ulterated.	. 65.62	1.53	1.2	64.5	-17.2	-18.7	28.		
7931	Claret		E7 17		4.5	50.6	- 9.6				
2327	Urange		62.53		-7	58.6	-16.0		28.		
2941	)		64 27		12.6	48.5	- 1.2	2 -17.6			
9590	Pineann	le	- 64.32		3.1	58.6	-13.6				
				1.31	33.41	27.5	25.0		725 1064 191 3700		
1102	Kaspber	ry	- 64 63				30.0			10.8	
958			- 08.95					CALL TO STREET		76.0	
994	I "				.23	51.7	- 14.4 - 8.8		\$000A HINDY SELECTION \$150		
994	4 Root Da	er	600+		7.1	55.9 22.8	32.8				
		rry	66.03		39.I 4.5	22.0					
1996:	2 "		66.23		16.03		14.0				
1105	5 "	nerry					THE RESERVE	6 - 7.		10.6	
an.	777.						土 0.	o ± 0.0	0		

TABLE XIV—CHEMICAL EXAMINATION OF FRUIT SYRUPS, FRUIT JUICES

			Acids		1		POLARI	IZATION.	
Station No.	n	Solids.	other than carbonic calculated as citric acid.	Cana	Invert sugar.	Direct.	After inversion.	Temp. Co.	Afte invers Read:
	Fruit juices not found adulterated.								Readi at 86°
9760	From Manufacturer.  Blackberry  Cherry	5.32 14.33	o.65 o.80	0.0	4.6 6.5	-1.3 -1.9	-1.3 -1.9	29.0 26.0	
9772	6 Black Currant Red Currant Grape	10.00 7.58 15.29*	2.4I 2.09 0.9I	0.0	9.2 7.2 21.7*	-2.7 -2.1 -6.5	-2.7 -2.1 -6.5	26.0 27.0 25.0	
9766	Lime Fruit Orange Pineapple Plum	7.78 12.72 8.07 10.81	6.50 2.44 0.81 1.00	0.0 0.0 1.5	0.0 7.1 5.1	±0.0 -2.1 ±0.0	$\pm 0.0$ $-2.1$ $-2.0$	26.0 26.0	-1.
9768	Quince	10.41* 8.47 5.69	0.99 1.36 0.99	0.0 0.0 0.0 0.0	0.3 16.7* 7.8 5.1	-0.1 -5.0 -2.3 -1.5	-0.1 -5.0 -2.3 -1.5	26.0 25.0 26.0 26.0	-2.
	Pure Fruit Juices Made in Laboratory.								
9880	Peach Red Raspberry Blackberry	9.41 8.94	0.95 1.19 1.22	5.4 0.8 0.0	2.I 8.6 8.7	4.8 -1.6 -2.4	-2.2 -2.8 -2.4	28.0 26.0 30.0	±0.0 ±0.0
9883	Huckleberry Pineapple Fruit Juices Adulter-	11.40*	0.51	0.6 7.4	16.7* 9.1*	-4.0 4.7	-4.8 -4.8	30.0 28.0	-1.0 -0.8
	Grape	21.10	1.00	0.2	27.2	-7.8	-8.o	26.4	
9566 9907 9909		19.00 23.11 3.55	0.87 0.84 3.39	0.4 0.0	22.4 25.1 0.0	-5.0 -7.0 ±0.0	-7.0 -7.5 ±0.0	26.8 26.0	
9 <b>9</b> 86	Raspberry  Bottled carbonated	8.94	1.43	0.0	6.6	-2.2	-2.2	26.0	
	beverages not found adulterated.								
9966	**	11.37	0.04	9.7	0.7	9.5	-3.2	27.	
9936		9.74	.03	7.6 8.2	0.3	7·5 8.0	-2.5 $-2.6$	26.	
9922	"	10.37	.03	8.7	0.0	8.6	-2.6	29.	
9912	"	9.05	.03	7.5	0.7	7.3	-2.5	27.	
9555 9574	"	8.60 7.59	10.	6.8 5.9	1.4	6.0	-2.5 $-1.7$	27.	
11034	Cream Soda	11.33	.03	9.1		10.0	-2.0	25.5 25.5	
9586		9.96	.03	8.9		9.0	-2.8	24.	
9932 9578		8.35	.01	7.I 6.3	0.7	7.5	-1.8	24.	
9921	"	8.94	.01	7.8	0.7	6.I 8.0	-2.2 -2.2	24. 25.	
9916		4.75	.01	4.1		4.3	-1.1	26.	
9964	Ginger Ale	12.60	.13	9.0	2.3	8.3	-35	25.	
9960	"	9.63 6.94	.03	8.I 5.4	0.3	8.0 5.0	-2.6 $-2.0$	25. 26.5	
9975	"	7.97	.07	6.1	1.0	5.8	-2.2	27.	
11033	"	10,94	.II	8.3	1.7	7.8	-3.0	26.5	
9572 9931	"	12.56	.10	7.9	3.0	7.0	-3.4	25.	
9581	"	9.97 8.48	.06	8.2 6.3	0.7	8.0	-2.8 $-2.3$	25. 25.	
9919	"	9.70	.07	6.6		7.0	-1.7	25.	
9538	"	9.83	.18	2.2	5.0	0.8	-2.0	30.	
9591		8.89 7.51	.16	4·5 6.3	3.3	3.5	-2.4 -1.7	25.	
9528		8.52	.08	5.6	I.9	5.0	-1.7 $-2.3$	25. 25.	
11011	T C- J-	5.05	.03	4.3	1.0	4.0	-1.7	25.	
9935	Lemon Soda	9.09	.05	7.0	0.0	7.0	-2.2	25.	
9920	"	4.83	.03	4.2	1.3	6.2	-2.5 -1.1	24. 25.	

\* See method of analysis.

TABLE XIV—CHEMICAL EXAMINATION OF FRUIT SYRUPS, FRUIT JUICES and BOTTLED BEVERAGES—Continued.

				Acids				TOLAKI	ZATION.	
ion			Solids.	other than car- bonic calculated as citric acid.	Cane sugar.	Invert sugar.	Direct.	After inversion.	Temp. C°.	After inversion Reading at 86° C
	2.1		8.19	.08	7.1	0.0	7.1	-2.2	25.	
-01	Lemon Sod	d	10.60	.08	8.8	0.7	8.6	-3.0	24.	
10	"		9.04	.06	7.4	0.3	7.3	-2.5	24.	
57	"		8.51	.05	7.2	0.7	7.0	-2.5	24.	
53			8.48	.06	10.9	4.6	9.6	4.4	30.	
	Moxie		8.32	.OI	7.2	0.7	7.0	-2.4	25.5	
87	Root Beer		6.02	.06	0.0	9.4	-2.6	-2.6	30.	
30	"		8.87	.OI	5.8	2.6	5.0 8.5	-2.6	25.5	
23	**		12.75	.06	9.0	1.7	8.5	-3.3 $-3.0$	26.5	
[]	**		10.79	.OI	8.8	1.0		The state of the s	26.	L. T. Want
50	"		8.28	.03	7.3	1.0	7.0	-2.5 $-1.2$	25.	
75	44		4.82	.01	2.8	1.0		-2.9	24.	
81	"		10.27	.01	9.4		9·5 7·5	-2.3	25.	
80	Sarsaparilla	L	10.19	.03	7.5		7.9	- 1.9	24.	
			10.16	.03	7.4	0.0	7.I	-2.2	25.	
31 85	"		9.78	.03	7.I 7.2		7.5	-2.0	25.	
33	44		9.49	.02	11.4	0,0	11.7	-3.3	25.5	
42			14.73	,01	5.3		5.6	-1.4	24.2	
30			7.10	.03	7.4	0.0	7.4	-2.3	25.	
17	"		7.12	.01	5.6	0.0	5.7	-1.7	24.4	
73	"		9.52	.01	7.2	0.0	7.3	-2.2	25.4	
28	"		8.43	.02	6.4	0.0	6.4	-2.1	23.	
13	"		10.34	.OI	7.38	0.3	7.3	-2.4	25.	
58	"		9.92	.II	2.5	1.6	2.0	-1.3	25.	
98	**		9.76	.OI	7.74	0.2	8.0	-2.2	24.4	
12	"		5.41	.01	3.3	0.7	3.5	-0.9	25.	
		ed Bottled Water.								
6=			8.87	.08	5.6	0.3	5.5	-1.8	29.	
			8.46	.04	7.0	0.3	6.9	-2.3	25.	
		Tonic	7.53	.17	2.54	4.3	1.3	-2.0	28.5	
		a	9.23	.09	5.9	0.0	5.5	-2.4	24.	
		a	9.75	.II	7.4	1.3	7.0	-2.8	25.	
	Ginger Ale		11.20	.24	6.3	4.3	5.0	-3.3	25.	
138	"		9.52	.15	7.6	0.3	7.5	-2.5	25.	
30	"		11.12	.27	5.3	5.5	3.7	-3.3	25.	100
36	"		9.42	.22	6.00	2.3	5.3	-2.6 -2.3	25. 30.	
84	"		10.18	.52	0.7	11.3	-2.4	-3.3 $-2.9$	25.	
40	"		9.70	.14	2.8	6.7	0.8	-2.9 $-2.8$	25.	
52	"		10.69	.14	4.64	4.4	3.3	-2.2	25.	
56	"		7.75	.12	8.00	2.3 1.6	7.5	-3.0	25,	
	Lemonade		10.40		0.2	10.9	-3.1	-3.4	24.	
4.6	Lemon So	la	13.48		5.30	1.0	5.0	-2.0	24.	1
29	Orange	1a	7.80	AND THE RESERVE	6.14	1.0	5.8	-2.3	24.	
10			9.09	A STATE OF THE STA	6.38	0.2	6.3	-2.1	24.6	
955	6.		15.08		7.83	4.1	6.6	-3.7	25.	100
183	"		9.48		7.3	0.3	7.2	-2.4	25.	
25			9.67		7.37	0.7	7.1	-2.6	25.	
50	"		9.40		5.4	2.4	4.7	-2.4	25.7	
559	66		9.59		7.45	0.7	7.3	-2.5	25.	
67	Phoso			.27	0.3	II.I	-3.0	-3.4	25.5	
56.	Raspberry	·		.08	6.62	1.3	6.2	-2.5	25.2	
560	Soot Beer		7.72		3.6	3.8	2.5	-2.2	27. 24.2	
952	aparill	a	9.91		4.47	3.3	3.5	-2.4 $-2.2$	28.5	
563	Straw		9.65		2.47	5.3	1.0	-2.2 $-2.0$	25.5	
924	Hawberry	7	7.01		3.43	3.1	7.0	-2.0 $-2.3$	25.	
-	1 TO		9.42		7.07	0.3	6.5	-2.2		
915				.05	0.59	0.5	0.0	11/1/11/19/2001		
915 554 013	A STATE OF THE PARTY OF THE PAR				5.41		5.1	-2.0	25.6	

#### PEANUT BUTTER AND PEANOLIA.

### By A. L. WINTON.

Peanut Butter, No. 9749, is made by the Atlantic Peanut Refinery, 145 South Front st., Philadelphia.

It claims to contain nothing but the peanut and salt. "It is not a roasted peanut mixed with oil and salt, but is prepared by a new "German Process." This sample was bought of Johnson & Bro., State st., New Haven, for 25 cents per one-half pound.

Peanolia, "a refined Peanut Butter," No. 9748, is made by the Peanolia Food Co., 106 Park st., New Haven. Bought of E. E. Nichols, New Haven. Price, 25 cents per one-half pound.

Neither of these articles was found to contain either boracic, salicylic, or benzoic acids.

Their analyses are as follows:

#### ANALYSES OF PEANUT BUTTER AND PEANOLIA.

	Peanut Butter. No. 9749.	Peanolia. No. 9748.
Water	2.10	1.98
Salt	3.23	4.95
Other mineral matters	0.80	1.08
Protein	The state of the s	29.94
Fiber	2.30	2.10
Starch		5.58
Sugars, dextrines, etc		5.63
Fat		46.68
Other matters by difference	4.22	2.06
	100.00	100.00

Protein is calculated by multiplying the total nitrogen present by 6.25. Starch was determined by the diastase method. Sugar, dextrines, etc. represent matters soluble in water, hydrolyzed with acid, and calculated as dextrose from their copper-reducing power.

These two preparations are very much alike in composition, rich in protein, or "flesh-forming" material, and in fat.

#### CHEMICAL PRESERVATIVES.

By E. H. JENKINS, W. L. MITCHELL AND A. W. OGDEN.\*

In the Second Report on Food Products the Director of this Station has discussed the nature of these preservatives and the reasons why the extensive and rapidly increasing use of them has become a serious evil.

These reasons may be briefly summarized as follows:

Any preservative operates by destroying the life or suspending the activity of those organisms which cause decay, fermentation and putrefaction.

Antiseptics are, accordingly, for the most part decided poisons. In a certain dilution, with water for example, they may counteract or kill the lower, weak organisms of fermentation and putrefaction without apparent injury to the higher and stronger plants and animals. Whether an antiseptic shall operate as a harmless preservative, or as an unhealthful or even fatal poison in any case, depends upon the quantity and frequency of the dose.

The power of different, apparently well, persons to overcome the action of the common antiseptics, salt, vinegar, wood-smoke and alcohol, and to carry on the digestive processes under their influence, is very various, some suffering no inconvenience from doses which seriously hinder digestion or disturb the health of others.

This statement is equally true of the newer preservatives that are now so extensively and surreptitiously used, viz., borax, formaldehyde, boric, salicylic and benzoic acid.

But a dangerous difference between the long-used and familiar antiseptics and the newer preservatives lies in the fact that while the former are at once recognized by taste or smell, the latter are usually undiscoverable by the senses and their presence in any article of food can only be make known to the consumer by the explicit statement of the producer or by the tests of a chemist.

<sup>\*</sup>The determinations of boric acid and salt in the preservatives discussed in this paper were made by Mr. Mitchell, the analyses of the preparations containing formaldehyde were made by Mr. Ogden, who with Mr. Jenkins did the other analytical work involved. This paper was prepared by Mr. Jenkins.

It needs to be emphasized here that, in regard to foods and food preservatives, each person is a law unto himself, and to avoid discomfort and ill health he must find out what he can eat and drink with satisfaction and what he should avoid. This becomes impossible if his food is liable to be loaded with antiseptics that he cannot at once recognize.

Even milk and oysters, which once we could safely assume to be "fresh," are at present not uncommonly preserved for days by adding to them either borax or formaldehyde.

It is just these foods too, which are frequently prescribed for persons of feeble digestion, and convalescents.

"Fresh" opened oysters, "guaranteed to be pure and as represented," are sold in the New Haven market, which contain more than 38 grains of borax to the pint.

While the opinions of medical men may differ widely regarding the effects on healthy adults of "moderate" doses of borax, we doubt if any reputable physician would assert that it is safe for a patient to subsist on food liable to contain such quantities of borax, during a long period of convalescence.

It is clear that, whether or not these preservatives, which have come into extensive use of late years, are proved to be harmless when administered in moderate amount to healthy adults, it is necessary in the interests of public health that the purchaser should be informed in all cases of their presence and proportions in the food products which he consumes, as he is informed when salt, vinegar, or wood-smoke are used.

The Food Law most justly provides that "an article shall be deemed adulterated" if it contain any antiseptic or preservative not evident and not known to the purchaser or consumer (Sec. 3, seventh). In Sec. 3 (c), an exception is made when a preservative "is added to a food because the same is required for the protection or preparation thereof as an article of commerce in a fit state for carriage or consumption," "and not fraudulently to conceal the inferior quality thereof."

This exception raises a point of law which would make necessary a court decision to establish the construction of the statute.

We believe the law without the exception just noted would be perfectly just, requiring that food products preserved with antiseptics not evident to smell or taste should be truly and distinctly labeled so as to inform the buyer of their presence.

In the Lancet—a leading English medical journal—of Jan. 2, 1897, appeared an article on the subject, containing communications from Sir Henry Thompson, Haliburton, Pavy, Brunton and other leading physiologists and physicians, who generally agree that, whatever difference of opinion there may be regarding the physiological effects of antiseptics, taken in small and continued doses, vendors of food products containing them should nevertheless be required by law to state, on labels or otherwise, the name of the preservative used and also the quantity used. At a recent meeting of the Incorporated Society of Medical Officers of Health (England) the following resolutions were adopted: (1) "That the Incorporated Society of Medical Officers of Health strongly disapproves of the practice of adding preservative chemicals to milk and other goods. (2) That if preservative chemicals are added to any food, a full disclosure as to the nature and amount thereof should be made to the purchaser."

In view of the fact that a considerable number of preservatives are now being extensively advertised in trade journals and elsewhere, many of them under proprietary names, and that antiseptics, as our reports show, are used in many kinds of food products, it becomes important to learn of what these preservatives are made and in what proportions they are used, if the directions which go with them are followed.

Accordingly, the Station has secured a considerable number of the advertised preservatives and these have been qualitatively—and as far as possible quantitatively—analyzed.

The results of this work appears in the following pages. We have considered it important also to cite the manufacturer's claims for each article and the directions for use. A comparison is given of the selling prices of these proprietary articles with the retail cost of the materials that compose them.

#### PRESERVATIVES FOR MILK AND CREAM.

9501 "Freezine. The only Scientific Milk and Cream Preserver." Manufactured by B. Heller & Co., Chicago, Ill.

"The advantage which we claim for Freezine over all other milk preservatives is the manner in which it affects the bacteria and preserves the milk. It is perfectly harmless and is not injurious to the human

system. Freezine does not in any way affect the composition, color or taste of milk. By the use of Freezine the milk or cream is not adulterated."

#### DIRECTIONS.

"Use about one tablespoonful of Freezine to every five gallon can of milk. This quantity will keep the milk sweet and in good condition for forty-eight hours without the use of ice. For cream increase the quantity one-half."

Prices.—Quart bottleseach	\$1.00.
Half-gallon bottles	2.00
Gallons	3.50

This preparation is a liquid containing 5.19 per cent. of formaldehyde. Used at the rate indicated in the directions, each quart of milk would receive three quarters of a grain, or .05 grams.

The standard commercial preparation of formaldehyde, having the trade name "formaline" and containing over 35 per cent. of formaldehyde, cost at the time the sample of Freezine was bought, \$1.40 per quart and contains six and one half times as much of the antiseptic agent as Freezine. At the present time, (Nov., 1899) the cost of formaldehyde is fifty cents per pound or about \$1.10 per quart.

11638 Iceline. "A wonderful discovery. Keeps milk and cream sweet, without ice. Indispensable to dairymen, the shipper's friend."

#### DIRECTIONS.

"For Milk. Use about one-half to one tablespoonful of Iceline to every ten gallon can. Milk can be kept without the use of ice for 48 hours in a good sweet condition.

In case you desire to keep the milk sweet a longer time, give the milk another charge at the end of 36 hours."

#### PRICE LIST.

#### No discount. These prices are net.

Quart bottleseach	\$1.00
Half-gallon bottles	2.00
Gallon bottles	3.50.

This preparation is made by Heller Chemical Co., Chicago, Ill., and was bought from Hatch & Co., I Desbrosses st., N. Y. It contains 1.92 per cent. of formaldehyde, which is less than

half as much as was found in the sample of Freezine, made by B. Heller & Co., and it is directed to use only one tablespoonful to ten gallons of milk, whereas of the Freezine one tablespoonful is used with five gallons of milk.

Methods of Analysis. Ten grams of the formaldehyde solution are weighed into a flask and treated with an excess of standard ammonium hydrate solution.

The corked flask is shaken at intervals for several days. By this means the whole of the formaldehyde is converted into hexamethylamine.

The solution is then transferred to a weighed platinum dish, evaporated at a low heat—below 100° C.—nearly to dryness and the drying is finished in a desiccator. Allowance is made for the solid residue left by the formaldehyde solution on direct evaporation.

From the weight of hexamethylamine the corresponding formaldehyde is calculated.

Instead of weighing, the excess of standard ammonia may be distilled off and determined by titration and the percentage of formaldehyde calculated from the ammonia held in combination.

The former method gave 5.22 and 5.16 per cent. in sample 9501. The latter method, 5.15, 5.18, 5.20, 5.22, 5.22 per cent. Or five grams of the formaldehyde solution are digested with an excess of standard ammonia solution in a stoppered flask for 24 hours and the remaining excess of ammonia is determined with decinormal sulphuric acid, using one or two drops of a one per cent. solution of corallin or rosolic acid as an indicator.\*

When free acid is present in the sample its quantity must be determined and taken into account.

By this method sample No. 9759 gave in four trials 1.94, 1.94, 1.97 and 2.10 per cent., an average of 1.99. By the two methods described above 1.79 and 2.12 per cent. were found.

9759. Special M Preservaline. Made by the Preservaline Mfg. Co., N. Y. City.

"The greatest, best and only scientific preservative for milk, cream, buttermilk, etc.

"Simply stir the Preservaline into the milk or cream. To keep milk 48 hours use 1 to 2 tablespoonfuls to every 40 quarts of milk. For a longer period use proportionally more. Double the quantity for cream."

The sample of this preservative was a solution containing 1.99 per cent, of formaldehyde.

If used according to directions, one quart of milk treated with it would contain from .01 to .02 gram (.15 to .30 grain) of formaldehyde.

<sup>\*</sup>Zeitschr. für Untersuchung des Nahrungs and Genussmittel, May, 1895, p. 357.

9998 Rex Magnus Snow Flake Brand. Preservative for milk and butter. This and the following article, No. 11174, are made by the Humiston Co. of New Haven, and were bought by a Station agent from the company. Price 50 cents per single pound. The sample of this preparation contained 12.06 per cent. of salt and the equivalent of 78.15 per cent. of boric acid, of which about 35 per cent. is free and the rest is in the form of borax.

It is directed to use one-half ounce of the preservative to each gallon of milk, which amounts to 2.8 grams (42 grains) of boric acid—or the equivalent in borax—to one quart of milk.

11174. Rex Magnus, Pearl Brand or Cream Preservative.

"To each gallon of cream dissolve in a half tea cup full of hot (but not quite boiling) milk or cream a moderately heaped teaspoonful of the Pearl, then pour this into the cream (after it is cold), and thoroughly mix." "The above proportion is at the rate of one-half of an ounce of Powder to a gallon of cream. If it is desired to keep cream more than ten days use 50 per cent. more than above directed." Price 50 cents per single pound.

The sample of this brand contained 8.22 per cent. of salt and the equivalent of 95.72 per cent. of boric acid. The sum of these two ingredients is 103.94 per cent. This excess over 100 per cent. is accounted for by the fact that a portion of the boric acid is in form of borax and that the molecular weight of boric acid,  $H_3BO_3$ , is greater than that of the chemically equivalent anhydrous borax, (Na<sub>2</sub>B<sub>4</sub>O<sub>7</sub>).

Cream treated with this material, according to the manufacturers' directions, will receive per quart 3.5 grams or 52 grains of boric acid—or the equivalent borax—and 0.29 gram or 4.4 grains of salt.

9758. M Preservaline for Preserving Milk and Cream. This, and the mixtures described below which bear the name Preservaline, are made by the Preservaline Mfg. Co., New York.

To keep milk for 36 hours use I ounce M Preservaline to 40 qts. of milk.

2 4400		3					1
4.6	4.6	48 "	2	"	44	66	
44	"	60-72 "	3	44		"	
"	"	4-6 days	5	"	"	66	
44	cream for	48 hours use	3	44	"	toIo	gals, of cream.
"	"	60-70 "	4	"	"	66	"
44		5 days	5	44	"	"	"
66		longer	6-8	"	"	66	

The sample of M Preservaline consists of the equivalent of 97.81 per cent. of boric acid with two per cent. of other matters, chiefly soda.

When used according to directions, from .72 gram—or 10.8 grains—to five times that quantity of boric acid, would be added to each quart of milk and from 2.1 grams—or 32 grains—to twice that amount would be added to each quart of cream.

9761. B. B. Preservaline Especially for Creamery Use.

It "should not be used for milk or cream intended to be drank or to be made into ice cream."

For cream add one ounce more.

The sample of B.B. Preservaline contained 32.56 per cent. of salt and for the rest consists of boric acid and borax equivalent to 65.42 per cent. of boric acid.

When used as directed, one quart of milk would receive from 7 grains (.47 gram) to five times that amount of boric acid or the equivalent borax.

9760. Preservaline Butter Powder.

"Makes churning easy, . . . removes all unpleasant flavor, saves time, labor and money. Produces finer butter." . . . "Removes all unpleasant taste caused by the cows eating turnips, weeds and other strong foods."

"For each gallon of cream, add to the cream in the churn, and before churning, from one-half to one tablespoonful of Preservaline Butter Powder dissolved in half a pint of lukewarm water."

This preparation is bicarbonate of soda.

9762. Cream Albuminoid. Made by the Preservaline Mfg. Co. Size B, costing 50 cents, contains 119 grams or about 4 ounces.

It is directed to dissolve the contents of this package in one quart of warm water, pour slowly into three gallons of *thin* cream, stirring for several minutes. After standing six or eight hours the mixture is to be stirred again and is then ready for immediate use. It "keeps the cream perfectly sweet for five to seven days."

The sample of this article contained 50.4 per cent. of boric acid, mixed with some proteid body—apparently gelatine.

The material itself contains 7.36 per cent. of nitrogen, or excluding the boric acid, about 14.7 per cent. of nitrogen.

When used as directed there are added to one quart of cream 5 grams or 45 grains of boric acid.

#### PRESERVATIVES FOR CIDER.

9756. Preservaline for Cider. Made by the Preservaline Mfg. Co. "A simple, harmless preparation free from taste. smell and color."

One ounce is enough to treat 20 gallons of cider. This preparation consists entirely of salicylic acid. Used at the rate indicated, one gallon of cider will contain 1.45 grams of salicylic acid. One quart will contain 0.36 gram or 5.4 grains.

No. 9901. Blue Seal Preservative. Bought by an agent of the Station from the Blue Seal Extract Co. of Boston, Mass. Labeled. "One Pound of Blue Seal Preservative especially adapted for"- Price \$1.00 per pound.

For preserving cider it is directed to use 2 to 3 ounces of Blue Seal Preservative dissolved in a little hot water for a barrel of cider, but if it is desired to keep the cider over summer 5 to 6 ounces should be used.

The sample of this preservative contained 29.76 per cent. of boric acid, and for the rest consists of salicylic acid (70.24 per cent.).

Used as indicated, there would be added to each quart of cider at least 0.096 gram-1.4 grains-of boric acid and 0.225 gram-3.4 grains-of salicylic acid, and twice those amounts might be added.

9902. Forman's Cider Preservative. Made by C. D. Forman, Geneva, Ohio.

"It contains no salicylic acid or sulphate (sic) of lime as nearly all antiferments do. It can be added to cider whenever it suits the taste, and will preserve all its properties without further change, imparting a pleasant aroma, making it more palatable and inviting. It is perfectly harmless to the human system"

Two fluid ounces of the preservative are used for 45 gallons of cider.

The sample of this preservative was an alcoholic solution of beta naphtol; identified by its melting-point and characteristic reaction on boiling it in strong potash solution with chloroform.

11608. Preservite. Sold by Otto Hann & Bro., 268 Water St., New York City.

"The fresh juice as it runs from the press is dosed at the rate of 21/2 to 3 ounces of our Preservite to the barrel of juice." . . . . . "When the cider has cleared itself, which it will do after some time, if treated with our Preservite, rack into clean barrels, and dose again with 11/2 to 2 ounces of Preservite, bung up," etc.

This material contains over 96 per cent. of benzoate of soda. If treated as above directed each quart of finished cider would contain from 0.6 to 0.7 gram (0.0 to 101/2 grains) of benzoate of soda.

#### PRESERVATIVE FOR WINE.

9903. Forman's Preservative for Wine. Made by C. D. Forman, Geneva, Ohio. No directions accompanied the article. The sample of this preservative was a solution containing 36.13 per cent. of formaldehyde.

#### PRESERVATIVES FOR BEER.

9778. Compressed Preserving Powders. For preserving beer. Large size for half barrels. Made by Wm. Zinsser & Co., 197 William St., N. Y. Bought from the manufacturer.

Each cubical "powder," the dose for a half barrel of beer, weighs about 16 grams, a little more than half an ounce. \* The sample examined contained 49.01 per cent. of salicylic acid, the only other ingredient detected being cane sugar. If used according to the manufacturers' directions, a half barrel of beer, 161/2 gallons, would receive 7.9 grams of salicylic acid.

This is equivalent to about .12 gram—1.8 grains—per quart and half that quantity in a half litre glass or "stein."

9755. Patent Compressed Antacid Tablets for the Preserving of Lager Beers. Made by E. J. Beggs & Co., 101-103 Beekman St., N. Y. City.

These tablets are guaranteed "to be perfectly harmless, having neither taste nor smell, and will not affect the flavor, color or brilliancy of the beer but will keep it in sound condition and full body." Price 80 cents per pound in five pound lots.

The tablets weighed 4.7 to 4.8 grams, ½ of an ounce. One tablet is to be used to ½ barrel of beer.

The sample analyzed contained 44.76 per cent. of salt, and 27.12 per cent. of free salicylic acid, besides salicylate and carbonate of soda in quantities not ascertained.

Used at the rate indicated, one-eighth barrel, four gallons, would receive 1.29 grams of free salicylic acid and 2.13 grams of salt. One quart would contain .08 gram—1.2 grains—and a ½ litre glass, half that quantity.

9754. Emken's Preserving Cakes No. —. Made by New York Malt Roasting Co., Emken Chemical Co. Prop.

A small sample given to us by a brewer.

The sample contained 22.09 per cent. of free salicylic acid, cane sugar, and a considerable quantity of salicylate of soda, besides small quantities of magnesia and sulphates.

9779. A. Boake Roberts & Co.'s "K.M.S." in tablet form, sold by Charles Zoller, agent, New York.

"The best preservative for ale or beer." "24 tablets to the ounce. To be used in finished lager beer or ale at the rate of an eighth to a quarter of an ounce per American barrel."

The sample of this material contained:

Sulphate of potash	11.34
Bisulphite of soda	1.84
Bisulphite of potash	84.35
Other matters by difference	2.47
	100.00

The tablets contain 49.82 per cent. of sulphurous acid. If used as directed there would be added to each quart of beer .015 gram—or .23 grain of sulphurous acid and about half that amount to a half litre glass.

9753. K. M. S. Compressed Preserving Powders. Made by Rudolph Schneider of New York. A small sample sent by the manufacturer. The weight of the tablets and the directions for use were not learned. These tablets contained

Sulphate of soda (anhydrous)	16.61 per cent.
Bisulphite of soda Sugar	48.00
Other matters, not separately determined, water of crystallization	
	100.00

The sulphurous acid present amounts to 17.16 per cent.

PRESERVATIVES FOR MEATS, GAME AND FISH.

9999. Rex Magnus, Viandine Brand. Preservative for Meat, Poultry, Fish and Game.

The printed "Uses" of the brand suggest injecting whole carcasses, dipping meats into a solution of it, wrapping roasts or steaks in cloths wet with such a solution. It can also be used for hardening and whitening tallow, etc.

The sample of this preservative contained 19.61 per cent. of salt, and borax and boric acid equivalent to 81.77 per cent. of boric acid.

11173. Rex Magnus. The Sportsman's Rex, for preserving trout, bass, delicate fish and game.

The directions are to sprinkle the preservative over the game, after drawing, inside and out, to wrap in cloths wet in a solution, or soak for some time in a solution of I pound of the preservative in 2 gallons of water.

"This brand has been prepared especially for sportsmen, and combines all the best qualities of several of our leading brands, and may be used for keeping milk, cream and all kinds of animal food."

This preservative has essentially the same composition as the one immediately preceding.

9997. Rex Magnus, The Ocean Wave Brand, for oysters, clams and sea food generally.

Oysters, clams and scallops are treated by stirring or mixing them with a solution of one pound of the preservative in two gallons of water to each twenty gallons of the fish food.

Fish are dredged with the preservative, one pound to one hundred pounds of fish or by soaking from two to six hours in the solution above described.

This brand contains 9.71 per cent. of common salt and 88.85 per cent. of boric acid, part of which is combined with soda in the form of borax.

11172. Rex Magnus Preservative for Sausage. It is directed to use one pound of this preparation to one hundred pounds of sausage meat.

The sample was a pasty mass from which liquid separated on standing.

It contained:

Sulphate of soda  Normal sulphite of soda  Bicarbonate of soda  Salt  Other matters not determined, chiefly water	6.55	per	cent.	
and characterists and a second	100.00			

The water expelled at a boiling heat was about 19.00 per cent. and there was also some unidentified organic matter. The sulphurous acid present amounted to 3.33 per cent.

9757. "A" Preservaline for Sausages, Tenderloins, Fresh Meats, Poultry, etc.

For sausage, white pudding, head cheese and the like, it is directed to sprinkle one-half pound over every 150 pounds of meat while being chopped.

One pound dusted over 500 pounds of fresh meat is sufficient to keep it.

Poultry, drawn and undrawn, are to be immersed for ten minutes in a solution made by dissolving one-quarter pound of this preservative in two gallons of water.

The sample of this preservative contains 32.00 per cent. of salt, and 68 per cent. of borax.

9780. Freeze-Em. Made by B. Heller & Co., Chicago., Ill.

The directions which accompany this article recommend its use on ribs and loins, dressed beef, pork sausage, etc. The directions for use on chopped beef may suffice to show the method and objects of its use. "To every 50 pounds of meat use one ounce of Freeze-Em. Sprinkle it over the meat before or while it is being chopped. When Freeze-Em is used, all kinds of small pieces of beef can be chopped up for Hamburger steak; it can be exposed for show on the counter and will remain perfectly fresh for many days." \* \* \* "Another great advantage for the butcher is that all kinds of small pieces of meat can be used, and also that water can be worked into the meat."

The sample of this material contained:

Sulphate of soda	39.14
Normal sulphite of soda	57.48
Salt	
Other matters by difference	
the state of the s	100.00

It contains 29.19 per cent. of sulphurous acid.

#### Summary.

An examination of the results given above shows that milk and cream preservatives now on the market depend for their antiseptic effects on salt, formaldehyde, borax and boric acid; and that if the directions given by the manufacturers are followed, a quart of milk will be dosed with from .01 to .05 gram (.15-.75 grain) of formaldehyde or with .47 to 3.6 grams (7.4-54.0 grains) of boric acid. Cream will receive from .94 to 5.0 grams (14.1-75 grains) of boric acid per quart.

Wine and cider preservatives have been found to contain formaldehyde, salicylic acid, boric acid, benzoic acid and betanaphtol.

The cider, treated as directed by the manufacturers of the preservatives, may contain 0.36 to 0.9 gram (5.4–13.5 grains) of salicylic acid or 0.19 to 0.38 grams (2.9–5.8 grains) of borax or 0.6 to 0.7 gram (9.0–10.5 grains) of benzoate of soda per quart.

The beer preservatives contain salicylic acid and sulphurous acid in form of sulphites or bisulphites, and beer treated with them may contain from 0.04 to 0.12 gram (0.2-0.6 grain) of salicylic acid or 0.015 gram (0.23 grain) per half-litre glass.

Of sulphurous acid, preserved beer may contain .015 gram (0.23 grain) per half-litre glass.

#### Maas and Waldstein's Preserving Salts.

The Station bought six packages of "Preserving Salts" Nos. I to 6, made by Maas and Waldstein of New York, "Manufacturers of . . Preservatives, Antiferments, Food Colors, Flavors, Sweeteners, Extracts, in conformity with the laws and regulations of the Board of Health."

Each package contained one pound of "salts" and cost fifty cents. That each package bore a different number suggested

the probability of differences in chemical composition and in the uses to be made of their contents.

The directions for use were, however, the same on each package. "To 100 pounds, take 3-4 oz. dissolved in a half-pint of warm water."

All the samples contained between 29.05 and 33.16 per cent. of boric acid, free and combined, and between 7.26 and 7.59 per cent. of chlorine, equivalent to about 10½ per cent. of salt.

### ANALYSES OF BORAX.

#### By A. W. OGDEN.

In view of the fact that at present borax is, if not a "food product," at least an ingredient of food and drink as found in our Connecticut market, a number of samples of "borax" were bought at drug stores and department stores in New Haven and analyzed with the following results:

### Bought at Drug Stores.

9899. Squibb's Chemically Pure Borax. Made by E. R. Squibb & Sons, Brooklyn, N. Y. Bought of W. A. Spalding, New Haven.

11553. Bought of W. A. Spalding, New Haven.

11552. Bought of E. A. Gessner, New Haven.

11551. Bought of C. S. Leete & Co., New Haven.

#### ANALYSES. Leete & Squibb's Spalding's Gessner's Co.'s 11551. 11552. Anhydrous borax ..... 69.87 70.69 55.39 53.II Water at low red heat..... 29.75 29.28 46.69 44.29 Undetermined and loss..... 0.38 0.03 0.32 0.20

100.00

100.00

100.00

These samples are all quite pure borax. two varieties of which are found in commerce that differ in the form of their crystals and in the proportions of their "water of crystallization."

100.00

The two samples 9899 and 11553 are essentially octahedral or pentahydrated borax, that contains 30.8 per cent. of water. The two others are mainly prismatic or decahydrated borax,

which when freshly made contains 47.1 per cent. of water, but which slowly loses water on exposure to dry air.

The samples cost 18 to 20 cents per pound. A comparison of these prices with those charged for proprietary antiseptics containing approximately the same quantities of boric acid indicates that either the expenses or the profits of the food preservative business must be large.

# Bought at Department Stores and Groceries.

ogoo. Black Diamond Refined Powdered Borax. Put up by Archibald & Lewis, 193 Front St., New York City. Bought of The Gamble-Desmond Co., New Haven. Price 12 cents per pound.

by Thos. F. Condon & Co., 15 Jay St., New York City. Sold by S. S. Adams, New Haven. Price 16 cents per pound.

11602. Rising Sun Borax. Refined Powdered Borax. Put up by James A. Blanchard, New York City. Sold by Ewen McIntyre & Co., New Haven. Price 10 cents per pound.

Analy	ISES.		
Borax  Bicarbonate of soda  Other matters by difference	9900 31.60 63.02	none 99.81 0.19	52.32* 37.20 10.48
	100.00	100.00	100.00

As the analyses show, none of these samples of "borax" were what they were sold for; one contained no borax whatever, another contained nearly two-thirds of its weight of saleratus and another more than a third of its weight of saleratus.

# ON TESTING FOOD PRODUCTS FOR BORIC ACID AND BORATES WITH TURMERIC PAPER.

# By E. H. JENKINS AND A. W. OGDEN.

In our experience this test is much more satisfactory than the flame test—depending on the greenish tinge given to an alcohol flame by boric ether—because it leaves a record of the reaction, independent of the observation of the one making the

<sup>\*</sup>Equivalent to 36.2 per cent. of anhydrous borax.

test, at the moment when the green flame appears, and because it will show certainly the presence of smaller quantities of boric acid than the other.

Properly used, the turmeric test is perfectly reliable, but we have not found in text-books a full statement of the precautions to be observed.

When freshly prepared turmeric paper, made as directed in Fresenius' Qualitative Analysis, is moistened with an aqueous solution of chemically pure boric acid and dried at a gentle heat, the paper remains yellow with an orange reddish tinge, always slight, its density depending on the concentration of the solution. A solution of one gram of boric acid in 225cc. of water gave a faint color to turmeric paper moistened with it and then dried, which might easily be overlooked by an unpracticed person or ascribed to "traces" of boric acid. When, however, the dried paper is moistened with ammonia it becomes very dark brown, almost black, and quite different in appearance from turmeric paper made alkaline with ammonia.

When to the boric acid solution above described are added 8cc. of our standard HCl (1cc. of which contains .026 gram HCl) the reddish tinge imparted to turmeric is much more pronounced; with 16cc. and 24cc. of standard HCl the color becomes much deeper red, and the presence of boric acid is made unmistakably evident.

If to 20cc. of a boric acid solution such as that described above, 0.75cc. of strong hydrochloric acid (32 per cent. HCl) is added, the reddish brown color is more pronounced than with 24cc. of the standard HCl. Addition of still larger quantities of hydrochloric acid increases the density of the reaction color.

If to the boric acid solution (I gram in 225cc. of water) 22cc. of strong hydrochloric acid are added, the reaction is perfectly satisfactory, although the turmeric paper on drying becomes brittle. There is no evidence that any large excess of hydrochloric acid interferes with the reaction.

It thus appears that free, chemically pure boric acid cannot certainly be distinguished by the reaction with turmeric from that in combination, since the presence of another acid is necessary to make the reaction quite decisive.

The impure boric acid of commerce, which contains some chlorin, either free or combined, gives a more pronounced reaction with turmeric paper.

Regarding the delicacy of this test, we find that a solution of one part of boric acid in 5000 of water gives an unmistakable reaction; one part in 10,000 gives a reaction which is not absolutely satisfactory, but quite decisive when the borate stain is made alkaline with ammonia.

One part in 20,000 gives a color to turmeric not distinguishable from that which is imparted by hydrochloric acid alone, but when made alkaline with ammonia there appears the bluish black color quite different from that produced on turmeric paper alone, or turmeric moistened with hydrochloric acid.

Borax solution, I gram in 225cc. of water, imparts to turmeric the usual color given by alkaline solutions. When standard HCl is added in amount exactly sufficient to decompose the borate,—determined by titration with lacmoid,—the resultant solution imparts to turmeric paper, after drying, a barely noticeable reddish tinge, which would easily be disregarded. But on moistening this paper with ammonia a dark brown, almost black color is produced, very different from that made by ammonia on turmeric paper alone. A further addition of 8cc. of our standard hydrochloric acid to the solution of boric acid just described, did not cause a very striking deepening of the color produced on turmeric. But the addition of strong hydrochloric acid—0.75cc. to 20cc. of the solution—gave a very strong and perfectly unmistakable reaction for boric acid.

It appears from these observations that free boric acid cannot readily be identified by the turmeric paper test if borates are present.

The material to be tested must in all cases be acidified with hydrochloric acid in order to ensure a satisfactory reaction with turmeric paper.

A considerable excess of hydrochloric acid must be added to the solution to be tested,—one-thirtieth by volume of concentrated HCl is not too much.

Perfectly decisive reactions need not be expected where less than one part of boric acid is present in 10,000 of water.

# ANALYSES OF FORMALDEHYDE OR FORMALINE. By A. W. Ogden.

This substance, which has decided antiseptic properties, in its pure state is a gas, but is used commercially in aqueous solution. In a previous article, pages 141 to 143 are given analyses a number of proprietary articles, sold as food preservatives, the antiseptic properties of which are due to the formaldehyde in them.

Below are given four analyses of formaldehyde, sold under its true name, which serve to show the usual strength of the solution as it is found in market.

At present this article costs about \$1.10 by the single quart and contains 35 per cent. or more of formaldehyde.

The proprietary solutions cost \$1.00 per quart and contain from  $\frac{1}{7}$  to  $\frac{1}{17}$  as much formaldehyde.

11640. Formaldehyde. Merck. A one-pound bottle.

11642. Formaldehyde. Fries Bros., 92 Reade St., New York City. These two samples were bought of W. A. Spalding, New Haven.

11641. Formaldehyde. Merck. A one-quarter pound bottle bought of F. S. Calhoun & Co., New Haven.

11643. Formaldehyde. Sold by M. Cahm, New York City.

#### ANALYSES OF FORMALDEHYDE.

	Merck.	Fries Bros.	Merck.	Cahm.
	11640	11642	11641	11643
Residue on evaporation at 100° C	-	0.17	0.05	1.29
Specific gravity at 20° C		1.0807	1.0769	1.0820
Percentage of formaldehyde	36.02	42.30	38.00	37.82

#### BANANA FLOUR.

This is stated to be prepared by drying the flesh of the fruit of the banana after removing the skins. The samples were submitted by Mr. A. E. G. Lubke, 92 West Houston St., New York.

	9889 Porto Rico Bananas.	9890 Florida Bananas.	9891 Honduras Bananas.
Water	13.43	5.34	10.33
Ash	2.24	2.90	2.55
Protein	3.50	2.81	2.87
Fiber	0.54	0.84	0.73
Nitrogen-free extract	79.82	87.45	87.02
Fat	0.47	0.66	0.50
	100.00	100.00	100.00

The samples are quite alike in composition, containing less than half as much protein as rice. Their nutritive value rests almost wholly in the materials which constitute the "nitrogenfree extract."

#### VINEGAR.

Three samples of vinegar, sent by purchasers for examination, contained the following percentages of solids and acids.

Station No.	12206	12207	9765
Solids	2.29	2.35	2.27
Acids as acetic acid		3.90	4.10

#### MILK AND CREAM.

The Station has not drawn samples of market milk for examination during the past twelve months, but there have been sent in by dealers and buyers thirty-seven samples of milk, four of separator skim milk and two of cream, in all of which fat has been determined and in fifteen of the number the percentage of total solids also. The Station has no assurance that the samples were accurately drawn, but the milk was in most cases represented to be market milk from different dealers, mostly in New Haven.

The percentage of solids, in fifteen samples of milk, ranged from 11.53 to 15.10 and averaged 13.06.

The percentage of fat ranged from 2.2 to 7.1 per cent. and fourteen of the thirty-seven samples of milk had less than 3.5 per cent. of fat.

Three samples of cream contained respectively 18.25, 20.25 and 21.75 per cent. of butter fat.

Four samples of skim milk, from a centifugal separator, contained the following percentages of fat: 0.08, 0.23, 0.03 and 0.08.

# FOOD PRODUCTS EXAMINED FOR THE DAIRY COMMISSIONER IN THE TWELVE MONTHS ENDING JULY 31, 1899

#### BUTTER.

Two samples of suspected butter were examined and found to be oleomargarine.

#### MOLASSES.

CONNECTICUT EXPERIMENT STATION REPORT, 1800.

Two hundred and thirteen samples of molasses and syrups have been examined in the year ending July 31, 1899.

Method of Examination. 13.024 grains (one-half the normal weight) of molasses were dissolved in about 80 cc. of water, 3 cc. of basic lead acetate were added, the volume was made up to 100 cc. and the whole was thoroughly mixed and passed through a dry filter. The rotation of the clear and nearly colorless filtrate was determined, in a 200 mm. tube. with a Schmidt and Haensch half shade double compensation polariscope The reading, doubled, gave the sugar degrees or per cent. No correction was attempted for the volume of the lead precipitate.

To 50 cc. of the filtrate referred to above were added 5 cc. conc. C. P. hydrochloric acid, and, after thorough mixing, the flask containing the solution was placed in a cold water bath, which was then quickly heated to 68° C. After standing at that temperature for 10 minutes, the contents of the flask were quickly cooled and the solution, filtered from lead chloride when necessary, was examined in a 220 mm. tube, provided with a water jacket. The temperature was noted with the reading. This reading, doubled, gave the sugar degrees after inversion.

Water heated to 86° C., was then passed through the jacket and a third reading made at that temperature.

The rotatory power of dextrose is not greatly affected by the temperature, but that of levulose diminishes as the temperature rises, so that invert sugar becomes practically inactive at about 86°.

Results of Examination. Of the 213 samples examined for the Dairy Commissioner 44 were found to be adulterated with glucose syrup. The percentage of adulterated samples is 20.7. In 1898 the percentage was 20.1 and in 1897, 32.8.

#### HONEY.

In two samples of strained honey, in bottles, submitted by the Dairy Commissioner, no evidence of adulteration was found.

#### VINEGAR.

Of the forty-five samples examined for the Dairy Commissioner, the larger number were sold as cider vinegar. The total solids in these samples ranged from 1.20 to 3.61 per cent. and the acidity, reckoned as acetic acid, from 2.73 to 5.74 per cent.

#### COFFEE.

The sixty-one samples of coffee collected by the Dairy Commissioner are included in those reported on pages 106 to 111.

### COMMERCIAL FEEDING STUFFS.\*

In accordance with the requirements of the law regarding Commercial Feeding Stuffs, which is given on pages 96 and 97 of this Report, the Station has analyzed two hundred and fortyone samples of feeds during the last twelve months, and has already published the results of this work in Bulletin 130. In order, however, that the present Report shall contain a full account of the Station work, as required by law, the account of the work on feeding stuffs is also made a part of this Report.

#### USE OF COMMERCIAL FEEDING STUFFS.

Commercial Feeding Stuffs are bought to supply certain deficiencies in the cattle food which is raised upon the farm.

Hay, corn fodder, ensilage and stover with corn meal, raised at home, form the basis and make up the bulk of the cattle food and supply all of the coarse feed and of the starch, sugar and fat which are required. They are, however, deficient in digestible protein.†

<sup>\*</sup>The microscopic work referred to in this paper was wholly done by A. L. Winton. The chemical analyses were mostly made by A. W. Ogden, W. L. Mitchell and Clifford Langley. The discussion of the results is by E. H. Jenkins.

Protein is the name now commonly given to a class of substances (also termed "proteids" or "albuminoids") of which the muscles, brain, nerves, tendons and all other working or necessary organs and parts of the animal body largely and essentially consist. Protein contains

from 14 to 19 per cent. of nitrogen.

The white of eggs, the fiber of lean beef, the clot of blood, the curd of milk and the gluten of wheat are familiar examples of protein. Other similar matters are found in all animals and in all plants.

The animal cannot grow or long exist without constantly renewed supplies of protein in its food. The animal itself is totally unable to create protein. Only plants can originate protein, which they do from the plant-food of air, soil and fertilizers or manures. Animals can Produce or create blood-protein, brain-protein, flesh-protein and milk-Protein, but only by appropriating and transforming or making over the similar but different protein of plants.

Other needful food-substances or nutrients, such as cellulose (woody fiber), starch, sugars, gums, pentosans (that yield gums and jellies), acids and fats or fat oils, contain no nitrogen and collectively are commonly termed "non-nitrogenous matters"; we shall usually designated nate them as "non-protein."

Few farmers are now raising as much protein, in concentrated form, as is required to bring cattle up to and maintain them in the most profitable condition. Two chief defects in our present farm management are that little care is given to the raising of crops rich in protein and that, as a rule, insufficient protein goes into the food of our cattle.

If the quantity of digestible protein in the food is too small, the animals produce less beef or milk than they easily would with a proper supply of protein. Furthermore, when protein is deficient, the other (non-nitrogenous) matters of the ration are in excess of the animal's capacity for assimilating them and are therefore to some extent wasted. The latter (starch, sugar, etc.) in part pass through the body, incompletely digested and—unlike the protein—give little value to the manure.

To meet and overcome these defects in home-grown cattle food, dairymen and keepers of live-stock buy commercial feeds; they should buy them *chiefly* with the purpose of getting digestible protein in cheap and concentrated forms.

A feed rich in digestible protein is, when properly used, "milk-producing"; a feed rather poor in protein, however highly endorsed, cannot prove permanently satisfactory, or be a "milk producer" in any way superior to home-raised coarse feed and corn meal.

Every farm on which cattle are kept for profit should yield all the hay, corn fodder, corn ensilage, corn stover and corn meal which the live stock on it need to eat.

One hundred pounds of each of the feeds just named contain, on the average, the following quantities of digestible nutrients or elements of food:

Table I.—Quantities of Digestible Nutrients in One Hundred Pounds of the Feeds Named.

(From Armsby, Penn. Ag'l Ex. Sta. Rep., 1897-98, p. 45.)

Total dry matter  Digestible protein  Digestible non-protein*  Ratio of digestible protein to digestible non-protein	Hay. 91.1 4.8 49.2	Corn Fodder Field-cured. 57.8 2.5 36.1	Corn Stover Field-cured. 59.9 2.0 34.8	Corn Ensilage. 27.9 1.1 18.2	Corn Meal. 85.0 5.5 71.1
("Nutritive Ratio")		1:14.4	1:17.4	1:16.5	1:12.9

<sup>\*</sup>Since fat is believed to have about 2½ times the nutritive effect of starch and similar non-nitrogenous matters, the digestible fat is, in these calculations, reduced to its "starch equivalent" by multiplying by 2½.

Observation and careful experiment have shown that milk cows need, per day and per 1,000 pounds of live weight, about 24 pounds of dry matter including 2 to 2½ pounds of digestible protein and from 13½ to 15 pounds of digestible non-protein (sugar, starch, fat, etc.), and that the quantity of digestible non-protein in this standard ration should be between five and one-half and seven times as great as the digestible protein.

Now a glance at the preceding table shows that no one of these staple farm products, nor any combination of them, can furnish the most profitable cattle food.

All of them have from ten to seventeen times as much non-protein as protein, and hence a properly balanced ration cannot be made up from them without adding some feed much richer in protein and poorer in non-protein than any one of them.

Feeds rich in protein are what the stock owner most commonly needs to buy, and they are the ones the purchase of which is most likely to be profitable. All feeds contain non-nitrogenous matters, starch, sugar, etc., but those best worth buying *should* have a considerably larger proportion of protein than any which are commonly raised on the farm.

In the preparation of vegetable foods for human consumption and in the manufacture of cotton seed and linseed oils, certain by-products are produced, unfit for human food, but rich in protein and valuable as feed for horses and cattle. There are also certain other products which are of very little value as cattle food because of the small amount of protein in them, or they are uneconomical to buy, because they contain no larger proportion of protein than corn meal which is raised on the farm.

Both kinds of by-products are now offered for sale, frequently without an analysis or other statement to inform the buyer as to the real nature or value of what he is purchasing, and in consequence a good deal of money is spent for cattle feeds uneconomically.

# THE AVERAGE COMPOSITION OF COMMERCIAL FEEDING STUFFS.

In order to show the average composition of the various brands of feeding stuffs which are at present offered in the New England market as well as the range or variation of composition, Table I has been prepared. This includes the analyses, more than 1,600 in number, which have been published since May, 1898, in Bulletins 44, 47, 48 and 51 of the Maine Station, in Bulletins 53 and 56 of the Massachusetts Station and in Table II pages 178 to 195.

Table I gives the number of analyses on which each average is based, the average percentages of protein and fat, and the highest and lowest percentages of each of these ingredients found in any single analysis.

In a few instances, where the figures found in a single analysis were such as to make it quite certain that the sample was adulterated or was not of the kind represented, they have been excluded from the average and from the minimum figures.

In some cases, not only is the lowest percentage of protein and fat given, but also the one or two percentages which stand next; for sometimes, among a large number of analyses, there is a single result very much lower than any other, which marks an extremely exceptional case.

# ANALYSES OF THE COMMERCIAL FEEDS FOUND IN THE CONNECTICUT MARKET IN 1899.

During the year ending Nov. 1st, 1899, the Station has drawn two hundred and forty-one samples of commercial feeding stuffs and in conformity with law gives the results of their examination in Table II, pages 178 to 195 of this Report.

The law prescribes that the analysis "shall include determinations of crude fat and crude protein and such other determinations as may at any time be deemed advisable."

The analyses here reported include determinations of moisture, ash, fiber and nitrogen-free extract, in addition to protein and fat. Many of the feeds have also been examined carefully with the microscope to determine what materials if any were present other than those named in the brand or label.

These feeds are classified as follows and are discussed in following pages in the order here given (see page 165):

Table I.—Average Composition of Feeds as determined by Analyses made in the New England States, later than May, 1898, and compiled by the Conn. Agricultural Station, New Haven, Conn., Jan. 1, 1900.

	Analyses.	PR	OTEIN.			FAT.			
	of	Average.	Highest.	Lowest.	Average.	Highest.	Lowest.		
	No.	Av	H	J P	- Av	H	Lo		
Notion Seed Meal, hulled, all analyses	205	45.4	52.6 51.9 51.2	40.3 41.2 41.7	11.2	17.0	6		
" Southern Cotton Oil Co's	33	45.3	48.3	41.4	10.7	13.1	9		
" Amer. Cotton Oil Co's	46	45.5	50.8	40.3	11.4	12.2	8		
" Sea Island unhulled	8	26.8	36.1	24.4	7.0	8.2	5		
inseed Meal, New Process	31	38.2	42.2	34.6	2.4	3.5	2		
" " Amer. Linseed Co's	23	38.5	42.2	34.6	2.2	3.5	1 2		
" " Old Process, all analyses	25	35.7	38.9	31.8	7.2	9.6	4		
" " Nat'l Linseed Oil Co's	11	37.2	38.9	35.I 36.I	6.7	9.6	2 5		
Wheat Bran, all analyses	120	15.8	17.9	13.6	4.7	5.6	10000		
" " from Winter Wheat	45	TF F	17.8	13.9	4.4	5.6	1		
" from Winter Wheat	45	15.5	17.4	13.9	4.4	5.0	100		
" from Spring Wheat	53	16.1	17.5	15.I 15.I	4.9	5.6 5.3	4		
Wheat Middlings, all analyses	135	17.0	22.2	12.4	5.0	7.I 7.I	2		
" from Winter Wheat	20	16.0	17.9	12.4	4.8	5.I 5.0	4		
" Spring Wheat	60	18.8	22.2	16.0	5.2	7.1	9		
			21.9	16.5	J	5.9			
Mixed Wheat Feed, all analyses	219	16.6	20.0	14.0	4.7	5.8	1		
" from Winter Wheat	88	16.2	18.5	13.8	4.5	5.4			
				14.5		5.2	:		
" from Spring Wheat	60	17.3	19.8	15.6	4.9	5·5 5·4	:		
Sed 5	1 100			16.2			4		
Red Dog Flour	9	19.3 9.5	10.8	16.5 8.6 8.9	4.4	5·3 4·7			
Atlantic Gluten Meal, Atlantic Starch Works	2	48.9	49.1	9.0 48.8	7.9	2.0			
Chicago Gluten Meal, Glucose Sugar Rfg. Co	76	36.7		31.7	2.7	7.6			
or Gruten Mear, Grucose Sugar Rig. Co	,5	30.7	43	31					

Table I.—Average Composition of Feeds as determined by Analyses MADE IN THE NEW ENGLAND STATES, LATER THAN MAY, 1898, AND COMPILED BY THE CONN. AGRICULTURAL STATION, NEW HAVEN CONN., JAN. I, 1900—Continued.

	alyses.	I	ROTEI	N.,		FAT.
	No. of Analyses.	Average.	Highest.	Lowest.	Average.	Highest.
Cream Gluten, Chas. Pope Glucose Co.	40	34.1	41.2	30.9	0	6.1 5.4
Buffalo Gluten Feed	34	27.5	38.9 29.6 29.5 29.0	25.3 26.3	3.1	4.9 4.7 4.3
Diamond Gluten	30	23.6	30.1 27.0 25.8	20.3	3.6	5.0 4.4
Golden Gluten	15	27.0	296		3.0	4,0
Hominy Chops, White Meal	20	11.2	12.0 11.8 11.6	10.7	7.8	3.4 9.7 9.5
Ground Oats Provender	3 22	11.0 9.4	13.7 10.8 10.6	8.3 7.9 8.2	4.0 3.8	9.3 5.0 5.4 4.8
Corn and Oat Feed, Victor Am. Cereal Co	26 17	9.2	10.5 11.3 12.3	8.3 9.5 8.2	3.9 3.7	4.5 5.1 7.1
Oat Feed, Crescent " Quaker, Am. Cereal Co.*	36	7.9	8.6 12.8 12.4	7.3 7.4 7.8	3·3 3·4	3·7 4·3 4·3
" Various brands	16.	9.3	11.7	7.9 4.4	4.2	4.I 8.8
Corn, Oats and Barley Feed, American Cereal Co. H. O. Co.'s Dairy Feed	6	9.4 11.9 19.0	12.8	II.3 I5.5	4·3 4·5 4·4	5.4 5.4
		29.0	20.9	16.5	4.4	5.0
" " Horse Feed	18	12.4	13.8 13.7 13.3	II.0 II.I	4.2	4.8 4.5 4.4
" Poultry Feed	14	17.5	19.5	11.7 15.0 16.7	5.5	6.0 5.I
Am. Cereal Co.'s Quaker Dairy Feed	5 8	12.8	17.8 14.1 15.5	17.1 11.3 13.4	3.9	5.9 4.4 5.9
Right Bran	3 4	27.7	33.4	24.8 14.3	4.8	5.9
King Gluten, Des Moines Mill	39	32.9	37.1	26.4	15.4	19.8
" Indianapolis Mill	IO	34.6	37-3	32.1	4.8	6.9

<sup>\*</sup> The American Cereal Co.'s Quaker Oat Feed is no longer made, being superseded by Dairy Quaker Feed.

	Exar	Samples nined.
Cotton Seed Meal. Linseed or Flax-seed Meal. Ground Wheat Bran, from Winter Wheat Spring Wheat Unclassified Middlings, from Winter Wheat. Spring Wheat Unclassified Mixed (Wheat) Feed, from Winter Wheat Spring Wheat Unclassified Unclassified		10 12 1 7 9 5 1 6 17 15 7 25
Corn Meal		9 2 5 4 2 6 8 2 2 6 8 2 13 6 14 1 2 1 5 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1
Beef Scraps		241

### COTTON SEED MEAL.

After removing the cotton fiber by machinery as far as possible, the black outer covering or "hull" of the cotton seed is broken off by machinery and separated from the yellow kernels or meats. These kernels are cooked and while still hot are subjected to hydraulic pressure, which removes a part of the oil and leaves the residue, "cotton seed cake," in very hard plates or sheets which can be cut with a saw like boards. These cakes when broken and finely ground make the "cotton seed meal" of the feed market: the most concentrated cattle food which is in general use.

In the ten samples examined, the analyses of which appear in the table, page 178, no admixture of foreign matters was found and all were of good quality as regards chemical composition, the percentage of protein ranging from 49.38 to 44.20 and of fat from 12.96 to 8.55.

The average of many recent analyses of cotton seed meal gives 45.4 per cent. of protein and 11.2 per cent. of fat, while these ten samples contain on the average 46.4 per cent. of protein and 10.4 per cent. of fat.

Undecorticated cotton seed meal, full of black hulls and with only 30 per cent. of protein, and cotton seed meal adulterated with rice refuse, have been found in this State in times past. At present much more cotton seed meal is used in Connecticut as a fertilizer,—chiefly for tobacco,—than as a feed, and the frequent publication of analyses made in the interest of tobacco growers has driven out the inferior grades of cotton seed meal.

#### Guarantees.

Three of the samples were from lots having a guaranteed analysis. The guaranteed and actual percentages of protein and fat in these cases were as follows:

		Pı	otein.	F	at.
		Found.	Guaranteed.	Found.	Guaranteed.
12125	Dixie Bran	45.9	43-48	0.0	10-14
12126	Chapin & Co	44.2	43	12.8	0
12132	J. E. Soper & Co.	44.7	43	9.6	Ó

In neither case is there any deficiency of protein. In one case there is a per cent. less of fat than is guaranteed, but the protein in this sample is nearly three per cent. above the guarantee.

#### LINSEED MEAL.

For removing the oil from flaxseed or linseed two methods are employed. Under the "old process" the crushed seed, while warm, is subjected to hydraulic pressure which squeezes out much of the oil. The residue is in the form of hard cakes which when broken and ground make the "old process linseed

meal." Under the "new process" the oil is removed from the crushed seed by a solvent, like benzine, which is afterwards fully removed from the residue by steaming. The extracted residue is "new process" meal.

Practically all the flax seed on the feed market has been treated by one or other of these processes. New process linseed meal contains on the average two and a half per cent. more of protein and four and three-quarters per cent. less of oil or "fat" than old process meal.

Of the twelve samples examined none were found in any way adulterated.

Samples 12156 and 12074 (though labeled "old process") and samples 12088 and 11567 are new process meals, as is indicated by the low percentage of fat.

Samples 11385, 11381 and 11585 are inferior, because of their low percentages of protein.

#### WHEAT FEEDS.

These are by-products in the manufacture of wheat flour. Several different processes of milling are in common use yielding by-products which are not entirely alike in composition. There are also differences in composition between the products from winter wheat and those from spring wheat.

Wheat Bran consists of the outer layers of the wheat berry which are dark in color and do not easily pulverize.

Wheat Middlings,—as found in the feed market—, consist of inner layers of the covering of the berry, which are lighter in color and more easily pulverized than bran, and of other parts from which fine white flour cannot be made. Red Dog Flour is the poorest grade of flour, off color and often sold as a cattle food.

It is also used for paste and in making "pancake leather"—composed of leather scraps and flour paste, compacted by hydraulic pressure, stated to be made up into soles for children's shoes.

Many mills do not sell bran and middlings separately, but run them together and sell the product as "Mixed Feed."

Red Dog Flour is also sometimes run in to the Mixed Feed. In the compilation on page 163 as well as in the tabulation of the wheat products analyzed at this Station, which appears on pages 178 to 185, the product from the following mills is classed as from winter wheat:

Acme Milling Co., Indianapolis, Ind. American Cereal Co., Chicago. Blish Milling Co., Seymour, Ind. Cole, H. C., Milling Co., Chester, Ills. Eldred Mill Co., Jackson, Mich. Evans, Geo. F., Hoosier Mills, Indianapolis, Ind. Hannibal Milling Co., Hannibal, Mo. Harter, Isaac, & Co., Galena, O. Holly Milling Co. Hunter Bros., St. Louis. Jenks, J., & Co., Sand Beach, Mich. Kehlor Bros., St. Louis, Mo. Lawrenceburg Roller Mills Co. "Snowflake," Lawrenceburg, Ind. Lexington Roller Mill Co., Lexington. Kv.

Maumee Valley Milling Co., Defiance. Ohio. McDaniel & Pitman Co., Franklin, Ind. Meyer, J. T. & Co., Clinton, Mo. Miles & Son, Frankfort, Ky. Model Roller Mills, Nashville, Tenn. Moore, R. P., Milling Co., Princeton, Ind. Rex Milling Co., Kansas City, Mo. Saginaw Milling Co., Saginaw, Mich. Stock, F. W., Hillsdale, Mich. Stott's Flour Mills, Detroit, Mich. Taylor Bros. Milling Co., Quincy, Ill. Valley City Milling Co., Grand Rapids Mich. Voigt Milling Co., Grand Rapids, Mich. Walsh De Roo Milling Co., Holland Mich.

The wheat products from the following mills are classed as from spring wheat:

Anchor Milling Co., Superior, Wis.
Bay State Milling Co., Winona, Wis.
Daisy Roller Mill Co., Milwaukee, Wis.
Duluth Imperial Mill Co., Duluth.
Freeman Milling Co., Superior, Wis.
Grafton Roller Mills, Grafton, N. D.
Lake Superior Mills, Superior, Wis.
Listman, Wm., Milling Co., Superior,
Wis.

Minkota Milling Co., Superior, Wis. Moseley & Motley Milling Co., Rochester, N. Y. North Dakota Milling Association, No. Dakota.

North Western Consolidated Milling Co., Minneapolis.

Pillsbury-Washburn Co., Minneapolis. Russell & Miller Milling Co., Superior, Wis.

Star & Crescent Milling Co., Chicago. Washburn-Crosby Co., Minneapolis. Whitney & Wilson, Rochester, N. Y.

At present, winter wheat bran is worth on the average about seventy-five cents per ton more than spring bran, although the latter as a rule contains a half per cent. more of protein and a per cent. more of fat than the former.

But white winter wheat bran (from Michigan or Canada) sells for from seventy-five cents to a dollar per ton more than the common red wheat.

#### Ground Wheat.

A single sample was analyzed and found free from admixture with foreign matters.

#### Wheat Bran.

Eight samples of winter wheat bran and nine of spring wheat bran were analyzed. Regarding four others it is not known which kind of wheat they represent. In none of them was there any evidence of adulteration.

All the winter brans contained more than the average percentage amounts of protein. In several of the spring brans the percentage of protein was rather low.

Occasionally "cheap" bran is offered for several dollars a ton below the regular market rates. Such "bargains" are to be looked upon with great suspicion. In a "cheap" bran referred to us from another State, microscopic examination showed the presence of finely ground corn cobs.

#### Middlings.

Six samples of spring wheat middlings, one of winter wheat middlings and seventeen regarding which it is not known whether they represent winter or spring wheat, were examined.

Of the unclassified middlings, Nos. 12159, 12144 and 14012 have such low percentages of protein and the two former such low percentages of fat as well, that unless they were sold under a guarantee which corresponded with their actual composition, or at a reduced price, the buyer would be justified in objecting to them.

Some sorts of middlings closely resemble bran, while others are very fine and starchy, having much the look and composition of wheat flour.

They also show a wide range of composition. Thus one of the samples contained over twenty per cent. of protein, while another contained less than thirteen. The price is practically the same, but the one is a valuable feed and the other is uneconomical to buy even at a much lower price.

As a rule spring wheat middlings contain two and one-half per cent. more of protein and a half of one per cent. more of fat than winter wheat middlings.

#### Mixed (Wheat) Feed.

Nineteen analyses of feed from winter wheat are given in the table page 182, nine of feed from spring wheat and twenty of feed in which the kind of wheat is not specified.

Of the winter wheat feeds all are of good quality, a single one, 12802, being deficient in fat.

Of the spring wheat feeds two, 12105 and 12803, are rather low in protein, but all appear to be genuine wheat products free from adulteration.

The same is true of the twenty-five samples of feed in which the kind of wheat is not specified.

Mixed feed from spring wheat contains as a rule about eighttenths per cent. more of protein and three-tenths per cent. more of fat than that from winter wheat.

#### CORN MEAL.

In the table on pages 184 to 187 are given nine analyses of this article which show the usual range of composition. They were all free from admixture with cobs or other adulterant.

We have already called attention to the fact that while corn meal raised on the farm may be used in a ration, it has to be supplemented by more nitrogenous, more "concentrated" feeds. But it is poor economy to buy corn meal, for feeding milch cows, at a cost of \$17 to \$19 per ton, when wheat feeds and gluten feeds, which are much richer in protein and much more fit to balance the ration, can be bought at just about the same price as corn meal.

Old crop corn meal contains from ten to fourteen per cent. of moisture. New crop meal may contain twenty per cent. or more of moisture, with correspondingly lower percentages of other ingredients.

#### GLUTEN, GLUTEN MEAL, GLUTEN FEED.

These are by-products obtained chiefly in the manufacture of glucose and corn (or wheat) starch.

The process used for separating these by-products by the Glucose Sugar Refining Co. of Chicago, at all its factories,—Chicago, Rockford and Peoria, Ill., Davenport and Marshall-

town, Iowa, may be outlined as follows: The corn, after soaking for twelve to twenty-four hours in warm water containing three-tenths of one per cent. of sulphurous acid, is ground with water which carries off the mill product in suspension. By rightly adjusting the amount of water and corn, the chits or germs separated by the grinding float on the surface and are skimmed off. A large percentage of oil may be removed from these chits by pressure and the germ cake may be sold by itself or in mixture as a cattle food.

After separating the germs, and straining to remove part of the starch, the residue is ground once more and again passed over sieves which retain the hull or husk of the kernel. This is dried, ground and sold as "corn chop." The gluten or nitrogenous matter of the kernel and the starch suspended in water which have passed together through the sieves are next run with water over settling tables, where the starch, by reason of its greater specific gravity, settles first out of the stream of water and is thus separated from the gluten. The gluten is dried, ground and sold as cattle food while the starch alone is used in the factory. It will be seen from this description that no chemical is used in this process, except a very small quantity of sulphurous acid which must be completely washed out with the large quantities of wash water used.

We are advised that the methods employed by the Charles Pope Glucose Co. and by the National Starch Manufacturing Co. in extracting these feeds are essentially like those used by the Glucose Sugar Refining Co.

On pages 186 to 189 are given the analyses of gluten meal and gluten feed which have been lately made at this Station.

Atlantic Gluten Meal, made by the Atlantic Starch Works, Westport, Conn., is derived from wheat, being a by-product in the manufacture of wheat starch, and contains a larger percentage of protein than any other feed in our markets.

The manufacturers guarantee 38-40 per cent. of protein and the two samples analyzed contained respectively 48.8 and 49.1 per cent. with 1.70 and 2.04 per cent. of fat.

The manufacturers of *Chicago Gluten Meal* state that it contains 36 per cent. of protein and 3.0 per cent. of fat, but we are informed that this statement refers to the *dry matter* of the meal.

The lowest percentage of protein found in the dry matter of any sample was 38.8 and the lowest percentage of fat 1.95. But the sample with this low percentage of fat contained in the dry matter 43.8 per cent. of protein, nearly seven per cent. more of protein than the guarantee, and for feeding purposes is of course worth to the buyer more than gluten meal which contains the exact guaranteed amounts of protein and fat. The five samples of Chicago gluten meal contain on the average 12.32 per cent. of water, 37.17 of protein and 2.5 of fat: or calculated on the dry matter 42.2 per cent. of protein and 2.85 of fat.

Cream Gluten Meal, made by the Chas. Pope Glucose Co. of Chicago, is stated by the manufacturers to contain 34.12 per cent. of protein and 3.20 of fat. In the four samples examined protein ranges from 32.12 to 35.37 per cent. and fat from 1.70 to 3.78 per cent., while the average figures were 33.91 per cent. of protein and 2.44 per cent. of fat; nearly two per cent. more of protein and a half per cent. less of fat than the guarantee.

King Gluten is made by the National Starch Manufacturing Co. at two factories, and the product of these factories is quite unlike in composition.

As appears in the table on page 186, the product of the Indianapolis mill contains about 34.6 per cent. of protein and 4.8 per cent. of fat, while that of the Des Moines mill contains 32.9 per cent. protein and 15.3 per cent. fat. Buyers should find out, before purchasing, which product they are getting, for the one brand covers two very different feeds.

Gluten Feed. The gluten feed now made by the Glucose Sugar Refining Co. at its several factories is stated to be uniform in composition. The output of the Davenport factory is sold under the brand "Davenport Gluten Feed." That of the Marshalltown factory is branded "Marshalltown Gluten Feed"; that of the Peoria factory is branded "Buffalo Gluten Feed" and that of the Rockford factory as "Rockford Diamond Gluten Feed." "Golden Gluten Feed" is no longer sent out under that brand.

All these brands, as made at the present time, are stated by the manufacturer to contain 27.0 per cent. of protein and three per cent. of fat *in the dry matter*.

The six samples of Buffalo Gluten Feed contained on the average (9.63 per cent. of water) 30.2 per cent. protein and 3.6 per cent. of fat. The protein in the dry matter of all was well above 27 per cent.

In one case the fat was below 3 per cent.

The percentages of protein in the three samples of "Rockford" gluten feed and the two of "Diamond" gluten feed ranged from 22.81 to 30.12. It is possible that some of these samples represented feed manufactured before the consolidation of these factories and the introduction of uniform methods of preparation.

The gluten feed made by the National Starch Mfg. Co. apparently has no guarantee.

#### HOMINY CHOPS.

Also called hominy feed, white meal, Baltimore meal, is a by-product from the manufacture of hominy. The eight samples analyzed were of average composition and no evidence of adulterants was found in them.

#### GROUND OATS.

Of the two samples examined, one, 11558, is of inferior quality, having much less protein and fat than should be present and much more fiber. It is made of light and inferior oats or oat hulls or clippings have been mixed with it. Oats contain, on the average, 11.8 per cent. of protein, 5.0 per cent. of fat and 9.5 per cent. of fiber.

#### PROVENDER.

This is supposed to be a mixture of equal weights of ground corn and oats.

The thirteen analyses show a wide range of composition and two of them at least, 12904 and 11356, have such low percentages of protein together with such large percentages of fiber as to make it probable that oat hulls have been added to them. Provender to be of good quality should certainly contain at least ten per cent. of protein.

#### CORN AND OAT FEEDS.

In the table are given analyses of six samples of this class which have about the same composition as provender, most of them containing however a larger percentage of fiber (hulls).

The Victor Corn and Oat Feed, made by the American Cereal Co., is the only brand, in this class, bearing a statement of composition. The guarantee is 9.46 per cent. of protein and 3.92 per cent. of fat. One of the samples, 11365, falls short of the guaranteed protein by nearly one per cent. and of the guaranteed fat by one and three-tenths per cent.

Champion Bell Fodder, 12127, is simply a corn and oat feed of average quality, under another name.

#### OAT FEEDS.

Analyses of fourteen samples of Oat Feed appear in the table and one of Oat Chaff.

Those made by the American Cereal Co. contain a fair amount of protein and fat.

The same is true of 12903. But all the others contain far less protein than good corn meal even and almost or quite as much woody fiber as good hay.

They are factory wastes of very inferior feeding value, consisting largely of oat chaff, which are sold to dairymen in this State for nearly the same price as good wheat bran.

No feeder can afford to use them, however cheaply he can buy them. They ought not to have a place in the feed market.

Oat chaff, as appears in the table, 12190, can be bought under its true name for \$7.00 per ton. It can be bought under the name of "Oat Feed," as also appears in the table, 12197, for \$15.00 a ton.

Some of the oat feeds contained some wheat, but no other foreign matter was detected.

The Quaker Oat Feed is the only brand which has the guaranteed statement of composition which the law requires.

This guarantee is, protein 12.03 per cent., fat 3.49 per cent. Only one of the four samples contained the guaranteed amount of protein, and three of them contained much less than this amount.

We are informed by the manufacturers that Quaker Oat Feed is no longer made, being superseded by Quaker Dairy Feed.

#### CORN, OATS AND BARLEY.

Two samples bearing this brand, made by the American Cereal Co., have about the same composition as their oat feed, though with less fiber.

#### OTHER MIXED FEEDS.

Feeds made by the H. O. Co., Buffalo, N. Y.

H. O. Dairy Feed. Six samples of this article have been examined. The chemical analyses given in the table show them to have a tolerably uniform composition, differing from bran in having somewhat more protein, considerably more woody fiber and less carbhydrates and fat. Microscopic examination shows them to be mixtures of oats, corn, wheat and cotton seed.

This brand is guaranteed by the manufacturers to contain 18 per cent. of protein and 4.5 per cent. of fat.

Two of the analyses fall slightly below the guaranteed protein and none of the samples contain the guaranteed percentage of fat.

H. O. Horse Feed. Nine samples of this article have been examined. It consist of oats, corn, wheat and linseed. Twelve per cent. of protein are guaranteed in this brand and four and a half per cent. of fat. With one exception the analyses substantially came up to the guaranteed protein, but all show less fat than is guaranteed.

H. O. Poultry Food. Three samples of this material also appear in the table: They contain oats, corn and wheat, and are guaranteed to contain 17 per cent. of protein and 5.50 per cent. of fat.

One of the samples contains two per cent. less of protein and nearly one per cent. less of fat than is guaranteed.

Feeds made by the American Cereal Co., Chicago, Ill.

Quaker Dairy Feed. The analyses of five samples of this feed are given in the table. The feed is composed of oats and wheat and guaranteed to contain 12.09 per cent. of protein and 3.49 per cent. of fat. The percentage of fiber shows the presence of a considerable quantity of oat hulls. In two of the samples the percentage of protein fell below the guaranteed amount. One analysis is also given of the American Poultry Food, made by the same company, and one of their Stock Food.

#### Blatchford's Calf Meal.

Called "The Perfect Milk Substitute." The directions for using, however, indicate that for very young calves it is to be used with skim milk and for older calves a double handful is given daily, in addition to their other feed. The quality and quantity of the other feed would affect somewhat the profitableness of this feed, which costs \$3.50 per 100 pounds.

The sample examined contained linseed meal, a starchy bean meal, wheat middlings, cotton seed meal, carob bean and husk and fenugreek. It contains about the same percentages of protein, fat and nitrogen-free extract as the gluten feeds.

#### RYE BRAN AND RYE FEED.

The five samples examined were genuine and of very similar composition. Rye bran sells for the same price as wheat feeds and contains less fat and from one and one-half to two per cent. less of protein. It is of less value in "balancing" a ration than the wheat feeds and therefore cannot be as economical a feed to purchase. All the samples consisted wholly of rye. None of them had any guaranteed statement of composition.

#### MALT HULLS.

A single analysis, 12261, of this feed shows it to be of inferior value as a feed. It represents a sample sent to T. S. Gold, West Cornwall, by a feed dealer in Chicago.

#### STARCH FEEDS.

Schumacher's Starch Feed, 12078, contains much less protein than wheat bran and is of no value in balancing a ration. It contains oats, corn and wheat. The dry Glen Cove Starch Feed, 12135, ranks in composition with the gluten feeds, and contains as much protein as the best wheat brans.

#### PIONEER CLOVER MEAL.

This material, No. 12189, is put up for a poultry food and claims to be, and apparently is, ground clover hay. Its cost is \$1.00 for 50 pounds.

#### CAROB BEANS.

As this material forms a part of one of the mixed feeds above referred to and as no analyses of beans and pods were at hand, analyses were made both of the beans and pods, from which is calculated the composition of bean and pod together.

In one hundred parts of the unopened pods are 7.5 parts by weight of seed and 92.5 parts of empty "husks" or pods. The analyses were as follows:

	Seeds.	Husks.	Full Pods. (Seed and Husk.)
Water	12.84	14.15	14.05
Ash	3.27	3.25	3.26
Protein	15.00	4.81	5.57
Starch*		.85	
Sugars and dextrines†	5.31	40.63	41.56
Reducing sugar‡	None	3.62	3.25
Other nitrogen-free extract	54.59	27.67	26.99
Fiber	7.16	4.80	4.98
Fat	1.83	.22	.34
	100.00	100.00	100.00

#### AMERICAN CATTLE FEEDING SALTS.

No. 12192, made by the American Cattle Feeding Salts Co., 138-140 55th St., New York City. John M. Draper, Agricultural and Research Chemist, Manager.

Said to consist of "various tonic substances and natural salts," which when added to the other feeds is a "means of growing prime beef, brighter in color, wavy or marbled in texture, and with pure white fat, in much less time than is possible under the present system of feeding."

The "Salts" contain about 16 per cent. of common salt, 63½ per cent. of Glaubers salts, 4.8 per cent. of Epsom salts, 9.3 per cent. of carbonate of soda, a per cent. and a half of matter insoluble in water and for the rest contains water and some volatile matter.

The last three analyses of the table are of beef scraps and animal meal used as poultry food.

‡Reducing power of aqueous extract determined without hydrolysis

<sup>\*</sup>By diastase method.
†Carbhydrates soluble in water calculated as dextrose after hydrolizing with acid and deducting "reducing sugars."

TABLE II.—ANALYSES OF COMMERCIAL FEEDS ( )

Station No.	Name of Feed.	Manufacturer or Jobber.	Retail Dealer.
2002	Cotton Seed Meal		East Hartford, G. M. White & So
12125	" Dixie Brand		
12126	66 A	Chapin & Co., St. Louis	
12103	American		Hartford, Daniels Mill Co.
2071			" C. A. Pease & Co
11379		I. E. Soper & Co. Boston	"Smith, Northam & Co. New Britain, M. D. Stanley
[2132	"	" " " " " " " " " " " " " " " " " " "	New Haven, R. G. Davis
12149	"		" Abner Hendee
12895	"		the second secon
	• (1,00)		Average of the above 10 analyse of Cotton Seed Meal
12093	Linseed Meal		East Hartford, G. M. White & So
11395	"		Hartford, Daniels Mill Co
2074	" "Old Process"		" C. A. Pease & Co
12088		Hunter Bros., St. Louis,	Smith, Northam & Co
1392	1	Mo.	
11385	"	Chapin & Co., Boston	
11381		J. E. Soper & Co., Boston	
12156			New Haven, J. T. Benham
12147		Hunter Bros., St. Louis	" Abner Hendee
12894	Old Flocess	American Linseed Co	New London, Beebe & Bragan.
	Linseed Meal	American Emisco Co	Willimantic, H. A. Bugbee Average of the above 8 analyses o Old Process Linseed Meal Average of 25 recent analyse
			Old Process
			Lowest
		Control April 1	Average of the above 4 analyse
			of New Process Linseed Meal- Average of 31 recent analyses
			New Process
			Highest
			Lowest
12194	Ground Wheat	C. M. Cox & Co., Boston	Torrington, B. C. Patterson
	Bran from Winter		
	Wheat.		TT .( 10 .1
			Hartford, Smith, Northam & Co
12801 11383	" Michigan	City Mills Co., N. Y.	New Britain, Hugh Reynolds
11565			New London, Beebe & Bragan-
2131	" Coarse Amber		
	Wheat		New Haven, R. G. Davis

			Ana	LYSES.			
Station No.	Water.	Ash.	Protein.	Fiber.	Nitrogen-Free Extract. (Starch, gum, etc.)	Ether Extract.	Price per ton.
	9.10	5.90	48.83	4.24	23.38	8.55	\$24.00
12092	8.80	6.72	45.88	4.27	25.30	9.03	23.00
12125	7.72	7.52	44.20	5.70	22.09	12.77	23.00
12103	7.74	7.40	45.76	6.92	21.23	10.95	24.00
12071	8.20	6.48	49.38	4.41	22.54	8.99	25.00
12087	8.85	7.33	46.01	5.33	21.36	11.12	23.00
11379	6.84	7.86	47.00	5.76	21.23	11.31	26.00
12132	9.15	5.88	44.69	5.87	24.83	9.58	25.00
12149	9.09	6.48	48.38	4.87	22.59 23.85	8.59	24.00
12895	7.14	7.42	43.94	4.69	23.03	12.96	25.00
	8.26	6.90	46.41	5.53	22.52	10.38	
			45.4			11.2	
			52.6			17.0 6.5	
			40.3			0.5	
12093	10.71	5.56	35.07	7.48	31.59	9.59	28.00
11395	10.71	4.90	36.19	8.56	34.97	4.67	27.00
12074	11.16	5.56	36.07	8.39	36.59	2.23	29.50
12088	9.77	6.24	38.13	8.11	35.04	2.71	26.00
11392	10.28	6.06	34.56	8.00	32.00	9.10	28.00
11385	10.58	5.13	31.81	8.85	36.97	6.66	
11381	10.20	5.50	32.06	8.79	36.67	6.78	30.00
12156	10.83	5.61	36.26	8.58	36.89	1.83	29.00
12147	9.82	6.62	33.76 34·37	7.12	33·54 35·59	9.14 9.42	28.00
11567	6.94	5.15	40.44	7.64	32.62	2.98	28.00
11585	9.76	5.64	32.94	8.51	36.89	6.26	30.00
	9.87	5-75	33.84	8.05	34-79	7.70	
			35.7			7.2	96443
		1111	38.9			9.6	
			31.8	-74-	1111	4.7	
	10.73	5.64	37.72	8.18	35.29	2.44	
			38.2	111111111111111111111111111111111111111		2.4	
			42.2			3.5 1.8	
			34.6		1	1.8	
12194	12.02	5.48	18.12	6.34	53.17	4.87	18.00
12806	TO 0-	-	****	6.00	10.00	0.00	
12801	12.80	5.00 6.27	17.37	6.92 8.80	53.99 51.80	3.92 4.18	3333
11383			23.09	118	3		
11565	10.84	6.49	15.62	9.01	53.47	4.57	
12131	11.31	6.16	15.37	9.59 8.18	53.18	4.39	21.00
	10.17	6.93	16.19	0.10	54.24	4.29	19.00

<sup>\*</sup> Car load lots delivered.

TABLE II.—Continued. ANALYSES OF COMMERCIAL FEEDS. (2007)

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Station No.	Name of Feed.	Manufacturer or Jobber.	Retail Dealer.
12151 12900 11576	" White Wheat	Valley City Milling Co. Grand Rapids	"Abner Hendee Norwich, Joseph Connor & Son. Average of the above 8 analyses of Winter Wheat Bran Average of 45 recent analyses Highest
11372 12096 11398 12805 12081	"	Freeman Milling Co Pillsbury	Berlin, T. B. Wickwire  East Hartford, G. M. White & Co Hartford, Daniels Mill Co  "Smith, Northam & Co  "E. P. Vates & Co
11384 12152 12906 11569	" Coarse	Washburn, Crosby Co	New Britain, Hugh Reynolds New Haven, J. T. Benham  "Abner Hendee New London, Arnold Rudd Average of the above 9 analyses of Spring Wheat Bran Average of 53 recent analyses Lowest
12115 12077 12065 11389	"	Ferguson & Lewis, Roch-	Bridgeport, Taylor & Clark Hartford, Cummings & Garvin " C. A. Pease & Co
12800 12804 11396 12160	Middlings, Spring W head A B B B B Coarse	Pillsbury  " "  Northwestern Consolidated Milling Co., Min-	" Daniels Mill Co
12901	No. 2 Middlings, Winter	neapolis	"R. G. Davis Abner Hendee Average of the above 6 analyses of Spring Wheat Middlings Average of 60 recent analyses Highest Lowest
11575	Wheat.	Valley City Milling Co.,  Grand Rapids	Norwich, Joseph Connor & Sons

			Ana	LYSES.			
Station No.	Water.	Ash.	Protein.	Fiber.	Nitrogen-Free Extract. (Starch, gum, etc.)	Ether Extract.	Price per ton.
	0	5:98	16.13	8.20	55.20	4.51	\$19.00
12151	9.98 8.06	6.53	15.94	8.74	56.61	4.12	20.00
11576	11.40	5.33	15.25	8.32	55.37	4.33	1177
	10.98	6.08	15.94 15.5	8.46	54.25	4.29	
			17.8			5.6	
MIN. (1997)	AD-1777	7777	13.6			3.5	
			13.0			3.3	
******	10.53	6.98	15.56	12.12	49.87	4.94	19.00
11372	9.74	6.51	16.37	8.87	53-37	5.14	20.00
11398	11.88	5.80	15.81	7.83	54.26	4.42	20.00
12805	12.99	6.72	15.06	10.96	49.84	4.43	
12081	11.31	6.54	15.75	10.42	50.92	5.06	20.00
11384	11.45	6.40	15.12	10.37	52.03	4.63	18.00
12152	10.25	6.54	15.31	11.56	51.28	5.06	18.00
12906	8.20	5.86	16.37	9.11	55.95	4.51	19.00
11569	11.44	6.01	15.44	10.59	52.15	4.37	19.00
	10.86	6.37	15.64	10.20	52.20	4.73 4.9	
			16.1			5.6	
			17.5 15.1			4.4	
		0.5770	15.1				
12115	9.86	6.27	15.75	9.68	53.76	4.68	18.00
12077	10.39	5.79	16.94	8.04	53.78	5.06	20.00
12065	10.75	6.35	15.75	9.46	52.86	4.83	20.50
11389	11.65	5.50	15.31	8.50	54.91	4.13	21.50
0	0		18.06	r 06	56.26	4.81	
12800	12.18	3.33	16.50	5.36 9.53	51.04	5.35	1111
12804	11.48	5.30	17.19	10.26	50.06	5.49	21.00
11396	11.46	5.52 4.7I	17.32	9.48	51.67	5.76	19.00
12100	11.00	4.71	17.32	9.41	3,	3.,	
12137	11.63	5.45	16.00	10.31	51.57	5.04	17.00
12901	8.43	5.18	16.69	10.07	54.38	5.25	20.00
	11.17	4.91	16.96	9.17	52.51	5.28	
			18.8			5.2	The state of the s
			22.2			7.I	Mark Miles
			16.0			3.3	
Train			** 0=	6.87	56.71	4.42	19.00
11575	11.76	4.37	15.87 16.0	0.07	50.71	4.8	19.00
		DAY THE	17.9			5.I 4.4	De la Constitución de la Constit

# Table II.—Continued. Analyses of Commercial Feeds. (1997)

_			
Station No.	Name of Feed.	Manufacturer or Jobber.	Retail Dealer.
		700	
	Middlings, unclassified.		
12113		T. B. Chase & Son, New	D.I
TOTIT		York	Bridgeport, Taylor & Clark Bristol, W. O. Goodsell Guilford, G. F. Walter Hartford, C. A. Pease & Co
11557	Puritan	I. T. Benham New Haven	Guilford G F Walter
12067	N. Y. Brand No. 2		Hartford, C. A. Pease & Co.
12084	XX71 :	·	" E. P. Yates & Co.
12159	White		Trow Haven, J. I. Bennam
12142	1 1110		K. G. Davis
12143	Coarse		
11566		New York City Mills	New London, Beebe & Bragan
11571		Whitney & Wilson, Roch-	
0		F. W. Stock, Millsdale,	
		Mich	Norwich A A Reckryith
12105		C. M. Cox & Co., Boston	Torrington, B. C. Patterson
12193			
11584		Bay State Co., Winona,	
14012	Middlings, Colonial	Minn	Willimantic, H. A. Bugbee New Haven, Abner Hendee
	Mixed Feed from Win-		
	tone Whaat	Market and the second second second	
11367	Anchor	C. M. Cox & Co., Boston	Berlin, J. C. Lincoln
11368	Buckeye	American Cereal Co.,	
11550	"	American Cornel Co	
		Chicago	Guilford F H Rolf
11560	I. Harter Co.'s	Chicago	" Koll
2122	Coarse		Guilford, F. H. Rolf
2121	Medium Snow Flake		
	Anghar	Anghar Will Ca Sand	II
2060	Acme	Anchor Mill Co., Superior	Hartford, Daniels Mill Co C. A. Pease & Co
12802	Acme		" Smith, Northam & Co
1359	Snow Flake Brand	Lawrenceberg Mills Co.,	Meriden, Meriden Grain & Feed C
		IndAmerican Cereal Co.,	Meriden, Meriden Grain & Feed C
11364	Buckeye	American Cereal Co.,	
		Chicago	" A. H. Cashen
11378	Show Flake	Ind	New Britain, M. D. Stanley
11387	Hannibal Mixed Feed	Hannibal Milling Co.,	
-		Hannibal, Mo	" Hugh Reynolds
2153			"Hugh Reynolds New Haven, J. T. Benham
2128			" R. G. Davis
4017	Acme Feed	Acma Co. Indiana	North Haven, The Co-Op. Feed C
4016	Mixed Feed	Miles & Son, Frankfort,	Rockville, Edward White
4010		Ky.	North Haven, Cooperative Feed C
			, , , , , , , , , , , , , , , , , , , ,

1			ANALY	SES.			
ation No.	Water.	Ash.	Protein.	Fiber.	Nitrogen-Free Extract. (Starch, gum, etc.)	Ether Extract.	Price per ton.
					54.2E	6.26	\$19.00
	11.58	4.18	18.63	5.00	54.35	4.35	
12113	11.07	4.29	14.38	5.57	60.34	4.83	21.00
IZIII	11.86	4.24	17.56	7.11	54.40	5.05	20.00
11557		4.30	18.44	6.59	55.18	5.77	21.50
12067	10.44	4.32	20.13	4.68	54.60		21.00
12066	10.50	5.27	19.19	6.98	52.92	1.72	
12084	13.92	2.86	13.69	3.03	65.31	2.88	20.00
12159	12.23		17.25	4.94	55.88	5.41	18.00
12142	12.08	4.44	12.85	1.05	67.15	2.70	20.00
12144	12.61	3.68	17.88	8.11	52.09	5.91	18.00
12143	11.32	4.69		4.48	54.24	7.70	21.00
11566	10.92	4.91	17.75	4.40	34-1		
11571	12.74	3.58	17.31	6.31	54.56	5.50	20.00
			76.70	6.16	59.72	1.84	21.00
11578	11.75	4.34	16.19	6.78	50.76	5.64	16.00*
12195	12.50	4.88	19.44		61.68	3.80	17.25*
12193	12.74	2.86	14.87	4.05	01.00		
	100000000000000000000000000000000000000	0	18.62	8.13	. 51.69	5.56	19.00
11584	11.62	4.38		5.48	62.37	6.80	20.00
14012	7.85	3.75	13.75	5.40			
					halos	Arrest Marie	
11367	10.93	5.34	16.56	8.28	53.79	5.10	20.00
11301				7.21	54-55	4.37	20.00
11368	11.27	5.48	17.12	1.21	54.55		
			17.75	6.82	53.98	4.37	20.00
11559	12.11	4.97		6.76	56.49	4.27	20.00
11560	11.69	5.04	15.75	7.90		4.59	18.00
12122	9.73	6.57	17.13	7.90			-0.00
		6.06	16.75	7.41	55.28	4.53	18.00
12121	9.97	6.06	16.12	8.94		5.20	21.00
11397	11.58	5.06		6.97		4.60	20.00
12069	10.18	6.33	17.00	6.48		3.60	
12802	13.28	5.11	18.12	0.40	33.4.		80.00
11359	11.02	4.86	17.31	7.57	54.96	4.28	20.00
		F 20	16.37	6.5	5 55.98	4.41	20.00
11364	11.30	5.39	1.037			4.30	21.00
11378	10.76	5.45	17.56	7.2	6 54.67		
			15.56	6.9	5 57.32	4.05	20.00
11387	11.75	4.37	16.63	7.2		4.79	18.50
12153	10.68	5.94	16.32	7.0		4.58	18.00
12128	10.88	5.96		8.9		4.87	
14017	8.94	5.42	17.62	7.1	1 -	4.00	20.0
11594	11.24	5.48	17.50	/	3, 3		
14016	8.16	6.75	16.37	9.2	54.33	5.17	18.0

<sup>\*</sup> Car load lots delivered.

# TABLE II.—Continued. ANALYSES OF COMMERCIAL FEEDS. (A)

_	· ·		(24)
Statio No.	Name of Feed.	Manufacturer or Jobber.	Retail Dealer.
1135	5 Sunshine Mixed Feed	- Hunter Bros., St. Louis	- Wallingford, E. E. Hall- Average of the above 19 analyses of feed from Winter Whom
	Mixed Feed from Spring Wheat.		Average of 88 recent analyses Highest Lowest
12120	Post Fine		Hamden, Ira W. Beers
1210	Minkota		Traitiond, E. H. Arnold & Son.
1200	1110. 4	PHISPHIT	Smith, Northam & Co.
12082	Superior Mixed Feed	Lake Superior Mills Wis	" E. P. Yates & Co New Britain, C. W. Lines
11376	Golden Bull Mixed Feed		. New Britain, C. W. Lines
T4070	Boston	Winona, Minn.	
14018	DOS(ON	Imperial Mill Co., Duluth	North Haven, The Co-Op. Feed Co. Average of the above 9 analyses of feed from Spring Wheat. Average of 60 recent analyses. Highest
	Mixed Feed, unclassified.		Lowest
	THE RESIDENCE OF THE PARTY OF T	Hollister, Crane & Co., N. Y.	Dault I O T
11373	Roston Food	m D O	Berlin, J. C. Lincoln "T. B. Wickwire Bridgeport, Taylor & Clark
12001	No. 2		East Hartford, G. M. White & Co.
12099	St. Louis Mixed Feed -		Hartford, Daniels Mill Co
12102	St. Louis "		
12070 11555 11357 11360	Boston "Mixed Feed Stirling Mixed Feed Mixed Mixed Feed Mixed Feed Mixed Feed Mixed Feed Mixed Feed Mixed Feed	N. Y. City Mills Chapin & Co., Boston	" Meriden Grain and Feed
2902			CoNew Canaan, Grange
2106	New York Mixed Feed		" R. G. DavisWillimantic, E. A. Buck & Co
1586	" "		" H. A. Bugbee
2112	Corn Meal.	W M T	
2089		Smith, Northam & Co.,	Bridgeport, Taylor & Clark
		Hartford	East Hartford, G. M. White & Co.

			ANA	LYSES.			
Station No.	Water,	Ash.	Protein.	Fiber.	Nitrogen-Free Extract. (Starch, gum, etc.)	Ether Extract.	Price per ton.
11355	10.92	4.65	17.00	6.66	56.72	4.05	\$20.00
	10.86	5.48	16.87	7.44	54.87	4.48	
	10.00	5.4-	16.2			4.5	
			18.5			5.4	
			13.8			3.6	
	10.42	5.26	16.25	8.27	54.30	5.50	18.00
12120	10.29	5.26	16.75	7.83	54.97	4.90	20.00
12105	11.20	3.75	16.00	5.20	59.63	4.22	20.00
12803	12.05	3.51	15.56	9.36	54.66	4.86	
12086	10.19	7.11	18.75	9.41	49 45	5.09	18.00
12082	11.16	6.27	17.38	8.57	51.51	5.11	20.00
11375	11.12	5.00	16.69	8.80	53.33	5.06	20.00
1000		awa di tan					
11376	11.12	5.75 4.80	16.75	9.18 8.05	51.56 55.00	5.64 5.26	18.00
14018	10.00	4.00	10.01	0.05			
	10.85	5.18	16.77	8.29	53.84	5.07	
			17.3			4.9	
			19.8			5·5 3.8	
		J. House	15.6		777	3.0	
11070	11.01	5.87	17.50	6.52	54.98	4.12	20.00
11370	11.02	5.27	16.50	8.67	54.16	4.38	20.00
11373	11.00	4.56	16.13	5.57	58.20	4.54	
12000	10.46	6.05	15.82	6.33	56.77	4.57	20.00
12001	10.79	5.64	16.00	7.04	56.07	4.46	20.00
12099	10.14	5.60	15.00	6.97	57.92	4.37	19.00
12101	10.43	5.37	16.31	7.50	54.99	5.40	19.00
12102	10.17	4.98	16.88	6.75	56.68	4.54	19.00
11393	12.00	5.06	17.62	7.24	54.17	3.91 5.46	20.00
12070	10.72	5.04	16.88	6.53	55·37 53·22	4.62	21.00
11555	12.00	5.32	17.81	7.54	53.49	4.41	20.00
Trofo	10.66	5.85	17.50	7.43	53.56	5.00	20.00
11360	8.06	4.99	19.13	7.43	54.57	5.82	14.00
12902	8.03	5.98	16.19	9.11	55.96	4.73	20.00
12158	10.87	5.47	18.00	7.66	53.98	4.02	18.00
12196	11.22	5.99	16.00	8.58	53.23	4.98	. 19.00
11591	12.10	5.78	15.50	9.03	53.46	4.13	20.00
11590	10.61	5.60	19.00	7.94	52.85	4.00	20.00
11586	11.02	5.72	17.19	8.73	53.04	4.30	20.00
12112	14.30	1.31	10.25	2.45	67.98	3.71	17.00
12080	13.91	1.45	9.88	1.50	68.90	4.36	19.00

<sup>\*</sup> Car load lots.

### TABLE II.—Continued. ANALYSES OF COMMERCIAL FEEDS. ( )

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#### Station No. Name of Feed. Manufacturer or Jobber. Retail Dealer. Hartford, E. H. Arnold & Son Cummings & Garvin 12076 Daniels Mill Co. 12007 C. A. Pease & Son 12064 E. P. Yates & Co. 12079 Middlefield, S. E. Miller 11604 12138 New Haven, R. G. Davis Average of the above 9 analyses of Corn Meal.... Average of 17 recent analyses. Highest.... Lowest \_\_\_\_\_ 11388 Atlantic Gluten Meal\* Atlantic Starch Works, Middletown, Meech & Stoddard Westport, Conn. ..... New Haven, R. G. Davis Glucose Sugar Refin'g Co. East Hartford, G. M. White & Co. 12005 Chicago Gluten Meal\_\_ Hartford, C. A. Pease & Co. ----12068 E. P. Yates & Co.... 12080 New Britain, Hugh Reynolds .... 11386 M. D. Stanley ..... 11380 Average of the above 5 analyses of Chicago Gluten Meal.... Average of 76 recent analyses.... Highest \_\_\_\_\_ Lowest \_\_\_\_\_ 11394 Cream Gluten -----Hartford, Daniels Mill Co.... Smith, Northam & Co. -12085 Meriden, Meriden Grain and Feed 11361 Co. ..... Norwich, A. A. Beckwith ...---11577 Average of the above 4 analyses of Cream Gluten Average of 40 recent analyses ----Highest ....-Lowest .... Sent by A. Cullen & Co., N. Y. City 11600 King Gluten Meal .... Natl. Starch Mfg. Co... (Indianapolis Mill). Average of 10 recent analyses---Highest .... Lowest .... 12108 King Gluten Meal --- Natl. Starch Mfg. Co ... West Hartford, C. M. Beach ----(Des Moines Mill). Average of 39 analyses \_\_\_\_\_ Highest \_\_\_\_\_ Lowest 11500 Gluten Feed, Buffalo -- Glucose Sugar Refining Co., Chicago .... Bridgeport, Berkshire Mills .---Glucose Sugar Refining 11574 Co., Chicago ..... Groton, Groton Grain Co.---

			Ana	LYSES.	0		
Station No.	Water.	Ash.	Protein.	Fiber.	Nitrogen-Free Extract. (Starch, gum, etc.)	Ether Extract.	Price per ton.
	TO 20	1.22	9.75	1.96	69.74	3.94	\$19.00
12104	13.39	1.65	9.45	1.71	68.24	4.70	19.00
12076	14.65	1.56	9.44	1.71	68.20	4.44	18.00
12097	17.38	1.40	9.56	1.65	66.82	3.19	19.00
12064	13.61	1.91	9.56	1.66	69.05	4.21	19.00
12079	12.35	1.26	10.00	1.75	70.96	3.68	
11604	16.54	1.39	9.51	1.63	67.14	3.79	19.00
	14.49	1.46	9.71	1.78	68.56	4.00	
100000000000000000000000000000000000000		001211	9.5			4.0	
			10.8			4.7	
			8.6			2.7	
11388	8.66	1.12	48.75	0.85	38.92	1.70	25.00
12136	7.26	1.07	49.06	0.88	39.69	1.87	21.00 23.00
12095	10.26	1.05	41.29	1.10	44.43 46.85	2.02	23.50
12068	11.86	1.83	35.94	1.41	42.34	1.62	24.00
12080	17.16	1.22	36.25	1.52	44.69	2.63	30.00
11386	11.56	0.60	37·75 34.62	1.56	48.24	4.19	25.00
	12.32	1.31	37.17	1.42	45.32	2.46	
			36.7			2.7	
			41.3			7.6	
			31.7			1.4	
11394	10.00	0.99	32.12	2.36	52.24	2.29	25.00
12085	11.25	0.95	34.94	1.35	47.73	3.78	20.00
11161	9.90	0.54	35-37	1.43	51.06	1.70	24.00
11577	9.27	0.84	34.12	1.49	52.30	1.98	25.00
	10.10	0.83	34.14	1.65	.50.84	2.44	
			34.1			3.2	Land W
			41.3			6.1	
			30.1			1.6	
11600	7.40	0.45	33.12	1.21	55.03	2.79	
			34.62			4.80	
			37.32			6.87	
			32.11			2.65	
12108	8.15	0.89	32.07	1.93	41.69	15.27	
			32.89			15.35	
			37.06			19.77	
			26.38		11 10	11.71	
11599	10.10	2.60	27.00	7.10	50.03	3.17	20.0
	-50						
11574	10.12	1.67	27.12	7.27	51.48	2.34	25.0

<sup>\*</sup> Made from wheat.

Table II.—Continued. Analyses of Commercial Feeds. ( )

		1 0	(23)
Station No.	Name of Feed.	Manufacturer or Jobber.	Retail Dealer.
12123	Gluten Feed, Buffalo.	Glucose Sugar Refining	
11377		Co., Chicago	Hamden, Ira W. Beers
12155		Co., Chicago	New Britain, C. W. Lines
14015		Co., Chicago	New Haven, J. T. Benham.
12150	" Rockford	Co., Chicago	North Haven, Cooperative Feed C
2899	"	Co., Chicago Glucose Sugar Refining	New Haven, Abner Hendee
11570		Co., Chicago	
		Co., Chicago	New London, Arnold Rudd Average of the above 6 analys of Buffalo Gluten Feed Average of 34 recent analyses Highest Lowest
1568	Golden Gluten Feed	Glucose Sugar Refining	
		Со	New London, Beebe & Brogan Average of 15 recent analyses Highest Lowest
12133	Diamond Gluten Feed	Glucose Sugar Refining	
11597	a a a	Glucose Sugar Refining	New Haven, R. G. Davis
		Co	Rockville, Edward White Average of 30 recent analyses Highest Lowest
12821	Gluten Feed	National Starch Mfg. Co	Bridgeport, Berkshire Mills Co
-			
11374	Gluten Meal		Berlin, T. B. Wickwire Hamden, Ira W. Beers
	Hominy Chop.		
11562		American Cereal Co.	Guilford, F. H. Rolf.
12908	"White Meal"	C M Cox & Co Roston	" Abner Hendee
14011	"Hominy Meal"	Miner, Hillard Co.,	New Haven, R. G. Davis
11603			
11391 11354	"	C. M. Cox & Co., Boston	Middletown, Meech & Stoddard Wallingford, E. E. Hall Average of the above 8 analyses Hominy Chop
			Average of 20 recent analyses. Highest Lowest

			ANAL	YSES.			
ation No.	Water.	Ash.	Protein.	Fiber.	Nitrogen-Free Extract. (Starch, gum, etc.)	Ether Extract.	Price per ton.
12123	9.85	2.60	28.57	6.08	49.73	3.17	\$18.50
	9.20	1.55	27.75	6.60	50.81	4.09	23.00
11377	10.04	2.83	26.32	6.58	51.24	2.99	19.00
12155	8.46	2.39	27.12	6.85	51.48	3 70	18.00
14015	8.77	0.90	25.19	7.07	54.30	3.77	19.00
12899	7.21	0.64	22.81	6.34	59.79	3.21	20.00
	9.55	0.88	30.12	6.85	49.26	3.34	19.00
11570	9.63	2.27	27.31	6.74	50.80	3.25 3.1	
			27.5			4.7	
			29.6 25.3	1111		2.3	
	0.0	0.82	27.25	6.58	53.12	3.75	22.00
11568	8.48	0.02	27.00			3.00	
	1111	1012	29.6			2.0	
			23.6			2.0	
12133	9.87	0.88	23.69	5.85	56.14	3.57	19.00
******	8 00	0.72	24.37	6.65	55.75	3.52	22.00
11597	8.99		23.6			<b>3.6</b> 5.0	
			30.1			2.3	
			20.3				
12821	7.35	o.60 o.88	21.37	7.43 7.63	57.07 53.33	6.18	20.00
			26 70	3.58	56.37	3.71	20.00
11374	9.75 8.17	0.40	26.19 18.94	7.94		10.72	18.00
77760	10.65	2.46	11.25	7.61	62.92	5.11	19.00
11562	7.14	3.00	12.00	4.01	64.36	9.49 7.56	18.00
12908	6.85 7.85	1.93 2.45	11.37	3.22 5.96		9.26	17.00
		2.81	10.87	4.18	67.32	8.46	16.50
14011	6.36 9.66	3.32	11.06	5.10	61.86	9.00	18.00
11391	10.20	2.80	11.75	5-4:		8.67 6.93	18.00
11354	8.71	1.95	11.25	3.8	5 67.31		10.00
	8 40	2.60	11.35	4.9	2 64.64	8.06	
	8.43	2.00	11.2			7.8	
			12.0			4.0	
100000	1/		10.3			4.9	

Table II.—Continued. Analyses of Commercial Feeds. (

Name of Feed.	Manufacturer or Jobber.  Miner & Hillard Co., Wilkesbarre	Retail Dealer.
	Wilkesharre	
	Wilkesharre	
"		Berlin, J. C. Lincoln
	R. J. Hardy, Boston	Guilford, G. F. Walters
Provender.		
	Valley Grain Co., Brattle boro, Vt	Groton Groton Co
	Guilford Town Mill	Guilford G F Walter
		Hartford, C. A. Pease & Co.
	M. L. Crittenden, Buffalo	Hartford, C. A. Pease & Co.  E. P. Yates & Co.  Middlefield, S. E. Miller  New Haven, P. C. Davis
	S. E. Miller	Middlefield, S. E. Miller
		Trew Havell, It. G. Davis
	J. 1. Domain	I. I. Dennam
	E W D : 1	" Ahner Hondon
	E. W. Bailey & Co., Mont- pelier, Vt.	New London, Arnold Rudd
	Mass.	
	American Cereal Co.,	
	Chicago E. A. Buck & Co	Wallingford, E. E. Hall- Willimantic, E. A. Buck & Co.
	M. L. Crittenden, Buffalo	"W. D. Grant
		Average of the above 13 analyse of Hominy Chop
and Oat Feed	Miner, Hillard Co.,	Lowest
ance Corn and Oat	Wilkesballe, Fa	Torrington, Geo. W. Greene
ed	H-O. Co., Buffalo	New Britain, Hugh Reynolds
or Corn and Oat		
or Corn and Oat		Berlin, J. C. Lincoln
or Corn and Oat		Guilford, F. H. Rolf
ed	"	Meriden, A. H. Cashen
ed		Rockville, Edw. White
nnion Bell Fodder	Hollister Crans & Ca	
apion Bell Fodder	N. Y	New Haven, R. G. Davis
ker Oat Feed	Amer'n Cereal Co., Chi'go	Hartford, Daniels Mill Co
North colonial access		" C. A. Pease & Co
		New Haven, Abner Hendee
"		Rockville, Edward White Willimantic, H. A. Bugbee Average of the above 5 analyse of Quaker Oat Feed Average of 36 recent analyses Highest
	or Corn and Oat ed	American Cereal Co

			Ana	LYSES.			
Station No.	Water.	Ash.	Protein.	Fiber.	Nitrogen-Free Extract. (Starch, gum, etc.)	Ether Extract.	Price per ton.
	10.10	3.69	10.94	10.35	59.94	4.98	
11371	9.69	4.78	8.25	19.67	54.46	3.15	\$16.00
11558	7.7						
	12.72	1.87	8.94	4.51	67.59	4.37	20.00
11573	12.36	1.94	10.50	4.53	66.30	4.37	21.00
11556	11.59	2.53	10.44	5.10	65.81	4.53	21.50
11554	10.96	3.03	9.50	13.85	59.33	3.33	20.00
11605	12.00	1.80	10.56	4.52	66.79	4.33	
12140	11.28	4.36	9.25	9.52	61.44	4.15	19.00
12154	11.99	1.81	10.13	4.18	67.48	4.41	18.00
12904	8.35	3.61	7.94	13.75	63.21	3.14	
11572	12.08	1.82	8.87	6.14	67.46	3.63	20.00
11581	12.55	1.81	10.00	3.85	66.97	4.82	20.00
11356	9.11	3.83	7.94	15.28	60.89	2.95	19.00
11589	12.65	1.88	10.81	5.27	65.18	4.21	21.00
11592	10.24	4.02	9.25	13.40	59.82	3.27	20.00
	11.57	2.64	9-55	7.99	64.49	3.96	
			9.4			3.8 5.4	
		7.555	7.4			2.4	
	1.11						20.00
12819	7.13	3.98	10.56	3.06	70.92	4.35	20.00
11382	9.86	4.44	9.37	13.54	59.64	3.15	
11369	8.77	4.12	9.87	12.85	59.78	4.61	18.00
11564	11.08	3.58	9.37	11.83	60.16	3.98	20.00
11365	10.66	3.77	8.50	12.85	61.53	2.69	19.00
11593			10.62	13 60	57.80	4.23	19.00
393	9.03	4.72	10.02	1300	57.00	4.23	
12127	9.14	3.31	9.88	12.88	59.75	5.04	18.00
12098	7.44	5.25	11.44	17.16	54.71	4.00	18.00
12073	7.95	5.39	11.56	15.83	55.30	3.97	19.50
12148	8.37	5.30	10.25	19.58	53.80	2.70	17.00
11596	8.42	5.05	13.12	17.73	51.83	3.85	18.00
11583	7.90	4.77	11.94	18.95	53.01	3.43	18.00
	10.8	5.15	11.66	17.85	53.74	3.59	
			10.26			3.4	
			12.8			4·3 2.7	
			7.4		7.77	2.7	

TABLE II .- Continued. ANALYSES OF COMMERCIAL FEEDS

FEEDS.	(A)

-			
Station No.	Name of Feed.	Manufacturer or Jobber.	Retail Dealer,
12820	Crescent Oat Feed	A. Cullen & Co., N. York	
11400 12083	Joliet Oat Feed		Hartford, E. P. Yates & Co
12114 12107 12100 11606 12903 12197	" No. 2	Illinois Cereal Co.	Bridgeport, Taylor & Clarke Hartford, E. H. Arnold & Son "Daniels Mill Co. Middlefield, S. E. Miller New Haven, Abner Hendee Putnam, J. W. Andrews
12190	Oat Chaff		New Haven, R. G. Davis
12091 11561	Corn, Oats and Barley-	American Cereal Co	East Hartford, G. M. White & Co Guilford, F. H. Rolf
11366	Quaker Dairy Feed		
11563	" "	American Cereal Co.,	Berlin, J. C. Lincoln
1390	"	American Cereal Co.,	Guilford, F. H. Rolf
12134		Chicago	Middletown, Meech & Stoddard.
11579		Chicago	Norwich, A. A. Beckwith  Average of the above 5 analyse of Quaker Dairy Feed
12094	Stock Food, Corn, Oats and Barley	American Cereal Co	East Hartford, G. M. White & Co
11595	American Poultry Food	American Cereal Co	Rockville, Edward White Average of 14 recent analyses Highest Lowest
1363	H-O Dairy Feed	H-O Co., Buffalo, N. Y	Meriden, Meriden Grain and Fee
2141			Co. New Haven, R. G. Davis
2907			" Abner Hendee
1582	" "	44 45	Norwich, Norwich Grain and Fee
1352	" "		Wallingford, E. E. Hall
11587	и и	" "	Willimantic, H. A. Bugbee Average of the above 6 analyse of H-O Dairy Feed Average of 20 recent analyses Highest
		The second secon	

	Analyses.						
Station No.	Water.	Ash.	Protein.	Fiber.	Nitrogen-Free Extract. (Starch, gum, etc.)	Ether Extract.	Price per ton.
222	6.36	5.60	7.25	23.28	54.34	3.17	1 2212
12820			9 0 1	21.80	52.03	2.65	\$19.00
11400	9.35 8.26	5.23 5.12	8.94 7.88	20.55	55.14	3.05	19.00
	7.24	5.77	8.75	21.88	53.50	2.86	16.00
12114	6.74	5.93	6.44	26.64	51.59	2.66	19.00
12107	6.20	5.77	7.06	24.88	53.30	2.79	16.00
12100	8.51	5.78	6.87	27.19	49.18	2.47	
11606	6.67	4.71	11.25	20.22	54.38	2.77	15.00
129 <sup>0</sup> 3 12197	9.03	4.19	4.37	28.11	52.81	1.49	15.00
12190	7.80	7.48	5.12	28.53	49.17	1.60	7.00
	9.33	4.46	12.50	11.33	57.71	4.67	20.00
12091	9.60	4.48	11.31	13.15	56.85	4.61	21.00
11366	8.26	4.89	13.19	16.12	53.74	3.80	18.00
11563	9.50	5.27	11.31	18.47	51.94	3.51	19.00
11390	7.86	4.92	13.75	17.39	52.34	3.74	19.00
12134	8.02	5.30	11.69	15.66	54.98	4.35	17.00
11579	7.94	4.63	14.12	16.62	52.73	3.96	18.00
	8.31	5.00	12.81	16.85	53.16	3.87	
12094	9.33	4.46	12.50	11.33	57.71	4.67	20.00
11595	9.56	2.95	13.62	7.20	60.49	6.18	24.00
			17.5			5.5	
			19.5		0	6.0	
			15.0			4.7	
11363	9.00	2.82	17.31	13.15	53.72	4.00	22.00
12141	9.67 7.57	4.50 3.47	20.32 18.75	12.46	48.88 53.4 <b>2</b>	4.17 3.69	19.00
11582	8.59	3.51	18.69	13.40	51.94	3.87	21.00
11352	8.80	4.45	18.87	12.18	51.47	4.23	22.00
11587	9.31	4.21	17.62	15.27	49.79	3.80	21.00
	8.82	3.83	18.59	13.26	51.54	3.96	alds.
			19.0			5.4	
			21.2	-111	V 10.	3.7	
			15.5			3.1	Wall G. S.

# TABLE II.—Continued. ANALYSES OF COMMERCIAL FEEDS.

#### Station Name of Feed. Manufacturer or Jobber. Retail Dealer. 12110 H-O Horse Feed ..... H-O Co., Buffalo, N. Y ... Bristol, Geo. Eaton ... " -- Hartford, Daniels Mill Co. 11399 Meriden, Meriden Grain and Feed 11362 Co. New Haven, R. G. Davis 12130 Abner Hendee 12145 46 12897 Norwich, Norwich Grain Co. 11580 Wallingford, E. E. Hall 66 11351 Willimantic, H. A. Bugbee 66 11588 Average of the above 9 analyses of H-O Horse Feed Average 18 recent analyses\_\_\_\_\_ Highest .... Lowest 12101 H-O Poultry Food.... H-O Co., Buffalo...... New Haven, R. G. Davis..... Abner Hendee.... Wallingford, E. E. Hall\_\_\_\_ 11353 Average of the above 3 analyses of H-O Poultry Feed .... Average of 14 recent analyses.... Highest .... Lowest \_\_\_\_\_ 12072 Rye Bran ..... Hartford, C. A. Pease & Co. New Haven, J. T. Benham..... 12157 R. G. Davis-----12130 Abner Hendee ..... 12146 12905 Rye.Feed..... 12261 Malt Hulls ----- H. C. Edwards, Chicago West Cornwall, T. S. Gold\* ----12078 Schumacher's Starch Feed \_\_\_\_\_ American Cereal Co. \_\_\_ Hartford, Cummings & Garvin ---12135 Glen Cove Starch Feed Nat'l Starch Mfg. Co.... New Haven, R. G. Davis -----12188 Blatchford's Calf Meal. J. W. Barwell, Waukegan, Ill......New Haven, R. G. Davis -----12180 Pioneer Clover Meal \_\_ The Bennett & Millett Co., Gouverneur, N. Y. .... New Haven, R. G. Davis -----12198 Carob Bean 12100 Carob Bean (Seeds)... 12200 Carob Bean (Hulls) 11358 Animal Meal .......... Bowker Fertz. Co., Boston Meriden, S. A. Billings .----14013 Poultry Food ..... J. Lederer & Co., New Haven \_ \_\_\_\_ 12896 Beef Scraps New Haven, Abner Hendee

#### \* Not a dealer.

			Ana	LYSES.			
Station No.	Water.	Ash.	Protein.	Fiber.	Nitrogen-Free Extract. (Starch. gum, etc.)	Ether Extract.	Price per ton.
	9.21	3.23	12.07	10.34	61.04 58.59	4.11	 
12110	10.28	3.64	13.25	10.19	50.59	4.05	\$22.00
	10.38	1.95	12.87	9.10	61.80 60.88	3.90	22.00
11362	9.92	3.17	11.13	10.68	59.98	4.22	21.00
12145	10.51	2.98	11.63	10.43	62.74	4.47 4.05	24.00
12897	8.02	3.28	13.12	8.79	60.58	4.03	21.00
11580	10.35	2.91	12.62	9.51	60.17	4.31	21.00
11351	10.29	2.78	12.50	9.95 11.6 <b>3</b>	58.64	3.80	22.00 21.00
11588	10.40	3.47	. 12.00	11.03	50.04	3.00	21.00
	9.93	3.05	12.36	10.07	60.49	4.10	
		7777	12.4	7577	1	4.2	
			13.8			3.6	
			110			3.0	
12191	8.91	2.63	17.12	4.87	60.46	6.01	30.00
12898	8.00	3.01	17.75	4.91	60.66	5.67	33.00
11353	10.80	2.32	15.00	2.86	64.35	4.67	26.00
	9.23	2.65	16.62	4.21	61.84	5.45	
			17.5			5.5	
	2232		19.5			6.0	
			15.0			4.7	
12072	11.75	3.69	14.81	2.97	63.95	2.83	20.00
12157	12.45	3.00	14.50	3.15	64.18	2.72	18.50
12130	12.17	3.03	14.25	2.92	64.74	2.88	18.00
12146	12.54	3.02	14.69	3.01	63.90	2.84	19.00
12905	8.67	3.44	14.50	2.70	68.08	2.61	22.00
12261	7.73	6.14	10.44	22.77	51.76	1.16	12.00†
12078	9.32	4.82	12.69	9.78	58.84	4.55	21.00
12135	11.20	0.54	21.13	3.15	60.73	3.25	19.00
12188	8.93	5.46	24.75	5.06	51.11	4.69	70.00
12189	8.36	6.76	9.50	28.28	44.68	2.42	40.00
12198				0		0.01	
12100	14.05	3.26	5.57	4.98	71.80	0.34	
12200	12.84	3.27 3.25	15.00	7.16 4.80	59.90 72.77	0.22	
11358	6.20	41.43	36.94		4.18	11.25	40.00
14013	0			0.01	0.01	16.08	26.00
12896	7.48	21.10	51.12	2.01	2.21	16.26	36.00°
	7.64	17.90	49.12	3.79	5.29	10.20	35.00

<sup>#</sup> Wholesale price. + Car load lots delivered.

#### SUMMARY.

No cases of actual adulteration have been found among the samples examined.

A considerable number of these "feeds," notably most of the so-called "oat-feeds," are however of such inferior quality that they cannot be used to any profit."

It appears that the three most concentrated feeds, the three which, pound for pound, will go further in "balancing" or piecing out the ration made from home-grown feed, viz: cotton seed, linseed and Atlantic gluten meal, are the most costly. This is as it should be. Yet of these, the one which contains the most protein, "Atlantic gluten meal," is the cheapest. It does not follow that it should be bought to the exclusion of the others. Linseed meal, though a very expensive feed, is greatly relished by cattle, flavors the food and is generally regarded as an excellent thing to keep cows "in condition."

But evidently the wise feeder will endeavor to use the cheaper forms of protein, as far as possible.

An examination of the prices and analyses of the feeds given in the table also shows that the market prices bear very little if any relation to their feeding value. That is, "feed" costs from \$17.00 to \$20.00 per ton at retail, whether it is concentrated, rich in protein, and well suited to supplement the homegrown feed, or whether it is a starchy food and of much less value in compounding suitable cattle rations. In this condition of the market, special care in the purchase of feeds and some knowledge of their chemical composition will be found highly advantageous in keeping the cost of milk production down to a point which will admit of profit in the business.

# ON THE AVAILABILITY TO GRASS OF NITROGEN IN FORM OF NITRATE OF SODA, COTTON SEED MEAL AND FINE, HARD BONE.

SEASON OF 1899. (SECOND YEAR.)

By E. H. JENKINS AND W. E. BRITTON.

These cultures are in continuation of those described in the Report of this Station for 1898, pages 289 to 296, which were begun in February, 1898.

The aim of the experiment is to study the availability of nitrogen in the forms named, to a crop which occupies the land permanently or for several seasons.

These cultures are in galvanized iron pots, wired on the upper edge, eight inches in diameter and twelve inches deep and having in cross section an area of about 1-125,000 of an acre. The bottom of each pot is slightly concave, and in the center is a hole with a collar three-fourths of an inch in diameter. The pot is supported on three iron legs, so that the lowest point of the collar is two and one-half inches above the platform on which the pot stands. These pots are like those used in experiments described in our earlier reports and before using were painted inside with two coats of asphalt varnish. The soil used was a very sandy loam from a field which, it was stated, had not been manured, fertilized, or cultivated for many years. Six determinations of nitrogen in samples taken from as many different parts of the heap of soil which had been screened, mixed and ready for use, gave the following percentages of nitrogen: 0.097, 0.100, 0.100, 0.099, 0.099, 0.098. Each pot contained twenty-nine pounds of soil and 13.022 grams of soil-nitrogen.

To the soil of each pot were added 9.5 grams of precipitated calcium carbonate (containing lime equal to one ton of slaked lime per acre), 1.8 grams of muriate of potash, equivalent to about 500 pounds per acre and 1.2 grams of precipitated phosphate of lime (containing phosphoric acid equal to that in about 1,000 pounds of acid phosphate per acre), besides the nitrogenous fertilizers, which were fine enough to pass circular holes one-fiftieth inch in diameter.

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The quantities of nitrogen supplied to the soil of the several pots are given in Table I, page 200, and are equivalent to the following quantities of fertilizer per acre:

Nitrate of Soda, 461 lbs. per acre, and 231 lbs. per acre. Cotton-seed Meal, 991 " 496 " Bone, 1,990 " 995 "

The quantities of fertilizer-nitrogen were alike, whether applied in form of nitrate, cotton seed meal, or ground bone. In each pot were first placed fourteen pounds of the soil under experiment. With fifteen pounds of the soil were carefully mixed the fertilizers mentioned above, and this mixture was then filled into the pot, great pains being taken to pack the soil alike in all the pots of the series.

The pots, including a layer of gravel on the bottom. weighed five pounds each, and each received twenty-nine pounds of soil, equivalent to twenty-five pounds twelve ounces of water-free soil. The soil with 15.50 per cent. of water in it contained 70 per cent. of the moisture which it could hold if saturated, and with 11.60 per cent. of water in it the soil had 50 per cent. of what it could hold if saturated.

During the course of these experiments the moisture content of the soil was therefore allowed to sink to 11.6 per cent., and was then raised, by adding water, partly on the surface and partly at the bottom, to 15.50 per cent., as determined by frequent weighings.

Into each pot were transplanted three small sets, cut from a turf of common red-top. One dozen such sets as were used for this purpose contained 0.052 grams nitrogen. The pots were filled and planted Feb. 14th to Feb. 17th, 1898, and stood till June 10th in the greenhouse, having a temperature by day of about 60° F., and by night about 50° F. During the summer the pots were placed in the summer vegetation house, and brought into the greenhouse again in October.

The grass was cut whenever it reached a length of three or four inches, thus imitating the practice of grazing or lawnmowing, and all the clippings were carefully saved.

In early summer nitrogen was determined in the three clippings which had been already made, again in the fall it was determined in the next three clippings, and in a seventh clipping made Jan. 7th, 1899.

The results of the first year's observation are given in a table on page 291 of the Station Report for 1898 and are there discussed.

Immediately after the seventh clipping, Jan. 7, 1899, the soil of the pots was allowed to dry till it contained but 11.6 per cent. of water. To each of the pots numbered 361, 362, 363 and 364 was added 0.8385 gram nitrate of soda; to each of the pots numbered 365, 366, 367 and 368 were added 1.8007 grams cotton seed meal, and to each of the pots numbered 370 and 371 were added 3.6308 grams of raw knuckle bone flour.

The above quantities of the three fertilizers named contained the same amount of nitrogen,-0.1333 gram,-and the fertilizers were from the same stock which had been used for these experiments in the previous year. In every case the material was spread as evenly as could be on the surface of the soil, which was immediately watered to bring the percentage of water in the soil to the maximum named above.

Of the pots which had received no nitrogenous fertilizer, 357, 358 and 359 had a rather thin stand of grass with much dead stubble, while the fourth, 360, was well covered.

All those pots to which nitrate had been added, 361, 362, 363 and 364, had a good thick turf and made fair growth.

Those pots which had received cotton seed meal, Nos. 365, 366, 367 and 368, were fairly well covered with turf, which was, however, not as close or thick as in the nitrate series.

The grass in pots 370 and 371 which had received bone had not well covered the surface but showed a short thin growth and much dead stubble.

In order to learn whether the first year's cropping had removed from the soil more potash and phosphoric acid than had been put on in the fertilizer, a number of determinations were made from which it appeared that the soil of the pots which had received most nitrate, had each lost by cropping 0.265 gram of phosphoric acid and 1.304 grams of potash. The other pots of the series had lost less of each of these. To each pot, at the beginning, had been added 1.8 grams of muriate of potash and 1.2 grams of precipitated dicalcium phosphate containing in all about 0.9 gram of potash and 0.498 gram of phosphoric acid. It being evident that more potash had been removed from some of the pots than had been added in the fertilizer,

the earth of the pots was again allowed to dry to the lower water limit, one gram of muriate of potash was added on the surface and the pots were watered on the surface to the upper waterlimit.

The pots stood in the green-house till June 9th, when they were moved to the summer vegetation house. On November 13th they were brought again into the green-house for the winter.

The growth of grass was cut on March 8th, May 9th, and July 8th. These three cuttings were analyzed together. The grass was also cut on Aug. 9th, Sept. 11th and Nov. 24th, 1899. and these three later cuttings were also analyzed together.

The results appear in Table I.

TABLE I-ON THE AVAILABILITY TO GRASS OF NITROGEN IN NITRATE OF SODA, COTTON SEED MEAR AND FINE, HARD. RAW BONE. SEASON OF 1899.

		in littly water to d	pounds per acre.	acre,		First three cuttings.		d three ings.	Total Crop.	
Station No.	Crop.	Nitrogenous Fertilizer.	Equivalent pour	Nitrogen per pot.	Air-dry weight, grams.	Nitrogen, grams.	Air-dry weight, grams.	Nitrogen, grams.	Air-dry weight, grams.	Nitrogen, grams.
357	Grass	Nothing	0.00	.0000	6.0	.1320	4.6	.1017	10.6	.2337
358			0.00	.0000	6.3	.1279	5.5	.1062	11.8	.2341
359	"	"	0.00	.0000	6.2	.1290	5.I	.1000	11.3	.2290
360	"	"	0.00	.0000	5.2	.1217	4.4	.0964	9.6	.2181
361	"	Nitrate of Soda	231	.1333	9.4	.2378	5.7	.1157	15.1	-3535
362	"	"	231	.1333	94	.2218	5.5	.1128	14.9	.3346
363	44		231	.1333	9.9	.2257	5.3	.1065	15.2	.3322
364	"		231	.1333	7.5	,2003	4.8	.1104	12.3	.3107
365	"	Cotton Seed Meal	496	.1333	7.5	.1770	4.4	.0968	II.Q	.2738
366	"	"	496	.1333	8.4	.1772	5.2	.1134	13.6	.2906
367	44	"	496	.1333	6.9	.1615	4.1	.0877	11.0	.2492
368	44	"	.496	.1333	7.6	.1740	4.5	. <b>o</b> 968	12.1	.2708
370	"	Ground Bone	995	.1333	4.7	.1100	3.9	.0858	8.6	.1967
371	"	44	995	.1333	6.0	.1332	5.3	.1124	11.3	.2456

Discussion of the Results in 1899.

The grass in the four pots to which no nitrogenous matter has been added for two years, yielded during the second year an average of 10.8 grams of air-dry crop and 0.2287 gram crop-nitrogen per pot.

The grass in the four pots to which 0.1333 gram of nitrate was added at the beginning of the second year yielded an average of 14.4 grams of air-dry crop and 0.3328 gram crop-

nitrogen.

From which it appears that 0.1333 gram of fertilizer-nitrogen caused an increase of 3.6 grams air-dry crop and 0.1041 gram of crop-nitrogen over and above the yield of the unfertilized soil. This is a gain of one-third in the crop, and of the nitrogen added in the fertilizer, 78.1 per cent. was recovered in the crop, while 21.9 per cent. was either left in the soil, stubble and roots or escaped from them into the air.

The grass in pots which received 0.1333 gram nitrogen in form of cotton seed meal yielded an average of 12.15 grams of air-dry crop with 0.2711 gram of crop-nitrogen,-a gain over the crops from pots which received no nitrogenous fertilizer, of one-eighth,—12.5 per cent. Of the nitrogen of the fertilizer only 31.8 per cent. was recovered in the crop and 68.2 per cent. was retained in soil, stubble and roots or escaped from them into the air.

The grass in the two pots which received a top-dressing of 0.1333 gram nitrogen in form of hard, raw bone yielded on the average slightly less dry matter and nitrogen than was harvested from pots which received no nitrogenous fertilizer whatever. The difference is, however, insignificant.

## Comparison of the Yields of 1898 and 1899.

In Table II is given a statement of the weights of air-dry crop and of crop-nitrogen harvested in the two years from the beginning of the experiment.

In 1898, 90 per cent. of the larger and 77.4 per cent. of the smaller applications of nitrate-nitrogen were recovered in the crops; in 1899, 78.1 per cent. of the nitrate-nitrogen were recovered.

In 1898 the larger amount of nitrate-nitrogen in the fertilizer increased the total crop by 31.7 per cent. and the smaller amount by 5.6 per cent.; in 1899 the increase was 33.3 per cent.

In 1898, 49.9 per cent. of the larger application of nitrogen as cotton seed meal, and 65.9 per cent. of the nitrogen of the smaller application were recovered in the crop; in 1899 only 31.8 per cent. It should be borne in mind that the fertilizers in 1898 were mixed with the soil, while in 1899 they were applied as a top dressing.

In 1898 the applications of cotton seed meal increased the crop by 6.3 and 2.1 per cent. respectively; in 1899 the increase was 12.5 per cent.

In 1899, as in 1898, the application of hard raw bone had absolutely no effect on the crop.

TABLE II-ON THE AVAILABILITY TO GRASS OF NITROGEN IN NITRATE OF SODA, COTTON SEED MEAL AND FINE, HARD, RAW BONE. (SUMMARY OF CROPS OF 1898 AND 1899.)

Pot.	Nitroge	Nitrogenous Fertilizer.							
		Equivalent Nitrogen pounds per acre. Per pot.			Crop of 1898.		Crop of 1899.		
No. of		1898.	1899.	1898.	1899.	Air-dry weight.	Grams nitrogen.	Air-dry weight.	Grams
357	Nothing	0.00	0.00	0.00	0.00	27.2	-7399	10.6	.2337
358		0.00	0.00	0.00	0.00	29.1	.7119	11.8	.2341
359	"	0.00	0.00	0.00	0.00	31.2	.7464	11.3	.2290
360	"	0.00	0.00	0.00	0.00	26.1	.7175	9.6	.2181
361	Nitrate of Soda	461	231	.2665	.1333	38.0	.9725	15.1	.3535
362	"	461	231	.2665	.1333	36.7	.9642	14.9	.3346
363		231	231	.1333	.1333	30.6	.8335	15.2	.3322
364	**************************************	231	231	.1333	.1333	29.4	.8308	12.3	.3107
365	Cotton Seed Meal	991	496	.2665	.1333	30.9	.8648	II.q	.2738
366	"	991	496	.2665	.1333	29.5	.8588	13.6	.2906
367	**	496	496	.1333	.1333	28.7	.8058	II.O	.2492
368	"	496	496	.1333	.1333	29.2	.8276	12.1	.2708
370	Ground Bone	1990	995	.2665	.1333	27.7	7435	8.6	.1967
371		995	995	-		25.5	6957	11.3	.2456

In general the weights of air-dry crops in 1899 are between one-half and one-third as large as the corresponding ones in 1898, and the crop-nitrogen of 1899 is about one-third that of 1898.

The soil of each pot contained at the beginning of the experiment more than 13 grams of nitrogen, exclusive of what was added in the fertilizers. Of this, the crops in the pots receiving no fertilizer-nitrogen have taken off less than I gram, yet if to this soil containing more than 12 grams of soil-nitrogen,

we add 0.1333 gram of nitrate-nitrogen, or about one onehundredth part of what is already in the soil (but in inert form), the yield of the crop is increased by one-third.

These facts well illustrate the inertness of the soil-nitrogen and the fact that an amount of nitrogen too small to be certainly detected in the soil by chemical means, may yet make all the difference between a good crop and a poor one.

Present condition of the grass in these cultures.

Pots 257, 258, 259 and 260 have a rather thin sod and some moss in each pot.

261 and 264 are fairly well covered with sod.

262 and 263 are not well covered, but better than 257-260.

265, 266, 267, 268 are as well covered with sod as any of the preceding. Moss in all of them.

270 not half covered with sod. 271 very mossy, not more than half covered with sod.

The soils in the pots tested with sensitive litmus paper do not have an acid reaction. Three which were tested with lacmoid, 370, 371 and 367, gave a slight alkaline reaction.

The cultures are being continued.

### Summary.

The yields in 1899 were without exception much less than in 1898. This may have been due to a lack of available potash in the second year, to difference in the amount of sunlight, or to possible change in the mechanical condition of the soil, caused by the watering.

The important fact brought out by the cultures is that in this soil and under the conditions of our experiment, while the nitrogen of nitrate of soda and cotton seed meal very largely increased the crop and the crop-nitrogen, the nitrogen of fine hard raw knuckle bone had absolutely no effect of this kind.

There is no evidence that the fertilizer-nitrogen of hard raw bone, applied two years ago, has yet been assimilated in any amount by grass which has been growing continuously in the soil with it.

We do not assert that the nitrogen of this bone is not available to crops, but only that in this soil and under the conditions described in this paper, it has not been available.

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ON THE AVAILABILITY TO HUNGARIAN GRASS OF NITROGEN IN FORM OF NITRATE OF SODA, COTTON SEED MEAL AND RAW, BOILED AND STEAMED BONE.

Pots 373 to 442. (Season of 1899.)

BY E. H. JENKINS AND W. E. BRITTON.

Cultures made by us in 1896, Report of this Station for 1896, page 204, in a sandy loam from under turf, showed that, under the conditions there specified, fine raw bone flour, which passed fine bolting cloth, was about one-third as efficient a source of nitrogen to the maize crop as cotton seed meal, and that coarser grades of the same kind of bone supplied but very little nitrogen to this crop.

In 1897, Report of this Station, 1897, page 270, cultures of oats followed by Hungarian grass were made in a sandy loam taken from a field on which maize had grown for six years without fertilizers or manure. In these tests the nitrogen of raw knuckle bone, the particles of which passed circular holes 1/50 inch in diameter, had only one-sixth of the availability of the nitrogen of nitrate, and one-quarter of that of linseed, cotton seed, caster pomace, steamed horn and hoof, etc. In the same report, page 277, are described cultures made in the same kind of soil as those just referred to, using Hungarian grass as a crop. It appeared from these cultures that while 95.3 per cent. of the nitrogen of nitrate of soda and 57.9 per cent. of that of cotton seed meal were taken up by the crop, under like conditions only 11.3 per cent. of the nitrogen of the finest bone flour-made from hard, raw knuckle bone—was taken by the crops, and still less than that percentage from coarser grades of bone. These experiments, as well as those extending over two years, described on pages 197 to 203 of this Report, in which a perennial crop was used, show that under the conditions of our tests the nitrogen of raw knuckle bone, even when the bone is very fine, is not readily nor satisfactorily available to either maize, oats, Hungarian or red top grass.

In the tests now to be described, it was sought to learn whether, under like conditions, the nitrogen of soft raw bone,

and of steamed and boiled bone, was more available to plants than that of hard raw bone.

The vegetation pots used were precisely like those already

described in this Report, page 197.

The light sand soil with which they were filled came from a field which the owner stated had not been manured, fertilized or cultivated for many years.

Twelve samples of this soil, containing 12.77 per cent. of water, taken at different times during the charging of the pots and from different parts of the heap of sifted and well-mixed soil, contained the following percentages of nitrogen: 0.106, 0.109, 0.110, 0.109, 0.108, 0.112, 0.106, 0.114, 0.109, 0.113, 0.110, 0.110. The average of all determinations is 0.1095 per cent. of nitrogen. The soil itself had a faint acid reaction to litmus paper.

With 18.23 per cent. of moisture in it the soil had 70 per cent. of the water it could hold when saturated. With 13.74 per cent. of moisture in it, it had 50 per cent. of its water-holding capacity. Each pot when ready for filling weighed alike, the same quantity of soil (30 pounds, containing 12.77 per cent. of water) was put into each, and by frequent weighing and watering when necessary the water content of the soil was kept between 13.74 and 18.23 per cent.

The operations of charging the pots were carried out as described an page 198.

To the soil for each pot were added 6.6 grams of freshly slaked lime, free from magnesia, 1.8 grams of muriate of potash (48.54 per cent. of potash) and 1.2 grams of dicalcium phosphate containing 41.50 per cent. of phosphoric acid besides the nitrogenous fertilizers named in Table IV.

The nitrogenous fertilizers tested were the following: nitrate of soda with 16.08 per cent. of nitrogen, cotton seed meal with 8.42 per cent. of nitrogen, hard raw knuckle bone,—sawings, and scraps from "ivory goods," made by the Rogers & Hubbard Co. of Middletown,—the same article used in the experiments described on page 197, containing 4.16 per cent. of nitrogen, soft raw bone containing 3.98 per cent., boiled bone containing 2.77 per cent., and steamed bone containing 2.31 per cent. of nitrogen, sent to us by Lister Fertilizer and Chemical Works, and representing grades of bone now in market.

All of these materials were ground to pass circular holes 1/50 inch in diameter.

On June 7th, twenty seeds of Hungarian grass were planted in each pot at a depth of about one-half inch, and the soil was watered up to 70 per cent. of its water-holding capacity. By the 10th the young plants began to appear and on the 20th they had appeared in all the pots.

On June 29th the plants were about eight inches high and beginning to stool in most of the pots. On Aug. 20 the crops were harvested, the seed being ripe and likely to drop if cutting was longer delayed.

The surface soil was loosened and the root system was pulled up as well as could be with the stalks. The roots, stalks, leaves and heads were ground together, making one sample of all the plants from each pot.

On Aug. 25 the pots were planted to rye.

Table IV, page 209, gives the results from the crop of Hungarian grass.

### Discussion of the results.

Cultures in pots numbers 373 to 382 received no fertilizernitrogen and show the capacity of the soil-nitrogen for supporting plant production.

The air-dry crops in these pots ranged in weight from 36.5 to 43.4 grams and averaged 40.44 grams, while the crop-nitrogen ranged from 0.2691 to 0.3207 gram and averaged 0.2932 gram. That is, of the 14.91 grams of nitrogen contained in the soil of these pots only about two per cent. was available to the first crop.

Five pots, numbers 383 to 387, received 0.2664 gram of fertilizer-nitrogen in form of nitrate of soda. In these pots the weight of the air-dry crop averaged 59.16 grams and the crop nitrogen averaged 0.5035 gram. Subtracting from these the corresponding weights from pots which received no fertilizernitrogen, there is left 18.72 grams of air-dry crop and 0.2103 gram of crop-nitrogen, which represent the fertilizer effect of the 0.2664 gram of nitrate of soda. That is, on this soil, nitrate of soda, at the rate of about 460 lbs. per acre, increased the crop by 46 per cent., and 78.9 per cent. of the fertilizer-nitrogen was recovered in the crop.

The next five pots in the series received half as much fertilizer-nitrogen as those just mentioned, in form of nitrate of soda. The average weight of air-dry crop from these five pots was 50.64 grams and of crop-nitrogen 0.3775 gram. Subtracting, as before, the corresponding weights from pots which received no fertilizer-nitrogen, there is left 10.2 grams of airdry crop and 0.0823 gram of crop-nitrogen, which represent the effect of the fertilizer-nitrogen.

That is, on this soil, nitrate of soda, put on as a fertilizer at the rate of 230 pounds per acre, increased the yield of Hungarian by 25.2 per cent.; and of the nitrogen applied to the soil 62 per cent. was recovered in the crop.

In like manner may be calculated the percentage crop-increase and the percentage of the fertilizer-nitrogen recovered in the crop for each of the fertilizers used. These results are given in the following:

TABLE III.—PERCENTAGES OF CROP-INCREASE AND OF FERTI-LIZER-NITROGEN RECOVERED IN THE CROPS.

Fertilizer per acre.		Crop-increase.	Fertilizer- Nitrogen re- covered in crop.
Nitrate of soda 462	pounds	46	79 -
" 231	"	25	62
Cotton seed meal 871	"	28	38
" 436	"	18	44
Hard raw bone 1760	"	—I.7	1.3
" 880	"	0.7	<b>—2</b> 6.6
Soft raw bone 1840	"	16.3	8.8
920	"	4.3	10.0
Steamed bone 3170	44	19.1	8.5
" 1585	"	4.8	-13.9
Boiled bone 2650	"	5.3	-1.2
" 1325	"	3.0	-32.3

Inspection of these figures shows that from sixty-two to seventy-nine per cent. of the fertilizer-nitrogen in form of nitrate of soda and from thirty-eight to forty-four per cent. of the fertilizer-nitrogen in form of cotton seed meal were available and taken up by the crop.

The results where bone-nitrogen was applied are very irregular and much less nitrogen was present in some crops which had grown in pots to which bone was added as a fertilizer than in crops from pots which had no fertilizer-nitrogen added to them. In no case where bone was used as a fertilizer did more than about eight and a half per cent. of the fertilizer-nitrogen become available to the crop. In every case the larger application of bone had a better effect than the smaller one.

The cause of the irregularities, especially in the yields of nitrogen, are not apparent.

The weight of air-dry crop was not sensibly increased by the hard raw bone and the increase from boiled bone was small, but the larger applications of both soft raw bone and of steamed bone very noticeably increased the yield of air-dry crop.

In general it appears that soft raw bone and steamed bone have increased the weight of crop, while raw bone had no such effect and boiled bone but very slight effect.

The larger doses of nitrogen from steamed bone and soft raw bone increased the crop-nitrogen by about eight per cent., while the larger doses of nitrogen from raw bone and boiled bone did not increase the crop-nitrogen.

Where the smaller doses of bone-nitrogen were used in each case less nitrogen appeared in the crop than where no fertilizer-nitrogen was employed.

TABLE IV—AVAILABILITY OF NITROGEN OF NITRATE, COTTON SEED MEAL, AND RAW HARD BONE, RAW SOFT BONE, AND STEAMED AND BOILED BONE. CULTURES OF HUNGARIAN GRASS. SEASON OF 1899.

				Amoun'	r of Nitro Fertilizer	GENOUS	Air-dry	
No. of Pot.	Nitrogenous Fertilizer.		Equivalent pounds per acre.	Grams of fertilizer per pot.	Grams of fertilizer- nitrogen per pot.	crop. Weight in grams.	Grams of crop- nitrogen.	
	Nothir	ng				1100	36.5	.2847
373	"	8					41.2	.2719
374	46						42.2	.3207
375	66				1201111		43.4	.3038
376	- "						39.9	.2793
377	46						37.8	.2873
378	66						41.4	.2601
379	- 44			70-7		Yell Mark	40.3	.3023
380	46			3 7 7 7 7		7777	40.0	.3040
381	- 16			MATCH N		Red Toller	41.7	.3086
382							41./	.3000
383	Nitrate	of Soda		462	1.657	.2664	58.0	.5510
384	"			462	1.657	.2664	61.2	.5569
885	- 66	44		462	1.657	.2664	60.I	.4568
186	46	"		462	1.657	.2664	60.7	.5342
387	66	44		462	1.657	.2664	55.8	.4185
88	44	"		231	0.820	.1332	49.4	.4051
89	66	44		231	0.829	.1332	50.9	.3410
	16	"		231	0.829	.1332	50.2	.3765
90	44	"		231	0.829	.1332	51.2	.3481
92	"	"		231	0.829	.1332	51.5	.4068
	C-44	C1 1/	r 1	871	6 -	.2664		2202
393	Cotton	Seed M	rear_		3.165		53.1	.3983
394	- "	"	"	871	3.165	.2664	51.9	.4256
395	"	16		871	3.165	.2664	50.7	-3752
396	"	"		871	3.165	.2664	51.0	.3417
397	"	"		871	3.165	.2664	51.1	.4292
398	"	"		436	1.583	.1332	50.2	.3865
399	"	"	-	436	1.583	.1332	46.6	-3542
100		"	-	436	1.583	.1332	48.1	.3271
101	"	"	-	436	1.583	.1332	45.0	.3420
102				436	1.583	.1332	49.5	.3465
103		Raw Bor	ne	1760	6.426	.2664	37.9	.2843
104	"	"		1760	6.406	.2664	37.6	.2632
105	"	66 66		1760	6.406	.2664	44.0	.2992
106	44	"		1760	6.406	.2664	37.8	.3137
107	44	44 44		1760	6.406	.2664	41.4	.3229
108	16	** **		880	3.203	.1332	38.5	.2657
109	46	16 66		880	3.203	.1332	40.1	.2566
110	44	44 44		880	3.203	.1332	43.7	.2578
411	44	66 66		880	3.203	.1332	39.5	.2252
412	46			880	3.203	.1332	41.7	.2836

TABLE IV—CONTINUED.

	Alle de arte e la de		r of Nitro Fertilizer		PANADA		
No. of Pot.	Nitrogenous Fertilizer.	Equivalent pounds per acre.	Grams of fertilizer per pot.	Grams of fertilizer- nitrogen per pot.	Air-dry crop. Weight in grams.	Grams of crop- nitrogen.	
413	Soft Raw Bone	1840	6.696	.2664	50.5	.3384	
414		1840	6.696	.2664	42.8	.2996	
115		1840	6.696	.2664	47.4	.2844	
416	" " " "	1840	6.696	.2664	47.0	.3384	
417	" " "	1840	6.696	.2664	47.6	.3237	
418	" " "	920	3.348	.1332	40.8	.2489	
419		920	3.348	.1332	42.8	.2568	
420		920	3.348	.1332	44.2	.2652	
421	" " "	920	3.348	.1332	42.6	.2854	
422		920	3.348	.1332	40.6	.2761	
423	Steamed Bone	3170	11.537	.2664	49.1	.3339	
424		3170	11.537	.2664	51.5	.3296	
425	" "	3170	11.537	.2664	46.5	.3162	
426	" "	3170	11.537	,2664	44.I	.2911	
427	" " "	3170	11.537	.2664	49.7	.3081	
428	" "	1585	5.768	.1332	43.6	.2965	
429	" "	1585	5.768	.1332	43.5	.2784	
430	" "	1585	5.768	.1332	40.2	.2693	
431	"	1585	5.768	.1332	42.9	.2703	
432		1585	5.768	.1532	41.7	.2585	
433	Boiled Bone	2650	9.621	.2664	44.3	.2747	
434	"	2650	9.621	.2664	42.3	.2707	
435	" "	2650	9.621	.2664	41.7	.2919	
436	"	2650	9.621	.2664	41.2	.3090	
437	' " " " " — — — — — — — — — — — — — — —	2650	9.621	.2664	43.4	.3038	
438	" "	1325	4.810	.1332	40.3	.2499	
439	"	1325	4.810	.1332	39.0	.2574	
440		1325	4.810	.1332	41.8	.2549	
441	" "	1325	4.810	.1332	44.2	.2343	
442		1325	4.810	.1332	43.I	.2543	

### ON THE AVAILABILITY OF THE NITROGEN OF HARD RAW BONE AS AFFECTED BY APPLICATIONS OF SLAKED LIME.

Pots 443 to 467. (Season of 1899.)

By E. H. Jenkins and W. E. Britton.

As noted on page 204 of this Report, we have already made several series of cultures in which was tested the availability of nitrogen in hard raw bone of various degrees of fineness to Red-top and Hungarian grasses, oats, rye and maize. In none of these cultures was the fertilizer-nitrogen of the bone available to the extent of more than about 12 per cent., while under the same conditions the nitrogen of nitrate of soda was freely available as well as that of cotton seed meal.

Soils from three different places were used in these experiments, but the three were of the same general character; rather light sandy loams deficient in available plant food, *i. e.*, having little "natural fertility." They were naturally "leachy" and liable to suffer from drought more than heavier soils, but in these cultures, they contained at all times a sufficient water supply (from 50 to 70 per cent. of the water-holding capacity of the soil).

The soils in these cultures had sufficient available potash, phosphoric acid and other ingredients of plant food to produce a much larger crop than was harvested; available nitrogen was therefore the one thing lacking and in none of the cultures did hard raw bone supply it in any considerable quantity.

It remained to see whether anything could be added to the soil which would render the nitrogen of raw bone available within it.

Naturally lime was first tried, because its effect in "unlocking fertility" has long been known and commented upon in agricultural writings.

In our experiments in 1896, referred to on page 204, each pot received 10 grams of precipitated calcium carbonate, equivalent to 1,850 pounds of carbonate or 1,036 pounds of oxide of lime per acre.

In the two series of experiments referred to on pages 259 to 270 and pages 271 to 277 of our Report for 1897 (made in small pots), 50 grams of precipitated calcium carbonate were mixed with the soil of each pot, equivalent to 13,700 pounds of carbonate or 7,700 pounds of oxide of lime per acre.

In the experiments referred to on pages 197 to 203 of the present Report, 9½ grams of precipitated calcium carbonate were added to the soil of each pot, equivalent to 2,600 pounds of carbonate or 1,460 pounds of oxide of lime per acre.

Lime in form of carbonate therefore has not made available the nitrogen of the bone.

In the cultures now to be described was tested the effect of freshly slaked hydrate of lime.

The pots used were in all respects like those described on page 197. The glass tubes for ventilating and watering were a little larger, having an inside diameter of one-half inch.

The pots were brought to a uniform weight of five pounds by putting in gravel. The soil was taken from the same heap from which the pots in the series just described, pages 204 to 210, were charged. Fourteen pounds of this soil containing 15.69 per cent. of moisture was put in each pot on June 29th.

On July 3d the fertilizers for each pot were carefully mixed with 16 pounds of the soil, which at the time contained 14.7 per cent. of moisture, and the mixture filled into the pot. Twenty seeds of Hungarian grass were placed equi-distant on the leveled surface of this soil and covered one-half inch deep.

To the soil of each pot in the series were added 1.8 grams muriate of potash (.8737 gram potash), 1.2 grams di-calcium phosphate and 6.4 grams of fine hard knuckle bone (No. 12201) containing 4.16 per cent. of nitrogen, or 0.2662 gram nitrogen).

To pots Nos. 443 to 447 inclusive no lime was added.

Pots 448 to 452 received 6.6 grams; pots 453 to 457 received 13.2 grams; pots 458 to 462 received 19.8 grams and pots 463 to 467 received 26.4 grams of freshly slaked but dry lime containing only traces of magnesia.

The largest dose of slaked lime is equivalent to 0.23 per cent. of the dry matter of the soil or 0.17 per cent. of calcium oxide.

The equivalent lime per acre is shown in Table V, page 216. The pots were placed in the summer vegetation house and the

water content of the soil was kept by frequent weighing and watering between 70 and 50 per cent. of the water-holding capacity of the soil.

The plants grew thriftily without accident. During July the plants in soil to which no lime had been added were strikingly taller than the others, which matured more slowly. By August 12th plants in all the pots had headed. On August 31 the plants in pots 443 to 452 were nearly ripe. Those in pots 453 to 457 were still green and had much longer and larger heads than the plants in pots to which no lime was added.

These differences are well shown by Figure 2 of the plate opposite page 216. The heads at the left grew on soil which received no lime; those on the right grew on soil dressed with lime at the rate of  $3\frac{1}{2}$  tons per acre; those in the center grew on soil dressed with  $1\frac{1}{4}$  tons of lime per acre.

On September 18 the stalks and leaves were cut off, the heads having been previously cut as they ripened. The surface soil was loosened and the stubble with adhering roots was pulled out.

The average lengths of the stalks with their heads at harvest were as follows:

			47. 1		Inches.
When	re no lin	ne was a	pplied		42.4
1800	pounds	of lime	per acr	e	42.0
3600	"	44	4.6		41.8
5400	"	"	44		41.0
7200	"	4.6	"		41.4

The heads were weighed in air-dry condition and nitrogen determined in them. The stalks, leaves, stubble and roots from each pot were dried together and the percentage of nitrogen determined in them.

The results appear in Table V, page 216.

### Discussion of the Results.

A comparison of the cultures in pots 448 to 457 with those in pots 403 to 407, see page 209, is instructive.

These two sets of cultures were in pots of the same size and shape, filled with soil from the same thoroughly mixed and uniform heap—the quantity of soil was larger by 11½ ounces in the series 403 to 407—the fertilizers and the quantity

of lime added was the same in all cases, the planting, watering and care were alike and the seed was from one common stock. The only apparent difference between the two was that the series 403 to 407 was planted on June 7th with 20 seeds of Hungarian grass and harvested August 20th, while the series 448 to 452 was planted on July 3d and harvested on September 18th.

Following is a comparison of the average yields per pot:

	r-dry Crop. grams.	Nitrogen of Crop.
Pots 403-407	39.7	0.2967
" 448-452	43.4	0.3112
Difference	3.7	.0145

The cultures planted in July yielded about 10 per cent. more of air-dry crop and 5 per cent. more of nitrogen than those planted early in June.

This difference is probably due to the more favorable conditions as to heat under which the cultures 448 to 452 made their early growth.

A study of the table on page 216 shows that the yields of air-dry crop and of crop-nitrogen were fairly uniform in the five pots of each group which represented a different dose of lime, the difference in crop-nitrogen of any one yield from the average of the five being in the extreme case 8 per cent. and in most cases much less.

The average yields per pot in each series may be summarized as follows:

					Total Crop. grams.	Crop-Nitrogen. grams.	
No	lime	added	Nos.	443-447	51.9	0.3606	
6.6	grs. li	me add	ed "	448-452	- 43.4	0.3112	
13.2	"		"	453-457	46.9	0.3988	
19.8	"			458-462	57.9	0.4979	
26.4	"			463-467	58.3	0.5559	

### SUMMARY.

I. An application equal to 1,800 pounds of slaked lime per acre decreased the yield of grain by II per cent., of straw (including roots and stubble) by 19 per cent., and of cropnitrogen by about 14 per cent.

2. An application equal to 3,600 pounds of slaked lime per acre, instead of further decreasing the yield, increased the yield of grain by 13 per cent. and of crop-nitrogen by 10 per cent., while the yield of straw and stubble was 14 per cent. less than where no lime was applied.

3. Applications equal to 5,400 and 7,200 pounds of slaked

lime per acre increased the crop as follows:

## PERCENTAGE INCREASE OVER CROPS FROM SOIL TO WHICH NO LIME WAS ADDED.

		5400 pounds of lime per acre.	7200 pounds of lime per acre.
Per cent.	increase of	grain36.8	43.7
		straw* I.2	1.9
"		crop-nitrogen38.1	54.1

In these cultures, therefore, in which hard raw bone was used as a fertilizer, applications of large quantities of slaked lime (two and three times as much lime as bone) increased the grain in the crop by 36 to 44 per cent. and the crop-nitrogen by 38 to 54 per cent. over the yield from pots to which no slaked lime was added; but the yield of straw was not increased by the use of lime. From this series alone cannot be calculated the actual percentages of the fertilizer-nitrogen recovered in the crop, for the yield of crop-nitrogen from the soil without fertilizer is not determined nor the effect of the lime in making the soil-nitrogen available. Further experiments are being made on these points. These cultures, however, prove that slaked lime has made very much more available the nitrogen of the soil, or more probably, the nitrogen of the bone which without lime was almost inert as a fertilizer.

+ Decrease.

<sup>\*</sup> Includes roots and stubble.

TABLE V.—EFFECT OF LIME ON THE AVAILABILITY OF HARD RAW BONE. CULTURES OF HUNGARIAN GRASS.

No. of Pot.	Quantity of Lime* added to pot, grams.	Equivalent Slaked Lime per Acre, pounds.	Weight of Air-dry Heads, grams.	Nitrogen in Heads, grams.	Weight of Air-dry Stalks and Roots, gms.	Nitrogen in Stalks and Roots, grams.	Total Airdry weight of Crop, grams.	Total Ni trogen of Crop, grams.
443	None	None	14.6	.1986	37.5	.1538		
444	"	"	17.3	.2232	36.1		52.1	.3524
445	"	44	15.7	.1963	35.3	.1444	54.4	.3676
446	"	"	15.7	.2198	37.5	.1447	51.0	.3410
447	44	"	14.7	.2308		.1575	53.2	.3773
	100			.2300	34.3	.1337	49.0	.3645
448	5.0	1800	14.8	.2072	28.6	22		
449			13.6	.1863		.1115	43.4	.3187
450		terres viet	13.5	.1809	30.4	.1216	44.0	.3079
451			13.8		29.5	.1239	43.0	.3048
452	reserve P	Wast Abu	13.8	.1960	28.7	.1177	42.5	.3137
	et aller	al dense	13.0	.1960	30.2	.1148	44.0	.3108
453	10.0	3600	16.8	.2386	7,624,634		101	
454	entout - K		17.9		33.4	.1403	40.2	.3789
455	No. of the	See Jack Bloom	19.2	.2578	30.9	.1483	48.8	.4061
156			17.8	.2784	30.0	.1350	49.2	.4134
157	D. S. 1941	Smile To a	18.4	.2599	30.6	.1346	48.4	-3945
	A CONTRACTOR		10.4	.2742	29.5	.1269	47.9	.4011
158	15.0	5400	20.9	2108				
159	Statulate &	311	21.9	.3198	37.3	.1790	58.2	.4988
160	A STATE OF		21.9	.3351	34.8	.1670	56.7	.5021
161				.3074	37.2	.1711	58.4	.4785
62	Now Torres	2.5	19.9	.3144	34.2	.1710	54.1	.4854
			22.8	.3511	39.4	.1734	62.2	.5245
.63	20.0	7200	21.8	2444		10	Market .	
64	III STORY IS A		20.7	.3444	35.9	.1687	57.7	.5131
65				.3830	28.8	.1987	49.5	.5817
66	61.036	A LONG TO BE	1 12 15 10 10 15 10 10	.3904	34.2	.1915	58.3	.5819
67	Bossella	military to the		.3658	36.5	.1898	59.8	.5556
			42.2	·3331	42.0	.2142	66.2	.5473

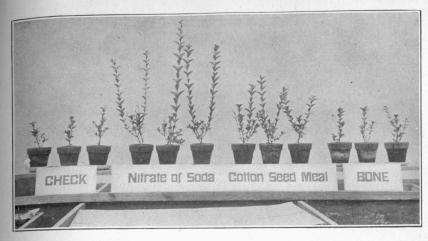


FIGURE I. California Privet with Various Nitrogenous Manures. See page 217.



FIGURE II. Heads of Hungarian Grass. See page 213.

# AN OBSERVATION OF THE EFFECTS OF NITROGENOUS FERTILIZERS ON CALIFORNIA PRIVET.

### By W. E. BRITTON.

In connection with the propagation of California privet (Ligustrum ovalifolium), for use as a hedge, a single observation was made on the fertilizing effect of nitrogen in form of nitrate, cotton seed meal and ground bone. Five dozen plants of nearly equal size, grown from cuttings of the previous spring, after washing the soil from their roots, were potted off in five-inch standard flower pots.

The soil into which they were thus transplanted was extremely sandy, consisting largely of disintegrated red sandstone and practically free from humus. It was screened through a sieve with four meshes to the inch. With the 1,300 grams of this soil used in each pot were mixed one gram of carbonate of lime, 0.8 gram of dissolved bone black and 0.4 gram muriate of potash. No nitrogen was added to the soil used for twelve of the pots. But to the soil for each of the other pots was added 0.2 gram of nitrogen.

In each of twelve, the nitrogen was in form of sodium nitrate, in twelve others in form of cotton seed meal and in twelve others in form of fine hard raw bone.

The pots were watered on the surface in the usual way, but glazed saucers were placed beneath them to prevent loss by leaching and about a month after setting the plants began to grow.

The potting was done in December, 1898, some of the plants blossomed in the summer of 1899, and in October the test was discontinued.

The plants in soil to which nitrate had been added were much larger than any others, and the foliage was of a darker green color. Those in soil to which cotton seed meal was applied made only a fair growth, while the effect of the bone fertilizer was scarcely apparent.

Figure 1 of the plate facing page 216, prepared from a photograph, well shows the growth caused by the different forms of nitrogen. The plants marked "check" had received phosphoric acid and potash, like the others, but no nitrogenous fertilizer.

### 

While this observation has no importance in fixing the relative agricultural value of the several forms of nitrogen, it is a striking illustration of the differences of effect of the several nitrogenous fertilizers with the soil and the plant under experiment.

## ON THE USE OF COMMERCIAL FERTILIZERS FOR FORCING HOUSE CROPS.

### By E. H. JENKINS AND W. E. BRITTON.\*

The work here described is a continuation of the experiments begun in 1894, the results of which have appeared in the Reports of this Station for 1895, pp. 75 to 98; 1896, pp. 205 to 221, and for 1897, pp. 278 to 308.

## I. EXPERIMENTS WITH TOMATOES. SUMMARY OF THE WORK EXTENDING OVER FIVE YEARS, 1894-1899.

Beginning with the season of 1894–1895, experiments have been conducted each season with soils and fertilizers for growing tomatoes under glass. One crop was grown the first season and two crops each of the other seasons, making nine crops in all. The results and chief points of interest are given in this paper.

## CROP OF 1894-1895. [Report for 1895, page 90.]

r. It was found that tomatoes which were normal in size, color, taste, and chemical composition could be grown in a soil of coal ashes and peat moss by the aid of fertilizer chemicals. A yield of two or more pounds per square foot of bench space can be obtained in this way, such a crop taking up in vines and fruit, fertilizer ingredients at least equal to the following:

Grams	i.	Pounds	. Ounces.
Nitrogen168	equivalent to	Nitrate of Soda 2	5
Phosphoric Acid 65	"	Dissolved Bone Black o	13
Potash362	"	Muriate of Potash 1	9

Nearly four-fifths of this fertilizer went into the fruit.

2. From the weights and chemical analyses of the ripe fruits it was found that each 100 pounds of tomatoes removed from the soil approximately:

0	unce	0	Ounces.	
Nitrogen	2.2	equivalent to	Nitrate of Soda	14
Phosphoric Acid			Dissolved Bone Black.	
Potash	4.6		Muriate of Potash	10

<sup>\*</sup>The experiments in this series have been planned and this paper prepared conjointly by the authors. The cultural work has been done by Mr. Britton. All the chemical work involved has been done by Messrs. Winton, Ogden and Mitchell.

- 3. Plants grown in the soil of coal ashes and peat moss without the addition of fertilizers produced only one or two very small tomatoes each.
- 4. Of the three varieties, Acme, Ignotum and Dwarf Champion, the first gave the largest yield in the soil of coal ashes and peat, while Ignotum yielded best in compost. Dwarf Champion proved an unprofitable variety.
- 5. The tendency to bear double flowers which produce irregular shaped fruit, seemed to bear no relation to the quantity of fertilizers applied, soil, or to the variety. The same plant produced both single and double blossoms.

### CROP OF 1895-1896. [Report for 1896, page 220.]

- 6. This season two crops of the Lorillard variety were grown, plants being set in the benches about October 1st for the first crop and February 14th for the second crop. With equal amounts of fertilizers the first crop was only seven-tenths as large as the second on account of less sunlight during the short days of early winter.
- 7. The largest quantities of nitrogen, phosphoric acid and potash taken by any one crop (Plot 30, Feb. to July, 1896) per 100 square feet of bench space were as follows:

Gram	s.	Pounds.	Ounces.
Nitrogen226	equivalent	to 3	10 Nitrate of Soda.
Phosphoric Acid 74		I	o Dissolved Bone Black.
Potash391	"	I	12 Muriate of Potash.

Less than two-thirds of these fertilizer ingredients were contained in the fruit. Of course much larger quantities should be present in the soil.

8. With the larger quantities of fertilizer chemicals used on the plots this year, larger amounts of nitrogen, phosphoric acid and potash entered into the composition of the fruit. Every 100 pounds of ripe tomatoes took from the soil:

C	unce	s.	Ounce	s.
Nitrogen	2.9	equivalent	to 18.2	Nitrate of Soda
Phosphoric Acid	1.2	"	7.5	Dissolved Bone Black.
Potash	5.0	"	10.	Muriate of Potash.

9. By the use of fertilizer chemicals, and a soil composed of anthracite coal ashes mixed with three per cent. of peat moss

there was no difficulty in growing a larger crop of tomatoes than could be obtained from a rich compost either with or without the addition of fertilizer chemicals.

To. During the ripening season the quantities harvested each week were somewhat more uniform from the compost. Two-fifths of the whole crop from the coal ashes and peat was harvested within one week.

11. Roots growing in coal ashes and peat were free from nematode galls, while those in compost were somewhat affected.

## Crops of 1896–1897.

[Report for 1897, page 293.]

Two crops of Lorillard tomatoes were grown in compost and in a soil composed of bituminous coal ashes and peat. The results of the tests may be summarized as follows:

12. The yield from compost was larger where no fertilizer chemicals were used. The addition of chemicals seemed to depress the yield.

13. From a mixture of bituminous coal ashes and peat with fertilizer chemicals added, larger crops were produced than from a rich compost of turf and manure.

14. Tomatoes are much more productive when grown in a mixture of coal ashes and peat than when grown in coal ashes without the peat.

15. In the tests here reported, the plants growing in compost yielded more fruit during the first month of the ripening season than those in the ashes and peat. From then on the weekly yield was largest from the plots of coal ashes and peat.

16. There seems to be no great difference in value between anthracite and bituminous coal ashes when mixed with peat and used as a soil for growing tomatoes.

17. The best yields of tomatoes were obtained from the soil of coal ashes and peat to which had been added per 100 square feet of bench space:

6.4 pounds of Nitrate of Soda.

Dissolved Bone Black.

Muriate of Potash.

The amounts of fertilizer chemicals which can be used with profit depends on the season of the year in which the crop is

raised. The crop which is in the house from September to February will not bear as much fertilizer as the following one growing from February to July, on account of the smaller amount of sunlight in the first period which the plants can

18. Plants which received large quantities of freely soluble plant food in the soil of coal ashes and peat had much less extensive root systems than those in the same soil less heavily fertilized or in compost, and when full grown, wilted more easily.

## CROPS OF 1897-1898. [Hitherto unpublished.]

In this season two crops were grown. The plants were of the Lorillard variety for the first crop and for the second Lorillard, Acme, and Essex Hybrid were used, two plants of each being set in each plot. The compost and coal ashes plots were made to alternate with each other throughout the house. To each plot of coal ashes and peat were added:

65 grams Nitrate Nitrogen from 411.64 grams of Nitrate of Soda. Organic " " 700. "" Cotton Seed Meal. Phosphoric Acid " 141.36 " Dissolved Bone Black. Potash " 215 Muriate of Potash.

For the second crop the quantities of fertilizers removed by the first crop were replaced. The plants were positively injured as a result of the large quantities of fertilizers and small yields were obtained. The chief points of interest in the trials are as follows:

19. Quantities of fertilizer chemicals consisting of

			O CO
0	unces.	Pounds	. Ounces.
Nitrogen	28 equivale	ent to \ 6	8 Nitrate of Soda.
		- 11	2 Cotton Seed Meal.
Phosphoric Acid		2	I Dissolved Bone Black.
Potash	21 "	3	4 Muriate of Potash

for each 100 square feet of bench space proved excessive for both crops and positively injured the plants as well as reduced the yield.

20. In the second crop Lorillard was superior to either Acme or Essex Hybrid for forcing.

Crops of 1898-1899. [Hitherto unpublished.]

Two crops of Lorillard tomatoes were grown: Sutton's "Best of All" was used in one plot in the second crop. Soils of compost and of coal ashes and peat were placed in alternate plots throughout the house. Each combination of soil and fertilizers was made in triplicate sets, the plots being in various parts of the house. Three plots were filled with compost which had been "sterilized" by heating for one hour with steam. Nitrogen was furnished to different plots of coal ashes and peat in form of nitrate of soda, cotton seed meal and fine bone, respectively.

The chief points noted in the results are as follows:

21. There was practically no difference in the average yields from plots dressed with nitrogen in nitrate of soda, cotton seed meal or ground bone. The yield from plots dressed with bone was slightly below the others.

22. The soil of coal ashes and peat on the average yielded more tomatoes than the compost.

23. "Sterilizing" the compost by heating for one hour with steam caused it to produce a heavier growth of plant, and a smaller yield of fruit.

24. A poor subsoil which was used in the benches, whether fertilized with chemicals or not, produced only about one-third as much weight of tomatoes as the compost.

25. Sutton's "Best of All" gave a slightly larger yield than Lorillard as well as fewer and heavier fruits per plant. It was somewhat later in blossoming and maturing fruit. It does not appear to be greatly superior to Lorillard as a forcing variety.

Methods of Pollination. Tomatoes grown under glass will not ordinarily set fruit unless hand-pollinated, because the insects and other agencies that effect pollination in the field are absent from the forcing house. We have usually pollinated the flowers by holding a spoon or ladle under each blossom and tapping the flower from above with a pencil or small stick. The jarring of the flower shakes the pollen into the spoon and brings the stigma in contact with it. We have always found this method satisfactory. A visitor related his success in effecting pollination by pulling away the corolla of the flower after

it had fully opened. In the tomato flower the stamens are united to the corolla and in tearing this off the anthers are broken open and the pollen, if ripe and dry, escapes into the air and some usually reaches the pistil of the flower and fertilizes it

In growing the second crop of tomatoes described in this paper, this method of pollination was given a trial in a few small plots wholly outside the fertilizer experiment.

Blossoms pollinated in this manner produced as many fruits as where the spoon method was used, nearly every one setting. The spoon method, however, took less time, and it seems more likely to effect cross-fertilization, which, on the whole, is probably to be desired if the grower wishes to improve his strain or variety of plants.

### II. OBSERVATIONS ON GROWING LETTUCE UNDER GLASS.

In the 19th Report of this Station for 1895, pp. 93-95, is an account of some experiments in raising lettuce under glass, which showed that:

- 1. Lettuce of good quality was grown in soil made of coal ashes and peat moss dressed with fertilizer chemicals.
- 2. The lettuce crop—roots and heads—took from such a soil the following quantities of the elements named, per 1,000 heads:

	Grams.		Pounds.	Ounces.
Nitrogen	282.6 eq	uivalent	to 3	15 Nitrate Soda.
Phosphoric Acid.	87.7	"	I	2 Dissolved Bone Black.
Potash	621.0	"	2	10 Muriate.

3. To supply this plant food to the soil, it was necessary to mix with the coal ashes and peat the following quantities of fertilizers per 1,000 plants or per 387 sq. feet:

	ounds.	Ounces.
Nitrate of Soda	. 9	13
Dissolved Bone Black		15
Muriate of Potash	- 3	8

Lettuce has been raised in the forcing house every year since 1895, and a brief account of our observations follows:

In nearly all cases only the Boston market varieties were planted.

The seed was sown in flats, and when the plants were large

enough to handle they were pricked out in the benches, 4 inches apart each way. Later the plants were again transplanted and then set 8 inches apart in the trial plots.

In 1896, twenty plots on the center bench of the newly completed forcing house were planted to white tennis ball lettuce, each plot being 53/4 inches deep and having an area of 14.5 square feet.

Ten of these plots were filled with a rich compost of rotted turf and horse manure and ten with coal ashes, sifted through a sieve with 4 meshes to the inch, with which 5 per cent. of peat moss, passed through the same sieve, had been carefully mixed.

During the season 3 crops of lettuce were grown on each of the plots.

I. Sub-irrigation was practiced in two plots of each kind of soil, but the yield of lettuce was smaller than where surface irrigation was employed.

2. With the mixture of coal ash and peat moss, an application of 162.9 grams of nitrate of soda, containing 26 grams of nitrogen per plot, with 49 grams of dissolved bone black—equivalent to 8.1 grams of phosphoric acid—and 88.8 grams of muriate of potash—equivalent to 44 grams of potash—gave as good results as any larger amounts of these ingredients.

3. The yield from plots of coal ashes alone was decidedly less than from the mixture of ashes and peat moss.

4. From the compost soils to which only small quantities of nitrate were added, no larger yields were got than from the corresponding ashes and peat plots, but when to the compost were added the same amounts of fertilizers as to the ashes and peat, the yields were larger from the compost. In all cases more marketable heads were got from the compost plots.

In the experiments of the next season, 1896–1897, a mixture of from 9 to 12 per cent. of peat moss with coal ashes proved to be a better soil medium for lettuce than mixtures containing less than that amount.

For these tests the following quantities of chemicals were mixed with the soil of each plot:

Nitrate of Soda	231	grams,	equivalent	Nitrogen	32.5
Dissolved Bone Black.				Phosphoric Acid	
Muriate of Potash			11	Potash	44.4

In soil containing twelve per cent. of peat moss 1,000 plants,—roots and heads—removed:

In 1897–1898, the black swamp muck of this neighborhood (Beaver Swamp), which contains no fiber, proved quite inferior to peat moss as a soil medium.

A number of comparisons were made of the growth of lettuce on rich compost and of its growth on the same kind of compost which had been "sterilized" by heating it for one hour with live steam, which raises the temperature of the soil to above 100 C.

Rawson's Hot-house and Grand Rapids were the varieties used, 18 plants of each being set in each plot.

In every case a better crop was grown on sterilized soil than on the corresponding plots untreated. Lettuce transplanted only once was much larger and heavier than that which was twice transplanted. Fertilizer chemicals depressed the yield in each case, while the addition of lime did not greatly affect the weight or quality of the crop. The following table shows the results obtained from these cultures:

NUMBER OF PLOT.	192	193	200	201	202	203	204	205
Compost Soil, how treated	Steri- lized.	Steri- lized.	Not Steri- lized.	Not Steri- lized.	Not Steri- lized.	Not Steri- lized.	Steri- lized.	Steri- lized.
How fertilized	Fert. Chemi- cals.	Lime.	Fert. Chemi- cals.	Lime.	0	0	0	0
Number of transplantings	2	2	2	2	2	I	2	I
Yield grams. Hot-house, 18 plantsGrand Rapids, 18 plants	1206 1989	1224 2096	702 1188	1080 1434	1098	1080 2236	1172 2152	1019 2808
Total weight, both varieties, gms.	3195	3320	1890	2514	3082	3316	3324	3827

### III. CARNATION CULTURES, SEASON OF 1898-99.

This work is a continuation of the experiments described in the Twenty-first Annual Report of this Station for 1897, page 293, and as the house, benches and plots were there described and figured on page 309, it is unnecessary to further describe them here, except to state that the carnation cultures occupied the plots 174 to 185 of the house F, which is shown on page 228 of the present report.

In the season of 1897-1898 the yields of carnation blooms were rather small and the differences between the yields of plots differently fertilized were not striking.

Many plants, too, were injured or destroyed by the stemrot disease, all of which made the tests quite unsatisfactory for the purposes of our experiments.

In the season of 1897-1898 the largest number of blooms per plant was produced on rich compost to which nitrate of soda, dissolved bone black and muriate of potash had been applied at the rate of 620 grams, 154 grams and 422 grams respectively per 100 square feet of bench space, while the compost without fertilizers gave a slightly smaller yield of blooms than the soils made of coal ashes with 3 per cent. of peat to which were added 1240 grams of nitrate of soda, 462 grams of dissolved bone black, and 844 grams of muriate of potash per 100 square feet of bench space.

### EXPERIMENTS OF 1898-1899.

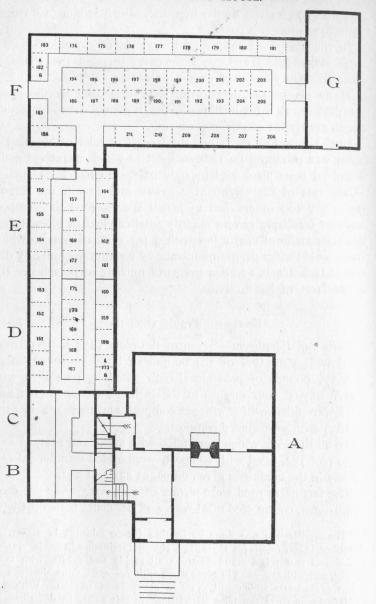
Soils and Fertilizers—Seven of the plots (174 to 180) were filled with a mixture of 184 pounds of bituminous coal ashes and 5½ pounds of peat moss, both sifted by passing a wire screen having four meshes to the inch. Two plots (181 and 182) were filled with sterilized\* compost, and three others (183 to 185) with unsterilized compost.

To all the plots which were filled with ashes and peat, as well as to plot 184, filled with compost, were added commercial fertilizers in the quantities given on pages 231 and 232.

The fertilizers used were nitrate of soda with 15.82 per cent. of nitrogen, cotton seed meal with 4.48 per cent., bone dust with

<sup>\*</sup>The sterilization was done by heating for 60 minutes in steam, as described in our report for 1897, page 310. Examination in the laboratory has shown that this method destroys all molds and yeasts, with their spores, and with few—and in many cases with no—exceptions, destroys all forms of bacteria which will grow in presence of oxygen. With this explanation we use the term "sterilized" in this paper to describe soil treated by the method referred to.

### PLAN OF FORCING HOUSE.



4.94 per cent. of nitrogen and 19.98 per cent. of phosphoric acid, dissolved bone black with 16.97 per cent. phosphoric acid and muriate of potash with 46.63 per cent. of potash.

In every case the fertilizer was thoroughly mixed with the

whole body of soil before it was put into the plot.

The plots were filled on September 15th, 16th and 17th.

Plants—The plants were obtained from a neighboring carnation grower early in May, and were making good growth when received. They were planted in a sandy and not over-fertile soil in a dry situation and made a rather slow growth during the season, though the plants were doing well when transferred to the house, September 19th. Six plants each, of Daybreak, Thomas Cartledge and Lizzie McGowan varieties (making eighteen in all) were set in each plot, with the exception of plot 183, which not being of full size, received three Thomas Cartledge plants and six of each of the other varieties. A few of the supposed Thomas Cartledge plants proved to be Eldorado. The Lizzie McGowan variety was seriously damaged by the stem-rot disease which is mentioned in a note at the end of this paper.

Notes During Growth—The day after setting the plants the soil was moved away from the base of each stem and the stems, after drying off, were coated with Bordeaux Mixture. After the mixture had become dry the soil was replaced; two months later this treatment was repeated, the object sought being to learn if by this means the plants could be kept free from the disease known as stem-rot. A fuller discussion of this disease

and treatment appears on page 236. On October 18th the plants were beg

On October 18th the plants were beginning to grow and buds were appearing on the Daybreaks. The Cartledge plants suffered from "rust" and "spot," which was soon checked by picking off all diseased leaves and spraying occasionally with potassium sulphide solution, one ounce of the sulphide in two gallons of water, to which a little fir-tree-oil had been added. The Lizzie McGowan variety was least subject to disease at first, but did not grow as fast as the others and later in the season was seriously injured and many plants killed by stemrot. On December 9th Daybreaks were beginning to blossom freely. On March 10th red spider became troublesome in the south end of the house, and a spray of water was applied as a

remedy. This doubtless aggravated the stem-rot disease. All lateral buds were removed as they appeared, leaving only the terminal buds to open.

Toward the end of the season the blossoms were smaller and all the plants were light-colored and apparently in need of more plant-food.

The temperature of the house was kept between 60° and 65° F. during the day, and about ten degrees lower at night.

On June 20th the plants were removed from the benches.

At all times during their growth those which grew in the mixtures of coal ashes and peat appeared to be quite as thrifty as those growing in the compost.

Harvesting—The blossoms were picked twice each week in about the same way as if for market, but the diameter and length of stem of each blossom was recorded, as well as the total weight of each variety from each plot. From the fresh weights of the crops and the chemical analyses of the cut flowers were computed the quantities of nitrogen, phosphoric acid and potash, which had been removed from the soil by the flowers.

The following tables are a statement of the yields from the several plots and also show the fertilizers employed:

Moss PEAT CULTURES

				7 % I Daybreak.			
180	95. 337.5 303.5 45. 70.68 12. 60.	236	1758	Lizzie Cowan.	2.30		
				*Thomas *Thomas of the control of th	нн		
				S 20 Daybreak.	H H		
179	214.4 60. 1729. 60.	240	2014	Lizzie 7 % % McGowan.	нн		
	12			*Thomas *Zhomas *Zhoma	2.10 13.		
				S S Daybreak.	2.11 13.2 17.3		
178	910.8 45. 129.	274	1612	Lizzie Lizzie McGowan.	H .		
	6			Cartledge.	2.07 12.8 21.1		
				24.9 Daybreak.			
177	177 1350 60. 70.68 12. 129.	267	6661	D. T. O. McGowan.	2.33 11.4 10.1		
	·			Thomas 23 Lardedge.			
				135 Daybreak.	2.13 12.4 17		
176	012.5 45. 70.68 12. 129. 60.	263	1876	Lizzie Lizzie	-		
	01			Thomas Cartledge.	- 44		
				og 10 Daybreak.			
175	285. 45. 70.68 12. 129. 60.	241	241	241	3066	Lizzie McGowan.	-
				Thomas & & Cartledge.	нн		
	80		7	93.3 Daybreak.			
174	190. 30. 70.68 12. 129. 60.	225	1086	Lizzie Z & McGowan.			
			À	Thomas Sartledge.	H H		
Number of Culture Plot	Fertilizers Applied.  Nitrate of Soda, grams Cotton Seed Meal, " Ground Bone, " Equivalent Nitrogen, " Dissolv'd Bone Black, gr'ms Equivalent Phos. Acid, " Muriate of Potash, "	Yield. Number of blooms per plot	Weight of blooms per plot,	Variety	Ave. weight of blooms, "Ave diameter of blooms, inches		

\* Partly " Eldorado" variety.

Table II.—Carnation Cultures 1898-1899. Compost.

Sterilized.		141 977	Lizzie A CGowan. Lizzie A McGowan.
St			Eldorado.
d.	.,	ř	7.1 9.9 Daybreak.
Sterilized.	95. 15. 23.56 4. 64.5	118	Dizzie Lizzie
0,			7.23 4 Eldorado.
.pq.			13.1.9. 8.33 o Daybreak.
Sterilized.		290 1818	Lizzie Lizzie A. WcGowan,
0)			2 H 2 S 1 L 2 S Cartledge.
ized.			12.9 Daybreak.
Not Sterilized. 182	!!!!!!	232	Lizzie
No			*Thomas *Thomas *6.5 % of 11.0 % of 14.0 % of 15.0 % of
ized.			11.7.06 55.33 Daybreak.
Not Sterilized.		210 1731	Lizzie 7 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2
No	The later of		*Thomas
Soil Number of Culture Plot	Nitrate of Soda, grams Equivalent Nitrogen, "Dissolved Bone Black, "Equivalent Phos. Acid, "Muriate of Potash, "Equivalent Potash, "	Number of blooms per plot Weight of blooms per plot, grams	Variety  Number of blooms, grams.  Weight of blooms, grams.  Ave. weight of blooms, "  Ave. diameter of blooms, inches.  Ave. length of stem, "  Ave. No. of blooms per plant.

Partly Eldorado variety.

Only three plants: calculated in table as full plot.

TABLE III.—AVERAGE YIELDS FROM DIFFERENT FORMS OF

	COAL ASHES AND PEAT MOSS.				COMPOST.	
	Nitrate Nitrogen.	Cotton Seed Meal Nitrogen.	Bone Nitrogen.	Nitrogen from three sources.	Not Sterilized.	Sterilized
Average yield per plot of three varieties.  Number of blooms.  Weight of blooms, grams.  Diameter of bloom, inches.  Length of stem, "  Excluding McGowan variety.  Number of blooms, grams.  Ave. weight of blooms, "  Ave. weight of blooms, "	233 2026 8.7 2.25 12.8 197 1790 9.0	265 1937 7·3 2·15 11.7 215 1590 7·3 2.07	257 2102 8.1 2.15 12.6 202 1708 8.4 2.10	12.6 180 1373 7.6	221 1671 7.5 2.12 12.3 162 1257 7.7 2.10	290° 2382 8.2 2.21 12.0 242 2059 8.5 2.17
Diameter of blooms, inches Length of stem, "	13.9	11.9	13.0	12.1	12.6	12.4

### Summary.

1. The four plots, 174, 175, 176 and 177, which contained the mixture of coal ashes, peat and commercial fertilizers, yielded a larger number of blooms, a greater weight of blooms and blooms of somewhat larger size, on the average, than the two plots 181 and 182, which contained rich unsterilized compost.

2. Plot 183, of "sterilized" compost, yielded more blooms than any other in the experiment, though the average weight of blooms was not as great as of those grown in the coal ashes and peat moss. The other plot of "sterilized" soil, No. 185, gave a very small yield. We believe that this is explained by the fact that through an oversight of the attendant it was omitted in the watering on a bright day and the plants were badly wilted.

The plot with sterilized soil to which artificial fertilizers were added yielded less than any other.

3. The comparison of the different forms of nitrogenous fertilizer, plots 174 to 180, indicates that fairly good results may be obtained with either nitrate of soda, cotton seed meal or bone.

<sup>\*</sup> Yield of a single plot, No. 183.

Plot 178, to which bone was added, yielded a larger number of blooms than any other. The blooms, on the average, were not larger than those from plots where nitrate or cotton seed meal

The nitrate plots produced blossoms having a greater average weight, diameter and length of stem than those from plots where other forms of nitrogen were used.

Blooms of average size and quality from plots 175, 177, 179, were analyzed. Also a sample was taken from plots 181, 182 and 183 to represent the compost soil. Ten blossoms of each variety, making thirty in all, composed each sample. The samples from the coal ashes plots were drawn from the plots having the larger quantity of nitrogen from each of the three different sources.

Assuming the composition of the blooms grown in soil with less nitrogen to be the same as that of the samples, the average yields (weight) of flowers from each source of nitrogen removed from the soil the following quantities of nitrogen, phosphoric acid and potash:

Source of Nitrogen.	REM	OVED IN BLOOMS.	
37.5 gms. in Nitrate of Soda	Nitrogen. 8.71 gms.	Phosphoric Acid. 3.48 gms.	Potash. 15.03 gms.
52.5 "BoneCompost unsterilized	0 6T 66	6.37 ".	9.52 '' 14.70 ''
" sterilized	7.93 " 11.26 "	8.25 " II.75 "	15.26 "

Ten thousand blooms of Daybreak, Cartledge and Lizzie Mc-Gowan varieties in equal numbers, grown in soil of coal ashes and peat, fertilized with nitrate of soda, dissolved bone black and muriate of potash, weigh 214 pounds and contain 373.81 grams of nitrogen, 149.35 grams of phosphoric acid, and 645.06 grams of potash. These quantities are equivalent to 5 pounds 2 ounces of nitrate of soda, I pound 15 ounces of dissolved bone black, and 3 pounds 1 ounce of muriate of potash.

The same number of blooms grown in compost soil weigh 178 pounds and contain 388.27 grams of nitrogen, 405.17 grams of phosphoric acid and 756.20 grams of potash equivalent to 5 pounds 5 ounces of nitrate of soda, 5 pounds 5 ounces of dissolved bone black and 3 pounds 7 ounces of muriate of potash.

It is interesting to note that the flowers gathered from the plots filled with the mixture of coal ashes and peat moss and fertilized with cotton seed meal as well as those fertilized with ground bone actually removed more nitrogen from the soil than those from the nitrate plots, while the greatest quantity was taken up in the blossoms from the sterilized compost.

Blooms from bone-fertilized plots contained a larger percentage of phosphoric acid, while the smallest percentage of this substance was found in flowers from the nitrate plots. The oreatest quantity of potash was removed in the blooms from the sterilized compost and the smallest from the coal ashes plots fertilized with cotton seed meal.

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### THE STEM-ROT DISEASE.

CONNECTICUT EXPERIMENT STATION REPORT, 1899.

By W. E. BRITTON.

In our experiments of 1896-1897, Report of this Station for 1897, page 293, the William Scott variety of carnation was attacked by a disease known among growers as "Stem-rot" and "Die-back." Dr. Sturgis\* found it to be caused by a fungus of the genus Fusarium, which develops in the stem of the plant at or just below the surface of the ground and so fills the ducts of the stem with its vegetative and fruiting threads as to wilt the plant and finally kill it by cutting off the water supply of the stem and leaves. The fungus occasionally fruits on the stems of the dead plants, appearing there as a pinkish mold. Other investigators have recorded similar diseases of cotton, tomatoes, melons and watermelons, caused by species of Fusarium. During 1897 the writer found snap dragon (Antirrhinum) plants affected with a similar disease. These plants were growing in the field near carnations, and about half of them wilted gradually and finally died. In a few cases the characteristic pink mold was found on the stems and under the microscope the spores appeared to be identical with those from the carnations. In the fall of 1898, asters sent to the Station showed what seemed to be the same disease. The stems, placed in a moist chamber, were soon covered with spore masses of a salmon pink color. It seemed probable that the carnation, snapdragon, and aster plants were attacked in a similar manner by the same or by closely related organisms. This was pointed out by the writer in an article published in The American Florist for November, 1898, and afterward reprinted in Gardening, Vol. VII, No. 153, page 138.

Just how the plants become infected has not been definitely determined, but probably the spores live over winter in the soil and gain access to the plant through the roots or stem beneath the surface of the ground. Attempts to inoculate healthy plants above ground failed, while seemingly healthy plants one after another became diseased in the field as well as after being set in the forcing-house benches.

In 1896-1897, and in 1897-1898 the William Scott variety was so badly diseased with stem-rot that it was afterward discarded in our cultures. The Lizzie McGowan proved to be the next most susceptible variety.

In the cultures described in a previous paper, the plants were set in the house on September 19th. On the following day the soil was removed around each plant to the depth of about two inches, and after the stems had become dry on the surface they were painted over with Bordeaux Mixture prepared from five pounds sulphate of copper, five pounds of lime and fifty gallons of water. When the fungicide had become dry upon the stems the soil was replaced.

On November 12th one plant of plot 184 had died from stemrot and was replaced.

About two months after the plants were set in the benches the Bordeaux Mixture treatment was again applied.

On December 9th a dead plant in plot 176 was removed and replaced. On the 20th a diseased plant was taken from each of plots 174 and 185, and apparently healthy plants were set in their places. During January and February several plants died from stem-rot, but all were of the Lizzie McGowan variety. During the first part of the season and as long as the supply lasted healthy plants were set in place of the diseased ones, but these soon became diseased and died. At the time the plants were removed from the benches on June 20th, the stem-rot had killed:

II	plants	in plot	174	
2	"	66	175	Soil consisting of Coal Ashan
7	66	4.6	176	Soil consisting of Coal Ashes and Peat.
I	66		177	and Peat.
4	6.6		178	Average number of diseased
I	"	* 66	179	plants per plot 4.3.
4	**	"	180	
3	"		181	
0			182	Soil consisting of Compost.
3	"	"	183	Average number of diseased
3	.66	"	184	plants per plot 3.4.
8		66	185	

One diseased plant in plot 180 and one in plot 184 were of the Thomas Cartledge variety. All others were Lizzie Mc-

<sup>\*</sup> Report of this Station for 1897, page 175.

Gowans. It must be remembered that only six plants of this variety were set in each plot at the beginning of the experiment, and that more would doubtless have died had the practice of resetting been continued to the end.

The loss from diseased plants was slightly greater in the soil of coal ashes than from compost.

The fact that seemingly healthy plants one after another became diseased and died after setting in the benches where diseased plants formerly stood, not one of them escaping attack, is a strong indication that infection takes place beneath the surface of the soil either through the stems or roots. Coating the stems with an active fungicide did not save the plants, as it would probably have done if the fungus entered the stem of the plant near the surface of the ground. Whenever the upper portion of the plant exhibited symptoms of the stem-rot an examination showed that the root-system was badly diseased or nearly dead. Removing a diseased branch has never saved a single plant so far as the writer's observation extends. These facts lead him to suspect that the fungus gains access to the tissues of the plant either through the rootlets or through some portion of the root-system considerably below the surface of the soil, and that when the top begins to wilt, the plant is already in the last stages of the disease.

## NOTE REGARDING THE EFFECT OF THE WINTER UPON CHESTNUT GRAFTS AND CIONS.

By W. E. BRITTON.

Some experiments in chestnut grafting were described in the Twenty-second Annual Report of this Station for 1898, page 276. In the conclusions therein presented it was stated that "from a single season's experience (1898) it would appear that the best time for grafting chestnuts in this vicinity is from May 15th to June 15th." The work was continued during the season of 1899, and as the winter of 1898-1899 was an exceptionally severe one, injurying many plants and trees that are usually considered hardy in this latitude, it is well to note the effect of the season upon the chestnut grafts. Nearly all the 1898 grafts were cut back severely in the spring of 1899 for the purpose of obtaining cions. Upon examining the grafts set in 1898 during the summer of 1899, it was found that the early set cions, that made the largest growth, withstood the effects of the winter better than those set late in the season. Cions set later than June 15th were all dead, and in some cases the stocks had been killed back to the ground. One cion set May 6th, which made a growth of over six feet in 1898, lived through the winter and made a total growth of over twenty-one feet in 1899. Others set the same day and which grew well in 1898, also made a good growth in 1899 and were then killed presumably by the extreme drought which prevailed through the latter part of the season. So that with the combined effect of winter and drought, the percentages of cions set in 1898 and now alive is very small.

About one hundred cions were set in 1899. These were cut for the most part from grafts of the previous season, and though they appeared to be in good condition at the time of cutting, many of them had suffered injury and after storing for a few weeks in the usual manner turned black under the bark and were unfit for use. Some of the cions which had been set early turned black in a similar manner, and under these conditions it would have been a waste of time and money to carry on extensive grafting experiments. A few lived, however, and made good growth during the season. Others started and were killed by drought, so that very few are now alive.

## INSECT NOTES.

By W. E. BRITTON.

The season of 1899 being remarkable for the cool weather and the small rainfall during the summer months, was especially favorable for the development of insect life. A large proportion of the insects sent to the Station for identification were scales. This may be an effect of the agitation and discussion over the San José Scale and indicates that fruit growers themselves are now looking for scale-insects in their orchards and nurseries.

The following notes are suggested by observation and correspondence:

A New Enemy of Peas—During the first week of July, both garden and sweet peas growing at the Station were seriously injured by a species of plant-louse. Soon after, specimens were received from Plantsville, Wolcott and several places about New Haven. Growers had never been troubled by similar pests before. Much injury to the pea crop was also reported in the canning districts of Delaware and Maryland. The pest was also found in Virginia, North Carolina, Pennsylvania, New Jersey, New York, Vermont, Ohio and Canada. A remarkable feature of this attack is that it was caused by a new and undescribed species previously unknown to entomologists as well as to peagrowers; and the fact that it appeared so suddenly and in such abundance as to seriously threaten an entire crop in a single season, is another proof of what has often been noticed, viz.: that when an insect is brought into a new country or changes its food plant it frequently becomes vastly more injurious than it ever was before.

Prof. W. G. Johnson, Entomologist of the Maryland Agricultural Experiment Station, has described this louse\* and given it the name *Nectarophora destructor*. In a paper before the Eleventh Annual Meeting of the Association of Economic Entomologists, at Columbus, Ohio, August 18th and 19th, 1899, Prof. Johnson reports that the losses to the pea crop in the State of Maryland, caused principally by this insect, have been estimated by conservative authorities at \$3,000,000, for the season.

Some of the Maryland growers report that the pest was present in their fields during 1898 and Prof. J. B. Smith stated that it was found upon late peas on the Experiment Station grounds at New Brunswick, N. J., in that year.

When badly infested plants in the Station garden were sprayed with whale-oil soap, one pound in five gallons of water, almost every insect was killed. In small gardens this treatment can be applied with ease and will insure a crop for table use; but in canning districts where peas are grown in areas of several hundred acres, the problem of destroying the pest is harder to solve, for to spray the vines might cost more than the crop would be worth. Kerosene and water (fifteen per cent. of kerosene) gave good results in the trials at the Maryland Station.

Prof. Johnson thinks that the species formerly subsisted upon one of our wild plants and reports several natural enemies of the "Destructive Green-Pea Louse," including syrphus flies, lady beetles and lace-winged flies. Some of these attacked the lice late in the season of 1899, but too late to be of any benefit to the grower. If these beneficial insects should increase with sufficient rapidity and not in turn be held in check by their natural enemies, the "Destructive Green-Pea Louse" would be largely destroyed without resorting to spraying. It is advisable, however, for every one who raises either sweet peas or garden peas next summer to be prepared to fight this pest in the manner suggested above.

Woolly Aphis on Elm Trees—During the latter part of June branches of an elm tree were sent to the Station which were infested with the Elm Tree Woolly Aphis Schizoneura Rileyi Thomas, described by Riley as Eriosoma ulmi in the first annual Report of the State Entomologist of Missouri for 1868. Dr. Riley stated that several trees in the city of Chicago had to his knowledge been killed by this insect.

The lice congregate in clusters on the branches or trunk of the tree and cause irregular warty growths and are usually found in dead sunken areas formed by their depredations. The insects are bluish white and are covered with a white substance resembling cotton or wool. The species is similar to the Woolly Aphis of the apple, S. lanigera Hausm, and may be destroyed in the same way by applying to the bodies of the insect a mixture

<sup>\*</sup>Canadian Entomologist, February, 1900, page 56.

of whale-oil soap and water, or kerosene and water. Unless the insecticide come in direct contact with the lice it will not prove effectual.

Spruce Bud Louse—On June 8th some spruce twigs sent for examination to the Station were found to be infested with the Spruce Bud Louse Adelges abieticolens Thomas. This insect is a broad, flat, plant-louse with slender, short, five-jointed antennæ, and without honey tubes. It attacks the spruce, deforming the terminal shoots and sometimes producing large swellings that are mistaken for cones. The European species, A. abietis L., also attacks the Norway Spruce in Massachusetts and produces a similar injury.

A spray of fir-tree oil, one-half pint in two gallons of water, will doubtless kill the Spruce Bud Louse.

Scale Insects—In the Report of this Station for 1898, page 273, it was mentioned that a new scale, Lecanium, on grape had been found in Connecticut. It was sent to the Station again this year from the same locality, and Mr. Pergande of the Division of Entomology, U. S. Department of Agriculture, has pronounced it Lecanium armeniacum Craw, a species common and abundant on the Pacific coast. Besides the grape it attacks all our common fruit trees and has now spread into the Eastern States as an addition to our already long list of fruit pests.

Several new localities infested with San José Scale have been brought to light during the year. One of the most important things to note, however, is the bringing into the State of two other species closely resembling the San José Scale, and probably just as undesirable. Both were shipped into Connecticut upon nursery stock and according to the statement of the purchasers each came under a certificate of inspection. One of these, Aspidiotus forbesi John. was found in 1894 and described in 1896 by Prof. W. G. Johnson, now of the Maryland Experiment Station. Prof. Johnson\* found it infesting cherry trees in Illinois and considered it the most dangerous scale insect then established in the State. He states that the insect is found on wild and cultivated cherry, apple, plum, pear, quince and currant. It was shipped into Connecticut on apple trees from Pennsylvania.

The other species is Aspidiotus ostræformis Curtis, a form of European origin and introduction, lately discovered in this country, which bids fair to become a very serious enemy to fruit trees. It greatly resembles the San José Scale and has been mistaken for that species many times. It has become well established in central New York and has been reported in Michigan and in Canada. It was shipped into Connecticut on pear trees from New York.

Either of the above mentioned scale-insects are from all accounts liable to become quite as troublesome to Connecticut fruit growers as the San José Scale. Hence the necessity of orchardists and nursery men giving their orchard trees and nursery stock the most rigid inspection not only once, but several times each season. Any new or suspicious scale-insects should be sent to the Station, where judgment can be passed upon them and treatment advised.

Beetle Infesting Wheat Middlings-A sample of wheat middlings taken from a dealer for chemical analyses and stored for some time in the chemical laboratory was found to be filled with small brown beetles. It was at first supposed to be the "saw-toothed grain weevil," Silvanus surinamensis L., which is common here, but as the sides of the thorax were found to be smooth instead of serrate, specimens were submitted to the Division of Entomology, U. S. Department of Agriculture, Washington, D. C., where they were identified as Læmophlæus pusillus Sch. Mr. Chittenden, who has made a special study of the insects infesting stored grains, thinks that this beetle is usually a scavenger not capable of doing much injury, but its economic position has not yet been definitely determined. The species is a common and widely distributed one, closely related to the "saw-toothed grain weevil." The same remedy will therefore suffice for both species and consists in enclosing the grain in a tight box with a shallow dish of carbon bisulphide inside. This substance is volatile and the fumes permeate the grain and kill all animal life therein. One pound of the liquid is sufficient for one hundred bushels of grain. As carbon bisulphide is very inflammable, care should be taken to keep all forms of fire away from it.

Flea-Beetle Injuring Primroses—Nearly all the plants of the Evening Primrose Enothera biennis L. growing about New

<sup>\*</sup> Bulletin Illinois State Laboratory of Natural History, Vol. IV, p. 380.

Haven were defoliated early in the summer by a small darkblue flea-bettle. Both adults and larvæ devoured the foliage Later in the season the same insect attacked the cultivated primrose in gardens, which is probably a variety of E. fruticosa L. Plants of this species growing in Edgewood Park were rendered unsightly by losing all foliage from the attacks of the insect. nothing but the bare stems remaining. As the plant is a vigorous perennial and the tops die in the fall, it was probably not vitally injured, but made unsightly, which defeats its use as an ornamental plant. Applying insecticides to foliage will of course prevent destruction by this leaf-eating insect. Adult beetles were sent to the Academy of Natural Sciences, Philadelphia, Pa., and identified by Dr. Henry Skinner as Haltica marevagans Horn. Injury to primroses by this insect has never before been observed by the writer.

Decrease of Fall Canker-Worms-During the season the Fall Canker-worm, Anisopteryx pometaria Harr., was much less abundant upon the Station grounds than for several years. The number of adults to emerge in the fall and early winter was not noticeably less than usual, but the larvæ were certainly much fewer and did less damage than in previous seasons. Here at the Station this species is responsible for all the canker-worm injury, while in certain localities half a mile distant the spring canker worm, Paleacrita vernata Peck., is the only species that can be found. In some localities both are found together. Canker-worms attack not only the apple and elm trees, but also the plum and cherry as well as the chestnut, hickory and several other forest trees. An experiment is in progress at the Station to determine the effectiveness of bands coated with various substances in combating the adults and larvæ of the Fall Cankerworm. A report of these observations will be made later.

### INSPECTION AND CARE OF NURSERY STOCK.\* By W. E. BRITTON.

Legislation-In fifteen states, laws have been enacted providing for the inspection of nursery stock and in some cases of orchard trees as well. The object of this inspection is to find out whether or not certain noxious insects or fungi are present which threaten the fruit-growing interests of the whole State and to prevent their spread by the sale of infected nursery stock. In many states the law forbids the transportation or sale of any stock which does not bear a certificate from a competent person stating that inspection was made on a given date and that no indications of the presence of noxious insects or fungi were found.

This provision makes it necessary for Connecticut nurserymen to have their stock inspected annually and to get a certificate of inspection in the approved form, as otherwise their stock will be excluded from those states which have inspection laws.

The fact that the inspection laws of different states vary considerably in their requirements is a further annoyance to nurseries which ship stock into all these states. At present Connecticut has no law and as a consequence infested stock may be shipped into this State from any neighboring state where the sale of such stock would be illegal.

Even the inspection and certificate system is inadequate, as has been shown by the fact, noted in a previous paper, that nursery stock has been shipped into this State under cover of a certificate which careful examination showed to be badly infested.

The San José scale has been the exciting cause of most of the inspection laws, a pest which can be extirpated by prompt treatment and which if permitted to live will surely destroy not only our fruit orchards, but also many ornamental trees and shrubs.

This scale has been distributed chiefly by means of nursery stock.

The Scale in Connecticut—The San José scale has been found in over twenty towns of this State, some of them containing

<sup>\*</sup> Reprinted in revised form from Bulletin 129, issued in May, 1899.

several distinct infested localities and mostly situated along the coast. The central portion of the State as far north as Hartford has also been invaded, and probably there are other infested areas not yet brought to our knowledge.

Nursery Inspection in Connecticut—Since the laws of neighboring states debar Connecticut nurserymen from shipping nursery stock into such states unless accompanied by a certificate of inspection, this Station has deputed a member of its staff to inspect nurseries upon application of the owners and to give certificates, in case no scale or other pests of a serious nature are found. Early in 1899 regulations were formally adopted by the State Board of Control regarding such inspection and the granting of certificates. The following circular embodies these rules.

THE CONNECTICUT AGRICULTURAL EXPERIMENT STATION.
NEW HAVEN, CONN.

Notice to Connecticut Nurserymen.

Some states, to which Connecticut nurserymen frequently ship nursery stock, have laws designed to prevent the further dissemination of certain insect and fungous pests, by requiring that all stock brought into these states, shall come from inspected nurseries in which none of these diseases have been found, and that a copy of the inspection certificate shall accompany each shipment.

In answer to requests from nurserymen, this Station has made inspections, and has given certificates when the stock was not found infested or diseased.

The following information is given for the benefit of those who may hereafter apply:

- I. One of the Station staff, competent to do the work, will inspect any nursery in the State upon the written application of the owner; there will be no charge for the services of the inspector, but his traveling and incidental expenses are to be paid by the nurseryman.
- 2. If no indications of San José Scale or other serious insect pest, or of dangerous infectious diseases are found, a certificate to that effect will be given.

The finding of any one of these pests or diseases will be a

cause for withholding a certificate until such pests or diseases have been eradicated and the inspector is satisfied that they no longer exist.

3. The certificate will be in the following form:

This form of certificate may be modified by the Station if considered desirable.

- 4. Upon evidence of the fraudulent use or abuse of certificates by any nurseryman, the Station may refuse to make inspections for him in the future.
- 5. When stock is known to be infested, nurserymen must take vigorous measures to eradicate the trouble from it. The Station will give advice as to the best methods of procedure. Where such measures are promptly taken by the owner of the nursery, the Station will not ordinarily make known the names of nursery firms having infested stock. The Station, however, reserves the right to publish this information, and will do so when the safety and welfare of the public seem to demand it.

Nursery Practices—As nurserymen and tree dealers generally buy more or less of their stock from various localities, it is not improbable that most of them at some time have thus brought the scale into their nurseries. Whether the insect has remained there and developed or not has depended largely upon their business methods. We wish to call attention to the fact that certain practices are favorable to the development and increase of the scale; and that if such practices are abandoned an infested nursery may more readily become clear of this pest. First of all the nurseryman should make himself familiar with the appearance and habits of the scale insect and should carefully watch his stock. Although much has been published about the insect, there are yet nurserymen who have never seen it and apparently have taken no trouble to inform themselves regarding it.

Experience shows that in a scale-infested nursery the insects are found most commonly and abundantly upon left-over stock which has been planted out and allowed to remain in nursery rows sometimes for three or four years. If any of this stock was even slightly infested when it was first received into the nursery, the insects have had time to multiply and become so numerous that they are easily detected by the inspector. Such stock is rarely of much value, and the nurseryman would do better to destroy it rather than let it remain as a breeding place for pests of all kinds. All unsaleable stock should be promptly destroyed by fire and the remainder fumigated or otherwise treated before planting out.

The official inspector, in examining nursery stock, will properly look over with the greatest care those trees which most commonly are found infested, viz: apple, pear, plum and quince. The San José Scale will attack many other kinds of trees and shrubs.

Scales are not as likely to be disseminated on blackberry and raspberry stock as upon fruit trees because their tops are cut off and burned previous to shipping the plants. Peach stock is also less liable to become infested in the nursery on account of its rapid growth.

The proprietor or foreman who works continually amongst the trees, if he will take the trouble to acquaint himself with the scale, should be the best inspector. He has opportunity to examine the stock when it is received, when it is planted out, during all its growth, and finally when it is dug and prepared for shipment. The official inspector, in making his tour of the nursery, may overlook insects or fungi that would not fail to be detected if he had frequent occasion to traverse the ground.

Suggestions to Orchardists—It is quite as important for the orchardist as for the nurseryman to treat his trees before planting out. The nurseryman should not be wholly blamed for the increase and spread of the scale. Many trees are planted each year only to be neglected, and if such trees are infested, all trees in the immediate vicinity soon become so. Trees can be treated much more effectively and economically before they are planted than afterwards. If it is not feasible for the fruit grower to fumigate them, they can easily be dipped, while bunched, into a solution of whale-oil soap. The tops should first be well pruned

and if the soap solution is in a barrel or deep tank, a bunch of trees can be plunged into it, top first, as far as the roots. It is perhaps best not to dip the roots. This method has been practiced by at least one Connecticut fruit-grower. The expense of such treatment is very slight.

Value of Certificates—The certificate states that an examination has been made and that certain insects and diseases have not been found. It does not, however, guarantee or imply that they are altogether absent. These pests are so difficult to detect, when present in small numbers on a few trees, that no person can so thoroughly examine a nursery of ordinary size in any reasonable time as to be warranted in stating that it is absolutely free from them. If they are but moderately abundant in any portion of the nursery the inspector will readily find them. The value of a certificate, then, is to show that a careful inspection has been made by a competent person, and that the inspected nursery is reasonably free from dangerous diseases and pests.

### TREATMENT.

There are three methods by which the San José Scale may be destroyed with little trouble or expense, viz: (1) Fumigating with hydrocyanic acid gas. (2) Spraying with kerosene and water. (3) Spraying with or dipping the trees in a solution of whale-oil soap.

For nursery stock, fumigation is probably the most efficient and cheapest treatment. It is attended, however, by more or less danger to the operator and should never be entrusted to careless employes. For orchard trees of considerable size one of the other methods will usually be preferred.

Fumigation—A tight box or house is necessary in which to enclose the stock. If the nursery is an extensive one it would probably pay to erect a house of two rooms for the purpose. The walls, roof and floor of such a house should be double boarded with heavy building paper between to make it gastight. A suitable number of doors should be arranged for convenience in filling and taking the trees from the house. Roof ventilators which can be opened and shut from the outside are a convenience. A house of this kind is inexpensive, and may be used as a storehouse when not needed for fumigating purposes.

For a small nursery, however, a tight box large enough to take in fruit trees may be used to good advantage.

Prof. W. G. Johnson, of Maryland, who has had much experience in fumigating nursery and orchard trees, recommends\* quantities of chemicals as follows for each 100 cubic feet of enclosed space:

25 grams (a little less than 1 oz.) (by weight) Potassium Cyanide 98-99 per cent. pure.

1¼ ozs. (liquid measure) Sulphuric Acid best grade commercial (sp. gr. 1.83).

17/8 ozs. (liquid measure) water.

The enclosed space should be computed, and the chemicals meted out accordingly. A stoneware jar of suitable size may be used as a generator. The water should always first be put in this and the acid poured in slowly in a thin stream with constant stirring. After filling the house or box with trees, place the jar inside and within easy reach of the door or lid. The cyanide is dropped into the jar and the operator should leave at once, and close the house immediately from the outside. To breathe the fumes may be immediately fatal. After the trees have been fumigated for half an hour the box or house may be opened from the outside, using the greatest care to withdraw at once to a safe distance. Ten minutes should elapse before anyone attempts to remove the trees. The trees, if dormant, will not be injured if left in the gas a much longer time or over night. This treatment is said to kill every form of animal life, and the operators should use every precaution in handling the chemicals and generating the gas in order to prevent accidents.

Cyanide of potassium is a most deadly poison.

Kerosene and Water—Kerosene alone has been used as a spray on plants with varying results. It is liable to injure the plants and is not to be advised for that reason. But kerosene can be mixed with water under pressure, a special pump being required for the purpose. Such a pump made by the Deming Co., Salem, Ohio, was figured in Bulletin 126 of this Station, page 7. A similar pump is also manufactured by the Goulds Mfg. Co. of Seneca Falls, N. Y. Two seasons' experience in fighting San José Scale in New York,† shows that I part of

kerosene to 4 parts water (a 20 per cent. mixture) will kill the scale and not injure the plants.

Whale-oil Soap—If one does not care to fumigate or go to the expense of buying a special pump for kerosene and water, he can destroy nearly all the scales by dipping or spraying the dormant trees with the following solution:

Whale-oil soap \_\_\_\_\_\_\_ 2 lbs,
Water \_\_\_\_\_\_ 1 gallon.

If the trees are in foliage, one pound of soap in five gallons of water may be used, but this will probably kill only the very young scales.

### SUMMARY.

1. Most of the inspection laws are especially aimed at the detection and destruction of the San José Scale.

2. Inspections are of great value, but certificates are not proof

that no scale exists in the nursery.

3. Nurserymen should either destroy all left-over stock or treat it before setting out in nursery rows.

4. The orchardist should also apply some treatment to the

trees before planting permanently in the orchard.

5. Fumigating with hydrocyanic acid gas is the surest and cheapest method of destroying the scale upon nursery stock, but great care must be taken in using the gas, as it is very poisonous.

6. Spraying with kerosene and water or with a solution of whale-oil soap, as described above, is also effectual, and is the treatment to be advised for large trees in the orchard.

<sup>\*</sup>Maryland Agr. Exp. Station Bulletin, 57, p. 93, 1898.

<sup>†</sup>Cornell Univ. Agr. Exp. Station Bulletin, 155, 1898.

# ON THE EFFECTS, ON TOBACCO, OF SHADING AND THE APPLICATION OF LIME.

By W. C. STURGIS.

In our Report for 1898 the disease of tobacco known as "Calico" was discussed as fully as the data at hand then warranted, and the reader is referred to the summary on pages 252 and 253 of that Report, for detailed information upon our knowledge of the subject up to that time. It is there stated that two principal and widely divergent theories regarding the cause of the disease have been advanced, viz: bacterial infection, and causes of a purely physiological character. Furthermore it was stated that the arguments in favor of the latter view seemed more weighty than those in favor of the former. although little, if anything, had been done to determine the precise nature of the physiological cause. Since 1898, however, efforts, apparently successful, have been made to determine this point, principally by Mr. A. F. Woods of the U. S. Department of Agriculture. The conclusions reached by Mr. Woods may be summarized as follows:\* Calico (the "Mosaic disease" of foreign writers) is due to the concentration in the leaves of an excess of a chemical ferment known as an oxidizing enzym. This substance occurs in the soil and, in small quantities, in many of the higher plants. When especially active or present in large quantities, it produces a variegation of the leaves and other symptoms of disease owing to its destructive action upon the green coloring matter and its capacity for retarding the free passage of starch through the diseased cells and consequently the activity of their growth.

The concentration of the enzym in the leaves, or in certain portions of them, is due to "unsuitable soil nourishment, and very moist soil with little light, accompanied by atmospheric conditions stimulating rapid growth. It is especially favored by poor or weak seed." The investigations of Mr. Woods show that the disease is infectious and that it can be produced by cutting back vigorous tobacco plants, withholding additional plant-food and stimulating the active growth of the resulting

suckers by a copious supply of water, a high temperature and partial shade.

This theory, which partakes of the nature of direct proof of the cause of calico, renders still more improbable the theory of bacterial infection in this case, and the question may be considered as relegated from the domain of the student of parasitic diseases to that of the physiological chemist. Nevertheless it is apparent that the methods recommended in our Report above referred to, page 253, for the prevention of calico, have not lost their significance as a result of the conclusions reached by Mr. Woods. Thus the sterilization of the soil in the seed-bed, on the supposition of the bacterial nature of the infection, would also be advisable on the enzym theory, since a temperature of less than 200° F. is sufficient to inhibit any further action on the part of the enzym. In the same manner the application of lime to render the soil more porous would, on this theory, be of value, as also would partial shading or any other device to bring about more equable atmospheric conditions and consequently a more even and regular process of growth.

In order to test the effects of lime and shading on the growth of the tobacco, the prevalence of calico and the quality of the finished product, permission was asked for and received from Mr. W. K. Ackley of East Hartford, to use a portion of his tobacco-land for this purpose. The soil was a close, clayey one, packing hard after a rain and requiring constant tillage; soil characteristic of the East Hartford tobacco lands where calico prevails. The piece selected for the experiment differed in no way from that of a large tobacco field immediately adjoining it, except that it had previously been used as a garden and had never borne tobacco. Our object being to test the effect of partial shade in connection with varying amounts of lime, it was decided to lay out the land in two long plots running north and south, with a six-foot alley between them, and to shade the western plot with screens made of laths. These two long plots were divided into four smaller ones, running east and west and separated from one another by four-foot alleys. To these plots it was proposed to add lime in varying quantities, from 300 pounds to 2,000 pounds per acre. Otherwise they were to be fertilized with barn-yard manure and fertilizer chemicals, as in ordinary tobacco culture. Each of the

<sup>\*</sup> See Centralblatt f. Bakteriologie, II Abth., Bd. V, No. 22, p. 750. (1899.) Science. New Ser., Vol. xi, No. 262, p. 17. (1900.)

smaller plots measured 39 feet by 14 feet, giving an area for planting, exclusive of the alleys, of 33 feet by 10 feet. This area would take 80 plants set 22 inches apart, in rows 3 feet 4 inches apart; of these 80 plants, 40 would be shaded and 40 unshaded, and each set of 80 plants would receive a different quantity of lime, from a quantity which might be considered as hardly appreciable up to one which would certainly be excessive.

On April 24th the lime was weighed out on the basis of 300 pounds per acre of quick lime for Plot I, 500 pounds per acre for Plot II, 1,000 pounds per acre for Plot III, and 2,000 pounds per acre for Plot IV.\* Each quantity so calculated and weighed out was mixed with a large bulk of damp sand in order to ensure its even application and half of it was at once applied broadcast to the plot, the remainder being kept for application after the manuring and ploughing of the land, the object being to get the lime as evenly and thoroughly mixed with the soil as possible to a depth of at least eight inches. On May 18th fine stable manure was applied at the rate of about eight cords per acre, and the land was ploughed shallow. On June 5th the land was ploughed to a depth of eight inches, the remainder of the lime was applied in the same manner as before and, after the addition of a fertilizer as a "starter," the surface was thoroughly harrowed. The following day a frame-work of scantling was nailed upon posts previously set at a distance of two feet from each corner of the plots to be shaded and upon this were nailed laths at intervals equal to the width of a lath. The screen thus formed cut off one-half of the direct sunlight and was at a height of five feet from the ground. Doubtless a less cumbersome and expensive method of screening might have been adopted, but fears were expressed that movable screens of light material and construction might be blown down and inflict damage on the tobacco and it was deemed inadvisable to run any risk of this nature. Moreover it should be added that the experiment was planned not so much in order to obtain immediate results of commercial value, as to secure some indications regarding the methods which might be employed with advantage in future work along the same lines. The matter of cost was therefore rather a secondary consideration.

Owing to dry weather the plants were not set until June 13th. They were watered the following day and from that time they all received ordinary seed-leaf culture.

During the period of growth, at least until after topping, it was very noticeable that the shaded plants were making much less growth than the unshaded ones; the leaves also were thinner, larger and darker green. The observations upon the prevalence of calico made at the close of the season may be summarized as follows:\*

	* Unshaded Plots.
Plot I. Lime @ 300 lbs. per acre.	I plant with top decidedly calicoed. 2 plants with tops slightly calicoed. I plant about three-quarters calicoed.
Plot II. Lime @ 500 lbs. per acre.	<ul><li>5 plants with tops decidedly calicoed.</li><li>2 plants with tops slightly calicoed.</li></ul>
Plot III. Lime @ 1000 lbs. per acre.	{ No calico observed.
Plot IV. Lime @ 2000 lbs. per acre.	f I plant showed the three top leaves "rusty." This appearance not identified with calico.
	Shaded Plots.
Plot I. Lime @ 300 lbs. per acre.	{ 2 plants with tops decidedly calicoed.
Plot II. Lime @ 500 lbs. per acre.	{ r plant with top decidedly calicoed.
Plot III. Lime @ 1000 lbs. per acre.	{ r plant with top decidedly calicoed.
Plot IV. Lime @ 2000 lbs. per acre.	§ 2 plants showed the top leaves "rusty." This appearance not identified with calico.

The following table shows the total percentage of calicoed plants on each plot, shaded and unshaded:

(late) male and a	Lime per acre.	Unshaded.	Shaded.
Plot IPlot II	300 lbs. 500 lbs. 1000 lbs.	10%	5% 2.5% 2.5%
Plot IV	2000 lbs.	o	0

<sup>\*</sup>It is to be noted that calico was very prevalent in all of the tobacco fields in the neighborhood.

<sup>\*</sup> The lime was air-slacked when applied.

Had this experiment been conducted on a larger scale and had the above results been maintained, no one would have hesitated to pronounce the use of lime at the rate of 1,000 pounds per acre to be most effective in diminishing the amount of calico. The experiment, however, was on too small a scale to be considered as a proper basis for any final judgment. Nevertheless it does indicate a very close relation between the preventive means recommended on purely theoretical grounds and the practical results attained by the use of those means. The cause of the "rustiness" observed on the top leaves of some of the plants in Plot IV was not investigated further than to ascertain that it was not due to the attacks of either insects or fungi. It had every appearance of being a physiological trouble and, of course, from the practical standpoint of damage caused to the leaves, is quite as obnoxious as calico. The effect of this excessive application of lime upon the finished product will be discussed later.

On comparing the shaded with the unshaded plots it is evident that on the whole there was less calico on the former than on the latter, the difference in the case of Plot II amounting to 15%. The use of lime at the rate of 500 pounds per acre has exerted no favorable action as regards the prevalence of calico, but under these conditions the beneficial effect of partial shade is very apparent.

There are other factors to be considered in connection with the shading of tobacco, the principal ones being the effect of shade upon the growth of the plant and upon the quality of the leaf. As has been said, the growth of the shaded plants was markedly slower than that of those in the open. This held good until the plants were topped. The shaded plants showed the bud lower down than the unshaded and were therefore topped unnecessarily low; but after topping, the plants filled out and produced unusually large leaves, remarkable besides for their thinness and their very dark color. Another peculiar effect, apparently due to the shading, was the abundance of the so-called "natural spots." While not more than one or two of the unshaded plants showed them, fully 30-40% of the shaded plants were liberally sprinkled over with the small, pale, whitish spots of dead tissue so welcome to the eye of the buyer.

Evidence of the slow growth of the shaded tobacco is seen

in the fact that the unshaded plants were ripe and ready to be cut on August 19th, while the shaded plants could not be cut before September 1st, and from later observations it seemed doubtful whether they had not, even then, been cut too soon. The plants were cut and hung entire without splitting the stalk.

On November 1st they were all taken down and the leaves stripped off and weighed. The following table shows the number of plants from each plot and the weight of the leaves.

	SHADED.		UNSHADED.	
tarte (fr. 5 waster 20 4)	Number of	Weight of	Number of Plants.	Weight of
region brasil traction to	Plants.	Leaves.		Leaves.
Plot IPlot IIIPlot IIIPlot IVPlot IV	39	9.5 lbs.	38	13 lbs.
	35	9.5 lbs.	40	14 lbs.
	43	11.5 lbs.	43	14 lbs.
	38	11.5 lbs.	40	14 lbs.

The difference in the weight of cured leaves from the shaded and the unshaded plots is very marked. The total weight of leaves from the 155 shaded plants is 42 pounds; from the 161 unshaded plants, 55 pounds. The stalks also, of the shaded plants were noticeably smaller and lighter than the others, a fact due in great measure to lower topping. Whether the increase of weight with the increased quantities of lime applied has any significance, I am not prepared to state. It is noticeable in both series of plots, especially in those shaded. As to the comparative quality of the leaves after curing it was remarked that the leaves from the shaded plots cured darker and with a greenish cast (the latter possibly due to the plants having been cut before they were fully ripe), that they were thinner in texture and that the veins were lighter in color and more prominent than in the case of the unshaded tobacco.

The apparent thin texture of the leaves from the shaded plants is made more evident by exact measurements. For this purpose leaves were selected from each set of plants a few days after they had been hung in the curing-barn and, from cross-sections taken in at least five different parts of each leaf, measurements were made showing the exact average thickness of each leaf and of its component parts. In order to understand

the significance of these measurements it is necessary to consider briefly the microscopic structure of a tobacco leaf as shown in Plate II, facing page 264. The upper surface is composed of a single layer of cells and forms the epidermis; the upper walls of these cells are considerably thickened and form a practically impervious layer known as the cuticle. Beneath the epidermis is seen a layer of columnar cells filled with round granules, the so-called "chlorophyll grains," which, by their green color visible through the transparent epidermis, give to the leaf its characteristic color. These cells compose the palisade layer and it is in them, through the agency of the chlorophyll grains, that most of the assimilative activity of the leaf takes place. Below the palisade layer is a loose tissue composed of cells which also contain chlorophyll, but in much smaller quantity than the palisade cells; these cells, known collectively as the "spongy parenchyma," conduct the products of assimilation from the palisade cells to the bundles of vessels and long cells which compose the veins; in them may here and there be seen stellate masses of crystals of calcium oxalate. The veins, for the sake of clearness, are omitted in the plate. Finally, the lower surface of the leaf, like the upper, is covered by a layer of epidermal cells; but here the epidermis possesses numbers of small openings or pores called stomata, through which the outside air has access to the internal tissues of the leaf. Both surfaces of the leaf are beset with large hairs arising from the epidermis.

With some understanding, then, of the structure of the various parts of the tobacco leaf, we may consider the effect of partial shade upon the thickness of the growing leaf.

The following figures represent, as stated above, the average of a number of measurements of sections taken at different points. The leaves selected were as nearly representative as possible.

6 (16 )	Shaded.	Unshaded.
Upper Epidermis Palisade Layer Spongy Parenchyma Lower Epidermis Total thickness of Leaf	19.5 $\mu$ * 153.3 $\mu$ 106.5 $\mu$ 16.1 $\mu$	28.5 $\mu$ 234.7 $\mu$ 146.3 $\mu$ 18.8 $\mu$ 428.3 $\mu$

<sup>\*</sup> The sign  $\mu$  stands for  $\frac{1}{1000}$  of a millimeter. I millimeter  $=\frac{1}{25}$  of an inch.

The total thickness of the leaf has been decreased, by shading, by over 30%; the upper epidermis by 31%; the palisade layer by 35%; the spongy parenchyma by 27%; the lower epidermis by 14%. This reduction in the thickness of the leaf was not, in the present instance, regarded as wholly advantageous by the growers, a view which may be partly explained by the fact that the grower naturally desires weight, while it is the buyer who is concerned chiefly with quality. It is difficult to see why a thick leaf is to be preferred to a thin one, providing, of course, that the latter retains the degree of firmness and elasticity essential in wrapper-tobacco. As a matter of fact, the growers of tobacco in Florida have gone to enormous expense in shading their plants in order to produce a leaf which shall, among other things, be exceptionally thin, such tobacco commanding a very high price.

However, it may be said that even should this method be capable of producing a leaf for which the buyers would give fancy prices, the expense of erecting such screens as I have described above would be prohibitive, at least under present conditions.

The purpose of the present experiment, so far as the shading was concerned, having been merely to note the effect of the latter upon the prevalence of calico, nothing further need be said here relative to its effect upon the texture and quality of the leaf. That shading may reduce the amount of calico, there seems good reason to believe.

The following summary, kindly furnished me by Mr. Ackley, represents his running comment upon the shaded tobacco up to and including the period of curing:

- I. The tobacco on the shaded plots grew much more slowly than in ordinary field-culture.
  - 2. It had a very dark green color all through the season.
- 3. It showed the bud low; after topping it filled out to a very large-sized leaf.
  - 4. During all stages of growth it maintained a very thin leaf.
- 5. It cured dark in color, with a greenish cast, prominent veins and very thin flesh.
- 6. In order to mature fully under screens, tobacco needs to be set very early.

After the tobacco was cured, the leaves were stripped off,

those from each plot were tied up separately and the whole was packed in boxes for shipment. On December 11th it was sent to the warehouse of Messrs. Sutter Bros. in East Hartford, and was there subjected to a forced sweat. On February 13th it was taken out of the case, although it was not completely sweated, and was submitted to experts for examination as to the quality of the separate lots respectively. The following represents the results of this examination:

#### UNSHADED.

### PLOT I.

Texture, poor, good grain. Color, fair. Size, medium. Vein, very prominent, wiry, curly. Stem, very prominent. Quality, very poor.

#### PLOT II.

Texture, rather poor, good grain. Color, good. Size, medium. Vein. fairly prominent, wiry. Stem, fairly prominent. Quality, poor.

#### PLOT III.

Texture, very good, very pronounced grain. Color, very good. Size, medium. Vein, desirable, not wiry. Stem, fair. Quality, very good.

#### PLOT IV.

Texture, fair. Color, good. Size, medium. Vein, fair, a trifle curly, tends to "white-vein." Stem, fair. Quality, good.

#### SHADED.

#### PLOT I.

Texture, thin, no grain. Color, poor, not fully sweated, shows some "rust." Size, large. Vein, fairly prominent, wiry. Stem, not desirable. Quality, poor.

### PLOT II.

Texture, thin, no grain. Color, poor. Size, large. Vein, prominent, somewhat wiry. Stem, prominent. Quality, rather poor.

#### PLOT III.

Texture, thin, not elastic, no body, no grain. Color, poor. Size, large. Vein, prominent, wiry, curly. Stem, prominent. Quality, very poor.

#### PLOT IV.

Texture, fair, no grain. Color, fair, (not ripe). Size, large. Vein, rather prominent, tends to "white vein." Stem, fairly prominent. Quality, fair.

The tobacco, on the whole, was pronounced of poor qualtiy; that from the unshaded plots was coarse, with harsh and wiry veins; that from the shaded plots was objected to as having been immature when cut and consequently of very poor color and of so thin and smooth a texture as to be practically worthless. It was noticeable that in the case of both the shaded and the unshaded tobacco the plots which received the largest quantity of lime (IV) showed a good deal of "white-vein." The best of the unshaded tobacco was adjudged to be that from Plot III, which had received lime at the rate of 1,000 pounds per acre. The best of the shaded tobacco was that which received lime at the rate of 2,000 pounds per acre. On the whole, the shaded tobacco was pronounced far inferior to the unshaded. This latter opinion did not prove to be shared universally; one expert buyer, who knew nothing of the history of the tobacco, pronounced in favor of the shaded tobacco, both as regards texture and quality.

A sample of the leaves from each plot was brought to New Haven and the character of the ash was tested. None of the tobacco, when rolled on a cigar and smoked, gave a good ash. The best was, without any question, the unshaded tobacco from Plot III. It is the general opinion among growers that the use of lime tends to produce a flaky ash, yet the tobacco from Plot III, which received lime at the rate of 1,000 pounds per acre, gave a smoother, whiter and firmer ash than that from Plot I, which received only 300 pounds per acre. No difference could be observed, as regards the character of the ash, between the tobacco which had the least amount of lime and that which had the most; in both cases the ash was grey, flaky and deficient in firmness. The burn of the tobacco from all of the plots was equally poor.

This experiment, inconclusive as it proved, opens up a number of interesting possibilities, not the least of which is that the use of lime may not, in all cases, exercise the deleterious effect on tobacco that some growers suppose it to, and that there is some reason for thinking that its use may tend to decrease the prevalence of calico.

# ON THE SO-CALLED "GRAIN" OF WRAPPER TOBACCO.

By W. C. STURGIS.

It is a well-known fact that tobacco leaves used as wrappers, frequently exhibit, after curing, numbers of minute, blisterlike pimples thickly scattered over the surface of the leaf and giving to the latter a somewhat granulated appearance and a roughish feeling quite different from that due to the hairs which beset the surface. This "grain" occurs on all kinds of tobacco which I have examined, viz. domestic, Sumatra and Havana, but in very varying degrees. Sometimes, especially in the finer grades of Havana tobacco, the "grain" is almost entirely absent: in other cases it is so prominent as to be distinctly visible to the naked eye, and it then gives to the ash a peculiar appearance which will be described presently. So far as I know, the cause of the "grain" has never been investigated, but the idea prevails among Connecticut tobacco growers that it is either in itself a desirable feature in the leaf or that its presence is indicative of superior quality. A cross-section of a tobacco leaf at a point occupied by one of these minute blisters shows, by means of the microscope, that the blister is caused by a dense deposit of some crystalline substance in the cells of the leaf. These deposits are sometimes so large that they equal or even exceed the thickness of the fresh leaf, and consequently when the leaf shrinks in drying the "grain" becomes apparent, often causing the rupture of the epidermis. If the deposit is small it does not, of course, become visible superficially, but only in the microscopic section; if smaller still, it becomes indistinguishable from the stellate aggregations of crystals which frequently occur in the cells of the spongy parenchyma of the leaves of tobacco as well as of many other plants. (See Plate II, page 264.)

If one of these large crystalline deposits is more closely examined, it is seen to be composed either of extremely minute particles or of radiating clusters of very fine, needle-like crystals. The latter form is characteristic of the deposit when it occurs in the ordinary cells of the leaf, while if it occurs in the large cells and vessels of the veins the deposit is composed of particles. In such cases the vessels, while retaining their original

form, become practically petrified and may then be dissected out in the form of brittle rods. This crystalline substance presents the following reactions in microscopic sections. It is insoluble in water, but readily and completely soluble in dilute hydrochloric acid.\* On heating (ascertained by lighting the leaf and watching the effect of the advancing heat upon an individual "grain") the deposit swells to three or four times its original volume and becomes distinctly visible on the cigarash. If the "grain" is prominent and abundant, the ash is seen to be roughened all over with little grey lumps. On removing some of these from the ash to a glass slide, and treating them with dilute hydrochloric acid, they are at once dissolved with copious evolution of gas.

These observations, coupled with what we know of the frequent occurrence of oxalate of lime in normal leaf-tissues, leads to the conclusion that the "grain" of tobacco-leaves is

caused by the excessive deposition of this substance in limited areas of the leaf. Upon heating one of these deposits, it swells and becomes converted into carbonate of lime, which dissolves in hydrochloric acid and gives off bubbles of carbonic dioxide.

This being the case, one might suppose that the addition of lime to the soil would make the "grain" of the cured tobacco more prominent. That this is not the case, however, was made evi-

dent by the results obtained from the use of lime in varying quantities in the experiment described on pp. 252 to 261 of this report. The "grain" on the cured leaves from plot I, which

received the smallest quantity of lime, was very small; on the leaves from plot II it was abundant and prominent; on III it was

fairly prominent; and on IV, which received the largest quantity of lime, the "grain" was even less marked than in the case of I. These plots were all grown in the open field. On the

shaded plots the leaves, after curing, showed practically no "grain" whatever. This was especially true of the intermediate plots II and III. On the leaves from plots I and IV the "grain"

was either wanting or so minute as to be plainly visible only under a lens. In this case, then, the use of lime has had no appreciable effect on the "grain." The only conclusion in this

<sup>\*</sup>Dr. Loew, of the U. S. Department of Agriculture, informs me that it yields, after treatment with sulphuric acid, numerous crystals of calcium sulphate.

respect which can be deduced from the experiment is that shading produces a leaf remarkably deficient in "grain," notwithstanding the fact that the thin texture of the shaded leaves would have made the "grain" more prominent had the deposits of calcium oxalate been present to an equal degree as in the unshaded leaves.

As to the question of whether the "grain" is formed during the process of curing or is present in the growing leaves, nothing definite can be said as yet. It is quite conceivable that after the plants are cut and hung, the leaves might draw from the stalk dissolved mineral matter which might later, as the sap dried out, be deposited in crystalline form within the cells. On the other hand, the deposits might exist in the growing leaf and yet not be visible externally as a "grain" until the shrinkage in thickness of the leaf, while curing, made them apparent. I am inclined to take the latter view of the case and to presume that. given a certain quantity (not necessarily a large one) of lime in the soil, tobacco plants, under certain conditions, may take it up in quantities far greater than they can utilize; that the excess is consequently deposited in crystalline form in the tissues, and that it produces a visible "grain" only after the shrinkage in thickness incident to the process of curing. va elima verior traveword excess edit over etre interactif i edition i e c

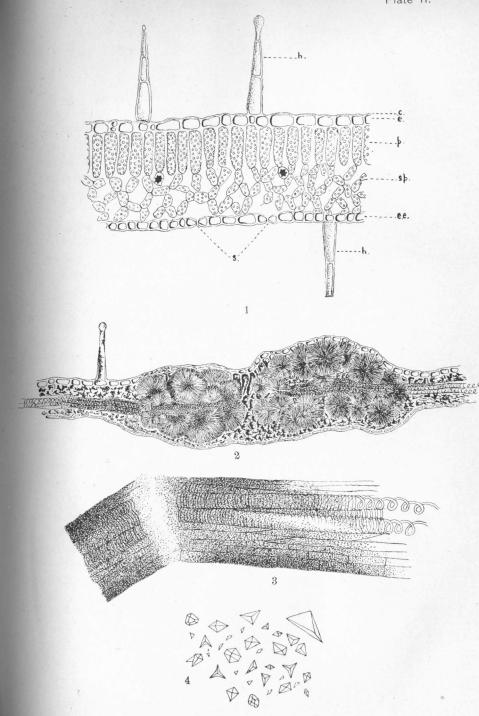
#### EXPLANATION OF PLATE.

Fig. 1. Cross-section of fresh Tobacco-leaf, highly magnified: c, cuticle; e, upper epidermis; p, palisade layer with chlorophyll grains; sp, spongy parenchyma with two crystals of oxalate of lime; ee, lower epidermis; s, stomata; h, hairs.

Fig. 2. Cross-section of cured Tobacco-leaf, showing the masses of needle-like crystals of calcium oxalate which cause the "grain." The contents of the cells are disintegrated and the leaf is much reduced in thickness. A vascular bundle densely charged with a crystalline deposit traverses the median line of the section. Magnified 105 diameters.

Fig. 3. Portion of a vascular bundle filled with crystals. Partly decalcified by treatment with dilute hydrochloric acid. Magnified 330 diameters.

Fig. 4. Isolated crystals of oxalate of lime from the vessels of the same bundle. Magnified 680 diameters.



## FURTHER NOTES ON THE POLE-BURN OF TOBACCO.

By W. C. STURGIS.

In the latter part of August of the past year, some tobaccoleaves showing the initial stages of pole-burn were brought to the Station by Dr. E. H. Jenkins. It has not proved an easy matter in the past to make any really conclusive observations upon this disease owing to the fact that growers naturally hesitate to proclaim the fact of its appearance, and also because, by the time the fact becomes known and an investigation can be instituted on the spot, the trouble has progressed so far that secondary changes have occurred which, more or less, prevent any accurate determination of the primary cause. Thus, in my first study of the subject in 1891 (Annual Rep., Conn. Agr. Exp. Station, 1891, pp. 168-173), the trouble had progressed so far that a process of decay had set in, and from the surface of the leaves a number of putrefactive bacteria could be isolated as well as a fungus of the genus Cladosporium. This same fungus developed upon partially cured, but hitherto sound, tobacco-leaves hung up in a warm, moist atmosphere, and this was in turn followed by the growth of bacteria in the spots affected and the consequent decay of the leaves; nevertheless there was no certainty regarding the initial stage of the trouble. It was therefore of extreme interest to secure specimens in which "pole-burn" had evidently but just started.

The leaves collected by Dr. Jenkins presented the normal appearance of partially cured tobacco, with the exception that here and there, especially in the neighborhood of the larger veins, the tissues were of a darker color and extremely tender. The surface of these irregularly circular, dark blotches was dull as compared with the silky lustre characteristic of the sound portions of the leaf, and in some cases a delicate, whitish mold could be seen upon them. Microscopic examination of this mold showed that it was a species of Alternaria, but none of the spores observed were mature and evidently the fungus had been checked in its earlier stages of growth by being brought into the laboratory and allowed to dry. The most rigid examination of the surface of these diseased blotches, made by allow-

ing a drop of water to stand upon them for half an hour and then transferring it to a glass side, failed to demonstrate the presence of any organisms on the leaves except the immature fungus above-mentioned. A similar result followed the direct examination of scrapings from the surface. It is evident, however, that such rough methods of research by no means preclude the possibility of bacterial infection. Unless bacteria existed in a vegetative form and in very great numbers on the surface of the leaves, their presence might be extremely difficult to prove by direct examination, while if, as is quite possible, they existed in the internal tissues, the epidemis remaining unruptured, they might not appear upon the surface at all.

In order to gain some information regarding the organisms associated with the initial stages of pole-burn, and incidentally regarding their location within or upon the leaf tissues, recourse was had to fractional plate-cultures in broth-gelatine.

From portions of the leaf showing the symptoms of disease noted above, circular bits of tissue, 1.5 cm. in diameter, were cut out with a sterilized knife. One of these was rinsed in absolute alcohol to destroy, as far as possible, all germs of bacteria or fungi upon the surface of the leaf, and was then thoroughly washed in sterilized, distilled water in order to remove the alcohol; the other received no antiseptic treatment. Each sample was then thoroughly macerated in a little sterilized water. A drop or two of this water was then added to 10 cc. of sterilized water in a test tube, and thoroughly shaken; from this tube a few drops were transferred to a tube of broth-gelatine melted at 35°C. The contents of this tube were then poured into a Petri dish; into the same tube were poured the contents of another tube of broth-gelatine, and so on, using the first tube each time as the source of infection, until six plate-cultures had been prepared from each sample of macerated leaf. These cultures, if successful, would evidently show what germs were associated with the leaves, and also whether they occurred on the surface only or were also to be found within the tissues where the treatment with alcohol could hardly affect them.

It is quite unnecessary to recount here the history in detail of these cultures. They were started on November 8th. On the 13th of that month the first plate in the series made from the untreated leaf showed a little mold. On the 23rd this mold had increased to such an extent as almost to cover the enrface of the gelatine; there were also in this plate one or two small colonies of yeast. The second plate in this series showed on the same date a large growth of yeast, but very little of the mold. The other plates of the series remained blank. The mold proved to be a species of Alternaria identical with that observed, by direct examination, on the surface of the leaf.

The series of cultures made from the leaf which had been rinsed in absolute alcohol differed from the other series in the complete suppression of the Alternaria and in the development in considerable quantities after ten days, of a large Bacillus. As in the first series, this occurred only in the first two plates of the series, a fact indicative of a rather scanty distribution of germs either within or upon the leaf. The only organisms developed in connection with the pole-burn were then, in this instance, a species of Alternaria, a Yeast and a Bacillus. The first named occurred only on the surface and did not, therefore, appear in the cultures from the leaf sterilized superficially with alcohol. The same is true of the yeast; but the bacillus occurred only in the cultures from the sterilized leaf and the inference therefore is that it was present within the tissues only.

Two months later these cultures were repeated with the addition of a series made from a bit of leaf doubly sterilized, viz. by rinsing in alcohol and then in formalin. In these three series it was again only the first plate of each which developed anything worthy of note. As a rule, the other plates either remained perfectly blank or else developed after at least a week, one or two small mold colonies near the edge, which might well have been due to outside infection.

From the doubly sterilized leaf there developed in the course of ten days one large, radiating, liquefying colony of small, motile rods of the type of Bacillus subtilis, which we may call Bacillus I; three smaller, flocculent, liquefying colonies of very large rods related to B. megatherium, which may be designated as Bacillus II; a few pin-head, moist, non-liquefying, tawny colonies of a Micrococcus; and one large, white, sterile mycelium near the edge. This would seem to be a remarkable result to obtain from a piece of leaf-tissue subjected to the combined action of such powerful germicides as alcohol and formalin. As a matter of

fact, however, it was only the first plate in the series which showed any growth whatever; that growth consisted of no more than fifteen or twenty colonies representing a similarly small number of germs; and finally, the leaf from which the cultures were made had been lying for several months on a laboratory table, protected only by a bell-jar. Under such conditions there was abundant opportunity for many bacterial spores capable of resisting the germicides used, to have collected upon the leaf and to have been transferred thence to the culture-plates. It may fairly be said that the cultures from the partially sterilized leaf presented no grounds for concluding that either bacteria or fungi were present within the tissues in sufficient numbers to account for the extensive damage wrought by pole-burn. Had they been so they would almost certainly have occurred in overwhelming numbers, not in the first dilution-culture merely, but in one or more of the subsequent ones.

The same general remarks apply to the series made from a portion of the leaf treated with alcohol only. Here the first plate yielded, after ten days, two small colonies of Bacillus I, two of Bacillus II, many of the Micrococcus, but all extremely small, and in addition, four small tufts of Aspergillus and Penicillium. Here again, there is no evidence to show that the internal tissues of the leaf contain any organism in quantity sufficient to produce the decay accompanying pole-burn.

As in the previous cultures, however, when we come to the cultures made from the leaf in its natural condition, we do find one organism appearing constantly and abundantly. After ten days the first dilution-culture contained small colonies of *Penicillium*, *Cladosporium*, *Fusarium*, *Bacillus II*, and another smaller, very active bacillus, liquefying rapidly, and of a pale straw-color. But overrunning all of these was a very abundant growth of brown mycelium, starting in at least eight different centres, and consisting entirely of the *Alternaria* before-mentioned.

I can only conclude from these cultures that, as far as regards the organisms associated with the earliest stages of pole-burn, this species of *Alternaria* is the only one which occurs in any abundance, and that it occurs only on the surface of the leaf, not in the internal tissues. These remarks must be understood to apply strictly only to the case in hand. Some years ago

I stated, as the result of some preliminary investigations upon the subject, that pole-burn was, in my opinion, due to an excessively damp atmosphere, inducing the growth of a fungus at certain points on the tobacco leaf, this being followed by a process of decay in which a species of Bacillus and a species of Micrococcus were the principal factors.\* The fungus which was associated with the trouble was, in that instance, unquestionably a species of Cladosporium; in the present instance it is as certainly a species of Alternaria. These statements are not, as might appear, contradictory. They merely indicate that, under certain atmospheric conditions, any saprophytic fungus which may be present in the curing-barn may attack the dead tissues of the leaves and start in them a process of disintegration which will almost surely be followed by true bacterial decay. It is interesting to note in this connection that the predominant forms of bacteria which occurred in the cultures during the investigations just described, were apparently identical with the large Bacillus and the Micrococcus observed in the similar case eight years ago.

It is perhaps necessary to say in conclusion, that these further observations upon the cause of pole-burn confirm the suggestions regarding remedial measures made in our Report for 1891, p. 173, e. s.

<sup>\*</sup> See Conn. Agr. Exp. Station, Rep. for 1891, pp. 170 and 171.

# ON FRACTIONAL FERTILIZATION OF MELONS AS A PREVENTIVE OF DISEASE.

### By W. C. STURGIS.

In the Report of this Station for 1898, pp. 230-232, an account was given of the favorable results attending the use of tobacco stems as a mulch for melon-vines. The advantage which the vines derived from this treatment was seen in a general increase of vigor owing to the gradual supply of plant-food made a available by the slow decay of the tobacco-stems. It occurred to me at the time that at least a part of the failure which has recently become so marked a feature of the melon-growing industry in

Connecticut might be due to the fact that the whole of the plant-food was supplied at the beginning of the season, and that by the time the fruit began to form, especially if heavy rains had intervened, the available supply was so far exhausted that the vines suffered from partial starvation and were therefore very susceptible to fungous attack and other injurious agencies.

An experiment was therefore planned to test the effect of small applications of plant-food from time to time throughout the growing season. For this purpose a portion of a melon-field was selected at North Haven on the farm of Mr. H. P. Smith, who has in the past so kindly offered us similar facilities for experimental work.

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The melons occupied a large upland field with a slight slope to the eastward. The soil was dry and sandy. The portion selected for the experiment was near the center of the field and consisted of nine rows, each containing twenty hills. This area was divided into three sections of three rows each and one of the sections was again subdivided into two as seen in the accompanying cut. These plots, like the remainder of the field, received the usual manuring, viz., a fork-full of compost, consisting of barnyard manure and tobacco-stems, placed in the hill at the time of planting; they all received the same culture throughout the season.

The plants made a good growth, and on July 1st were equally thrifty all over the field. Early in July the plots were staked out, and a fertilizer was prepared, consisting of muriate of potash, 13 lbs.; nitrate of soda, 41 lbs.; dissolved bone-black, 10 lbs. This was in the proportion of 4 parts of potash, 4 parts of nitrogen, and I part of phosphoric acid. On July 12th, when the vines were just beginning to show flowers and the runners averaged about two feet in length, the fertilizer was applied to plots A and B. The method of application was to scatter a handful of the fertilizer, thoroughly mixed, on the surface of the soil around each hill, at a distance of about ten inches from the center of the hill. On August 10th a like application was made on plots B and C. At this time the ground was fairly covered by the vines, fruit was setting in abundance, and the vines throughout the field showed a fine color and were apparently thrifty and vigorous. A week later, however, there was a very different state of affairs. On August 17th a visit to the field revealed the fact that the whole field, with the exception of the fertilized plots, was of a uniform yellowish tone, in marked contrast to the dark green color of the portion which had received the additional fertilizer. It will be noted that plot A received but the one application in July, plot B received an additional application in August, plot C received only the August application, and plot D received nothing except the original supply furnished at the time of planting. No difference was observable on August 17th, as regards vigor, between plots A, B and C; but plot D showed the same yellow color observable in the field at large, with the exception of the single row adjoining plot C, which had evidently benefitted by its proximity to the extra food-supply on that plot. As to the weather conditions during July and August when the vines were blooming and producing fruit, and were consequently making increased demands on the fertility of the soil, heavy rains occurred almost continuously from July 22nd to July 29th, while from the latter

date until August 10th there was no rain. Two light rains then occurred, but no more up to the middle of the month, when the conditions described above and indicative of partial starvation were observed. The application of the fertilizer on July 12th was followed by rain, that on August 10th was made during a rain-storm. These weather conditions were such as to diminish, at a critical period, the quantity of soluble plant-food originally in the soil, particularly in the loose, sandy soil at present under consideration, and at the same time to render immediately available the later applications of fertilizer.

On August 17th much time was spent in a most careful examination of the vines throughout the field for evidences of any specific cause of disease, and specimens were collected for future microscopic examination. The result of this search was entirely negative. Here and there a vine was found affected by the wilt disease, and more frequently leaves were found which showed the initial stages of the spotting due to the fungus Alternaria, but neither of these was at all adequate to explain the sudden loss of vigor and marked change of color which characterized the plantation. Only on the fertilized plots was there no yellowing of the vines, no decrease of vigor, and no spotting of the leaves. The conclusion was almost irresistible that the trouble was to be found primarily in a deficiency of available plant-food and that the indications of actual disease were merely incidental. Part of the trouble might possibly have been prevented. The wet weather in the middle of July induced a very active growth of weeds and, owing to the pressure of other work on the farm, the melon-field was somewhat neglected, so that the weeds soon completely covered it. Undoubtedly part of the starved condition of the melonvines was attributable to the luxuriant growth of the weeds; nevertheless on the experiment area, though it was covered with a rank growth of weeds, the vines retained a measure of vigor longer than in other parts of the field. As soon as the melons began to ripen it was found that they were of extremely poor quality, indeed they proved later to be almost worthless. This was partly due to the poor condition of the vines, and partly, as it appeared, to the fact that the quality of the seed was far below the average. The only melons which matured properly and were even of fair quality, were gathered from the experimental plots.

Through the kindness of Mr. Smith, a record was kept of the yield from these plots on August 25th, 29th and 31st. This record is given below. After the date last named the quality of the melons was so poor that no more were gathered.

			Aug. 25.	Aug. 29.	Aug. 31.	Total.	Remarks.
Plot	A* { \}	No. Wt.	94 166 lbs.	52 94 lbs.	260 290 lbs.	406 550 lbs.	Leaves slightly yellow on Aug. 23rd. All dead on Aug. 31st. Vines still green.
Plot	B* { \ \	No. Wt.	72 112 lbs.	28 46 lbs.	408 396 lbs.	508 554 lbs.	Leaves slightly yellow on Aug, 25th. Leaves and most of vines dead on Aug. 31st.
Plot	c {1	No. Wt.	148 lbs.	92 273 lbs.	0 0	421 lbs.	Leaves very yellow and dying on Aug. 25th. All dead on Aug. 29th.
Plot	D {	No. Wt.	40 152 lbs.	76 233 lbs.	0	116 385 lbs.	Leaves as in Plot C.

So many causes conspired to make this melon-crop a failure, that very little importance can be attached to the above figures. They do, however, indicate that the increase of vigor where the vines received additional plant-food during the growing season had its result in an increased production of fruit (cf. Plots A and D); that the additional advantage derived from two applications of fertilizer instead of one, was less than might be expected (cf. Plots A and B); and that a single application after the fruit was partly grown was of almost no value (cf. Plots C and D).

The fact that where additional fertilizer was applied there was almost complete absence of the wilt and the spotting of the leaves, is sufficient to warrant further experiments along this line.

<sup>\*</sup>The yield of the half-plots, A and B, are calculated on the basis of a whole plot; that is, the actual yield of each plot is multiplied by two.

## ON THE PREVENTION OF RASPBERRY-ANTHRAC-NOSE BY CULTURAL METHODS.

## By W. C. STURGIS.

The disease of raspberries known as "Anthracnose," and caused by the fungus Glaosporium necator, Ell. & Ev., is unquestionably the most serious enemy with which the grower of raspberries has to contend. It is hardly necessary to describe this disease. The small, roundish blotches, light in color and bordered by a dark purplish ring, which appear on the young canes and produce on older canes irregular, scab-like areas. serve to identify the fungus at sight. Numerous experiments have been made to ascertain how the young canes become infected in the Spring, how they may be protected from infection and whether or not there is any practical cure for the disease after it is once firmly established on the old canes. Thaxter has shown (Conn. Agr. Exp. Sta. Rep. for 1889, p. 172) that "fresh shoots, developed from below the ground as well as from the old canes above and below the diseased spots, show no signs of the fungus." From this he concludes that the vegetative portion of the fungus does not spread from the old wood to the new growth, but that the latter is infected by means of spores produced in Spring on the old centers of disease, and that by cutting out and burning all of the old, diseased canes, the danger of fresh infection may be very materially diminished if not totally prevented.

The most extensive experiments upon the treatment of anthracnose by means of fungicides have been made at the New York Experiment Station, and are fully reported in Bull. 124 of that Station. These experiments show that it is possible practically to free a plantation of raspberries from anthracnose by cutting out and burning the old diseased canes and by protecting the new growth by frequent applications of Bordeaux mixture; but at the same time it is shown that spraying does not increase the yield and is therefore not profitable. As a rule a raspberry plantation attains its maximum of productiveness in its third year, and most growers follow the practice of renewing their plantations after this period. In such cases, providing that proper care is exercised in selecting or purchas-

ing new plants absolutely free from anthracnose, there is little danger of very serious injury from the disease. Sometimes, however, it becomes advisable to fruit a certain plantation for a longer period and then some means of holding the anthracnose in check becomes necessary. According to the New York experiments it does not pay to attain this end by spraying, but there can be little doubt that by certain methods of culture the disease can be checked, at least temporarily, providing that the atmospheric conditions are not too unfavorable, and that by such means a plantation which would otherwise represent a total loss can be made remunerative for a season or two. The following is a good illustration of such a case.

Early in April last, I received from Mr. G. C. Beckwith of Nepaug a bundle of very badly diseased raspberry-canes, accompanied by a letter, stating that they were taken from an acre of a very heavy growth of canes which showed no sign of disease the previous season, but at the time of writing included hardly a single healthy plant. In reply to inquiries and suggestions, Mr. Beckwith wrote later that the disease was so bad that if he attempted to cut it all out there would be nothing left, and he suggested the possibility of spraying the plants as they stood, getting what fruit he could, and then destroying the whole plantation. A visit to Nepaug showed that Mr. Beckwith's description of the condition of affairs was hardly exaggerated, nevertheless he was advised to cut out as many of the diseased canes as possible and to spray the remainder with Bordeaux mixture, in the hope that thereby a fair crop might be gathered before the plantation had to be given up as worthless. This course was recommended merely as a temporary expedient, with no idea that any permanent results would be attained. The outcome, however, was far more successful than had been anticipated. Under date of January 25th, 1900, Mr. Beckwith wrote as follows: "Sickness just at the time when spraying should have been attended to, prevented my doing this, and the canes were not sprayed at all. But I gave them a very severe pruning as you suggested. Then followed cultivation. I also hoed and drew the dirt up over the old diseased stumps. I kept up thorough cultivation until the time of fruiting. The result was, I had not only a rank growth of young canes, but a splendid crop of fruit. You will

remember that we both thought it would not pay to try to do anything with the plants further than to get the one crop of fruit, but the canes grew so rank and appeared so free from disease that I am going to try the same experiment again another year, for I am satisfied that it was the pruning and the thorough cultivation which did the work. I took about 500 plants from this piece and set them in another lot; although I sprayed them several times there is now a considerable amount of disease among them."

These results are not difficult to explain in retrospect, and they may not be so favorable again. The pruning removed most of the fungus; what was left on the canes was doubtless kept from spreading by the lack of rain throughout the past Summer; and the thorough cultivation enabled the young canes to maintain their general vigor. Had the season been even a normally wet one, the disease would probably have been much more apparent. Mr. Beckwith's experience with plants taken from the diseased area gives abundant evidence of the danger of starting a fresh plantation from such a source, even under the most favorable conditions. It is safe to prophesy that, whatever the condition of the old plantation may be during the coming season, the new one will certainly be diseased.

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# MISCELLANEOUS NOTES. .

By W. C. Sturgis.

Downy Mildew on Melons. This mildew, known to botanists as Plasmopara Cubensis, is common upon cucumbers, especially under glass, but has been reported only once on melons in this State. That was in 1899 at South Manchester. It appears to be a common disease of both melons and cucumbers in New Jersey, New York and Ohio, and, besides these plants, it is known to attack the squash, pumpkin, watermelon, gourd, wild star cucumber (Sicyos), wild prickly cucumber (Echinocystis), and a number of other plants of the same family.

It was hoped that, with three serious parasitic diseases to diminish still further the continually decreasing returns from melon-culture in Connecticut, we might be relieved from the presence of a fourth, at least until some satisfactory means of dealing with the others had been found; but in the latter part of August last, I received from Mr. F. T. Ives of Meriden a number of melon-leaves, accompanied by a letter stating that, a week before, the vines from which the leaves had been taken were in a perfectly healthy condition, but that at the time of sending the specimens, every leaf on the two-acre field was dead and dried up. Sixty or seventy dozen melons had been picked in this field, but the ground was still covered with fruit which, owing to the rapid spread and disastrous effects of the disease, would be practically a total loss. Mr. Ives was inclined to attribute the trouble to the attacks of some insect, but its rapid spread was indicative rather of fungous attack, and the microscope confirmed this supposition. The upper surface of the leaves showed numbers of roundish or triangular, yellowish spots and blotches, which, on the lower surface of the leaf, were seen to be covered with a small, white mold, very like that seen in the case of the downy mildew of the grape, and easily identified as the fungus above-mentioned. That this disease, though hitherto decidedly localized, may become widely spread and do very great damage, is shown by the statement made by Mr. Ives that in 1898 it attacked his melons when the fruit was on the point of ripening, and destroyed more than 10,000 of them. Evidently it differs from other common diseases of melons in the lateness of its attack, seldom appearing before the fruit begins to ripen; in the unexpectedly sudden manner of its appearance; and in the rapidity of its progress, there being sometimes no more than a week intervening between the first evidence of the trouble and the total destruction of the plants over a large area. In these respects it resembles its near relative, the late-blight of potatoes (*Phytophthora*).

The same disease, as noted above, is liable to attack cucumbers, and very successful experiments in checking it on those plants are on record, but although similar experiments with melons have been tried, notably in Ohio,\* they do not seem to have been attended by the same measure of success. One reason for this is doubtless that the cucumber crop is harvested early, before the mildew becomes a serious menace, while melons have to remain in the field until mature and are thus exposed to the attacks of the fungus for a longer period. Nevertheless partial success, and in one or two cases entire success, has followed the use of Bordeaux mixture as a preventive of this mildew. Evidently then, there are two available methods by which the damage from this trouble can be minimized; first, by starting the plants under glass, forcing the growth, and transplanting to a warm, rich soil, thus securing the crop of fruit early enough to prevent the vines from being attacked by the mildew; secondly, by growing them in the usual manner from seed planted in the open and affording the vines protection, when almost full grown, by the thorough application of Bordeaux mixture. By the first method there would be the added expense of forcing and transplanting, but there is every probability that this would be more than offset by the early maturing of the fruit, the higher price which it would command, and the freedom of the vines from mildew; the second method would involve the expense of spraying and might, even then, prove unsuccessful. The expense of spraying need not exceed \$3.00 per acre for each application, and three thorough applications, beginning about the middle of July, should afford the highest possible degree of protection.

A Destructive Disease of Potatoes. About the middle of June I received word from Mr. J. W. Jennings of Southport that his potato-vines were blighting badly. The blight was

described by Mr. Jennings as a kind of wilt, the plants attacked suddenly withering without apparent cause and very soon becoming brown and dead. The trouble started near the center of the field when the plants were about eight inches high, and attacked only three or four hills; it spread, however, with great rapidity, the affected area doubling or trebling in size in the course of three days. At the time of Mr. Jennings' letter, he reported that about a square rod was affected. I at once visited Southport and examined the diseased field. The whole field appeared thrifty except in the one portion described by Mr. Jennings. In the center of this portion the vines were completely dead and the blackened and shrivelled stalks alone indicated where the hills had been. Toward the margin of the area, which was almost circular, indicating a gradual spread of the trouble in all directions from a single center, the plants still showed signs of vigor, though badly wilted; farther still from the center, hills could be found in which only one or two of the stalks had begun to wilt, the remainder being perfectly healthy. It would seem a simple matter, with all stages of the trouble thus before the eye, at least to hazard a guess as to its nature; but after thorough examination of the plants in the field and of abundant material taken to the laboratory, I found myself no nearer a satisfactory explanation of the trouble than before. Examination of the wilted plants showed that the stalks were hollowed out from a point about 2-8 in. above the surface of the ground to an inch or so below the surface. These hollow stalks had every appearance, in most cases, of having been caused by insects, indeed in several cases they showed a small perforation near the crown of the root which apparently had served for the entrance or exit of the insect. In other cases, however, the hollows in the stalks were not continuous but showed numerous cross-partitions, so that it was difficult to associate their production with insects. Notwithstanding the similarity in appearance between these hollow stalks and the injuries caused by the potato stalk borers (Trichobaris trinotata and Gortyna nitela), the most careful search failed to reveal the presence of either of these insects. If the trouble had been due to either of these borers, it would have been next to impossible, at that season, to overlook the larvæ of the insect within the stalks.

<sup>\*</sup> Ohio Agr. Exp. Sta., Bull. 105, pp. 230-232, 1899.

On the other hand, in the material examined microscopically in the laboratory, nothing of a fungous or bacterial nature was found which could apparently account for the wide-spread destruction of the tissues in the stalk. The whole subject of the cause of the trouble was therefore reserved for another season's work. Meantime I had advised Mr. Jennings to gather all of the diseased vines into a pile and burn them, taking the extra precaution of including a hill or two beyond the apparently extreme limit of the affected area. This was done immediately, and, in addition, Mr. Jennings saturated the whole area with Paris green in water. No more trouble was experienced, and the field produced a fine crop of sound potatoes.

Serious injury to Peas. During the past Summer there were several complaints from different parts of the State to the effect that the pea-crop was proving a failure. The trouble was said to make its appearance at about the blossoming period, and as a result the vines became yellow, dropped their leaves, failed to mature pods properly and, in some cases, turned brown at the surface of the ground and rotted off. The description of the trouble recalled a common disease of peas which appeared with unusual severity in Germany a few years ago and was there made the subject of very careful and thorough investigation.\* In this country the most serious of its attacks appear to have been in the pea-canning sections of Delaware.† The disease is caused by the leaf-spot fungus, Ascochyta Pisi, and usually does very little damage, being confined to a few of the leaves and pods. Occasionally, however, when the conditions are peculiarly favorable to it, it may become extremely active, destroying the crop entirely by attacking the stalks near the ground and causing them to decay. In such cases there seems good reason to believe that the fungous attack is not primarily above ground and due to the proximity of diseased plants, but that the fungus was present in the seed. The German investigations referred to above, show that the fungus may be present in the seed and yet not affect the germinative quality to any marked extent: it therefore becomes a matter of extreme importance to purchase seed which not only has a good record for germination, but which is known to have come from healthy

plants. In one case which was brought to my notice, a "damping-off" fungus (Pythium?) had apparently coöperated with the Ascochyta in causing the decay of the stalks, for the diseased tissues near the surface of the ground were found to be crowded with resting-spores (oospores) apparently belonging to the genus Pythium. This fungus had probably attacked the seedlings very early; it had then been checked by dry weather, but meanwhile had so weakened the plants that they fell a ready victim to the Ascochyta, which, had it not been for the Pythium, might have done no more than its usual trivial damage. Should the disease threaten serious injury in future, it would be advisable to obtain seed from a distance where the disease has not been present, to select land which has not borne peas for a number of years, to secure thorough drainage, to avoid the use of manure on the surface of the soil around the base of the plants, and finally, in case it is necessary to use the same land for two or more successive crops of peas, to gather and burn every vestige of the vines as soon as the crop is harvested.

The Leaf-Spot of Alfalfa. The growing of alfalfa as a fodder-crop in this part of the country has not attained proportions sufficient to attract much notice, nevertheless we occasionally hear of some serious damage done to the crop. During the past Summer samples of alfalfa were sent in to the Station, evidently attacked by the "leaf-spot" fungus, Pseudopeziza. This causes small, yellowish blotches on the leaves, in the center of which are seen the minute, black, fruiting cups of the fungus. In the West the "leaf-spot" disease does immense damage to alfalfa, sometimes destroying half the entire crop. It has been admirably described in the Report for 1897 of the Iowa Agr. Exp. Sta., pp. 25-34. Fortunately the frequent cutting to which, in the ordinary course of things, alfalfa is subjected, presents a ready means of checking the spread of the fungus, since if cut and fed to cattle before the spores mature, by far the greatest source of infection is prevented. We do not know at present exactly the season at which the spores mature, but as the specimens which I received last Summer were collected about May 15th and did not at that time show any mature spores, it is safe to assume that diseased plants do not become a serious menace to their neighbors before June 1st, and may

<sup>\*</sup>See Centralbl. f. Bakt., Abth. II, Bd. I, pp. 620-624 and 881-886. 1895. † Cf. Del. Agr. Exp. Sta., Bull. XLI, pp. 9-11. 1898.

therefore be safely cut and fed to stock up to that date. Should the disease occur later in the season the only practical means of combatting it is either by continuous cropping or by watching for its first appearance, which will generally be at not more than one or two points in the field, and immediately cutting and burning the affected plants.

Disease of Peppers. Notwithstanding the dry weather which characterized the past Summer, peppers, especially when grown upon low land, suffered severely from anthracnose (Colletotrichum nigrum). This disease makes its appearance on the fruit in the form of roundish blotches, which increase rapidly in size, become pale brown in color and finally give rise to numbers of minute pustules of a brown or finally black color. in which the spores are produced. Not only do these blotches disfigure the fruit, but they offer a favorable ground for the development of other organisms productive of decay. Fields were seen last Summer in which at least 25% of the fruit was rendered worthless by this fungus. No experiments looking to its prevention were attempted, but Halsted reports in the 17th Report of the N. J. Agr. Exp. Sta., p. 337, that fungicides are not efficient in this case. In a dry season Halsted secured good results from irrigation and by mulching the plants, but in seasons of normal rainfall these methods proved useless. Fortunately peppers are not a crop upon which the farmer places much dependence.

# OBSERVATIONS ON THE FERTILIZATION OF PEACH ORCHARDS.

By E. H. JENKINS.

For several years the Station has carried out experiments on this subject. One of them is here described as matter of record, although of course no decisive result can be looked for until after a considerable term of years. The peach is particularly unsatisfactory as an experiment crop because the fruit, which alone furnishes a numerical expression of the effects of fertilizers, tillage or other factors of growth, cannot be expected each year and sometimes fails for a number of years.

The experiment here described is on land of Mr. A. E. Plant in Branford. The orchard is on a high hill, some miles from the shore of Long Island Sound. The soil is a gravelly loam of fairly good quality. The history of the field is as follows:

After lying several years in grass, the lot was plowed in the fall of 1894, was dressed during the winter with from 75 to 100 bushels of unleached Canada ashes per acre, and was planted to peach trees in the Spring of 1895, the varieties being Mountain Rose, Champion and Early Rivers. Twelve hundred pounds of Mapes' corn manure was applied per acre, and the orchard planted to corn.

The following winter, 1895–1896, 75 to 100 bushels of unleached ashes per acre were again put on the land.

In the Spring of 1896, there were laid off on the south end of the orchard eight plots or blocks of trees. Each of these plots covered about one-third of an acre and had 48 trees standing on it. The number of trees of the three varieties named was the same on each plot. To the northern half of each plot, 3½ bushels or 167 pounds of slaked oyster shell lime were applied.

The plots, beginning at the west end, were marked and fertilized as follows:

F 260 "high grade sulphate of potash, 160 pounds of acid phosphate.

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These fertilizers, and the lime, have been applied each Spring, since 1896, in April or very early in May.

In August of each year, crimson clover has been sown on plots C, D, E, F, and has always grown well and lived through the winter. It is plowed under in May. Plot A has abundance of potash and phosphoric acid but gets no nitrogenous fertilizer. Plot B has each year about 500 pounds of cotton seed meal per acre, containing 35 pounds of nitrogen, while all the other plots receive their nitrogenous fertilizer in form of crimson clover as a green manure.

Plots C, D, E should show the effects of heavy dressing with muriate of potash and F should show the comparative effects of a heavy dressing of high grade sulphate.

The southwest corner of the field, on plot A, is the dampest part of the lot, in spite of an underground drain, and we believe plot A is the least favorably placed of all the plots.

Each year a certain number of the trees have died and have been replaced by new ones in the Spring. No case of yellows has been found in the whole orchard.

Each Spring a census of the trees which died during the last year, has been made, which is as follows:

## NUMBER OF DEAD TREES FOUND IN THE SPRING.

		1896.	1897.	18	398.	1899.	Total.
Plot A		2	12		2	I	17
В		3	6		I	I	II
C		2	3		I	I	7
D		0	I		2	0	3
E	1	0	I		0	0	I
F		0	0		0	0	0
		-		_	_		
		7	23		6	3	39

Plot A has suffered most, losing more than one-third of the trees on it in four years. This we believe, is partly due to the excess of water in the soil. Plot B has lost II trees, less than one-fourth of the whole number; C, D and E a smaller number, and on F not a single tree had died.

In 1898 there was a fine set of fruit buds, but most of the very young fruit fell later in consequence of cold storms at and just after setting time.

In 1899 there was an excellent set of fruit in the large orchard of which the trees above referred to form a part, while

in most orchards of the State, every flower bud was killed during the winter. As illustrating the vagaries of the peach crop and the New England winter, it is worth noting that in another part of Mr. Plant's orchard, more than 900 trees which blossomed fully in April soon showed signs of trouble and died before the leaves came out. They had been killed by the winter near the ground as effectually as if girdled with a knife.

The Early Rivers peaches, 95 baskets in all, were picked in our absence and no note is made of them. The other two varieties were picked and measured under the supervision of one of the Station staff. The crops were as follows:

### PEACH CROP. NUMBER OF BASKETS.

Рьот	A	В	С	D	E	F
No. of baskets	65	117	81	IIO	1551/2	1401/2
No. of trees in bearing exclusive of Early Rivers	20	31	23	27	36	30
tree in bearing	3.2	3.8	3.5	4.1	4.3	4.7

Any discussion of these results at the present time would be premature.

# EXPERIMENTS IN CURING AND IN FERMENTING WRAPPER-LEAF TOBACCO. SEASON OF 1899.

By E. H. JENKINS.

Curing the Crop.

These experiments are in continuation of those begun in 1897, described in the Reports of this Station for 1897, page 223, and for 1898, page 297.

The barn with the heating apparatus was described in our

last report as follows:

This barn is 60 feet long, 32 feet wide, 16 feet high to the eave plates, having vertical ventilators of the usual kind, hinged just below the eaves and opening down to the sills. It also has a ventilator two feet by three in each gable end, just below the peak, with a shutter which can be closed or opened from the ground by cords. Below this ventilator there are six narrow ventilators, hinged from the top. On each end of the barn are two large doors, built in the usual way, and on one side is a small door for entering the barn during the cure. The sides and ends of the barn are battened on the inside. The lower tier of poles for hanging tobacco rests on slip-girths, so that the lath of tobacco on this tier hang crosswise of the building, like those above. The barn is built on stone and brick piers. The space between the sills and the surface of the ground is boarded up. In the center of the barn is a brick chimneywith a flue thirteen by eight inches in the clear,—which goes through the roof just to one side of the ridge pole. Except that the barn has a chimney and is made as tight as possible and battened, it is not at all unlike other barns in the neighborhood. Two stoves of heavy sheet iron, two feet eight inches from front to back, with a breadth and height of two feet four inches, each stove having a cast-iron door with draft, are used for heating the barn. One stove on each side of the barn, midway from end to end of it, is set in an excavation outside the building, the bottom of the stove being six feet below the level of the sill. Around the sides and rear end of the stove is a brick wall, having an air space of five inches closed in the front side. This wall is five inches higher than the top of the stove, iron bars are laid across it, which support a sheet-iron cover,

and this, in turn, is covered with earth. On the front, near the bottom, are openings which supply air to this air-space, which surrounds the stove except on the front and bottom.

This whole structure is three feet below the sill at its nearest point. From the stove, and through the air-space, a smoke pipe seven inches in diameter passes under the sill and into the barn straight to the chimney, having a rise of about five feet in going the distance of seventeen or eighteen feet. From the air-space, two hot-air flues, seven inches in diameter, pass into the barn, which is built with its ridge running east and west. Within the building and four feet from the south side of the barn one of these flues turns at a right angle and runs east to within four feet of the east end of the barn, thence north to within four feet of the center line of the building, and thence west till it joins the smoke pipe near the chimney. The other hot-air flue on the south side runs in a similar way to the west end of the barn and back again to the smoke pipe. The arrangement on the north side of the barn is similar. By brick supports these hot-air pipes are given a pretty uniform pitch, rising all the way from where they enter the barn to where they enter the chimney.

The hot-air flues are also connected, where they enter the building, with the smoke pipe, and by the use of dampers, all the smoke can be sent through the smoke pipe direct, but the hot air from the hot-air chamber, through the flues; or by properly adjusting the dampers, the products of combustion can be sent through the hot-air pipes also.

It is best to start the fires with direct draft to the chimney, but when the chimney has got well warmed the draft is sufficient to draw the smoke through the hot-air flues without smoking the building at all.

The pipes are numbered, and, when not in use, taken up, boards being laid down where the pipe runs below the surface of the ground and covered over with earth. After the barn is filled with the harvested tobacco the pipes can be laid in an hour's time.

In front of each stove the earth is sloped up to the general surface of the field, and boards are so placed as to prevent caving. A lean-to affords protection to the one who tends the fires. The building was inspected by the insurance companies and insured on a premium of one and one-half per cent.

In the fall of 1898 the tobacco field, containing scant two acres, was dressed with the finely cut stalks of the crop of 1899. In the winter about twenty-nine tons of New York stable manure was put on the land in large heaps, which were spread in the early spring and plowed under on April 15th,

On May 3d, 4,000 pounds of cotton seed meal, 1,000 pounds of cotton hull ashes, 1,200 pounds of swift-sure superphosphate and two barrels of lime were sown broadcast on the field and cultivated in.

On May 12th two pounds of Paris green were mixed with two hundred pounds of moist bran and scattered over the rows to destroy cut worms. The tobacco plants were set on May 18th.

The crop was cultivated in the usual way, grew without suffering from drought and was harvested on August 4th and 5th, and hung as usual on lath, which were eight inches apart on the poles. At harvest the crop was believed to be a remarkably good one, certainly the best in appearance of any since 1892.

The crop was cured as far as possible in the usual way, heat being used simply to continue the cure when the weather conditions were unfavorable.

In a dry, hot day the interior of the barn, when filled with green tobacco, is much cooler than the air outside. For instance, on August 6th, a hot clear day, at 4 P. M., the air outside was at 82°, while in the middle of the barn it did not go above 74°.

The next day at noon the temperature in the shade outside was 80°, inside 70°. On August 8th at noon, in the shade outside, temperature 78°, inside 65°. At all these times every door and ventilator was wide open. Obviously at such times artificial heat would be quite unnecessary and perhaps harmful. The tobacco cures of itself quite fast enough and the movement of air, at least in the center of the barn—unless disturbed by high wind—is downward; i. e. the air within is colder than that without and although more moist is still heavier and sinks down, drawing in from above the warm, dry, outer air.

At night, however, the conditions are reversed and change very quickly between five and seven o'clock. A few illustrations of what was often noted will suffice.

On August 5, a close, "hot," foggy night, with a little rain, the temperature outside, from 10 P. M. till 2 A. M., ranged from 60° to 67°. Inside the barn, which was only open under the sills and in the ridge and with a moderate fire, the temperature was 72° to 73° all night.

The next night the temperature outside and inside the barn ranged as follows:

0		utside.	Inside.
4 P. M.		82°	70°
6 "		69	69
9 "		58	68
II "		54	66
I A. M.		51	66
3 "		51	65
5.30 "		51	65

The fire was started at 6 P. M.

A still more striking example of the low temperatures to which curing tobacco may be subject in August, is the following:

On August 8th, after a clear cool day, when the barn stood wide open, it was closed as soon as the temperature was alike outside and inside and a fire was started.

The temperatures in the night were as follows:

		0	utside.	Inside.
Aug. 8.	8 P. M.		48°	58°
	9 "		45	58
				59
	12 "		40	57
Aug. 9.	2 A. M.		38	55
	7 "		51	55
	12 M.		78	65

At two o'clock in the morning the air outside was only 6 degrees above the freezing-point of water.

In all cases the inside thermometer hung in the second tier from the ground and not over any hot-air flue.

It is clear that at night the air within the barn is much warmer than outside, and if it is only open under the sill and in the ridge the current will be in the direction opposite from that in the day time, i. e. upwards; the warmer, and therefore lighter air inside being pressed up by the colder, heavier air without.\*

These observations led us to follow the plan of opening the barn wide on clear, dry days and airing it thoroughly. As soon as the outside temperature fell to that of the inside, the barn was closed, except under the sills and in the ridge, and the fires were started and run through the night. The object was to assist the upward air current which naturally moves at night and to keep the tobacco from the night chill, thus making the temperature of curing much more nearly uniform.

The cure was started on August 5th, and on August 14th was well advanced, much further than in the case of tobacco cut at the same time, but curing under the usual conditions. Even the top leaves were turning yellow.

It was judged that as long as the weather was good no further heating was desirable, as it might dry the leaf too quickly. It was necessary for the writer to leave the experiment at this time and the barn stood open, night and day, till August 26th.

The leaves, excepting the mid-ribs, were nearly cured on that date. The tobacco was very damp, as the weather for a whole week past had been warm, damp and "muggy," with one very heavy rain:—typical "pole-burn weather."

The barn was closed, the fires started, and the whole crop was dried out without damage. Pleasant weather followed and on September 21st and 22d, the crop was taken down and stripped.

It is clear to us that this method of curing is a valuable help in preventing pole-burn. We are not yet prepared to recommend this special form of heating apparatus, and we find that while by it the bottom tier is absolutely protected from pole-burn there seems to be an eddy or place where there is dead air in the second or third tier which may give trouble. It is planned to experiment further on the subject.

# The Fermentation of the Tobacco Crop.

During the spring and summer of 1899, some observations were made on the temperature of tobacco which is fermented in cases by the method commonly practiced in Connecticut.

This method consists in tightly packing the sorted tobacco, tied in hands, into cases holding 300 pounds or more, which are piled up in unheated storehouses, turned once or twice and are sampled and sold after lying through one summer. The packing is done in the first three or four months of the year.

The thermometer readings were made by the firm of L. B. Haas & Co. of Hartford, who also kindly offered the use of four cases of wrapper-leaf tobacco for these observations. The telephone thermometers were loaned to us by Prof. Milton Whitney of the United States Department of Agriculture.

Readings were taken almost daily for several months, but a single weekly reading will show the changes of temperature sufficiently.

The four cases represent different grades of wrapper-leaf stored in different rooms of the packing house.

The temperatures in the center of each case were as follows:

Correlation of the Correlation o				
No. of Case.	2010	4	2393	329
Mar. 4	57°	65°	58°	_°
11	59	68	60	60
18	61	77	62	61
25	61	77	68	60
Apl. I	63	76	74	
8	.63	76	73	
15	63	78	73	
22	64	79	74	79
29	69	80	75	81
May 6	75	85	79	83
13	78	86	79	84
20	77	85	76	82
June 3	79	80	79	80
24	84.	81	83	82
July I	82	79	83	81
15	_	81	_	82
29	83	82 -	82	83
Aug. 5	Transfer .		83	

It will be seen that case No. 2010 lay for nine weeks, tightly packed before the tobacco reached even "temperate" heat, 70° F. Possibly the time was still longer, for we have not the date on which the leaf was packed.

<sup>\*</sup>Repeated observations made at night, while the fires were running, showed that the air five feet above the ground within the barn,—away from the flues,—was warmer, had lower relative humidity but a larger absolute humidity than the air outside. It must, therefore, be specifically lighter.

We certainly know that some cases of the 1898 crop damaged in the case, between the time of packing and the first of Mav and we believe that the greatest danger to cased tobacco from mold and mustiness is when it lies cold and damp, unfermented waiting for sufficient heat from the air to penetrate it and start the fermentation. During the last two years a "forced sweat" has been used by some dealers in order to get tobacco as soon as possible on to a waiting market. For this process the leaf is cased as above described and put into a room where the temperature is maintained for about six weeks at 100° to 130° and the air is kept somewhat moist. The tobacco comes out "sweated," with its gum gone and keeping its light colors. It is fairly satisfactory, quite even in color and has found a readv market. But opinions differ considerably as to its real value as compared with "natural sweat" leaf. In Sumatra, Cuba, Germany and Holland as well as in Florida, a third method of fermenting wrapper-leaf is universally employed for which there is no precise name. It is not a "forced" fermentation, for in the fermenting room the temperature is not raised above 80°-85° F. It is a "natural" fermentation, but the leaf is put at once into a summer climate instead of lying for several months in the cold, waiting for the turn of the seasons. It differs also from the other two methods in that the leaf is piled loosely in large heaps or bulks containing thousands of pounds for the fermentation, instead of being packed tightly in cases containing a few hundred pounds each. This method was discussed in our Report for 1898, page 302, where is also described an experiment in fermenting Connecticut leaf by this means, the first experiment of the kind, we believe, on record. This year the same experiment has been repeated with more skillful supervision and has demonstrated the unqualified success of the method.

Professor Milton Whitney of the Division of Soils of the United States Department of Agriculture, most kindly coöperated with us and secured for us the services of Mr. M. L. Floyd, the tobacco expert of the Department, who has had years of practical experience in handling, fermenting and selling cigar leaf tobacco in Florida and other States. To these gentlemen is largely due the success of the undertaking. Mention should also be made of the Connecticut Tobacco Experiment Co., an

organization of practical tobacco growers, which has for eight years coöperated with this Station in experimenting on the fertilizing, curing and fermenting of leaf tobacco.

The sorted tobacco cured as described on previous pages, was sent from Poquonock to the Station and on December 16th was weighed in as follows:

No. I.	Long wrappers	1,2891/2	pounds.
	Short wrappers	547	66
	Long seconds	375	46
" 4.	Fillers	1571/2	
" 5.	Dark wrappers	4491/2	
" 6.	Top leaves	2571/2	"
	Total	3,076	

The fermenting room, in the laboratory cellar, was kept at a temperature of 80°-85° by a steam pipe passing through it to the greenhouses beyond and the air could be dampened by blowing steam from a pet-cock in this pipe.

Mr. Floyd took charge of the whole operation. On December 14th about 1,900 pounds of trash tobacco, the sorting-room waste, was shaken out and sprayed with warm water till it was wet and "soggy," and put into the fermenting room in a loose conical pile, covered with blankets. The next day it was shaken over and piled as before.

It was no longer soggy, no water stain was visible; it was soft, pliable and elastic and contained 33.8 per cent. of moisture.

A thermometer in the center of this pile showed the following readings:

Dec.				
66	16.	A. M.		114°
	16.	M.		117°
"	16.	P. M.		117°
	7	emper	ature of the room, 80°-84°	

A platform 12 feet long and 5 feet wide was laid on joists which raised it four inches from the floor, with vertical headers of boards at each end. On this platform was packed a layer of the hot trash eight inches deep, and next above a layer of first wrappers, butts on the outside, tips always towards the center. A second layer was put on, the butts resting on the body of the

leaf below, and about a foot from the outside, overlapping, as shingles are laid. Then followed a thin layer of trash, then first wrappers as before and so on as long as the trash lasted. Then the remaining first wrappers were put on in layers without trash. No pressure was applied; the workmen stood on the floor and simply laid the hands of tobacco on the bulk loosely.

The trash was mixed in this way to increase the heat and moisture; for being a first experiment it was not thought wise to dip the wrappers. Experience showed, however, that water could have been safely used and the layers of trash omitted. The bulk was covered with blankets. The same day the No. 2 wrappers, which were too dry to ferment, were brought into "case" by dipping the butts about two inches deep into warm water, and then holding the hands by their butts and shaking them vigorously till the water was well distributed.

They were then loosely piled in the fermenting room to "draw."

The next day they were put on the bulk in the way above described, but without any trash tobacco.

All the other grades were brought into case in the same way and put in the bulk, which was in the end eight or nine feet high and must have weighed at least 5,500 pounds. The whole was covered with trash, woollen blankets and rubber blankets on the outside.

The air in the room was kept just moist enough so that a hand of unfermented tobacco hung in the room would remain pliable.

As the bulk was built, telephone thermometers were built in with it which could be easily read without removing them.

The records of this bulk are as follows:

			No. 1. Near bottom of bulk.	No. 2. A foot below No. 3.	No. 3. Near top of the No. 1 wrappers.	No. 4. Near top of bulk.
Dec.	18.	P. M.	88°	84°	73°	°
"	19.	A. M.	97	88	80	87
		P. M.	99	90	85	89
"	20.	A. M.	107	98	. 93	97
		P. M.	IIO	103	99	IOI
"	21.	A. M.	113	III	108	107
		P. M.	113	114	113	III
44	22.	A. M.	II4	118	119	115
		P. M.	II5	120	121	115

The heat rose somewhat slowly at the bottom of the heap. In other parts the temperature rose during the four days at the rate of from eight to twelve degrees in twenty-four hours.

As the event proved, the tobacco might have been left undisturbed for several days longer, but wishing to see how the fermentation was going, the bulk was taken down on December 22d, and rebuilt after shaking out the leaf slightly. This was finished in the afternoon of December 23d. As far as possible, the outside tobacco from the first bulk was put inside the second and what was at the top of the first bulk was laid at the bottom of the second. The readings of the thermometers inside the bulk were as follows:

			Nea	No. 1. r bottom, est side.	No. 2. In middle, west side.	No. 3. Near top, west side.	No. 4. Below center, east side.	No. 5. Near top, east side.
Dec.	23.	P. M.		83°	86°	92°	84°	85°
"	24.	"		93	92	96	89	93
66	25.	4.6		93	97	104	96	104
	26.	4.6		95	104	112	104	112
"	28.	"		100	112	115	116	114
- 44	29.			103	115	115	118	115
66	30.			107	115	115	118	115
"	31.	"		108	115	III	117	114
Jan.	I.	"		110	114	111	• 117	113

It is seen that the rise of temperature in the second bulk is much more gradual, only two or three degrees per day, and is not as large by some five degrees.

On the second of January, 1900, the bulk was turned once more in the same way as before and the thermometers replaced.

The record of this bulk is as follows:

100		No. 1.	No. 2.	No. 3.	No. 4.	No. 5.
Jan.	3	89°	94°	92°	88°	88°
	4	89	96	95	92	89
	5	90	99	98	97	102
	6	91	IOI	99	105	99
	7	90	104	IOI	107	105
	8	90	105	103	108	IIO
	9	90	108	105	108	112
	IO	89	107	105	105	113
	II	87	107	106	105	113
	13	84	105	106	105	112
	14	84	105	106	104	110
	15	83	104	105	104	109
	16	81	104	104	102	106
	18	80	103	104	102	108
	23	77	100	103	IOI	104

It was clear that active fermentation had ceased and the leaf had begun to cool off. Examination of leaves from different parts of the pile showed that the gum was gone and the whole body of leaf was thoroughly fermented or "sweated."

It was, however, allowed to stand in the bulk for some time longer. It was then examined by members of two large New York firms who deal in domestic leaf, a Connecticut tobacco dealer and a cigar manufacturer who handles large quantities of Connecticut wrapper leaf.

The unanimous opinion of all these gentlemen was that the process was a remarkably successful one. The leaf was of a perfectly even color from the tip to the stem end.

The gum was all gone, the leaf was light and elastic and there had not been the slightest damage during the fermentation. Particular attention was given to the leaves on which the butts of the next layer of leaves rested, as the dealers thought that there some damage must have been done. Careful search was made, but not a single damaged leaf could be found in the bulk. Another point was that of water-stain. As stated above, all the hands—except those of first wrappers—had their butts dipped in warm water and the leaves shaken out, immediately before putting into the fermenting room.

A few of the second wrappers came out of the fermentation with some water-stain near the mid-rib of the leaf, but none on the margin, but the most of the dipped leaves showed no traces of water-stain. The second wrappers were dipped just at night-fall and in great haste and probably not sufficient care was taken in shaking them out. If they had been left a few days longer in the first bulk, probably there would have been no water-stain, even in the over-wet leaves.

Our experience has shown that unfermented leaf will bear a good deal of wetting if it is warm and goes at once into active fermentation. But under no other circumstances will it bear wetting.

After being examined by these experts the crop was cased and after standing in the cases for two weeks at about 70° F. was shipped to be sold.

It is interesting to compare the weights of the fermented and unfermented leaf.

	a	Before casing nd fermenting.	After fermenting.
No. I.	Long wrappers	I,289½	1,2091/2
" 2.	Short "		5991/2
" 3.	Long seconds	375	371
" 4.	Fillers	157½	173
16 5.	Dark wrappers		462
" 6.	Top leaves	257½	253
	Total	3,076	3,068

The whole crop weighed only eight pounds less after fermenting than before, and three of the grades were damper at the end of the process than before they were dampened at the beginning of it. Of course the fermented leaf will dry out rapidly in the cases. Thus between February 7 and February 23, the loss of moisture from the whole casing was 247 pounds.

# THE AREA OF LEAF SURFACE ON THE TOPPED TOBACCO PLANT.

## By E. H. JENKINS.

To get an approximate idea of the amount of leaf surface on a tobacco plant or on an acre of tobacco, a single plant which had been topped and suckered and was ready for harvest was stripped of its leaves, eighteen in number. The outline of each leaf was carefully traced in pencil on a rectangular sheet of paper, and the figure of each leaf thus traced was cut out with scissors.

The area and weight of the sheets used for this purpose had been carefully determined beforehand. By weighing the leaf figures and the cuttings separately it was easy to calculate the area of these leaf figures, assuming that the paper is of uniform weight for each unit of surface. The eighteen leaves were thus calculated to have an area of 27.2 square feet.

Reckoning 7,700 plants to the acre, it would appear that the leaves from one acre of Connecticut Havana tobacco, at harvest time, would cover 4 s/10 acres.

# TESTS OF THE VITALITY OF VEGETABLE SEEDS By E. H. JENKINS.

Since November, 1898, two hundred and ninety-one samples of seeds, chiefly of garden vegetables, have been tested as to their vitality. This work has been done in the interest of seedsmen and of purchasers, and has been executed for the most part by Mr. Churchill.

The methods of testing adopted by the Association of American Agricultural Colleges and Experiment Stations have been closely followed, and the standard germinating chambers have been used.

Table I presents the average, maximum and minimum vitality of all the seeds tested at the Station by the newly adopted methods. The age of the seeds given in the table is that reported by the seedsmen or growers who sent the samples. The samples were in all cases drawn by the persons sending them. Since the samples were sent by the seedsmen for their own information, and it was understood that the results of the tests were not to be published as representing the character of their goods, there was no motive for any misrepresentation as to the age of the seed. The samples for the most part undoubtedly represented cleaned seed as prepared for market.

TABLE I.—GERMINATION TESTS OF VEGETABLE SEEDS.

	Age of Seed in years, when tested.	Number of Samples.	Average percentage by number of seed sprouting.	Maximum.	Minimum
Beans	0-1	7	86.5	100.0	56.7
Deans	1-2	15	QI.I	100.0	72.0
	2-3	8	87.0	100.0	59.0
	3-4	15	92.3	99.0	83.0
Beets	0-1	21	154.4	211.0	65.5
Jeets	1-2	16	162.8	230.0	75.0
	2-3	7	140.8	192.0	73.5
Brussels Sprouts	3-4	2	18.4	36.0	0.8
Cabbage	0-I	30	83.3	95.8	44.0
Jabbago	1-2	22	73.5	96.5	28.3
	2-3	3	71.5	88.0	43.0
	3-4	4	62.8	91.5	27.0
	4-5	2	64.9	85.8	44.0
	6-7	I	63.8		
Carrots	0-I	21	57.6	90.8	35.0
Samots	1-2	23	44.1	91.3	14.5
	2-3	5	43.6	54.2	31.0
Cauliflower	0-I	I	84.5	54.2	31.0
Jaumiower	1-2	6	51.2	88.3	27.5
		I	77.3		27.3
Celery	3-4 0-1	17	68.0	83.5	38.3
Solicity	1-2	15	34.7	63.8	4.0
			55.5	79.3	9.8
2000년 전 1200년 1월 1일	2-3 3-4	9		63.5	27.3
Corn, Sweet	0-I	5	55.4 83.4	99.0	32.9
Corn, Sweet	1-2	3	74.5	98.0	37.5
Cress	0-I	13	61.5	91.3	A 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1
Cless	1-2	3	69.8	91.3	35.5
Cuaumhara	0-I	10	86.3	99.0	57.0
Cucumbers	The state of the s		80.0	98.5	
	1-2	15	81.2	83.0	39.5
	2-3		1	90.0	79.5
	3-4	5	71.3		
Dandalian	4-5	I	79.0		7777
Dandelion	0-I	7 1 0 1 1 1 1 1 1 1 1 1	70.3		40.0
Egg Plant	0-1	2 2	48.5	57.0	40.0
Endive	1-2		43.2	52.5	34.0
Kale	0-1	2	87.3	94.0	80.5
Kall Daki	3-4	I	45.8		86.8
Kohl Rabi		2	90.1	93.5 86.0	76.3
Leek	0-I	5	81.3		
	1-2	3	76.5	79.3	74.0
	2-3	I	35.5	T00.0	79.0
Lettuce	0-1	27	87.6	100.0	18.0
	1-2	32	80.3	100.0	23.5
	2-3	12	75.8	98.8	23.8
	3-4	I	6.4		
	5-6	I	10.3		

TABLE I .- Continued.

	Age of Seed in years, when tested.	Number of Samples.	Average percentage by number of seed sprouting.	Maximum.	Minimum
Mangel Wurzel	0-I I-2	* 2	190.0 89.4	203.0 176.0	177.0
Musk Melon	2-3 0-1 1-2	4 8	103.5 75.4	181.0	20.0 21.0 28.0
	2-3 3-4	10 1 5	70.8 92.5 42.8	96.5	29.0
Onion, Connecticut grown	O-I I-2	155 31	72.4 55.5	97.5 91.5	36.8 0.8
California grown	2-3 3-4 0-1	20 I 33	18.1 59.5 91.3	68.3 97.5	77.3
	1-2 2-3 3-4	9 3 I	86.5 85.9 10.0	98.0 91.5	58.5 87.5
Parsley	0-I I-2	I 6	73·3 33·4	72.0	7.8
Parsnip	0-I I-2 2-3	5 4 1	49.9 15.6 30.3	63.5 42.8	34·3 2·5
PeasPepper	3-4 0-1	2 5	98.5 77.1	99.0	98.0 61.0
Pumpkin	I-2 O-I I-2	6 6 4	48.6 74.0 48.8	70.5 95.0 91.5	16.8 40.0
Radish	2-3 0-I	18	97·3 87·7	99.8	72.0
. 0.10	1-2 2-3 3-4	21 17~ 11	69.7 30.8 30.0	98.8 69.3 69.5	31.0 1.8 5.3
Salsify Spinach	0-I	I 12	80.5 84.9	89.7	59.5
Squash	1-2 0-1 1-2	1 12 5	72.0 87.4 93.0	100.0	68.8 75.0
Tomato	3-4 0-1 1-2	5 8 14 7	35.9 84.8 82.2	82.0 97.0	0.5 76.0
	2-3 3-4	1 3 6	65.5	93.5	55·3 43·5
Turnips	0-I I-2 3-4	6 6 5	94.9 85.9 79.2	98.8 97.8 94.5	88.8 40.3 49.8
Water Melon	0-I I-2	7	82.7 44.9	100.0 77.0	56.3
	2-3 3-4 5-6	7 I	41.7 42.0 69.5	81.0	0.0

The "percentage" of beet seed and mangel wurzel sprouting, as given in the table, is nearer 200 than 100. To test the vitality of beet seed, one hundred "seeds" are put in the germinating apparatus and all the sprouts are counted. As each beet "seed" is a fruit which may contain from two to six separate seeds, it is evident that the possible number of sprouts may be 600. To count the actual number of seeds in the one hundred fruits examined, which would make a true percentage statement of sprouting power possible, would be extremely laborious; but the form of statement here followed is sufficiently intelligible and is justified by usage.

Vitality of Onion Seed as affected by the Age of the Seed.

Since November 1, 1896, the Station has examined 214 samples of onion seed of the crops of 1896, 1897, 1898, and 1899. To these, in the following table, are added the results of tests made in previous years, by the methods recommended by the Association of Agricultural Colleges and Experiment Stations. In the samples examined, the percentage by number of seed which sprouted was as follows:

TABLE II.—VITALITY OF ONION SEED.

	CONNECTIO	CUT GROWN.	CALIFORNIA GROWN.	
	No. of Samples.	Per cent. Sprouted.	No. of Samples.	Per cent. Sprouted.
Seed stated to be less than I year old. Seed stated to be between I and 2	214	77-4	46	90.5
years oldSeed stated to be between 2 and 3	36	59.8	13	82.7
years oldSeed stated to be between 3 and 4	20	18.1	10	79.9
years old	I	59-5	I	10.0

While the number of samples examined of California-grown seed is not large enough to make a close comparison, it is quite evident that a larger percentage of the California seed germinates than of the Connecticut seed.

Table II also shows that onion seed more than one year old, as a rule, has much less sprouting capacity than new seed, although in Table V are numerous cases of onion seed more than a year old which sprout as well as most new seed. Whether the plants produced from old seed are as vigorous and productive as those from fresh seed is quite another question, on which laboratory germination tests can give no light.

Comparison of the Vitality of Crops of Connecticut-grown Onion Seed in the years 1894–1899.

The average sprouting capacity of Connecticut-grown onion seed, as determined for a number of years at this Station, has been as follows:

TABLE III.—VITALITY OF CROPS OF ONION SEED.

		No. of Samples Tested.	Average Percentage Sprouted,
In	1880	14	87.0
	1894	25	82.9
	1895	13	85.5
	1896	44	72.4
	1897	39	77.9
	1898	68	69.3
	1899	62	89.0

The sprouting capacity of onion seed in 1898 was unusually low, for reasons which are not evident, while the sprouting capacity of seed of the 1899 crop has been higher than in any previous year of which we have record.

The Sprouting Capacity of Different Varieties.

The average sprouting capacity of four varieties, of which a considerable number of samples has been tested, is as follows (only those samples are here included which were alleged to be less than one year old at the time of testing):

TABLE IV .- SPROUTING CAPACITY OF DIFFERENT VARIETIES OF ONION SEED.

Variety.	No. of Samples Tested.	Average Percentage of Sprouting Seed.
Yellow Globe	97	76.8
Red Globe	87	80.5
White Globe	39	80.0
White Portugal	23	68.6
Wethersfield Red	4	71.3

The three globe varieties are essentially alike in sprouting capacity, but the White Portugal appears to be distinctly inferior to them in this regard.

TABLE V.—GERMINATION TESTS MADE IN 1899 OF ONION SEED RAISED IN CONNECTICUT.

Vi	Station No.	Age of seed in	Percentage of Seeds by Number.			Number of days
Variety.		years at time of testing.	Sprouted in 14 days.	Remained hard.	Decayed.	within which one-half of the sprouting seed germinated.
Vellow Globe, Crop of 1899	2006	0-1	92.5	1.8		3
	2010	0-1	92.3	2.8		4
	2011	0-1	86.8	2.0		4
	2012	0-1	79.5	3.8		3
	2013	0-1	90.0	3.8		3
	2014	0-1	92.5	2.8		4
	2015	0-I	92.5	3.2		3
	2016	0-1	90.3	2.0		3
	2029	0-1	84.0	4.8		4
	2030	0-1	83.5	5.5		3
	2032	0-1	83.8	5.8		3
	2040	0-1	92.8	3.8		3
	2053	0-1	90.0	2.2		4
	2061	0-1	91.3	4.8		3
	2062	0-1	87.8	4.8		3
	2078	0-1	85.0	3.0		4
	2079	0-I	95.3	0.8		3
	2254	0-1	81.0	2.0		3
	2257	0-1	82.0	2.0		3
	2258	0-1	84.3	1.5		3
Crop of 1898	2259	1-2	25.8	18.3		4
Red Globe, Crop of 1899	2007	0-1	89.0	2.8		3
	2017	0-1	95.5	0.2		3
	2018	0-1	97.0	1.0		4
	2019	0-1	88.8	1.5		3
	2020	0-1	91.3	1.8		3
	2026	0-1	94.3	2.0		3
	2036	0-1	88.0	0.5		3
	2039	0-1	93.5	2.5		3
	2049	0-1	88.5	1.2		4
	2050	0-1	91.8	1.8		3
	2051	O-I	90.3	3.2		3
	2052	0-1	89.8	2.0		3
	2054	O-I	88.5	2.5		4
	2055	0-1	89.3	3.0		3
	2059	0-1	88.8	3.8		3

## TABLE V-CONTINUED.

	Station	Age of seed in	Perce	ntage of Se Number.	eds by	Number of days within which one-half of the sprouting seed germinated.
Variety.	No.	years at time of testing.	Sprouted in 14 days.	Remained hard.	Decayed.	
Red Globe, Crop of 1899	2063	0-1	88.8	2.2		
o.o.o., o.op o. 1099	2080	0-I	93.0	1.8		3
	2248	0-1	93.3	1.8		3 ?
	2249	0-1	95.5	1.0		1
	2250	0-I	86.8			? /
	2251	0-1	84.8	4.0 6.2		?
	2252	0-1	96.8			3
	2255	0-I	94.3	0.5 1.8		3
	2256	0-1	94.3	1.8		3
	2260	OI	57.0	15.2		3
	47.8		37.0	13.2		4
Crop of 1898	2048	1-2	56.8	18.0		=
	2284	1-2	0.0	34.5		5
White Globe, Crop of 1899	2008	0-1	97.5	1.5		3
	2021	0-1	97.0	1.2		3
	2022	0-I	90.8	3.2		4
	2023	0-1	95.3	0.8		4
	2024	0-I	92.8	1.0		4
	2027	0-1	89.5	0.8		3
	2041	D-I	94.8	2.8		3
	2056	0-I	92.5	1.0		3
	2057	0-1	93.8	2.0		3
	2000	0-I	85.8	3.2		3
	2077	0-1	91.8	2.0		
	2246	0-1	95.5	0.5		3 ?
	2247	0-1	85.8	1.2		?
	2253	0-1	94.8	1.5		?
Wethersfield Red, Crop of 1899	2072	0-1	66.0	3.5		3
	2287	0-1	74.5	4.0		3
Crop of 1898	2004	1-2	64.0	12.6		4
White Portugal, Crop of 1899-	2025	0-1	76.0	5.5		4
Crop of 1898_	2038	1-2	82.8	3.0		4

# THE NUCLEIC ACID OF THE EMBRYO OF WHEAT AND ITS PROTEIN COMPOUNDS.

BY THOMAS B. OSBORNE AND GEORGE F. CAMPBELL.

Frankfurt (Versuchs-Stationen, 47, 449) has estimated the proportion of various constituents of the embryo of wheat and found globulin, 21.62 p. c. and albumose 13.62 p. c.

O'Brien (Annals of Botany IX, 543) states that the proteids of wheat germs consist of globulins of the myosin-type, coagulating at 55°, soluble in dilute solutions of sodium chloride or magnesium sulphate and precipitated by excess of these salts; globulins of the vitellin-type, coagulating at 75°-78° and soluble in dilute solution of sodium chloride, but not precipitated by an excess; proteose; and albumin not coagulating below 80°, soluble in sodium chloride solution, not precipitated by an excess, nor by dialysis, nor by carbonic acid.

As neither of these investigators has given more than a superficial account of the protein\* substances found by him in the embryo of wheat, we determined to investigate this subject, in order to learn definitely which of the proteins contained in the wheat kernel are predominant in the embryo, and whether there is any special difference in character between the proteins of the more physiologically active germ and those of the dormant endosperm.

As a result of this investigation we have found that, of the proteids described by one of us† as constituents of the wheat kernel, the albumin (leucosin), the globulin and the proteose, which in the whole seed are present in small proportions, together constitute a large part of the embryo, and further, that gliadin and glutenin, the principal proteid constituents of the endosperm, are not present in the embryo.

Although the globulin and leucosin obtained from the whole seed were free from phosphorus, all of our preparations

<sup>\*</sup>In this paper the term protein denotes the basic molecules which, combined with simple acids, form the "simple proteids," and combined with other more complex groups, form the "compound proteids" (Hammarsten, Text-book of Physiology, translated by Mandel. Third Edition, 1900). The term proteid in this paper includes both of these groups of protein compounds.

<sup>†</sup> Osborne & Voorhees, Am. Chem. Jour., XV, 1893, 392.

of the globulin, and many of those of the albumin, from the embryo contained various yet considerable quantities of this element, and when digested with pepsin, yielded insoluble products having the characteristics of nuclein. The elementary composition of those preparations of the embryo-albumin which contained no phosphorus, or only traces, was the same as that of leucosin prepared from the whole seed, while the composition of those embryo-albumin preparations which contained phosphorus differed from that of leucosin in proportion to the phosphorus present.

Analyses of different preparations of embryo-globulin showed no agreement, even when corrected for ash.

These facts led us to examine our extracts for nucleic acid. and having found this acid and determined its composition, it was seen that the differences just alluded to disappear if we assume the phosphorus to be present as nucleic acid and calculate the analyses free from this acid and from ash.

In a paper recently published by one of us on "Some Definite Compounds of Protein Bodies" (Jour. Am. Chem. Soc., XXI, 486), it was shown that many, if not most preparations of socalled native proteids are, in fact, compounds of protein bodies with acids, and it was suggested that nucleoalbumins might prove to be similar phosphoric acid compounds.

In that paper it was also shown that the crystallized globulin, edestin, obtained from hemp-seed, forms a compound with one, and another compound with two molecules of hydrochloric acid, both of which are crystalline, and that the preparations of this globulin as commonly obtained, are mixtures of these in various proportions. It was also shown that the protein molecule can combine with more than two molecules of acid, so that several multiple compounds of one acid with the same protein molecule can undoubtedly exist.

That our preparations from the wheat-embryo are mixtures of two or more compounds is shown by the variable proportions of phosphorus which they contain. That phosphorus is a chief factor in determining the proportion of nuclein that separates during pepsin digestion is shown by the fact that the amount of nuclein found is always in close relation to the amount of phosphorus contained in the preparation.

That the preparations are not mixtures of already formed nuclein with ordinary proteid matter is shown by the difference in solubility and behavior of the original preparation from that of the nuclein derived from it.

It would seem, then, that the nuclein obtained by pepsin digestion is not an original constituent of the extract nor of the cells of the embryo, but results through combination of several molecules of nucleic acid with one of protein.

Accordingly we conclude that these phosphorus-containing preparations from the wheat embryo are mixtures of different protein nucleates and that when subjected to pepsin digestion, in consequence of the conversion of a part of the protein substance into proteose, the proportion of nucleic acid to unaltered protein is increased, so that higher acid nucleates are formed which are insoluble in the digestive fluid.

The grounds for these conclusions are given in the following detailed account of our investigation.

The material at our command consisted of a quantity of wheat germs, a specially prepared product of the Pillsbury Mills, from which the bran and endosperm had been very thoroughly removed, which was kindly procured for us by Mr. David Chidlow of Chicago.

The germ meal, which was prepared and sent to us in cold weather, was immediately extracted with petroleum naphtha and ground to a flour.

## I. THE NUCLEIC ACID OF THE WHEAT EMBRYO.

We shall later show that the precipitate produced by saturating the slightly acid aqueous extract of this wheat embryo meal with sodium chloride contains almost all the phosphorus of the extract. We accordingly extracted a large quantity of the meal with water, saturated the extract with sodium chloride and subjected the precipitate to a vigorous pepsin digestion. We thus obtained a considerable quantity of nuclein from which we prepared nucleic acid in the following manner:

The nuclein was thoroughly washed with water and then dilute potash solution was added until all the nuclein had dissolved and its solution become faintly alkaline to phenolphthalein.

This solution was cautiously treated with dilute hydrochloric acid until a precipitate was formed, which separated readily from the solution. This was filtered out and the clear filtrate found to yield no precipitate on adding a little more acid. A considerable quantity of strong hydrochloric acid was then added, causing a precipitate of nucleic acid, which separated in large flocks that rapidly settled to a coherent layer. The deposit continued to contract and soon became so dense and brittle that it could be ground to a powder even under water. The solution was decanted, the sediment was thoroughly washed, redissolved with alkali and again thrown down by adding acid. Since this last precipitate still contained much coloring matter, it was again dissolved with alkali and the solution poured into alcohol. This retained the basic coloring matter and threw down a voluminous precipitate of potassium nucleate, which was thoroughly washed with large quantities of alcohol, dried to remove the alcohol and then dissolved in water and the nucleic acid reprecipitated by an excess of hydrochloric acid. Since all the coloring matter had not been removed by the preceding treatment, the precipitate was twice dissolved in alkali and precipitated by pouring into a large volume of alcohol. The nucleic acid was then thrown down by gradually adding dilute hydrochloric acid to the solution of the potash salt; after thoroughly washing the precipitated acid with water and with alcohol it was dried over sulphuric acid and found to weigh 10.14 grams.

After drying to constant weight in hydrogen at 100°, its weight remained unchanged on further heating at 110° in air. When thus dried it had the following composition:

	I.	II.
Carbon	36.18	36.31
Hydrogen	4.48	4.42
Nitrogen	16.03	16.10
Phosphorus	8.95	8.86
Ash	3.52	
P2O5 in ash	2.88	
Difference	0.64	

The ash consisted, chiefly if not wholly, of potassium metaphosphate and therefore by subtracting from it the  $P_2O_5$  which it contained, we obtain the amount of inorganic base which

had been precipitated as an acid salt together with the free nucleic acid. Calculating our analyses free from this base, we have the following figures:

#### Composition of Nucleic Acid.

	Found.	Calculated for $C_{21}H_{31}N_8P_2O_{15}$ .
Carbon	36.48	36.16
Hydrogen	4.48	4.45
Nitrogen	16.17	16.01
Phosphorus	8.96	8.89
Oxygen	33.91	34.49
	100.00	100.00

About 2 grams of this preparation were hydrolyzed by heating for an hour and a half in a boiling water bath with 2 p.c. hydrochloric acid.

On adding ammonia to this solution, a precipitate soon separated which was digested on the water bath with an excess of ammonia, filtered out, washed, dried over sulphuric acid and found to weigh 0.27 gram.

This substance gave the murexide reaction and was insoluble in hot ammonia, both of which properties are characteristic of guanin. On analysis this crude guanin was found to contain:

	Found.	Calculated for guanin C <sub>5</sub> H <sub>5</sub> N <sub>5</sub> O.
Carbon	40.96	39.74
Hydrogen	3.67	3.31
Nitrogen	45.21	46.36
Oxygen	10.16	10.59
	100.00	100.00

The solution filtered from the guanin was precipitated by cold ammoniacal silver nitrate and the voluminous, gelatinous precipitate washed, pressed on filter paper, suspended in water and decomposed by hydrochloric acid. The solution, containing the hydrochloride of another base, was repeatedly evaporated with water to decompose the chloride and the free base found to weigh 0.2272 gram. This was again dissolved in water and the silver salt precipitated from a boiling solution, the silver compound was decomposed with hydrochloric acid and the solution of the hydrochloride was evaporated and crystallized.

The substance separated wholly in four-sided prisms, most of which were truncated by planes at right angles.

This hydrochloride was then converted into the picrate by dissolving in water, adding a little ammonia, evaporating to dryness, dissolving in about 100 cc. of water and precipitating with a 1.1 p. c. solution of picric acid added cautiously. The very voluminous yellow precipitate was quickly filtered out with the help of a pump, washed thoroughly with water and dried over sulphuric acid. We thus obtained 0.3766 gram of a picrate, which lost nothing on drying at 110° and had the following composition:

	Found.	Calculated for Adenin Picrate, C <sub>11</sub> H <sub>8</sub> N <sub>8</sub> O <sub>7</sub> .
Carbon	36.07	36.27
Hydrogen	2.51	2.19
Nitrogen	30.28	30.77
Oxygen	31.14	30.77 .
	100.00	100.00

From the behavior of this base and the composition of its picrate, it is evidently adenin. Since this acid yields on hydrolysis the purin bases, guanin and adenin, as well as phosphoric acid, there can be no doubt that it is a true nucleic acid closely related to the guanylic acid recently described by Bang (Zeit. f. physiol. Chem. XXVI, 133). The facts that we obtained these two bases from the nucleic acid in nearly molecular proportion and that almost all the nitrogen of the acid was recovered in the guanin and adenin separated from it, lead us to believe that both these bases exist together in the acid molecule. If such is the case, our formula already given must be multiplied by 2.5, making it, C58H77N20P5O37. This formula resembles that of guanylic acid, which calculated to the same basis, is C55H75N25P5O42. The two acids are different, since Bang's guanylic acid yields a pentose on hydrolysis, whereas we have obtained no evidence that any sugar can be derived from our acid. As we are at present engaged in a study of the reactions and constitution of this acid, we will reserve further statements respecting it for a future paper, which we expect to be able to publish soon.

# II. THE PROTEIDS OF THE WHEAT EMBYRO.

## The Aqueous Extract.

The germ flour, described on page 307, when treated with water, yields a gummy mass from which a clear extract is secured with difficulty. From 500 grams of meal an extract was obtained with 2,000 cc. of water, of which 1,400 cc. could be filtered clear. This extract was neutral to litmus, alkaline to lacmoid, and so acid to phenolphthalein that 19 cc. of decinormal alkali were required to neutralize 100 cc. of it to this indicator.

When a freshly prepared, dilute, aqueous extract of the recently ground wheat germs is heated in a water bath, no coagulation occurs, the solution becoming slightly opalescent. If a more concentrated extract, such as may be obtained by treating one part of meal with 5 parts of water, is thus heated, the entire solution solidifies to a firm, opaque jelly, free from visible particles. If, to either of these solutions a very little hydrochloric acid is added before heating, an abundant flocculent coagulum separates on heating.

After standing awhile, the aqueous extract becomes gradually acid to litmus, so that when heated slowly it becomes turbid at about 50° and a large flocculent coagulum separates at 55°. Heated to 65° for some time and filtered, a second coagulum may be obtained on raising the heat from 65° to 100°. The amount of this second coagulum is about one-third that of the first.

The coagulated proteid is dissolved by 0.5 p. c. KOH solution, but not perceptibly by 0.4 p. c. HCl solution, unless the latter is heated, when a clear transparent jelly is formed.

Freed from coagulable protein, the aqueous extract still contains a relatively large amount of substance which has the reactions of proteose.

When the concentrated aqueous extract is poured into a large volume of distilled water, a turbidity forms at first, which mostly disappears after shaking, indicating the absence of a notable quantity of globulin held in solution by the salts dissolved from the meal.

Saturation of the extracts with sodium chloride gives a considerable precipitate, only a small part of which can be

and dried over sulphuric acid, weighed 7.1 grams and made preparation 4.

In a clear water extract of wheat germ meal, dialyzed four days, there appeared a dense turbidity, due apparently to a globulin, since it dissolved on adding sodium chloride. Passing carbon dioxid gas through the dialyzing solution seemed to increase the turbidity, but effected no definite separation. As it was found that  $10 \, \text{cc.}$  of  $N_{10}$  HCl per  $100 \, \text{cc.}$  of the extract caused a separable precipitate, this proportion was added and the resulting flocculent precipitate brought into solution again by adding salt. The clear extract was then dialyzed for two days in running water and filtered from an amorphous precipitate, which was treated as later described on p. 326.

The filtrate from this precipitate was further dialyzed for three days more in running water and then, as nothing separated, for four days more into alcohol. The precipitate which resulted was dried over sulphuric acid, exhausted with water, in order to remove all uncoagulated proteids, as well as other soluble substances, dehydrated with absolute alcohol, again dried and weighed, yielding 12.0 grams of preparation 5.

Another aqueous extract was saturated with pure sodium chloride, the abundant precipitate filtered out, treated with dilute brine and the resulting solution filtered from a relatively considerable quantity of insoluble matter. This filtrate was saturated with sodium chloride, a second precipitate filtered out and likewise treated with dilute salt solution. The insoluble portion was removed by filtration and the clear filtrate dialyzed. The small precipitate separated by dialysis was washed and dried, weighed 4.8 grams and formed preparation 6.

The filtrate from the first precipitation of the substance of preparation 6, caused by saturating its solution with sodium chloride, as described above, was diluted with water and saturated with ammonium sulphate. The precipitate which resulted was dissolved in water and its solution precipitated by saturating with sodium chloride. Although this substance had previously been soluble in saturated brine, after precipitation with ammonium sulphate it was found to be nearly all insoluble therein, so that almost complete precipitation resulted on again

saturating with sodium chloride. The precipitate so produced was filtered out, dissolved in dilute salt solution and reprecipitated by dialysis. We thus secured 7.6 grams of preparation 7.

By saturating another aqueous extract of germ meal with sodium chloride a very large quantity of proteid was separated, which was filtered out, exhausted with dilute salt solution and washed thoroughly with water and alcohol. Dried over sulphuric acid, the preparation, 8, weighed 17 grams.

The filtrate and saline washings from preparation 8 were united and again saturated with salt, and yielded a small precipitate which, dissolved in brine and precipitated by dialysis, gave preparation 9, weighing 2.8 grams. As the salt-saturated solution from which this preparation had separated contained so little protein, it appears that nearly all the proteid precipitated from the aqueous extract by saturating with salt had been converted into the insoluble substance forming preparation 8.

The filtrate, from the salt saturation-precipitate produced in the aqueous extract, was dialyzed in water for several days and the still clear solution then dialyzed in alcohol for 24 hours. The proteid, thereby precipitated in a coagulated state, was filtered out, washed with water and then with alcohol, yielding 12.4 grams of preparation 10.

Another aqueous extract was saturated with sodium chloride and the precipitate, treated in the same way as preparation 8, yielded 18.0 grams of preparation 11.

The saline washings of the last preparation were dialyzed free from chlorides and gave a precipitate weighing 2.86 grams when washed and dried, which formed preparation 12, having the properties of a globulin, dissolving readily on adding salt and being precipitated from such solution by water.

The filtrate from the final precipitation of 12, when heated in a boiling water bath, gave a coagulum which formed preparation 13, weighing 1.64 grams.

The salt-saturated filtrate from the first precipitation of 11, as already described, was heated to boiling and the coagulum produced was filtered out, giving preparation 14, weighing 5.47 grams.

Since analysis showed that most of the preparations already described contained phosphorus, some even in large amount,

we made an attempt to separate the phosphorus from our extract, in order to determine, if possible, the relation of the preparations free from phosphorus to those which contained much phosphorus.

Two thousand grams of meal were treated with 6 liters of distilled water and the extract (four liters) was squeezed out as completely as possible in a press.

As a preliminary experiment, 100 cc. of this clear, filtered extract were made faintly alkaline to phenolphthalein, with about 40 cc. of  $N_{10}$  KOH solution. To insure a sufficient quantity, 20 cc. more of alkali were added and thereupon a little calcium chloride, which gave a precipitate that seemed to partly dissolve on adding sodium chloride. The undissolved part, when washed with dilute salt solution, water and alcohol and dried, weighed 1.7 p. c. of the meal, contained about 55 p. c. of organic matter and left 45 p. c. of ash, consisting of tricalcium phosphate.

To 2,000 cc. of the original extract were then added 1,350 cc. of a solution containing alkali equivalent to 1,560 cc. N/10 solution, with sodium chloride enough to form 6.5 p. c. of the total liquid. To this, a solution of calcium chloride was added, as long as a precipitate formed, and after standing over night the solution was decanted from the precipitate and filtered clear on a pulp filter. Of the clear filtrate, 2,200 cc. were made as neutral as possible to litmus, by adding 180 cc. of N/10 HCl solution. Of the thus neutralized solution, 1,000 cc. when gradually heated in a water bath, became turbid at 52° and a considerable coagulum separated at 53°. After the temperature had been slowly raised to 65° and kept at this point for some time, the coagulum was filtered out, washed and dried as usual, giving preparation 15, weighing 6.4 grams. Another portion of this extract, filtered from the calcium chloride precipitate, was saturated with ammonium sulphate while still slightly alkaline to litmus, the resulting precipitate filtered out, dissolved in water, its solution filtered clear and dialyzed. A slight precipitate formed on dialysis, which was removed by filtering, the solution was heated in a boiling water bath and the proteid thus coagulated was filtered out, washed, dried and weighed as usual, giving 3.07 grams of preparation 17.

To determine what effect the removal of the phosphorized

substance thrown out by calcium chloride had upon precipitation with salt, we made neutral to litmus a liter of the filtrate from the calcium chloride precipitate and then saturated with sodium chloride. The large precipitate which formed was washed by decantation with water, in which it gradually dissolved, until only an insignificant quantity remained. The similarly obtained precipitate from the simple aqueous extract we have shown on page 315, to be nearly all insoluble in water.

To separate globulin from the aqueous extract, 1,200 cc. of clear filtered extract were obtained from 200 grams of the germ meal treated with 2,000 cc. of water. 1,000 cc. of this extract were dialyzed in running water for six days, and the large precipitate resulting filtered out, washed with water and alcohol and dried over sulphuric acid, giving preparation 18, weighing 9.17 grams.

These preparations, thus variously obtained from the aqueous extract, were dried to constant weight at 110° and analyzed with the following results, most of the figures given in the table being the average of closely agreeing duplicate determinations:

TABLE I.—COMPOSITION OF PREPARATIONS OF PROTEID FROM THE WATER EXTRACT OF THE WHEAT EMBRYO.

DATAGE OF THE WHEAT EMBRIO.									
	1.	2.	3.	4.	5.	6.	7.	8.	9.
Carbon	51.13	50.52	50.17	52.39	51.77	52.13	52.73	43.59	52.28
Hydrogen	6.85	6.81	7.01	6.83	6.81	7.04	7.11	5.77	6.97
Nitrogen	16.28	16.47	16.66	16.20	16.11	16.48	16.00	15.16	16.38
Sulphur	1.18	1.17	00.1	1.32	1.30	1.49	1.53	0.90	1.39
Phosphorus.	0.72	0.97	0.91	trace	0.17	0.06	none	3.38	0.07
Ash	2.73	2.90	3.03	0.35	1.39	0.43	0.39	13.04	0.44
P2Os in Ash	1.88	2.09	1.91	trace	0.47	trace	none	6.73	trace
	10.	11.	12.	13.	14.	15.	16.	17.	18.
Carbon	51.21	46.67	51.87		51.95	51.65		52.02	49.59
Hydrogen	6.85	6.19	6.89		6.86	6.66		7.00	6.68
Nitrogen	16.18	15.89	16.65	16.31	16.08	16.02	16.09	16.45	16.34
Sulphur	1.10	0.93	1.19	1.35	1.60	1.13	1.12	1.24	0.91
Phosphorus.	0.46	2.53	trace	trace	trace	trace	trace	none	1.85
Ash	2.19	8.17	0.38	0.45	0.32	1.09	2.83	0.56	2.50
P2O5 in Ash	I.II	5.71	trace	trace	trace	trace	trace	none	1.79

Assuming that those of the foregoing preparations which contain phosphorus are compounds of protein with the nucleic

acid, which was separated from the aqueous extract of wheat germs and the composition of which is given on page 309 of this paper, and also assuming that all the phosphorus of these preparations is a part of the nucleic acid, we have calculated the composition of these preparations free from nucleic acid. The analyses were further calculated ash-free by subtracting the  $P_2O_5$  contained in the ash from the total ash, which seems permissible since the ash consisted almost wholly of metaphosphates of potassium and sodium, strongly indicating that the  $P_2O_5$  was derived from the nucleic acid. These calculations gave the following results:

TABLE II.—COMPOSITION OF LEUCOSIN CONTAINED IN THE PREPARATIONS FROM WATER EXTRACTS OF THE WHEAT EMBRYO.

	1.	2.	3.	4.	5.	6.	7.	8.	9.
C	52.93	52.75	52.41	52.57	52.57	52.47	52.93	53.23	52.64
H	7.12	7.16	7.38	6.85	6.91	7.08	7.13	7.09	7.02
N	16.45	16.68	16.94	16.26	16.27	16.55	16.06	16.30	16.46
S	1.29	1.32	1.13	1.32	1.34	1.50	1.53	1.60	1.41
0	22.21	22.09	22.14	23.00	22.91	22.40	22.35	21.78	22.47
	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00
	10.	11.	12.	13.	14.	15.	16.	17.	18.
C	52.63	52.44	52.06		52.11	52.16		52.30	53.45
H	7.06	7.10	6.92		6.88	6.73		7.04	7.30
N	16.40	16.26	16.71	16.38	16.13	16.20	16.56	16.54	16.57
S	1.17	1.34	1.19	1.35	1.60	1.14	1.15	1.24	1.16
				THE RESERVE OF THE PERSON NAMED IN	0			22.88	21.52
0	22.74	22.86	23.12		23.28	23.77		22.00	21.52

Of these preparations 1, 2, 3, 4, 13, 14, 15, 16 and 17 were obtained by coagulation with heat, 5 and 10 by coagulation with alcohol, 8 and 11 by saturation with sodium chloride, 6, 7, 9 and 12 by dialyzing salt solutions in water, and 18 by direct dialysis of the aqueous extract. Since some of these preparations formed the whole of the precipitable proteid contained in the extract, while others represented fractions, it is evident that all contain one and the same protein substance mostly combined with various proportions of nucleic acid.

Eliminating the nucleic acid, it thus appears that the composition of the protein part of those preparations which contain phosphorus is the same as that of the phosphorus-free proteid

preparations, although the former contain from very little up to more than 37 p.c. of nucleic acid.

Most of these preparations might, in accordance with custom, be called nucleoproteids, while 8 and 11 are, both in properties and composition, very much like nuclein. It is thus evident that these nucleoproteids and nucleins are nucleic acid compounds of protein which, owing to the high molecular weight of the nucleic acid, are more readily recognized as compounds than are those with acids of low molecular weight.

It is to be noted that these preparations show very diverse properties; some being like albumin; some like globulin; some being precipitated by saturation with salt, while others are not. As we have shown, these different properties are the result of changes caused by varying the conditions under which the proteid exists in the extract, and depend chiefly on the degree of acidity of the extract, whereby the numbers and kinds of acid molecules that combine with the protein molecule are altered.

Whatever may be the true cause of these changes, it is evident from the results here described, that the distinctions heretofore made between globulin and albumin, myosin and vitellin, etc., have very little value as a basis for classifying protein substances. This explains the difference between O'Brien's classification of leucosim as a myosin-like globulin, to which reference was made at the beginning of this paper, and our designation of it as an albumin, because of the ready solubility in water and coagulability by heat of the preparations which we had made.

Thus, preparation 18, weighing 9.17 grams, was insoluble in water and in salt solution and was not a precipitate of globulin, since in the filtrate from which it had separated on dialysis, only 0.87 gram of coagulable albumin were found instead of 9.5 grams as usually found by direct coagulation of the aqueous extracts; moreover the analysis shows it to be a compound of leucosin with 20 p. c. of nucleic acid.

On the preceding pages, it was shown that a small part of the precipitate, produced by saturating the aqueous extract with sodium chloride, is soluble in dilute salt solution and can be precipitated from this solution by dialysis, as a globulin-like substance, readily soluble again in salt solution. The precipitates thus obtained comtain little or no nucleic acid, and have very nearly the same elementary composition as leucosin, of which

they are evidently compounds with a small proportion of some body of low molecular weight.

It is plain from these facts that O'Brien's myosin contains the same protein substance as my leucosin.

O'Brien's "albumin" coagulating at 75°-80° is unquestionably more of this same leucosin as shown by preparation 3, which formed about 25 p.c. of the total coagulable proteid. It has been the writer's experience that complete coagulation, especially in a solution quite free from salts, can be effected, if at all, only by heating the solution much above the lower coagulation temperature of the proteid to be separated.

From the whole seed we obtained leucosin with the same composition and general properties as from the embryo, but our preparations from the whole seed were free from phosphorus. This was probably because the proportion of nucleic acid to protein matter was smaller in the whole seed than in the embryo so that on extracting with water the nucleic acid did not form soluble compounds with the leucosin, but remained undissolved in combination with protein. In the following table is given the average of analyses of leucosin from the cereals.

TABLE III.—Composition of Leucosin prepared from Various Cereals.

	Wheat Embryo.	Wheat Kernel.	Rye Kernel.	Barley Kernel,	Barley Malt.	Maize* Kernel.
C	52.65	53.02	52.97	52.81	53.07	52.72
H	7.04	6.84	6.79	6.78	6.72	7.05
N	16.43	16.80	16.66	16.62	16.71	16.82
S	1.32	1.28	1.35	1.47	23.50	1.32
0	22.56	22.06	22.23	22.32	5 23.50	22.05
	100.00	100.00	100.00	100.00	100.00	100.00

In an earlier paper on the Chemical Nature of Diastase (Jour. Am. Chem. Soc. XVIII, 542; Report Conn. Agr. Exp. Sta., 1895, p. 239) we pointed out that diastatic action appeared to be always associated with leucosin. Since our extracts

of wheat embryo were so rich in leucosin, we determined the diastatic power of the germ meal by extracting with four times its weight of water and found that, under the conditions of Lintner's test, 0.10 cc. of the extract so made, when added to 10 cc. of a 2 p. c. solution of soluble starch, formed within one hour, at 20°, enough sugar to reduce 5 cc. of Fehling's solution. The 0.10 cc. of extract corresponds to 25 milligrams of the germs, from which it is seen that this meal possesses high diastatic power, though it is inferior in this respect to active malt.

### Sodium Chloride Extract.

Wheat germ meal treated with 10 p. c. sodium chloride brine forms a dense jelly-like mass from which it is nearly impossible to separate the solution.

With 3 p. c. brine a manageable extract can be made by using from six to ten times as much solvent as meal. Thus, 100 grams of the meal treated with 600 cc. of 3 p.c. salt solution yielded in fifteen hours 400 cc. of clear filtrate. As has just been shown, the aqueous extract on dialysis, in consequence of a change which affects leucosin, deposits a large amount of proteid, chiefly in the coagulated form. In order to obtain preparations of the proteid substance soluble in salt solutions, but insoluble in water, which should be free from this coagulable albumin, we treated 2,000 grams of germ meal with 20 liters of 3 p.c. salt solution heated to 70°, whereby the leucosin was coagulated and the salt-soluble globulin brought into solution. The extract, neutral to litmus, was filtered clear, at once saturated with ammonium sulphate and the proteids thus precipitated collected on a filter, dissolved in water and the clear solution dialyzed in running water.

Proteid matter separated on dialysis in spheroids which, like legumin, conglutin and amandin, united to a plastic mass on the bottom of the dialyzer.

This precipitate was dissolved in brine, filtered absolutely clear, dialyzed for 48 hours, the large precipitate which separated allowed to settle, and the solution, which was nearly free from protein, decanted.

A portion of the precipitate was washed first with water, which rendered it opaque and dense, then with dilute and finally

<sup>\*</sup> This proteid was described by Chittenden and Osborne, Am. Chem. Jour. XIII, 327, as a myosin-like globulin, and was later, Jour. Am. Chem. Soc. XIX, 525, designated maysin by the writer. Since we now find that leucosin may form compounds having the properties of globulin, it is probable that maysin and leucosin contain one and the same protein substance.

with absolute alcohol and dried over sulphuric acid. This weighed 5.22 grams, and is preparation 19. The rest of the precipitate was completely dissolved in 125 cc. of 10 p. c. salt solution. To this, water was added until its volume was 425 cc.. thus making a salt solution of nearly 3 p.c. From this diluted solution a gummy deposit separated from which the fluid was soon completely decanted. The latter was further diluted with 325 cc. of water and the precipitate which resulted allowed to settle to a viscid transparent deposit. From this precipitate the solution was again decanted and dialyzed for 48 hours, but not more than a trace of globulin was deposited. The two precipitates produced by dilution were thoroughly washed with water and alcohol, dried over sulphuric acid and formed preparations 20 and 21, weighing respectively 11.4 grams and 8.15 grams. A part of each of these preparations was set aside for analysis and the rest, dissolved together in 10 p.c. salt solution, allowed to stand over night at 4°. The solution was then decanted from a slight sediment, filtered clear and heated to 80° in order to coagulate any leucosin which might be present, and after two hours filtered from a very small coagulum which had gradually formed.

This filtrate was dialyzed in water for four days and the globulin which separated was washed with water and with alcohol and dried over sulphuric acid, giving preparation 22.

The solution filtered from the first dialysis precipitates which yielded preparations 19, 20 and 21, was further dialyzed; a little globulin, which separated, was filtered out and the filtrate dialyzed into alcohol for four days. A precipitate was produced which, when washed with absolute alcohol and dried, weighed 25.0 grams. This substance consisted of proteid which will be described later, on p. 328. Another series of fractional precipitations of this globulin-like proteid was made by extracting four kilograms of the oil-free germ meal with 27 liters 3 p. c. brine, heated to 67° at the time it was applied to the meal. The mixture was thoroughly stirred and thrown on filters. A clear filtrate of about 12 liters was finally obtained, which was saturated with ammonium sulphate. The precipitate produced was dissolved in water and its solution dialyzed for forty-eight hours, whereupon a large quantity of spheroids separated which

on settling united to a coherent mass. This precipitate was washed by decantation with water, dissolved in brine and its solution made faintly alkaline to litmus by cautiously adding N/10 KOH solution. In order to separate phosphoric acid, a little calcium chloride solution was then added to this very slightly alkaline liquid and the latter, though apparently free from any precipitate of calcium phosphate, was filtered, whereby a little suspended matter was removed. The solution was made exactly neutral to litmus by adding 56 cc. N/10 HCl and dialyzed for 18 hours. A gummy precipitate, A, adhering to the bottom of the dialyzer, then separated, from which the solution, B, was decanted almost completely.

The precipitate, A, was dissolved in about 200 cc. of 5 p.c. brine and the liquid was poured into 800 cc. of water. The resulting flocculent precipitate settled rapidly to a coherent deposit from which the solution was decanted. The deposit was repeatedly washed by decantation with water, which caused it to lose its gummy character and become opaque, white and granular. After dehydrating with absolute alcohol and drving over sulphuric acid it weighed 15.5 grams and was marked preparation 23. The solution marked B was further dialyzed for 48 hours, when a second precipitate formed, which, like 23, completely dissolved in brine, to a solution perfectly neutral to litmus. This precipitate was washed by decantation with water, but the finer part settled so slowly that it was necessary to decant it together with the water. The sediment after exhausting with absolute alcohol and drying, weighed 23.5 grams, and formed preparation 24. On long standing, the decanted washings deposited the finely divided matter, which was then collected on a filter, dissolved in brine and its solution precipitated by water, giving 15.4 grams of preparation 25.

To determine the quantity of globulin contained in our oil-free germ meal, we treated 200 grams of the meal with 2,000 cc. of 3 p. c. salt solution heated to 65° and filtered the extract perfectly clear. Of this, 1,000 cc. were dialyzed until free from chlorides, when the precipitate of spheroids was filtered out, washed with water and with alcohol and dried over sulphuric acid. This preparation, 26, formed 5.05 p. c. of the oil-free meal.

To obtain a quantity of this globulin for digestion with pepsin, a quantity of germ meal was extracted with 3 p. c. salt

solution heated to 70°, the extract was filtered clear and saturated with ammonium sulphate. The precipitate produced was dissolved in water and the resulting gummy and somewhat turbid solution filtered clear. The filtrate was dialyzed until the solution gave no turbidity on pouring into distilled water. The proteid, which had then separated in spheroids, was filtered out, washed by decantation with water and with alcohol and dried over sulphuric acid, giving 27.3 grams of preparation 27.

A part of the extract from which 27 had been prepared was mixed with an equal volume of N/10 KOH, about twice the quantity necessary to neutralize the extract to phenolphthalein. The solution was then dialyzed in distilled water frequently renewed and in this way a considerable quantity of phosphorus was separated in the alkaline dialysate. When all, or nearly all, which it was possible to separate in this way, had been removed, the solution in the dialyzer was neutralized with N/10 HCl until it no longer reacted alkaline to litmus. This caused a turbidity. The acid was then further added until an acid reaction with litmus was obtained, producing a precipitate from which, after settling, the solution was decanted. The precipitate was then dissolved in brine, its solution filtered clear and dialyzed, whereby a substance was precipitated in spheroids, which was filtered out, washed with water and alcohol and formed preparation 28, weighing 3.0 grams.

These preparations had the following composition:

TABLE IV.—COMPOSITION OF PREPARATIONS EXTRACTED BY SODIUM CHLORIDE SOLUTIONS FROM THE WHEAT EMBRYO.

	19	20	21	22	23	24	25	26	27	28
Carbon			48.77	50.03	50.23	48.17	49.39	48.75	49.79	48.67
Hydrogen			6.44	7.04	6.89	6.54	6.78	6.52	6.76	6.56
Nitrogen	18.14	18.21	18.12	18.39	18.23	18.06	17.95	18.16	18.01	17.97
Sulphur	0.49	0.56	0.51	0.60	0.53	0.55	0.48	0.63	0.61	0.61
Phosphorus	1.15	1.03	1.35	0.76	0.56	1.41	1.17	1.41	1.11	1.55
Ash	2.29	1.86	2.25	1.30	1.22	3.85	2.60	2.66	1.11	2.94
$P_2O_5$ in ash.	1.66	1.34	1.68	0.84	0.80	2.00	1.82	2.00	0.68	2.30

These analyses, when calculated free from nucleic acid and ash, as was done for the albumin preparations, in the manner described on page 318, gave the following results:

TABLE V .- COMPOSITION OF THE GLOBULIN CONTAINED IN THE PREPARA-TIONS EXTRACTED FROM THE WHEAT EMBRYO BY SODIUM CHLORIDE SOLUTION.

	19	20	21	22	23
Carbon			51.37	51.58	51.40
Hydrogen			6.83	7.31	7.08
Nitrogen	18.59	18.59	18.62	18.70	18.45
Sulphur	0.57	0.63	0.60	0.66	0.57
Oxygen			22.58	21.75	22.50
					-
			100.00	100.00	100.00
	24	25	26	27	28
Carbon	51.56	51.86	51.40	51.98	51.70
Hydrogen	7.07	7.19	6.94	7.12	7.05
Nitrogen	18.85	18.41	18.71	18.37	18.53
Sulphur	0.67	0.55	0.75	0.70	0.75
Oxygen	21.85	21.99	22.20	21.83	21.97
			TANK DESCRIPTION OF THE PROPERTY OF THE PROPER		
	100.00	100.00	100.00	100.00	100.00

These figures plainly show that our globulin preparations are mixtures of nucleates of one and the same protein substance and contain from 5 to 15 p. c. of nucleic acid. The preparations contain the same protein as the globulin which one of us has previously described as occurring in the kernel of wheat, rye, barley and maize. In the entire kernel, so little of this globulin is present that it is difficult to prepare it pure therefrom. For this reason, we think, the analyses given below do not agree as closely as they might otherwise be expected to. From the whole seed this globulin is obtained entirely free from phosphorus, which we attribute to the much greater proportion of proteid matter to nucleic acid, in the seed, compared with that existing in the wheat embryo.

TABLE VI.—COMPOSITION OF THE GLOBULIN CONTAINED IN VARIOUS

	CEREAL	S.		
Wheat Embryo. 51.57 7.07 18.60	Wheat* Kernel, 51.03 6.85 18.39	Rye† Kernel. 51.19 6.74 18.19	Maizet Kernel. 51.99 6.81 18.02	Barley§ Kernel. 50.88 6.65 18.10
22.11	23.08	23.88	22.52	24.37
	Embryo. 51.57 7.07 18.60 0.65 22.11	Wheat Embryo. Wheat* Kernel. 51.57 51.03 7.07 6.85 18.60 18.39 0.65 0.65 22.11 23.08	Wheat Embryo. Wheat* Kernel. 51.57 51.03 51.19 7.07 6.85 6.74 18.60 18.39 18.19 0.65 0.65 22.11 23.08	Wheat Embryo.         Wheat* Kernel.         Rye† Kernel.         Maizet Kernel.           51.57         51.03         51.19         51.99           7.07         6.85         6.74         6.81           18.60         18.39         18.19         18.02           0.65         0.65         23.88         0.66 \ 22.52

<sup>\*</sup> Am. Chem. Jour., XV, 392.

<sup>+</sup> Jour. Am. Chem. Soc., XVII, 429, also Report of Conn. Expt. Station for 1894, p. 147.

<sup>‡</sup> Am. Chem. Jour., XIII, 327, 385 and XV, 20.

<sup>§</sup> Jour. Am. Chem. Soc., XVII, 539; also, Report Conn. Expt. Station for 1894, p. 165.

Having determined the composition of this globulin-like proteid and also that of the albumin, it became clear that several preparations obtained from the aqueous extract were mixtures of these two substances, thus showing the globulin to be present to some extent in the aqueous extract.

As noted, on page 314, when 2,000 cc. of an aqueous extract of about 650 grams of the meal were dialyzed in running water for four days, a dense turbidity was formed which could not be removed by filtration. This, however, on adding a little hydrochloric acid, was converted into a precipitate, which was readily dissolved by adding sodium chloride sufficient to make a 3 p. c. solution, and was precipitated from this solution by dialysis. We thus obtained 9.0 grams of preparation 29, which, dried at 110°, had the following composition:

#### COMPOSITION OF PREPARATION 29.

Carbon Hydrogen Nitrogen Sulphur Phosphorus	I. 48.30 6.49 17.40 0.83 1.91	11. 47.92 6.41 17.24 0.85	Av. 48.11 6.45 17.32 0.84	Corrected for Ash & Nucleic Acid. 51.70 7.07 17.74 1.08	Calculated for 60 per cent globulin. 40 "leucosin. 51.95 7.07 17.74 0.91
Oxygen Ash	3.95 2.95		1.91	22.51	22.53

This analysis corresponds pretty nearly with that of a mixture of 60 p.c. of the globulin with 40 p.c. of leucosin, except that the amount of sulphur found was somewhat greater than that calculated.

After heating another portion of the same aqueous extract to 65° for some time and filtering off the coagulum, the filtrate was dialyzed for five days into alcohol and the precipitate thereby produced filtered out and exhausted with water. The residue of proteid matter coagulated by alcohol, weighing 6.7 grams and marked preparation 30, was then dried at 110° and analyzed with the following results:

### COMPOSITION OF PREPARATION 30.

		Corrected for Ash and Nucleic Acid.	Calc. for. Globulin 40 p. c. Leucosin 60 p. c.
Carbon	49.49	51.80	52.13
Hydrogen	6.81	7.14	7.03
Nitrogen	16.87	17.32	17.30
Sulphur	0.93	1.14	1.05
Phosphorus	0.89	0002	A DESCRIPTION OF THE PARTY OF T
Oxygen		22.60	22.49
Ash	4.00		
P <sub>2</sub> O <sub>5</sub> 'in Ash	2.01	100.00	100.00

This analysis corresponds quite nearly with that of a mixture of 40 p. c. of the globulin with 60 p. c. of the albumin.

## THE PROTEOSE OF THE WHEAT EMBRYO.

In making the preparations already described considerable quantities of crude proteose were obtained from both the aqueous and sodium chloride extracts. After the leucosin and the globulin had been separated as completely as possible, the solutions containing the proteoses, as well as the unseparated residues of other proteids, were dialyzed into alcohol and the precipitates produced, washed and dried over sulphuric acid.

A mixture, weighing 15.4 grams, was made by uniting several such preparations that had been obtained from aqueous extracts from which most of the other proteids had been separated, without heat, by saturating with sodium chloride and dialysis into alcohol. The mixture contained much matter made insoluble in water by the final treatment with alcohol. This was filtered out, washed thoroughly with water and with alcohol and when dried weighed 4.18 grams, and was marked preparation 31. The filtrate from this was saturated with ammonium sulphate, the precipitate redissolved and again precipitated in the same way. The solution of the second precipitate was dialyzed in cold distilled water, until free from sulphate, and then for several days in alcohol. The precipitate thus produced was dissolved in water, a little insoluble matter filtered out, and its clear solution saturated with sodium chloride, which produced a small precipitate. This was filtered out, dissolved, and its solution dialyzed in water. The saltsaturated filtrate was likewise dialyzed and when both solutions were free from chlorine the dialyzers were transferred to alcohol and the proteose thereby precipitated. The proteose separating on saturation with salt, gave 0.6 gram of preparation 32, that from the salt-saturated solution, 0.97 gram of preparation 33. This small yield of proteose indicates great impurity of the original crude product and shows that the proportion of proteose to other proteids is very small.

Another crude product was obtained by dialyzing into alcohol an aqueous extract, after separating leucosin which had

been coagulated by heat. This, weighing 35 grams, was dissolved in water and the insoluble matter filtered out, washed and dried, giving preparation 34, weighing 7.26 grams.

The filtered solution was saturated with ammonium sulphate, the precipitate dissolved in water, and the clear solution dialyzed in distilled water until free from sulphates, and then in alcohol. The substance thus separated was again dissolved in water. and its solution saturated with salt; the precipitate thus produced was dissolved in water and its solution, as well as the salt-saturated filtrate, were dialyzed in water. When free from chlorine, these solutions were dialyzed in alcohol and yielded. respectively, preparations 35, weighing 4.0 grams and 36. weighing 1.84 grams.

Another preparation of crude proteose was obtained by extracting the meal with 3 p.c. sodium chloride solution heated to 70°, dialyzing the extract in water, coagulating the leucosin by heat and precipitating the proteose by dialysis in alcohol. A mixture of such preparations, weighing 31.6 grams, was treated with water, the insoluble matter filtered out, washed and dried, giving 5.16 grams of preparation 37.

The filtered solution was saturated with ammonium sulphate, the precipitate dissolved in water, the solution dialyzed in distilled water till free from sulphate, and then in alcohol. The separated proteose was redissolved in water and its solution saturated with sodium chloride. The precipitate which resulted was filtered out, dissolved in water and its solution, as well as the salt-saturated filtrate, were dialyzed in water till free from chlorine, and finally in alcohol.

The products thus obtained, formed, respectively, preparations 38, weighing 0.75 gram and 39, weighing 1.35 grams. One other proteose preparation was made from the aqueous extract previously described on page 316 from which the phosphorus was largely separated by making it slightly alkaline and adding calcium chloride. After heating the extract to boiling and filtering out the coagulum, the filtrate was dialyzed into alcohol, the resulting precipitate dehydrated with absolute alcohol, dried over sulphuric acid, redissolved in water and precipitated by saturating with ammonium sulphate. The gummy precipitate, having the general appearance and proper-

ties of similar precipitates of the proteoses obtained by the action of pepsin, was dissolved in water, dialyzed free from sulphates and then precipitated by dialysis in alcohol, giving 2 grams of preparation 40.

These preparations were dried at 110° and analyzed with the following results:

## COMPOSITION OF ALCOHOL-COAGULA AND OF PROTEOSE PRE-PARED FROM THE WHEAT EMBRYO.

TABLE VII. Residues of other proteids Proteose precipitated by sodium chloride. Proteose soluble in saturated NaCl sol. 35 33 36 40 52.36 49.44 51.93 49.94 48.46 48.70 48.44 48.99 6.87 6.98 6.85 6.80 6.70 6.73 6.71 6.85 16.01 16.00 16.30 16.79 17.08 16.26 16.91 16.76 16.16 16.80 1.85 4.08 1.30 1.24 I.IO 27.81 22.80 23.63 23.60 24.94 26.17 100.00 100.00 100.00 100.00 100.00 100.00 100.00 100.00

0.77

1.13

1.00

1.27

From these analyses it is seen that the matter insoluble in water, forming preparations 31, 34 and 37, consists of coagulated proteid apparently mostly derived from leucosin. The high proportion of sulphur in 31 and 34 is due to calcium sulphate, precipitated by alcohol from the aqueous extract.

0.30

Ash o.81

14.13

0.95

The remaining preparations have the low percentage of carbon, characteristic of proteoses made by pepsin digestion.

Whether the proteose precipitated by saturating its solution with salt is a different protein substance from that soluble in saturated salt solution or whether difference in solubility is due to the presence of different acid compounds of one and the same protein substance, is not demonstrated, but the agreement shown by these analyses, considering the difficulty of making quite pure preparations, indicates that the latter is the case.

THE PROPORTIONS OF THE VARIOUS PROTEID SUBSTANCES OF THE WHEAT EMBYRO.

Twenty grams of fresh germ meal, from which the ethersoluble constituents had not been separated, were treated with 500 cc. of water and after shaking for some time, the extract was filtered clear. Two portions, of 100 cc. each, were treated with a few drops of very dilute hydrochloric acid and heated in a boiling water bath. The coagulum which separated was collected on a filter and its nitrogen determined. To the filtrate from one coagulum, tannin was added and nitrogen was determined both in the precipitate and in the filtrate. Another lot of 20 grams was treated in the same way and nitrogen determined in the heat-coagulum formed in each of two portions of 100 cc. The amount of nitrogen corresponding to one gram of germ meal was found in the four coagula to be, .0163 gram; .0156 gram; .0159 gram and .0162 gram; in the tannin precipitate .0062 gram and in the solution filtered from the latter .0062 gram.

Twenty grams of germ meal were extracted with 500 cc. of 3 p. c. sodium chloride solution heated to 70°, whereby the leucosin was coagulated and the globulin and proteose dissolved. Of the clear filtered extract, 100 cc. yielded with tannin a precipitate containing .0166 gram N per gram of meal extracted.

Two portions of the meal, each of one gram, were exhausted with 3 p. c. sodium chloride solution heated to 70°, and nitrogen determined in the residues. The .0331 and .0309 gram of nitrogen found in the residues were from the leucosin and insoluble nitrogenous bodies, so that the nitrogen belonging to the latter equalled .0171 gram and .0149 gram. From the average of these figures we find the following amounts of the different forms of nitrogen in one gram of the wheat germ meal.

Nitrogen Grams,	
Insoluble in water and salt solution0.0160	
Insoluble in water but soluble in salt solution0.0100 =	= globulin nitrogen.
Soluble in water and coagulable by heato.o160 =	albumin "
Soluble in water, uncoagulable by heat, precipi-	
table by tannin	= proteose "
Not precipitable by tannino.oo6o =	= non-proteid "
Total	
Found by direct nitrogen determination0.0531	

We have shown that the coagulated leucosin preparations contain about 10 p. c. of nucleic acid, the globulin about 15 p. c., while those of the proteose contain none. Deducting these quantities from the nitrogen given in the table, we find 9.5 p. c. of the embryo to be leucosin, 4.84 p. c. to be globulin, and 3.03 p. c to be proteose.

The bodies which are represented by the insoluble nitrogen, we have been unable to separate from the embryo. The residue after extraction with hot salt solution contained .0076 gram of phosphorus. Since there was in this residue about .1000 gram of coagulated leucosin, in which we have usually found about 1 p. c. of phosphorus, we have .0061 gram of phosphorus remaining over. In view of the large proportion of nucleic acid found in the extracts of the embryo, it is not improbable that this phosphorus mostly belongs to nucleic acid, in which case there would be about 6.75 p. c. of nucleic acid containing .0108 gram of nitrogen, which leaves only .0052 of nitrogen for proteid matter in the insoluble residue. It seems probable therefore that this insoluble nitrogen largely belongs to compounds of the proteid with relatively much nucleic acid.

## Digestion of the Phosphorus-containing Proteids with Pepsinhydrochloric Acid.

Leucosin nucleate. Ten grams of the coagulated albumin, preparation 2, were suspended in 400 cc. of water and dissolved by adding 100 cc. of N/10 KOH solution. To the nearly clear solution which resulted, an equal volume of 0.4 p.c. HCl was added, together with some pepsin, and the mixture digested at 37°. In a short time the solution became perfectly clear, but later deposited a large coherent precipitate, which gradually contracted, but at the same time retained the form of the lower part of the beaker. From this the clear solution was decanted, the precipitate thoroughly washed by decantation, suspended in water and dissolved by adding 28 cc. of N/10 KOH solution, an amount of alkali just sufficient to dissolve all the substance and at the same time make the solution neutral to litmus. When to this solution decinormal acid was gradually added, no precipitate appeared until nearly one-half the quantity of acid required for complete neutralization

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had been added, but with 28 cc., the solution was neutralized and also completely precipitated, the addition of 2 cc. more acid giving no turbidity in the solution filtered from the precipitate.

This precipitate was washed with water and with alcohol and dried over sulphuric acid, forming preparation 41, weighing 1.54 grams.

To precipitate this substance a quantity of acid was added exceeding that of the alkali employed for solution by just 2 cc. The filtrate from the precipitate, however, required not 2 cc. of alkali, but 8.5 cc. for neutralization to phenolphthalein, showing 6.5 cc. of alkali to have been neutralized by the acid of the nuclein originally dissolved. The neutralized filtrate left on evaporation 0.3975 gram of substance, the aqueous solution of which was precipitated by hydrochloric or nitric acid, but not by ammonium molybdate solution until after boiling with acid for some little time, when yellow phosphomolybdate was precipitated. These facts indicate the presence in this filtrate of a nucleic acid.

More nuclein was made from the same preparation, 2, by suspending thirty grams in 0.2 p.c. HCl, containing pepsin, which, even at 20°, caused within two hours complete solution of the coagulated proteid. The solution was digested at 37° for 48 hours, during which time much nuclein separated, having the appearance and properties of the preparation just described.

After decanting the clear solution and thoroughly washing the residual nuclein, the latter was suspended in water and dissolved in 72 cc. N/10 KOH. The solution thus obtained was made neutral to litmus by adding 11 cc. of N/10 HCl, but no precipitate appeared till 1.5 cc. more of acid were added. To the solution 72 cc. N/10 HCl were added, giving a precipitate which, when washed and dried, made preparation 42 and weighed 3.4 grams. The filtrate from this precipitate, as in the former case, was strongly acid, requiring 12 cc. of N/10 KOH to neutralize it to phenolphthalein. Two other preparations of nuclein were made from 8.493 grams of 8, and 9.804 grams of 11, both being substances precipitated from the aqueous extract by saturating with sodium chloride. Each portion was suspended in about 300 cc. of 0.2 p. c. HCl, containing 0.1 gram of pepsin and, with frequent stirring, digested at 40° for 24 hours. Throughout

the digestion a large part of the substance remained undissolved. An equal volume of 0.2 p.c. HCl, containing 0.1 gram of pepsin, was again added to each and the digestion continued for 24 hours longer. The insoluble matter which remained was not coherent like the two former nuclein products, but consisted of a white, very finely divided substance which was easily filtered out and washed. After dehydrating with absolute alcohol these preparations were dried over sulphuric acid; from 8, 4.04 grams of preparation 43 were obtained and from 11, 4.16 grams of 44.

Globulin nucleate. Fifteen grams of a mixture of nearly equal parts of the globulin preparations 23 and 24 were next suspended in 0.2 p. c. HCl, containing 0.2 grams of pepsin, which, within a short time, almost completely dissolved the proteid matter. From this solution, on further digestion, the nuclein separated, forming a coherent deposit. After 72 hours digestion, the clear solution was decanted, the deposit dissolved in a little ammonia and its solution filtered perfectly clear from a very slight gelatinous residue. The resulting solution was then treated with acetic acid, added in excess of the amount necessary to neutralize the solution to litmus. Since, even on standing, the precipitate so produced separated imperfectly, an equal volume of alcohol was added. The substance, which then separated well, was filtered out, washed with dilute and with absolute alcohol and dried over sulphuric acid, giving 2.38 grams of preparation 45, or about 16 p.c. of the original substance.

The filtrate from the acetic acid precipitate gave a further slight precipitate on adding HCl, which had properties characteristic of nucleic acid.

Still another preparation of nuclein was made from the globulin by suspending 10 grams of 27 in water and adding 50 cc. of  $N/_{10}$  KOH. This solution was neutralized and an equal volume of 0.4 p.c. HCl at once added, producing a turbid solution, which, however, contained no visible particles. To this, pepsin was added and the mixture digested for 40 hours, during which time a coherent deposit of nuclein formed on the bottom of the beaker. From this the clear solution was decanted. The deposit was then thoroughly washed with water and dissolved in 43 cc. of  $N/_{10}$  KOH. To this clear solution

43 cc. of N/10 HCl were added, causing a gummy precipitate which could not be filtered until 15 cc. more acid had been added, when the precipitate rapidly settled as a coherent deposit, from which the solution was soon decanted. This solution required for neutralization to litmus 16 cc. N/10 KOH, and to phenolphthalein 18 cc. The precipitate when washed and dried gave 2.2 grams of preparation 46.

These six preparations were all dried at 110° and analyzed with the following results:

Table VIII.—Composition of Nuclein from the Proteids of the Wheat Embryo.

	41	42	43	44	45	46
Carbon	44.87	44.35	42.68	43.35	39.42	41.92
Hydrogen	5.82	5.77	5.45	5.47	5.03	5.25
Nitrogen	16.04	16.64	16.12	16.01	16.05	17.00
Sulphur	0.97	1.03	0.65	0.85	0.53	0.46
Phosphorus	4.58	5.07	5.32	4.88	5.27	5.63
Ash	0.60	0.78	1.72	1.72	17.42	1.17
P2O5 in Ash	0.29	0.55	1.24	0.94	10.56	0.69

If we subtract from the total ash the amount of  $P_2O_5$  found in it, we shall have a determination of the bases contained in the ash of these preparations.

We have calculated these analyses of nuclein free from the bases of the ash and from nucleic acid, in the way previously described, with the following results:

TABLE IX.—Composition of Protein Matter contained in the Nuclein.

			Z. O ODDILL.			
	41	42	43	44	45	46
Carbon	53.65	54.77	51.80	52.36	52.30	51.64
Hydrogen	7.23	7.46	6.85	6.73	6.91	6.60
Nitrogen	16.68	17.56	16.31	16.31	19.31	18.93
Sulphur	1.98	2.37	1.61	1.89	1.53	1.25
Oxygen	20.46	17.84	23.43	22.71	19.95	21.58
	100.00	100.00	100.00	100.00	100 00	100.00

The composition of the proteid matter in 43 and 44 is very nearly that of leucosin except as regards sulphur, the amount of which is decidedly greater. On the other hand, 41 and 42, which also were derived from preparations whose protein matter was leucosin, differ in composition very decidedly from

that substance. This is probably because on pepsin digestion the substance of preparations 43 and 44 remained throughout undissolved, whereas 41 and 42 separated on pepsin digestion from nearly clear solutions and therefore doubtless their protein matter had been to some degree altered by the pepsin before separating as an insoluble compound with nucleic acid. The two nucleins, 45 and 46, from the globulin which also had separated from solution, show similar differences in composition when compared with the unaltered globulin, carbon and nitrogen being higher and sulphur very much higher than in the globulin. The greatly increased proportion of sulphur would indicate that sulphur in some acid form had split from the proteid molecules undergoing hydrolysis and had become a part of the insoluble nuclein, as did the nucleic acid.

#### Conclusion.

The embryo of the wheat kernel contains:

1. A nucleic acid in considerable quantity. This acid is insoluble in water, forms soluble as well as insoluble compounds with proteid substances, and on hydrolysis yields guanin, adenin, phosphoric acid and other products not yet identified. It has the following composition:

#### NUCLEIC ACID.

Carbon	36.48
Hydrogen	. 4.48
Nitrogen	16.17
Phosphorus	8.96
Oxygen	33.91
	100.00

This acid is not identical with any nucleic acid heretofore described. On hydrolysis it does not yield any form of sugar. From guanylic acid recently described by Bang it also differs distinctly, in that its potash salt is extremely soluble in cold water and the ratio of P to N, being I to 4 instead of I to 5.

2. Leucosin, an albumin, (yield about 10 p. c. of the embryo) formerly found by the writer in small quantity in the whole kernel of wheat, rye and barley, and abundantly in malt. Leucosin begins to separate as a flocculent coagulum when the very

slightly acid aqueous extract of the wheat kernel or wheat embryo is heated to 52°. Even after long heating at 65°, the leucosin is only partly separated, and about one-third more coagulum of the same elementary composition is obtained on raising the temperature from 65° to 100°.

By saturating extracts of the kernel or of the embryo with sodium chloride, the leucosin is largely precipitated. from the former as a substance readily soluble again in water. from the latter as an insoluble compound containing about 30 p. c. of nucleic acid. From the latter precipitate, dilute salt solution extracts a small amount of nearly phosphorus-free proteid, which behaves like a globulin, being precipitated by dilution or by dialysis, but having essentially the same ultimate composition as leucosin.

By dialyzing the aqueous extract in water, nearly all the leucosin contained in it is precipitated, not like a globulin, but as an insoluble compound containing about 20 p. c. of nucleic acid. The following figures give the average of accordant analyses, calculated nucleic acid free, of 18 different preparations representing complete as well as fractional precipitations under the above and other conditions. These figures agree closely with the composition of the leucosin of wheat, rye, barley and malt.

#### LEUCOSIN.

Carbon	52.65
Hydrogen	7.04
Nitrogen	16.43
Sulphur	1.32
Oxygen	22.56
	100.00

3. A globulin, precipitated in spheroids by dialysis and by dilution as a coherent deposit. The yield is about 5 p. c. of the embryo. The solution of this globulin in 10 p.c. sodium chloride brine becomes turbid on heating to about 87°, and at 90°, on continued heating, a considerable flocculent coagulum separates.

Our preparations of this globulin contained from 6 to 17 p. c. of nucleic acid, most of them from 12 to 15 p. c. From this the proteid could not be separated by fractional precipitation.

Analyses of 10 different preparations of this globulin gave very closely agreeing figures when calculated free from nucleic acid, the average of which is as follows:

#### GLOBULIN.

Carbon	51.57
Hydrogen	
Nitrogen	18.60
Sulphur	0.65
Oxygen	22.11
	100.00

In composition and properties this globulin agrees with that found by the writer in the kernels of wheat, rye and barley. So far as we have been able to observe, it differs from edestin, the crystalline globulin obtained from seeds of hemp, flax and squash only in containing two-thirds as much sulphur.

4. Proteose, precipitated by saturating the aqueous extract, freed from globulin and albumin, with salt. One preparation, 35, was phosphorus free, and had the following composition:

## PROTEOSE.

Carbon	49.94
Hydrogen	6.80
Nitrogen	17.08
Sulphur	1.24
Oxygen	24.94
	100.00

5. Proteose, soluble in the salt-saturated solution filtered from the foregoing proteose and obtained free from phosphorus by precipitating with alcohol its solution freed from salt by dialysis. The average of analyses of four preparations of this proteose is the following:

#### PROTEOSE.

Carbon	48.65
Hydrogen	6.75
Nitrogen	16.68
Sulphur	1.10
Oxygen	26.82
	100.00

These proteoses together form about 3 p.c. of the embryo.

6. About one-third of the total nitrogen of the embryo is not extracted by water and salt solutions and appears to belong to insoluble compounds. This nitrogen is accompanied by phosphorus corresponding to about 6.75 p.c. of nucleic acid, which would contain two-thirds of this insoluble nitrogen. It seems probable, therefore, that this insoluble nitrogen belongs largely to insoluble compounds of nucleic acid and protein.

7. These phosphorus-containing preparations of globulin and leucosin, when digested with pepsin-hydrochloric acid, yield nuclein in proportion to the phosphorus which they contain. Calculated free from nucleic acid, the analyses of these nucleins show the protein constituent to have nearly the same composition as the proteid from which they were derived, the most marked difference being a greater proportion of sulphur in the former.

8. The proteids of the embryo differ from those of the dormant endosperm, of this as well as of other seeds, in the facility with which they undergo changes. These changes are the result of a redistribution of acids among the protein and other basic molecules, so that compounds form in the extracts of the embryo which contain various proportions of nucleic acid according to the changing conditions.

The writer has shown that the globulin, edestin, forms crystalline compounds with one and with two molecules of acid and also compounds with a greater number of acid molecules. There is reason to believe that all other native protein substances form similar compounds; in other words, that proteins are distinctly polyacid bases and that the acid characters which proteids display are due to acids united to their protein molecules, probably in the same manner as in the salts of the purin bases.

These nucleic acid compounds of the protein constituents of the wheat embryo appear to be compounds of this order. According to this view, no special distinction can be made between nucleins and nucleoproteids, the former being simply compounds containing a greater number of molecules of nucleic acid united to one molecule of protein.

That the wheat embryo in fact contained the same nucleic acid compounds as we have obtained from the extracts, is highly

improbable. All that we can conclude is that the embryo contains the different protein substances described, together with nucleic acid, and that these may unite to form a number of different compounds according to the conditions which prevail at any given time.

### THE PROTEIDS OF THE EGG YOLK.

By THOMAS B. OSBORNE AND GEORGE F. CAMPBELL.

The yolks of a large number of freshly laid hen's eggs were broken up by straining through a sieve and mixed with an equal volume of saturated pure sodium chloride brine. A somewhat turbid solution resulted, which was shaken out with about one-third its volume of ether, containing a little alcohol. After standing one night, a clear reddish ethereal layer separated, leaving the pale yellow aqueous solution almost clear. After shaking out a second time with ether the aqueous solution was dialyzed for forty-eight hours, whereupon a large quantity of proteid separated in spheroids which united to a salvy mass. This was freed, as far as possible, from the liquid, by draining on filters, redissolved in 10 p.c. brine and its solution dialyzed for three days. From the semi-solid mass thus obtained the liquid was decanted and the precipitate dissolved in 10 p.c. brine. A little transparent gummy substance (lecithin?) remained undissolved which rendered filtration very difficult. By filtering under considerable pressure on a thick layer of paper pulp about 700 cc. of perfectly clear filtrate, a. and 2,000 cc. of very nearly clear filtrate, b, were obtained. The latter, b, was dialyzed for four days, when the large deposit was filtered out and treated with about a liter of salt solution. A gelatinous, almost pasty mixture resulted, which was shaken out with ether. The two liquids at once separated, the ethereal being clear and strongly yellow in color and the aqueous almost perfectly clear and not at all gummy. Shaken out three times more with ether, this aqueous solution became suddenly opaque and gelatinous. The mass was dialyzed free from chlorides, the solid deposit was washed with alcohol and with ether and dried over sulphuric acid, giving preparation 1, weighing 60 grams. The clear solution, a (700 cc.), was diluted with three volumes of distilled water, and allowed to stand over night at a temperature of 6°. The proteid, which had separated on

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dilution, soon settled as a clear, transparent layer, from which the clear solution, c, was decanted completely. The proteid was readily and completely soluble in 10 p. c. brine to a perfectly clear pale yellow solution, which, when dialyzed until wholly free from chlorides, yielded the proteid in spheroids that subsequently united to a semi-solid mass. The latter was filtered out, washed thoroughly with water and with alcohol, and dried over sulphuric acid, giving 32.1 grams of preparation 2. The solution, c (decanted from the precipitate produced by dilution that yielded 2), was treated with 1,000 cc. more water. This caused a precipitate which within two hours formed a semifluid deposit. From this the solution d was decanted, and the deposit dissolved in brine yielding a perfectly clear solution, which was dialyzed until free from chlorides.

The proteid thus precipitated was filtered out, washed with absolute alcohol as long as anything could be removed thereby and then dried over sulphuric acid, giving preparation 3, weighing 16.5 grams.

The solution, d, was dialyzed free from chlorides, the precipitated spheroids were filtered out, washed with absolute alcohol and dried over sulphuric acid, making 5 grams of preparation 4.

The solution, page 339, filtered after forty-eight hours' dialysis from the substance that yielded the foregoing preparations, was further dialyzed until almost all its dissolved proteid had separated.

The precipitate thus produced was filtered out, dissolved in brine and the solution shaken out three times with ether. On shaking out the third time, the solution suddenly changed to an opaque jelly. This was then placed in a dialyzer, and when all the salt had been removed, the insoluble proteid was washed with absolute alcohol until everything soluble therein was extracted. Dried over sulphuric acid, this preparation, 5, weighed 75 grams. All these preparations were dried at 110° and analyzed with the following results:

Survey of the laborate		2	3	4	5
	1			50.69	50.48
Carbon	50.82	51.21	51.10		7.11
Hydrogen	7.11	7.07	7.21	7.06	15.50
Nitrogen	16.04	16.11	16.23	16.40	1.02
Sulphur	I.II	1.05	1.00	1.05	0.96
Phosphorus	0.91	0.81	0.79	1.20	3.19
Ash	2.37	2.49	1.56	3.23	2.15
P.O. in Ash	T.65	1.70	1.14	2.30	

The ash of all these preparations consisted of sodium metaphosphate containing about 70 p.c. of  $P_2O_5$ . We have therefore subtracted from the total ash its  $P_2O_5$ , the remainder representing the ash to be deducted in calculating the percentage composition of the proteid substance.

Any chlorine or sulphur that might belong to the ash would necessarily be lost during incineration.

Calculating these preparations free from ash, as thus corrected, we have:

	1	2	3	4	5
Carbon	51.18	51.56	51.31	51.16	51.00
Hydrogen	7.14	7.12	7.24	7.12	7.18
Nitrogen	16.16	16.23	16.30	16.55	15.66
Sulphur	1.12	1.06	1.00	1.06	1.03
Phosphorus	0.92	0.82	0.79	1.21	0.97
Oxygen	23.48	23.21	23.36	22.90	24.16
	-				
	100.00	100.00	100.00	100.00	100.00

1 and 5 represent the two main fractions that weighed 60 and 75 grams respectively; while 2, 3 and 4 represent fractions of 1, whose weights were respectively 32, 16.5 and 5 grams.

In composition all are nearly alike. A little more phosphorus was found in 4 than in the other preparations, probably because a larger proportion of some phosphorus-containing acid was combined with the protein of this final, very soluble fraction, which formed less than 10 p.c. of the total vitellin.

We have not yet succeeded in preparing this phosphorized acid free from proteid. The body, which we have thus prepared from egg yolk and analyzed, is not present, as such, in the egg, for the proteid substances of the yolk are readily and wholly soluble in salt solution, whereas all these preparations are entirely insoluble in salt solution. Insolubility in the cases of 2, 3 and 4 was caused by washing with alcohol, which at the same time removed much lecithin. Lecithin was not present as an admixture, but was chemically combined with the proteid, forming a compound soluble in saline solutions and having the properties of globulin, as is shown by the following experiments.

A. The alcoholic washings from the three successive fractions, 2, 3 and 4, were evaporated and left residues of crude

lecithin weighing 6.4796, 3,5913 and 1,3150 grams respectively. Adding these quantities to the weights of the corresponding fractions dried at 110°, we have the amounts of lecithin-protein compound originally composing them. These contained 18.00, 19.4 and 22.23 p. c. of lecithin respectively.

B. The yolks of two eggs were directly extracted with ether until practically nothing more was removed. The residual matter was then, as far as possible, dissolved in 10 p. c. salt solution, filtered perfectly clear and the solution diluted with water until an abundant precipitate separated. This was filtered out, dissolved in salt solution and filtered perfectly clear. This solution and that filtered from the precipitate previously produced by diluting with water were separately dialyzed.

The proteid precipitates thus obtained were filtered out and washed with water and alcohol. The part precipitated by dilution was found to contain 17.5 p.c. of lecithin, that which remained in the diluted brine, 22.3 p.c.—results in pretty close accord with those already stated.

C. Part of a large quantity of yolk vitellin which had suddenly become insoluble on shaking with ether, was thoroughly washed with water and then completely extracted with alcohol until all the lecithin, equal to 13.31 p.c., was removed. The solution, from which the above large quantity of insoluble proteid had originally separated, still contained a little protein matter and was therefore saturated with ammonium sulphate and the salt solution of the precipitate so produced was dialyzed. The substance which then separated in spheroids, after thorough washing with water, was still readily soluble in salt solution, but when washed with alcohol became insoluble and yielded to the alcohol 24.2 p. c. of lecithin.

Hoppe-Seyler considered this lecithin to be chemically combined with the proteid, with which view our experience is in full harmony. It is not possible that such large quantities of lecithin are simply admixed with the protein matter, for were this the case it could be readily removed by ether. Furthermore we could not dissolve a mixture of globulin and lecithin in brine and obtain a clear solution easy to filter. That the proteid should unite with lecithin is to be expected, since protein readily combines with acids. We must, accordingly, consider the protein of egg yolk to be largely, if not wholly, a lecithin

compound which, dissolves in salt solution, and behaves like a globulin.

Saline extracts of egg yolk, like those of plant-seeds, contain, according to circumstances, mixtures of compounds of the protein molecule with several different numbers of molecules of lecithin, of which the more soluble compounds contain the larger number of acid molecules.

That we find such a large proportion of lecithin in these compounds is accounted for by its great molecular weight. If the molecular weight of the protein were 15,000,\* its compound with four molecules of lecithin would contain over 17 p.c. of the latter.

Although we are not yet in a position to distinguish between these several compounds, it is nevertheless now necessary to make a distinction between the vitellin as it exists in the yolk, combined with lecithin, and the insoluble substance free from lecithin, which we have prepared and analyzed. As the designation vitellin has generally, if not always, been understood to apply to a protein substance, we suggest that this term be henceforth reserved for the protein, which in egg-yolk is united to lecithin and not to the compounds formed by their union, which may more properly be called lecithin-vitellin.

These considerations raise the question, are the preparations analyzed, vitellin, as defined above, or are they compounds of this protein with some other, at present unknown substance. Since the preparations yield paranuclein on digestion with pepsin, it appears highly probable that they contain paranucleic acid, but in less proportion than occurs in paranuclein.

To test this hypothesis we treated 10 grams of preparation  $\mathbf{5}$  with 100 cc. of N/10 KOH solution, and after standing some time added enough 0.4 p. c. hydrochloric acid to neutralize the alkali and give an excess of acid equal to 0.2 p. c. of the solution. Pepsin was then intermixed and the solution digested at 40° for forty hours. After some time a voluminous precipitate separated from the nearly clear liquid. This was filtered out, washed thoroughly with water and mixed with 45 cc. N/10 KOH solution, which dissolved the precipitate and just neu-

<sup>\*</sup>We have pointed out in a former paper, Jour. Am. Chem. Soc., XXI, 486, the reasons which make it probable that the weight of the protein molecule may be about 15,000.

tralized its acid reaction to phenolphthalein. This solution was filtered perfectly clear and 45 cc. of N/10 HCl were added. which threw out the paranuclein as a voluminous gelatinous precipitate. This was filtered out, washed thoroughly with water and with alcohol, and dried over sulphuric acid. This preparation, 6, weighed 2.38 grams. Another preparation of paranuclein was made by suspending 50 grams of preparation 5 in 2/10 p. c. hydrochloric acid, adding pepsin and, after digesting for twenty-four hours, adding more acid and pepsin and continuing the digestion twenty-four hours longer. The insoluble paranuclein was then filtered out, washed thoroughly with water and with alcohol, and dried over sulphuric acid. It weighed 15.7 grams. Preparation 7.

The yolks of 120 eggs were mixed with an equal volume of saturated sodium chloride brine and the mixture was shaken with ether containing a little alcohol. A perfectly clear red-yellow ether-layer and a clear pale yellow aqueous layer soon separated. The ether was drawn off and the aqueous solution again shaken with ether, which caused a part of the proteid to become insoluble, rendering the solution opaque and gelatinous. After the ether had separated, the aqueous solution was dialyzed until free from chlorides, when it was filtered and the very voluminous precipitate was suspended in four liters of 0.2 p.c. hydrochloric acid and digested with 3.0 grams of pepsin. After twenty-four hours the solution was decanted from a large deposit of insoluble matter, the latter was mixed with about one-third its volume of 0.4 p. c. hydrochloric acid and the digestion continued fortyeight hours longer, whereby the amount of insoluble matter was much reduced. The latter was then filtered out and repeatedly extracted with alcohol until the evaporated alcoholic washings left no residue. This required a large quantity of alcohol and more than a week of time. The residue, air dried, weighed 32 grams and formed preparation 8.

These preparations were then dried at 110° and analyzed, with results as follows:

# COMPOSITION OF PARANUCLEIN.

	6	7	8
Carbon	46.69	47.72	44.48
Hydrogen	6.77	6.80	6.52
Nitrogen	14.66	14.64	14.34
Sulphur	0.86	0.94	0.82
Phosphorus	3.29	2.52	4.19
Ash	1.89	5.01	3.43
P <sub>2</sub> O <sub>5</sub> in Ash	0.83	2.47	1.61

Assuming that the yolk proteid and the paranuclein are both compounds of paranucleic acid, we should be able to calculate the composition of the protein substance in our preparations if we knew the composition of this acid. Unfortunately we do not know this acid in the free state.

Liebermann and others have thought that paranucleic acid is identical with metaphosphoric acid, but we think it extremely improbable that metaphosphoric acid can exist in animal tissues.

In seeking to harmonize the analyses of paranuclein with those of the paranucleoproteid we find that they are brought into more or less accordance by reckoning them free from ash and from certain phosphoric acid radicals. Assuming that the hydrogen of the phosphoric acid is replaced by protein, we have "corrected" our analyses for the following phosphoric acids, viz.: HPO3, H3PO4, H8P2O9 and H5PO5 by subtracting from the ash its P2O5 and to the remainder (the bases) adding the phosphorus and oxygen of the respective acids and, after deducting their sum from 100, recalculating these remainders to percentage statements.

Corrected for PO3 we find no satisfactory agreement, as is shown by the following figures obtained by thus correcting the analyses of preparations 2 and 6.

	. 2	6
Carbon	52.68	50.86
Hydrogen	7.28	7.37
Nitrogen	16.57	15.97
Sulphur	1.08	0.94
Oxygen	22.39	24.86
alian Para and	00.00	100.00

Correcting for the other three acids, however, we find a close agreement between all the analyses of the preceding preparations as is seen in the following tables:

Composition of the Paranucleoproteid and the Paranuclein calculated free from PO<sub>4</sub> and Ash.

	Paranucleoproteid.						Paranuclein.			
	1	2	3	74	5	6	7	8		
Carbon 52	2.67	52.89	52.59	53.14	52.57	52.54	53.17	52.12		
Hydrogen 7	7.37	7.30	7.42	7.40	7.40	7.60	7.57	7.64		
Nitrogen 16	5.62	16.64	16.70	17.19	16.11	16.50	16.31	16.80		
Sulphur	1.15	1.09	1.03	1.10	1.06	0.96	1.05	0.96		
Oxygen 22	2.19	22.08	22.26	21.17	22.86	22.40	21.90	22.48		
100	0,00	100.00	100.00	100.00	100.00	100.00	100.00	100.00		

The agreement of these figures makes it plain that the paranuclein consists of one or more compounds of the protein (vitellin) containing a larger proportion of the same acid that exists in the paranucleoproteid from which it originated. These protein compounds with paranucleic acid are therefore analogous to those with the nucleic acid which we have obtained from the wheat embryo and described in the preceding paper.

If, as many seem to think, the paranucleic acid is not in fact  $H_8PO_4$ , it may be found to be either  $H_8P_2O_9$ , or  $H_5PO_5$ . These acids differ in composition so little from  $H_3PO_4$  that we find nearly or quite as close agreement when the analyses are calculated free from either of them, as the following table shows, in which is given the result of calculating the analyses free from  $P_2O_9$  and ash.

Composition of the Paranucleoproteid and the Paranuclein calculated free from  $\mathrm{P}_2\mathrm{O}_9$  and Ash.

		Para	nucleopro	F	Paranuclein.			
	1	2	3	4	5	6	7	8
Carbon 5	2.79	53.00	52.70	53.31	52.71	53.05	53.56	52.78
Hydrogen	7.39	7.32	7.44	7.42	7.42	7.69	7.63	7.74
Nitrogen I	6.66	16.67	16.74	17.25	16.19	16.66	16.43	17.02
Sulphur	1.15	1.08	1.03	1.10	1.06	0.98	1.05	0.97
Oxygen 2	2.01	21.93	22.09	20.90	22.62	21.62	21.33	21.49
10	00,00	100.00	100.00	100.00	100.00	100.00	100.00	100.00

Considering the great differences in phosphorus-content of these preparations, the striking agreement of the analyses thus calculated makes probable that the acid combined with the protein has nearly the composition  $\rm H_3PO_4$  and contains little, if any organic matter, or else contains an organic radical, whose composition is very nearly like that of the protein itself.

It may possibly be a methyl or ethyl phosphoric acid or some other quite simple organic phosphoric acid, but probably not so complex an acid as glycerophosphoric, as we have found a wide difference between the analyses when corrected for this acid.

It seems probable in view of these facts that further study will lead to the isolation and positive identification of this acid.

# CONCLUSION.

Sodium chloride solutions dissolve from egg yolk a large amount of protein matter which has the properties of a globulin, being precipitated by diluting or dialyzing its solutions.

The substance soluble in salt solution consists of a mixture of compounds of protein matter with lecithin. Preparations of these compounds contain from 15 to 30 p. c. of lecithin. The more soluble products obtained by fractional precipitation contain larger proportions of lecithin than the less soluble, that is, they are more acid compounds. These compounds might well be called lecithin-nucleo-vitellin.

The lecithin thus combined is not removed by ether, but readily by alcohol. The insoluble lecithin-free proteid, obtained by treating the lecithin compounds with alcohol, has a constant composition when obtained from successive fractional precipitations of the lecithin compound. The following is the average of five accordant analyses representing fractional precipitations of the substance:

# Composition of Nucleo-Vitellin.

Carbon	51.24
Hydrogen	7.16
Nitrogen	16.38
Sulphur	1.04
Phosphorus	0.94
Oxygen	23.24
	<b></b>
	100.00

This substance on digesting with pepsin yields paranuclein of variable composition. When the analyses of the nucleovitellin and the paranuclein are calculated free from phosphoric acid  $H_3PO_4$ , possibly identical with "paranucleic acid," the composition found for the organic part of all of these preparations is so nearly the same as to show that the proteid and the nuclein are both compounds of one and the same proteid body, vitellin, with a phosphoric acid, possibly  $H_3PO_4$ ,  $H_8P_2O_9$ , or some very simple organo-phosphoric acid. The composition of the organic part of the preparations calculated free from  $H_3PO_4$  gives as the average for eight preparations of the paranucleoproteid and the paranuclein the following figures:

### COMPOSITION OF VITELLIN.

Carbon i	52.71
Hydrogen	7.46
Nitrogen	16.64
Sulphur	1.05
Oxygen	22.14
	100.00

# THE PROTEIN CONSTITUENTS OF EGG WHITE.

By THOMAS B. OSBORNE AND GEORGE F. CAMPBELL.

A recent paper by the writer (Report of this Station for 1898 and Jour. Am. Chem. Soc. 21, 486) gave an account of preparations of crystallized egg albumin which justified the conclusion that with the substance commonly called ovalbumin there is associated one or more other protein bodies, the properties of which were not definitely ascertained.

We have since repeated this work on a larger scale and have not only confirmed the former observations, but have obtained much additional information respecting these other protein bodies.

# FRACTIONAL PRECIPITATION OF EGG WHITE.

Six liters of the whites of freshly laid eggs were gradually and carefully mixed with an equal volume of saturated ammonium sulphate solution and formed the precipitate A, which was filtered off. To the filtrate saturated ammonium sulphate solution was added until a small permanent precipitate was produced, and then a mixture of 600 cc. of saturated ammonium sulphate solution, 830 cc. of water and 27 cc. of concentrated hydrochloric acid were gradually added. After standing over night, the large quantity of fine needle-shaped crystals which separated, fraction B, was filtered out.

The filtrate, mixed with saturated ammonium sulphate solution until a small precipitate again formed, was allowed to stand over night, during which time another crystalline precipitate. C, separated.

By treating the filtrate from C in the same manner, another precipitate, D, was obtained, which consisted wholly of spheroids.

All the protein matter which remained in the filtrate from D was precipitated by saturating the solution with ammonium sulphate, and this made preparation E. These several fractions were then further divided as follows:

Precipitate A was treated with water, strained with difficulty, owing to its gummy character, through bolting cloth, and the slightly turbid solution thus obtained was dialyzed for several days. The considerable mucin-like precipitate which separated was filtered out, washed with much water and dehydrated with absolute alcohol, giving 26.88 grams of preparation. A.I.a.

The filtrate from the precipitate of A.I.a., saturated with ammonium sulphate, yielded a precipitate which was treated with a little water, and the part insoluble therein filtered out; the filtrate was allowed to evaporate until an amorphous precipitate separated. This precipitate was filtered out, united with the insoluble part of the ammonium sulphate precipitate, dissolved in water, and its solution dialyzed, yielding a precipitate which resembled that previously obtained by dialysis, being largely composed of gummy, mucin-like clots. This, when well washed with water and alcohol and dried, gave 7.28 grams of A.I.b. The dialyzed solution from which A.I.b. had separated, when treated with ammonium sulphate, yielded a precipitate which was filtered out, pressed on filter paper, dissolved in water and this solution dialyzed free from sulphate.

This dialyzed solution, evaporated at 40°, left a residue, marked A.2, weighing, dry, 16 grams.

The solution containing sulphate of ammonium, from which had been separated the substance yielding the two last named preparations, was further concentrated by gradual evaporation. and yielded a mass of needle-shaped crystals. These were separated by filtration, dissolved in water, the solution was dialyzed till free from ammonium sulphate and evaporated at 40°, giving preparation A.3, weighing 11.56 grams.

Precipitate B. This, consisting wholly of well-formed crystals, was dissolved in water and treated with saturated ammonium sulphate solution, which was added until precipitation began. After standing over night, the wholly crystalline precipitate was filtered out and the filtrate, marked b.2, treated as will be later described. The precipitate was again dissolved in water and enough ammonium sulphate added to give a precipitate from which, after a time, the solution was decanted. After pressing out the mother liquor, the precipitate was dissolved in water and the clear solution dialyzed, until wholly free from sulphate, when it was evaporated at 50°, giving 36.0 grams of B 1.

The filtrate from the precipitation of B.I treated with more ammonium sulphate, on standing twelve hours, deposited a large crop of finely developed crystals. This was filtered out and, treated in the manner described for B.I, gave 50 grams of B.2. The filtrate from B.2 was added to solution b.2.

Precipitate C. The filtrates from B.1 and B.2, forming solution b.2, were united with the aqueous solution of fraction C, ammonium sulphate was added to incipient precipitation and the mixture was allowed to stand over night. The substance, which separated in spheroids, was filtered out, dissolved in water and recrystallized by adding ammonium sulphate. On standing, the substance deposited in large aggregates of crystals, extending from the bottom of the dish in warty masses, some of them more than 2 cm. long and 0.5 cm. in diameter. These masses were wholly composed of exceptionally large and wellformed needle crystals. After separating from the mother liquor, this crystalline mass was dissolved in water and the solution dialyzed till free from sulphate, and, evaporated at 50°, gave 45 grams of C.I.

The filtrate from C.I, on standing, yielded a very large quantity of substance which was composed almost wholly of crystals, only a very few spheroids being detected among them. This precipitate, by the treatment applied to C.I, yielded 106 grams of C.2.

The filtrate from the first precipitation of C.I was treated with more ammonium sulphate, the filtrate from C.2 was added, and the mixture allowed to evaporate slowly until a precipitate separated, which consisted of a mixture of crystals and spheroids. This yielded C.3, weighing 32.5 grams.

Precipitate D. This was dissolved in water, ammonium sulphate solution was added and the mixture allowed to stand until a considerable separation of spheroids occurred, which, on settling, formed a clear, transparent deposit on the bottom of the dish.

After several reprecipitations, always without obtaining crystals, and thinking that the absence of crystals might be due to a deficiency of acid, we added to the solution 3 cc. of concentrated hydrochloric acid mixed with much ammonium sulphate solution. On standing, however, this solution, as before, deposited only spheroids. The deposit, after decanting the solution, was dissolved in water and its solution, after adding ammonium sulphate to incipient precipitation, was allowed to evaporate slowly. When considerable deposit had formed, the solution was decanted and allowed to concentrate until nearly all the remaining proteid matter had formed a coherent deposit of spheroids. These two deposits were each separately dissolved in water, their solutions dialyzed free from ammonium sulphate and evaporated to dryness at 50°, thus giving D.I, weighing 30 grams and D.2, weighing 20 grams.

The solution, decanted from the first precipitate which separated after adding acid, gave on evaporation a precipitate consisting wholly of spheroids, which formed D.3, weighing 55 grams. The solution from this, on further concentration deposited nearly all the dissolved protein in the form of spheroids which, by the usual treatment, gave 10 grams of D.4.

Precipitate E. This, when dissolved in water, yielded a brilliant yellow solution, slightly acid to litmus. Thereto saturated ammonium sulphate solution, containing I cc. of concentrated hydrochloric acid, was added, which, on standing, caused a precipitate. This was filtered off, dissolved in water, ammonium sulphate was added to incipient precipitation, and after standing seven days, the deposit of spheroids which had separated was filtered out, yielding 6.2 grams of E.I. The filtrate contained no protein matter.

The filtrate from the first reprecipitation of E was mixed with ammonium sulphate until a considerable amorphous precipitate had formed. This was filtered out, dissolved in water, and after adding ammonium sulphate and allowing the solution to stand six days, it gave a precipitate of spheroids which yielded E.2, weighing 15.65 grams.

The solution decanted from the first precipitation of E.2, after evaporating for six days, gave a deposit of spheroids mixed with a little amorphous matter, which was marked E.3, and weighed 22.5 grams.

We thus obtained from six liters of egg white, seventeen different fractions, containing 504 grams of substance, 262 grams of which were wholly crystalline, and since at least one-half of C.3 consisted of crystals, the total amount of crystalline matter was 278 grams. Evidently more than one-half the protein constituents of egg white can be crystallized. The yield of crystallized albumin was about the same as that obtained by the writer in his previous investigation, being about 4.4 grams of crystallized albumin per 100 cc. of egg white, as against 5.3 and 4.9 grams previously obtained.

Fractions E.2 and E.3. Since the fractions E.2 and E.3 appeared, by their behavior on heating with water, to contain at least three protein substances, the greater part of each preparation was treated with water. E.2 contained some matter insoluble in water which could not be filtered out, while E.3 gave a clear solution. Both solutions, heated in a water bath, gave a flocculent coagulum at 58° which, even after heating at 65° for some time, could not be filtered out. The temperature was therefore raised to 72° and held there some time, which caused more coagulum to separate in both solutions, but as the solutions could not even then be filtered, the bath was heated to boiling. With the rising temperature the coagulum rapidly increased, so that it could soon be filtered out on cloth. After thoroughly washing each coagulum with hot water and alcohol and drying over sulphuric

acid, we obtained preparations E.2.a, weighing 6.0 grams and E.3.a, weighing 8.6 grams. The clear bright yellow filtrates from these were united and poured into several volumes of alcohol, which threw out a white precipitate and held the yellow coloring matter in solution.

The precipitate, E.4, washed with alcohol and ether and dried over sulphuric acid, weighed 5 grams.

These preparations were then dried to constant weight at 110° and analyzed.

The heat coagulation points of their solutions, containing 2.5 p. c. of the protein substance and 10 p. c. of sodium chloride, were determined by gradually heating in a water bath. In Table I, page 354, T indicates the temperature at which the solution became turbid and F that at which flocks separated.

The specific rotation was determined with a Schmidt and Haensch polarimeter, the readings on the sugar scale being converted into degrees of circular polarization by multiplying by 0.346.

In the table the percentages of nitrogen marked K, were found by the Kjeldahl process, those marked A, by the Dumas or absolute method.

These results entirely confirm those given in our former paper, but in consequence of the more extended series of fractional precipitations in the work now under discussion we have plainer evidence of the presence of the several protein constituents of the egg white.

Of these fractions, B.1, B.2, C.1 and C.2 consist of ovalbumin, separated in a completely crystalline condition, and, with the exception of a trace present in C.2, are wholly free from the lower coagulating albumin, thus demonstrating this latter to be a distinct substance. The rotation and elementary composition of these fractions are essentially the same as that given in our former paper for similar products.

In fraction E.4 we have ovonucoid not coagulated by heat, with a specific rotation of 61.°5 and of the same composition as Möner¹ and Zanetti² found for this substance. (I Zeit. f. physiol. Chem. 18, 525 and 2, Ann. di Chim. e Farmac., No. 12,, 1897.) The successive fractions, from C.3 to E.3.a inclusive, all have a higher specific rotation and contain a relatively con-

TABLE I.—THE WEIGHT, ROTATION, COMPOSITION AND HEAT COAGULATION.

TEMPERATURES OF THE FRACTIONAL PRECIPITATES OF EGG-WHITE.

	* - M.				Calculate	d Ash-fre	e. ,	JAN 18			
Prepara-	Weight grams.	[a] <sub>D</sub>	C.	' н.	N.	S.	P.	0.	Ash.	Coagula- tion tem- perature.	Remarks.
A.1.a.	26.88	-21° 9′	50.69	6.71	14.49	2.280	trace	25.830	0.53	T 70° F 75°	Coagulum nearly disappears on boiling and reappears on cooling.
A.1.b.	7.28	-	50.95	6.85	14.82	1.938	none	25.442	1.41	-	9
A.2.	16.00	-31° 50′	52.76	7.12	15.48K 15.58K	1.687	0.123	22.770	0.41	T 64° F 70°	Practically all agulated above 70°.
A.3.	11.56	_	52.40	7.12	15.77K 15.66K	1.729	0.002	23.029	0.28	T 66° F 70°	
В.т.	36.00	-29° 53′	52.59	7.10	15.59K 15.51K	1.613	0.126	23.021	0.136	T 70° F 71°	None coagulated
B.2.	59.00	-29° 13′	52.78	7.09	15.54K 15.60A	1.619	0.127	22.814	0.150	T 68° F 70°	None coagulated below 68°.
C.1.	45.00	-30° 2′	52.75	7.31	15.57A 15.43K	1.613	0.131	22.696	0.350	T 69° F 71°	None coagulated below 69°.
C.2.	106.00	-30° 48′	52.79	7.00	15.57K 15.63A	1.634	0.126	22.850	0,20	T 62° F 65°	Only a trace coagulated at this temperature. The rest separated at 70° and above.
C.3.	32.40	-34° 2′	52.24	7.08	15.55A	1.755	0.085	23.290	0.290	T 57° F 57°	Considerable coagulated below 70°, but most above 70°.
D.1.	3 <b>0.</b> 00	-34° 18′	52.41	6.93	15.57A	1.796	0.106	23.188	0.14	T 51° F 53°	Much coagulated below 70°, but most above 70°.
D.2.	20.00	-37° 14′	52.29	6.94	15.61A	1.886	0.062	23.212	0.04		About 50 p.c. coagu-
D.3.	55.00	-41° 22′	51.62	6.94	15.23A 15.27K	1.972	0.048	24.170	0.10	T 52° F 55°	About 50 p.c. coagulated below 60°, about 35 p.c. at 70° and above. The rest did not coagulate.  Aqueous soud a clear
D.4.	10.00	-51° 30′	50.56	6.80	13.64A 13.54A	1.997	trace	27.033	0.11	T 62° F 64°	jelly. Salt sol. coagu- lated at 64°. And above. Muci unco-
E.1.	6.20	-33° 36′	51.91	6.94	15.02A 15.27K	1.700 1.710	trace	24.285	0.49	T 59° F 60°	p.c. was coagulated below 70°, much above
E.2:	15.65	-43° 7′	-	-	-	-	-	-		-	Less appeared to co- agulate below 70° than of E.I when heated in water with no salt.
E.3.	22.50	-49° 5′	-	_	-	_	-	-		_	Less separated below 70° than of E.2. when heated in water.
E.2.a.	6,00		52.40	6.91	15.69A	1.780	0.090	23.131	0.66	-	Not much separated below 70° when heated in water.
E.3.a.	8.60		51.94	6.84	15.31A	1.629	0.045	24.236	0.36	-	Not much separated below 70° when heated in water.
E.4.	5.00	-61° 38′	49.02	6.45	12.71A	2.379	0.11	29.441	0.750	-	No coagulum.

siderable amount of an albumin coagulating at a much lower temperature than ovalbumin.

The fractions C.3, D.1 and D.2 have nearly the same rotation, temperatures of coagulation and composition. We therefore subjected these to fractional precipitation, in order to determine whether they were mixtures of different proteids or were essentially one substance. The greater parts of these preparations were accordingly united, dissolved in about 400 cc. of water and saturated ammonium sulphate solution added, until a decided precipitate had formed. This was filtered out, freed from mother liquor, dissolved in water, the solution dialyzed until free from ammonium sulphate and then evaporated to dryness below 50°. The residue, F.1, weighed 7.5 grams. The filtrate from F.1, on evaporating at the room temperature, deposited a quantity of spheroids, mixed with a few crystals of ovalbumin. This deposit was filtered out, dissolved in water, to the solution saturated ammonium sulphate solution was added until incipient precipitation set in, and the whole was allowed to stand until a considerable precipitate composed of spheroids mixed with a few crystals had formed. This was filtered out and, in order, if possible, to convert the whole into crystals, the original reaction of the egg white was imitated by making the aqueous solution of the precipitate slightly alkaline with ammonia. A very small excess of hydrochloric acid was added and then ammonium sulphate to incipient precipitation, thus reproducing, as closely as we could, the conditions under which the first crystalline separation had been obtained. After standing, a precipitate formed which contained no crystals. This was filtered out and, by the usual treatment, gave F.2, weighing 18.32 grams. The solutions filtered from the two preceding precipitations of F.2 were saturated with ammonium sulphate, and the resulting precipitate dissolved in water, its solution dialyzed, and evaporated below 50°, gave F.2.a, weighing 7.83 grams. The filtrate from the first precipitation of F.2 on further evaporation gave a precipitate of spheroids which was dissolved in water, and by the treatment employed for separating F.2.a, gave 16.7 grams of F.3.

The solution filtered from the second precipitation of F.3 was saturated with ammonium sulphate and from the precipitate produced by the usual treatment, F.3.a, weighing 5.38 grams,

obtained. These several preparations were found to have the rotation, heat coagulation temperatures and compositions given in Table II.

Table II.—Composition, etc. of Fractional Reprecipitations of  $\tau_{\rm HE}$  Intermediate Fractions of Table I.

-	Ash free.										
Prep.	Weight grams.	[a] D.	C.	H.	N.	s.	Р.	0.	Ash.	Coagula- tion tem- perature.	Remarks.
F.1.	7.50	36° 4′	52.01	7.03	15.77D	1.768	0.069	23.353	0.36	T 58° F 64°	First Coagulum small, above 70° more than in F.2.a.
F.2.	18.32	32° 2′	52.36	6.95	15.59K 15.43K	1.689	0.117	23.374	0.47	T 68° F 68°	Only a trace below 70°, much above 70°.
F.2.a.	7.83	38° 35′	51.54	6.94	15.19K 15.22K	1.920	0.081	24.319	0.60	T 60° F 63°	Considerable below 65°, above 70° more than in F.3.a.
F.3.	16.70	40° 11′	51.32	6.72	15.34K	1.782 1.810	0.009	24.815	0.32	T 58° F 59°	Below 67° near- ly 35 p.c., at 70°, and above nearly 40 p.c. coagulated. More below 65°
F.3.a.	5.38	44° 25′	51.29	6.77	15.30D	2.025	0.027	24.588	1.06	T 62° F 64°	than in any of these fractions of F.

While none of these fractions was obtained free from the lower coagulating albumin, the relative proportions of the two albumins which the different fractions contained varied greatly, which fact, in conjunction with their rotation and composition, shows that a decided, though incomplete, separation has been effected.

In order to separate more completely the proteids which these mixed fractions appeared to contain, we dissolved 13.4 grams of D.3 in 500 cc. of 10 p. c. brine, and heated the filtered and perfectly clear solution slowly in a large water bath. A floculent coagulum began to separate at 52°, which, after heating for some time at 60°, was filtered off. The filtrate was then removed and this coagulum was washed with pure water, which, after the salt was removed, dissolved the coagulum almost completely. From these washings the proteid was separated by adding alcohol. When dried over sulphuric acid it weighed 5.00 grams and formed preparation D.3.1.

The solution filtered from the coagulum separating below 60°, when further heated became turbid at 64° and yielded a flocculent coagulum at 70°. This second coagulum was filtered off

after heating for some time at 88° and when washed and dried gave 3.5 grams of D.3.2. The filtrate from this gave no more coagulum on heating and after dialyzing free from chlorides was concentrated to small volume and precipitated by pouring into alcohol. This gave us 2.0 grams of D.3.3.

Seven grams of F.3 were dissolved in 280 cc. of 5 p. c. brine and the solution heated to 67°. The flocculent coagulum, which began to separate at 59°, was filtered out, washed and dried, giving 1.87 grams of F.3.1. The filtrate heated to 92° gave another coagulum which began to separate at about 70°. This, when dry, weighed 2.17 grams, F.3.2. The filtrate from F.3.2, dialyzed free from chlorides and precipitated by alcohol, gave 1.30 grams of F.3.3.

Twenty-five grams of K.3 (the more soluble part of a precipitate obtained by adding an equal volume of saturated ammonium sulphate solution to a large quantity of egg white) were dissolved in about 800 cc. of 10 p. c. brine, the solution filtered clear and heated to 60°. The coagulum was washed with salt solution, suspended in water after passing through fine bolting cloth to break up all lumps, washed thoroughly with water, and with alcohol, and was dried, giving 2.78 grams of K.3.1. Unlike ovalbumin, this coagulated proteid separated in a finely divided state, so that it could be easily washed through the cloth.

The filtrate from this coagulum was dialyzed free from chlorides and then evaporated to dryness below 60°, leaving a residue which weighed 17.2 grams and had a specific rotation of 37°.55′. This rotation being much greater than that of ovalbumin, the whole of this residue was dissolved in 10 p. c. brine, the solution heated in a boiling water bath, the coagulum, K.3.2, filtered off, the filtrate dialyzed free from chloride and the clear solution poured into alcohol. The substance, K.3.3, thus precipitated, weighed dry, 1.39 gram, and consisted of ovomucoid as shown by its rotation, 61° 30′.

The preparation K.3 was prepared from the precipitate produced by half saturating the egg white solution with ammonium sulphate, which precipitate is commonly supposed to consist almost wholly of globulin. Nevertheless our results show that K.3 contained about II p.c. of the albumin coagulating below 65°, 83.0 p.c. of ovalbumin and over 5 p.c. of ovomucoid.

That so much of this latter substance should be present in this preparation is surprising and shows the difficulty in separating ovonucoid from ovalbumin.

All these preparations were analyzed with the results given in Table III.

Table III.—Composition, etc. of Products Derived from Fractions D. F. And K.

					Ash	frèe.			7 13		NO IN LIVE	
Prepara-	Weight grams.		С	н.	N.	S.	Р.	0.	Ash.	Coagula- tion tem- perature.	Remarks.	
D.3.1.	5.00	-	52.19	6.84	16.10K	1.67	0.010	23.19	0.85	T 48° F 52°	Formed about p.c. of D.3.	4
D.3.2.	3.81	_	52.08	7.04	15.36	1.61	0.110	23.80	0.23	T 64° F 70°	Formed about p.c. of D.3.	3.
D.3.3.	2.00	61° 10′	48.90	6.61	12.16K	2.34	none	29.99	2.33	_	No coagulum, Formed about p.c. of D.3.	18
F.3.1.	1.87	-	6-0	-	16.03K 16.15K	17.3	trace	-2	1.19	T 58° F 59°	Formed about p.c. of F.3.	2
F.3.2.	2.17		-	-	15.16K	1.61	-	-	2.00	T 70° F 70°	Formed about p.c. of F.3.	3
F.3.3.	1.39	61° 20′		-	_		-	_	_	-	No coagulum. Formed about p.c. of F.3.	20
Х.з.г.	2.78		52.31	7.05	16.16K	1.71	trace	22.77	0.56	T 57° F 60°	Formed about p.c. of K.3.	I
K.3.3.	1.39	61° 30′	-	_		_	_	_		16—31 16—31	Formed about p.c. of K.3.	5.

These figures show that an albumin coagulating at 55°-57° forms nearly 50 p. c. of the products obtained from D.3. This albumin contains somewhat less carbon, decidedly more nitrogen and a little more sulphur than ovalbumin. Since it so closely resembles ovalbumin, and is so intimately associated with it the writer suggests that it be called *conalbumin*. The rest of the products from D.3 consist of about 35 p. c. ovalbumin and 18 p. c. ovomucoid. From F.3, 27 p. c. of conalbumin, 31 p. c. of ovalbumin and 20 p. c. of ovomucoid were obtained.

This investigation of the protein constituents of the egg white show's them to be ovomucin, ovalbumin, conalbumin and ovomucoid. These have the following properties:

Ovonucin is a glycoproteid recently discovered by Eichholz (Jour. of Physiology, 23, 167), to be present in small amount in egg white. This substance, precipitated by diluting egg white, has heretofore been regarded as globulin, but we find that nearly, if not quite, all of that which is so precipitated, is ovonucin.

From the whites of 240 eggs we obtained, although with some loss, 34.2 grams of ovomucin or about 7.0 p.c. of the proteid matter of the egg white, which is the proportion in which Dillner found the "globulin" to be present.

When freshly precipitated by dilution or dialysis, ovomucin loses its gummy character on thoroughly washing with water, but, when treated with salt solutions, forms a transparent gummy mass, which on agitation yields a clear but viscid solution.

When washed with alcohol and dried, ovomucin forms a light, white powder, partly soluble in sodium chloride brine, and gives a solution free from viscidity, which becomes turbid at 75°, and yields flocks at 78°. On boiling, this coagulum almost wholly dissolves and reappears on cooling.

Eichholz states that ovomucin dissolves in dilute sodium carbonate solutions. We find, however, that when treated with much I p. c sodium carbonate, only an apparent solution results, for, when this is brought into filters, a clear, thin fluid passes through the paper from which, by adding acid, only an insignificant precipitate can be obtained, while a clear and very viscid fluid, containing almost all the ovomucin, remains upon the paper.

We have made, page 349, two preparations of ovomucin which had the following composition:

#### OVOMUCIN.

	A.I.a.	A.I.b.
Carbon	50.69	50.95
Hydrogen	6.71	6.85
Nitrogen	14.49	14.82
Sulphur	2.28	1.94
Oxygen	25.83	25.44
	100.00	100.00

Ovalbumin is the chief constituent of egg white, 50 p.c of its proteids having been obtained in this investigation in the form of perfectly crystallized preparations of this substance, while a large proportion of the remaining proteid matter also consisted of this albumin.

Heat coagulum of ovalbumin. Solutions in pure water, containing 2.5 p. c. of pure ovalbumin, become turbid at 60°, and at 64° yield a flocculent coagulum.

When 10 p. c. of sodium chloride is added to these solutions the temperature of coagulation becomes higher, turbidity developing at 69°, and flocks at 70°.\*

When its solution is evaporated to dryness below 50°, and the ovalbumin redissolved in water or in brine, a small amount of substance coagulating at the lower temperature appears to be formed. Thus, sodium chloride solutions containing 2.5 p. c. of B.I, B.2, or C.I, before these substances had been separated by evaporation at 50°, remained absolutely clear until heated to 68° or 69°, while similar solutions, made by dissolving the dried substance, became turbid at 59° and yielded flocks in small quantity at 63°.

Preparations of ovalbumin obtained by evaporating their solutions in pure water to dryness below 50°, do not completely redissolve when treated with water.

Solutions of some preparations thus made, become very rapidly turbid when filtered, and gradually deposit a not inconsiderable quantity of insoluble matter. The amount of insoluble matter in all of our preparations was so small, that we have been unable to learn its nature, but in one case we obtained 0.72 grams from 15 grams of a preparation containing a larger proportion than any we had seen before. This insoluble substance, which contained 15.65 p. c. N, and 1.8 p. c. S, was probably a mechanical coagulum, as it tended to separate at points of contact between the surface of the albumin solution and the vessel containing it. Sodium chloride added to the solution in sufficient quantity diminishes the amount, or prevents its formation. See Hopkins, Jour. of Physiology, 25, 324.

It has been stated by Hammarsten that with a constant amount

of salt the temperature of coagulation changes with variable amounts of albumin in solution.

We, accordingly, prepared solutions of the dialyzed, but not dried, albumin which contained 5, 2.5 and 1.0 p. c. of ovalbumin and also similar solutions containing in addition 10 p. c of sodium chloride. These, when heated very slowly in a large water bath, coagulated as follows:

	V	Vater	10 p.c. Salt Sol.
rn a albumin	Turbidity	59°	68°
5 p. c. arbumin 7	Turbidity	64°	. 71°
3	Turbidity	60°	69°
2.5 p. c )	TurbidityFlocks	64°	71°
	TurbidityFlocks	61°	69°
			71°
	Turbidity	63°	
0.5 p. c	Flocks	none eve	n on boiling

These figures show no difference in temperature of coagulation, for solutions containing from 1.0 to 5.0 p. c. of ovalbumin, together with 10 p. c. of sodium chloride, but solutions of ovalbumin in pure water coagulate at a lower temperature than those containing 10 p. c. of this salt, those containing 5.0 and 2.5 p. c. of albumin, coagulate at one and the same temperature; those containing 1.0 p. c. coagulate somewhat higher, while a solution containing but 0.5 p. c. of albumin yields no flocks even on boiling.

When the proportion of albumin remains constant, while that of the salt increases, the temperature of coagulation rises, as the following table shows:

NaCl	Ovalbumin		
1.0 p. c.	2.5 p. c.	\ 61° \ 63°	Turbidity Flocks
3.0 p. c.	2.5 p. c.	1 63° 65°	Turbidity Flocks
5.0 p. c.	2.5 p. c.	\ 65° \ 67°	Turbidity Flocks
10.0 р. с.	2.5 p. c.	{ 68° 70°	Turbidity Flocks

From these results we may state that solutions in water which contain from 2.5 to 5.0 p.c. of pure ovalbumin become turbid on heating to 60°, and yield a flocculent coagulum at 64°,

<sup>\*</sup>Stärke (Pflüger's Archiv 12, 18) notes this effect of sodium chloride on the coagulation of the albumin.

while those containing, in addition, 10 p. c. of sodium chloride become turbid at 68°, and flocculent at 70°.

In the preceding experiments no acid was added to the solution to be coagulated, the acidity of the ovalbumin (I gram of albumin required 2.0 cc. of N/10 alkali for neutralization to phenolphthalein) being sufficient to bring about coagulation.

When the albumin was exactly neutralized to phenolphthalein, by adding potash, the solution remained clear when heated for some time at 100°. When this solution was treated with acid equivalent to the added alkali a large precipitate resulted which did not separate completely until a very slight excess of acid was added. Thus, when 0.5 gram of albumin was dissolved in 19.0 cc. of water, 1.0 cc N/10 KOH added, making the solution exactly neutral to phenolphthalein, and the mixture heated for ten minutes in boiling water, no coagulum was produced. When cooled, 1.0 cc. of N/10 HCl was added, which gave a precipitate, from which a clear filtrate could not be obtained; with 1.2 cc. however, the precipitation was so complete that the filtrate gave no turbidity with alcohol. When I gram of albumin was dissolved in water and 2 cc. of N/10 NH3 solution were added, a quantity just sufficient to neutralize the acid reaction of the albumin, the solution remained clear after heating for some time at 100°. After cooling, on adding N/10 HCl, the solution remained clear until nearly enough acid had been added to neutralize the 2 cc. of ammonia, but when the full 2 cc. were added the albumin was so completely precipitated that the solution filtered from the coagulum contained only a trace of protein matter. The solution, thus neutralized, with either potash or ammonia, gave off hydrogen sulphide when heated and acidified.

To six tubes, each containing 0.5 gram of albumin, dissolved in 10 cc. of water, were added respectively 0.2, 0.4, 0.6, 0.8, 1.0 and 1.1 cc. N/10 HCl and then water enough to make each up to 20 cc. When these mixtures were heated in boiling water, the one with 0.8 cc. of acid yielded some coagulum, that with 1.0 cc. but a trace, while that with 1.1 cc. remained clear, showing I cc. of N/10 HCl to be enough to convert 0.5 gram of albumin into a compound not coagulated by heat. The portions with 0.2 and 0.6 cc. were completely, while that with 0.8 cc. was incompletely, coagulated. When 0.5 gram of

albumin was dissolved in 20 cc. of water, containing from 0.5 cc. to 3.0 cc. of N/10 acetic acid and heated in a boiling water bath, the albumin was practically completely coagulated; with 5.0 cc. of acetic acid the solution became opalescent at 64°, and formed a firm, transparent jelly at 75°. On heating at 99° with 10 cc. of N/10 acetic acid the solution formed a clear, thin jelly.

When solutions in pure water of any of our purest preparations of ovalbumin were heated to boiling for some time the albumin was so incompletely coagulated that a clear filtrate could not be obtained.

Six 2 gram portions of pure ovalbumin, were dissolved, each in 100 cc. of water, and mixed with equal volumes of water, containing 1, 2, 3, 4, 5 and 6 cc. of N/10 acetic acid respectively, and the mixtures boiled and poured on filters. The portion with I cc. of acid clogged the filter, as the coagulum separated imperfectly, whereas the others yielded clear filtrates. These, when evaporated to dryness, left residues weighing 0.0492, 0.0332, 0.0320, 0.0446, 0.0648 gram respectively.

From this it is seen that with I cc. of N/10 acetic acid the coagulation is incomplete, while with 3 and 4 cc. the amount of matter remaining in solution is less than with 2 cc. or than with 5 and 6 cc. This dissolved matter, which is very soluble in water, yields a solution decidedly acid to phenolphthalein and to litmus, contains proteid, and reduces Fehling's solution. Since the proportion, in which it is produced, appears to depend upon the quantity of acid added, we are inclined to regard it chiefly as a product of the action of the added acid upon a small part of the albumin, whereby uncoagulable acid compounds are formed in small, but variable proportion.

Specific Rotation. This was determined for solutions of the ovalbumin in pure water, with a Schmidt and Haensch polarimeter, the readings of the sugar scale being converted into degrees of circular polarization by multiplying by 0.346, and the amount of dissolved albumin was ascertained by evaporating and drying the residue at 110°. Preparations B.1, B.2, C.1 and C.2 showed very nearly the same rotation as that found by us in our former work for preparations of pure ovalbumin. These determinations gave the following values for  $\lceil \alpha \rceil_n$ :

A*.129.31°	B.I29.53°
A*.229.40°	B.229.13°
H*.128.60°	C.130.03°
H*.229.81°	C.2

The degree of rotation was found to be the same in sodium chloride solutions as in water, and also to be the same for the albumin in the dialyzed solutions of the crystals, as in solutions of the albumin which had been separated from such solutions by evaporation at 50°.

Since this paper was written we have received the number of the Journal of Physiology issued April 24, 1900, containing a paper on "Pure Albumin," by F. G. Hopkins, in which he gives the rotary power of pure albumin as -30.70°. The remarkable agreement between the rotation of the many fractional crystallizations, obtained by Hopkins, is much closer than between those observed by us, which is probably due to his superior polariscope and to the stronger solutions of the albumin, containing considerable amounts of ammonium sulphate, which he employed. Because solutions rich in pure albumin, when free from salts, are not easily obtained absolutely clear and tend to become turbid, probably from mechanical coagulation, we were generally not able to use solutions so rich in albumin as those employed by Hopkins. The difference of 1.3° between the values of  $\lceil \alpha \rceil_p$  found by Hopkins and the writer, is probably chiefly due to the different methods employed for determining albumin in the solution examined. We have shown, page 363, that when ovalbumin is coagulated in the presence of a minimum of acetic acid, about 1.5 p. c. of uncoagulated matter remains in solution. Whether this occurs under the conditions under which Hopkins coagulated his albumin requires further investigation. Hopkins admits that the method employed by us is the more accurate, assuming that all ammonium sulphate can be separated from the albumin solution. We believe that we have accomplished this in view of the great care we have taken to detect the presence of sulphates in our albumin preparations and feel quite sure that we have not overlooked a quantity of ammonium sulphate sufficient to have caused a difference of 4 p.c. of the observed rotation.

Elementary Composition. In the following table we give the analyses of our four purest preparations of ovalbumin, and also analyses of two preparations made by Hofmeister's method as described on page 366:

#### COMPOSITION OF OVALBUMIN.

and the state of the state of	B.1.	B.2.	C.1.	C.2.	No. 2.	No. 3.	Average.
Carbon 5	2.59	52.78	52.75	52.79	52.82	52.78	52.75
Hydrogen	7.10	7.09	7.31	7.00	7.03	7.07	7.10
Nitrogen I	5.55	15.57	15.50	15.60	15.32	15.53	15.51
Sulphur I	.613	1.619	1.613	1.634	1.590	1.651	1.620
Phosphorus o	.126	0.127	0.131	0.126	0.123	0.112	0.122
Oxygen 23	3.021	22.814	22.696	22.850	23.117	22.857	22.898
100	0.000	100.000	100.000	100.000	100.000	100.000	100.000

# ANALYTICAL METHODS.

Carbon and hydrogen were determined by using an open tube with copper oxide, lead chromate and metallic copper, and finishing the combustion in oxygen.

Nitrogen was determined by Dumas' method, the air being removed by a Sprengel pump, the tube then filled with carbonic acid set free by heating sodium bicarbonate at the front end again, emptied by the pump and this process repeated. In this way all the air was removed and no fixed gas was driven off on heating the reagents. Nitrogen was also determined by the Kjeldahl method and results in close accord with those of Dumas' method were obtained.

Sulphur was determined by fusing about one gram of the substance with sodium hydrate and peroxide over an alcohol lamp. The reagents were proved to be free from sulphur.

Phosphorus was determined by fusing about one gram of the substance with sodium peroxide, dissolving the fusion in nitric acid, precipitating with molybdic solution and weighing as magnesium pyrophosphate.

The figures given in the above table agree well with those of others who have prepared and analyzed ovalbumin with especial care, as may be seen in the following table:

#### COMPOSITION OF OVALBUMIN.

	C.	H.	N.	S. I	P. 0.	
Hammarsten	52.25	6.90	15.25	1.64	23.69	uncoag.
Chittenden & Bolton	52.33	6.98	15.89	1.83	22.97	"
" "	52 33	6.98	15.84	1.8r	23.04	coag.
Bondzinski & Zoja	52.39	7.11	15.39	1.66	23.45	"
Osborne & Campbell	52.75	7.10	15.51	1.62, 0.	12 22.90	
Hopkins	52.75	7.12	15.43	1.57		

<sup>\*</sup>These are preparations of the old series formerly described, and the two first are *not* parts of fraction A of the present series.

There would be no longer any question about the composition of ovalbumin, were it not for Hofmeister's analysis of a single preparation (Zeit. f. physiol. Chem. 16, 187), and the recent assertion of Schulz (Ibid. 29, 86), that on crystallizing by the "acid process" a hydrate of Hofmeister's egg albumin is formed. This we have shown in our former paper to be untrue, for we there gave the results obtained by analyzing a preparation made exactly according to Hofmeister's method, which agreed quite well with the analyses of all our other preparations made by the acid method of Hopkins.

That there should be no question as to the composition of crystallized ovalbumin made according to Hofmeister's method we made preparation, No. 2, recrystallized six times and coagulated by alcohol, No. 3, by recrystallizing four times, pressing the crystals on filter paper, dissolving them in water, dialyzing the solution perfectly free from sulphate and evaporating the filtered solution at 50° to dryness.

Dried at 110° these preparations were found to have the following composition:

COMPOSITION OF OVALBUMIN CRYSTALLIZED BY HOFMEISTER'S METHOD.

	No. 2	No. 3	Average of the Analyses given on page 365
Carbon	52.82	52.78	52.75
Hydrogen	7.03	7.07	7.10
Nitrogen	15.32	15.53	15.51
Sulphur	1.590	1.651	1.62
Phosphorus	0.123	0.112	0.12
Oxygen	23.117	22.857	22.90
	100.000	100.000	100.00

These analyses are in almost exact agreement with the average given in the preceding table, and fail to confirm Hofmeister's figures for sulphur, or the conclusions drawn by him and by Schulz respecting the relation of the crystallized albumin to that heretofore obtained by other methods. The percentage of carbon found by us falls midway between that given by Hofmeister and the average of that given by the other investigators, with the exception of Hopkins. The very close agreement in composition between all the many fractions, having a constant rotatory power, analyzed by Hopkins and by ourselves, leaves little doubt as to the true elementary composition of crystallized

ovalbumin, especially in view of the close agreement of these analyses with those of Hammarsten and of Bondzynski and Zoja.

In view of the statements recently made by Schulz concerning the proportion of sulphur in ovalbumin (Zeit. f. physiol. Chem. 25, 16, Ibid, 29, 86), we used the very greatest care in determining this element. Our solutions of albumin were not only dialyzed until they gave no reaction with barium chloride, but until no sulphate could be detected in the water outside of the dialyzer, even after concentration. That our higher figures for sulphur are not due to ammonium sulphate, which could not be separated from the albumin by dialysis, is disproved, not only by the close agreement between our many analyses, but also by the fact that we obtained exactly the same figures from preparations free from conalbumin and ovomucoid, made by coagulating their dilute solutions at 70°-95°. Thus, we found in D.3.2 1.61, in F.2.1 1.64, in F.3.2 1.61, and in E.3.a 1.63 p.c. We have no doubt that these figures very closely represent the true proportion of sulphur contained in the ovalbumin, especially as they agree with the figures which Hammarsten obtained (Zeit. f. physiol. Chem. 9, 304), by four different methods, namely: 1.67, 1.67, 1.62 and 1.58 and also with those of Bondzynski and Zoja. The results obtained by Hopkins, (Jour. of Physiology 25, 306) which have come to our notice since this paper was written, leave no doubt whatever that the true proportion of sulphur is very close to 1.60 p.c., Hopkins finding an average of 1.57 p.c., while we find 1.62 p.c., the slight difference between our results being doubtless due to slight differences in our methods of operation.

It is to be noted that we have found a small but uniform quantity of *phosphorus* in all our preparations of crystallized albumin. In Table I, page 354, it is seen that the four crystallized preparations, B.I, B.2, C.I and C.2 all contained 0.12 p. c. of phosphorus, whereas all the other non-crystalline preparations contained less; the amount diminishing as the proportion of ovalbumin diminished in the successive fractions. In Table III, page 358, it appears that D.3.I, consisting of conalbumin, contained but 0.01 p. c., whereas D.3.2, consisting of coagulated ovalbumin, contained 0.11 p. c., and D.3.3, consisting of ovomucoid, contained but a trace.

In our earlier series of preparations, this phosphorus was found in the ash, as calcium phosphate; in our present series, only a part of it was present in the ash, in which it occurred as sodium or potassium metaphosphate.

As our former series of preparations were dialyzed in river water containing calcium bicarbonate and our later series in distilled water, it seems highly probable that this phosphorus belongs to an acid united with the crystallized albumin in the same manner as the writer has shown that hydrochloric acid unites with edestin to form crystalline compounds (Jour. Am. Chem. Soc. 21, 486).

As to the nature of this phosphorized acid we have learned nothing, owing to the small proportion in which it is present.

The carbohydrate split from the ovalbumin by boiling with acids.

These purest preparations of ovalbumin, which we have shown to have a constant specific rotation, the same composition and the same temperature of coagulation, when boiled with acids, all give solutions which yield considerable quantities of crystalline precipitates with phenylhydrazine.

When boiled with 3 p. c. hydrochloric acid for thirty minutes, the solution obtained reduces Fehling's solution, but fails to do so after boiling for three hours. The addition of Fehling's reagent to such solutions causes an intense biuret reaction, but no reduction of the copper salt takes place, even after adding considerable quantities of glucose. Evidently, by continued boiling, some substance is produced which prevents the reduction of the Fehling's solution. Blumenthal and Mayer (Ber. 32, 274), state that after long boiling this reduction is not so easily detected as after boiling for a short time.

Ten grams of each of the four preparations, B.I, B.2, C.I and C.2, were boiled with 200 cc. of 9 p. c. sulphuric acid for three hours and the solutions neutralized to litmus with baryta. The soluble matter was filtered out, washed with water, and filtrate and washings were evaporated to a volume of 100 cc. To this solution 10 grams of sodium acetate were added and 5 cc. of a mixture of equal volumes of phenylhydrazine and 99 p. c. acetic acid, and the whole heated for three hours in boiling water. After standing over night, the crystalline precipitates

were filtered off and washed rapidly with water and then with absolute alcohol, which removed a considerable quantity of deep red colored, amorphous substance. The washed precipitates were then dried at 110° and weighed.

In order to learn the effect of the presence of ovomucoid, upon this precipitation with phenylhydrazine, 10 grams of G.4, which had a specific rotation of 39° 22′, and contained much ovomucoid, were treated in the same manner as these albumin preparations and at the same time with them.

For comparison, 100 cc. of a solution containing I gram of glucose were treated with phenylhydrazine under the same conditions. The filtrate from each phenylhydrazine precipitate was further treated with 5 cc. of phenylhydrazine and 10 grams of sodium acetate and a second precipitate obtained. From the filtrates from the second precipitations no more could be separated by further additions of phenylhydrazine. The weight of each precipitate dried at 110°, is given in the following table:

 B.1.
 B.2.
 C.1.
 C.2.
 G.4.
 Glucose

 Ist\_\_0.2019 grm.
 0.1327 grm.
 0.1831 grm.
 0.0902 grm.
 0.2175 grm.
 0.3098 grm.

 2nd \_0.1030
 0.1027
 0.0980
 0.0281
 0.2684
 0.3187
 0.3187

 0.3049 grm.
 0.2354 grm.
 0.2711 grm.
 0.1183 grm.
 0.4859 grm.
 0.6285 grm.

Since from C.2 we got so much less of this substance than from the others, we repeated this experiment, using for the first precipitation 10 cc. of the phenylhydrazine-acetic acid mixture and 20 grams of sodium acetate. In this way we got

C.2.	
Ist	0.2787
2nd	0.0894
	0.3681

The crystals of the osazone obtained from the albumin consisted of feathery sprays and always appeared distinctly different from the aggregates of needles yielded by glucose. Two different preparations of the phenylhydrazine compound were separately recrystallized by dissolving in boiling absolute alcohol, adding water, boiling until most of the alcohol had been expelled and then allowing the solution to cool slowly until the sub-

stance separated in beautiful yellow crystals of the same form as the original precipitate. These melted at 187° and 189°.

The amount of this osazone indicates that a considerable quantity of carbohydrate is split from our albumin preparations by boiling with acids. The quantity of osazone which we obtained from our preparations varied from one-third to one-half of that given by I gram of glucose under like conditions, and if the compound from the albumin is precipitated in the same proportion as the glucosazone we may infer that the albumin yields on hydrolysis from 3 to 5 p. c. of carbohydrate. The amount of osazone which we have actually obtained corresponds to from 2 to 2.5 p. c. of carbohydrate calculated as glucose. Hofmeister (Zeit. f. physiol. Chem. 24, 170) obtained from I gram of ovalbumin 0.13 gram of osazone, from which he infers the presence of 15 p. c. of carbohydrate.

Does this carbohydrate come from the ovalbumin or from a residue of ovomucoid which we have not separated by our fractional crystallizations? Seemann (Archiv. f. Verdaungskrankheit 4, 275) obtained a copper oxide reduction from ovomucoid corresponding to 34.9 p.c. of glucose. If this proportion is correct, we must have at least 6 p.c. of ovomucoid in our albumin preparations, to account for the minimum yield of osazone, corresponding to 2 p. c. of carbohydrate. This is probably the least quantity of ovomucoid which could yield this quantity of osazone. From the incompleteness of precipitation of osazone, it is probable that the quantity of ovomucoid would have to be more than twice as great to yield the quantity of osazone found. From G.4, which had a specific rotation of 39° 22', we obtained nearly twice as much osazone as from the ovalbumin, due unquestionably to the presence of ovomucoid in this preparation. If this increased yield of osazone is attended by an increase of 10° in the rotation, an admixture of ovomucoid sufficient to yield such quantities of osazone would manifest itself by variations in the rotation of these albumin preparations, it being improbable that so much ovomucoid was admixed in uniform proportion in the successive crystallized precipitates. We have shown on page 363, that the preparations of ovalbumin when coagulated by heat, left in solution a small quantity of uncoagulable matter amounting to about 1.6 p. c. of the albumin, the nature of which we have been unable to discover, owing to its small quantity. It may be ovomucoid, since it contains proteid matter and yields a copper reducing body on boiling with acids, but in general appearance and manner of dissolving it does not behave like ovomucoid. As already stated on page 364, we think it more probable that this substance is a product of the action of acetic acid, whereby a small quantity of uncoagulable acid compounds of the albumin is formed. Hydrochloric acid, added in the same proportion as acetic acid, converts, in the absence of soluble salts, nearly all of the albumin into such uncoagulable compounds. A somewhat greater quantity of acetic acid does the same, entirely preventing coagulation. We therefore feel almost certain that the carbohydrate does not originate in admixed ovomucoid, but is derived from the substance constituting the crystallized ovalbumin.

This belief is strengthened by the fact that, so far as we know, all but two of the several investigators who have thus examined coagulated egg albumin, have found evidence of the presence of considerable quantities of carbohydrates among its hydrolytic decomposition products, although most of them have endeavored to separate every trace of ovomucoid. Spencer (Zeit. f. physiol. Chem. 24, 354), who failed to find carbohydrate, boiled his coagulated albumin for several hours with weak potash and then for thirty minutes with 10 p. c. potash, a procedure which might lead to the destruction of carbohydrate. Moerner (Centralbl. f. Physiol. 7), who also found no carbohydrate, gives no account of the method he used in preparing the ovalbumin.

Hammarsten regards crystallized ovalbumin as a glycoproteid and considers the carbohydrate group to be a constituent of a non-proteid substance combined with the protein substance proper.

This is certainly true of the nucleoproteid of the pancreas from which Bang obtained guanylic acid, which on hydrolysis yielded about 30 p. c. of carbohydrate. The mucins also appear to be compounds of protein matter with sugar-yielding substances.

We have stated our belief that crystallized ovalbumin is a compound of some acid with protein substance and consider it quite probable that this acid contains the carbohydrate group.

We have been unable to obtain any evidence of carbohydrate in edestin, the crystallized globulin of hemp-seed, nor, according to Hammarsten, can a carbohydrate be split from casein, vitellin, myosin and fibrinogen. This subject requires further careful study before a definite conclusion can be reached. At present the preponderance of evidence indicates that the carbohydrate is not derived from the protein molecule, but from substances combined with the protein as it is obtained from the tissues or secretions.

Conalbumin. Our fractions of the proteids of egg white, obtained after separating the crystallized fractions, all have a higher rotation and sulphur content and a lower temperature of coagulation than ovalbumin, as is shown in Table I. In Table III we showed that these fractions could be separated into two products by heating their solutions to 65°, filtering off the coagulum, and then heating the filtrate to 90°. In the filtrate from this latter coagulum a substance remained which was not coagulated by boiling.

The body coagulating at the lower temperature we designate conalbumin, on account of its close relation in properties and composition to ovalbumin. What this relation may be, we have not determined. Conalbumin and ovalbumin may be different compounds of the same protein, or the former may be a derivative of the latter involving a molecular change.

COMPOSITION OF COAGULATED CONALBUMIN.

	D.3.1.		F.3.1.		K.3.1.		Average.
	I.	II.	I.	II.	I.	II.	
Carbon	52.17	52.20			52.47	52.14	52.25
Hydrogen	6.98	6.70			7.02	7.07	6.99
Nitrogen	16.04	16.16	16.03	16.15	16.16		16.11
Sulphur	1.67		1.73		1.71		1.70
Oxygen	23.14				22.64		22.95
	100.00				100.00		100.00

These figures show very little difference in composition between ovalbumin and conalbumin, the carbon being about 0.5 p. c. lower, the nitrogen about 0.53 p. c. and the sulphur 0.08 p. c. higher.

It is possible that the higher sulphur is due to a little ovomucoid carried down with the coagulum, but this is hardly probable, as the ovalbumin coagulated in the filtrates from these preparations contained 1.61 p. c. of sulphur, which is exactly the quantity found in the most thoroughly purified prepara-

Temperature of coagulation. When a solution of conalbumin is heated sufficiently, a finely divided flocculent coagulum separates which is very difficult from the dense masses that form in a similar solution of ovalbumin. As we could not separate the conalbumin from the other associated proteids except by coagulation, the temperature of coagulation of this albumin could not be determined under definite conditions. The temperature at which this substance begins to coagulate is influenced by the proportion of salts present. From a solution containing 10 p.c. of sodium chloride it separates at a lower temperature than from solutions in pure water. From the former solutions it apparently separated completely below 60°, whereas from the latter it is impossible to separate it from the ovalbumin because the latter begins to coagulate before the separation of the conalbumin is complete.

From solutions containing 10 p.c. of sodium chloride the preparations D.3.1 and K.3.1 separated below 60°, the solutions becoming turbid at about 55°. When 2.5 p.c. of K.3, D.3 and F.3 were each dissolved in 10 p.c. brine their solutions became turbid at 57°, 52° and 58°, and flocks separated at 58°, 55° and 59° respectively.

Specific rotation. This we were unable to determine directly, but indirectly the following results were obtained. Of F.I, I.5 grams were dissolved in 10 p.c. brine, the solution heated to 65°, and the coagulum filtered out and washed. The filtrate was heated to 98° and the coagulum also filtered out and washed. The nitrogen was then determined in each coagulum and in the final filtrate, and the proportion of conalbumin, calculated on the dry preparation, was found to be 25.0 p.c.; of ovalbumin 62.7 p.c.; and of ovomucoid 12.2 p.c. Subtracting the amount of rotation due to the sums of the two latter from the total rotation of F.I, we found the amount of rotation caused by the 25 p.c. of conalbumin, which for 100 p.c. was equal to  $[a]_p$ —39°.

In the same way we found F.3 to contain 36.6 p. c. of conalbumin, 39.7 p. c. of ovalbumin and 23.7 p. c. of ovomucoid, from which we calculated for the conalbumin  $[\alpha]_D$  —36°. F.2.a. contained 30.9 p. c. conalbumin, 48.9 p. c. ovalbumin and 20.4 p. c. ovomucoid, so that in this preparation we found  $[\alpha]_D$  equal to  $-36^{\circ}$  21'.

Of course such determinations cannot be accepted as final, but they are sufficiently accurate to show that conalbumin has a different specific rotation from ovalbumin and is therefore a different substance. This conalbumin appears to be identical with albumin II, described by Panormoff (Chem. Centrabl. 1898, 11, 487), but so far as we can infer from this abstract of his original paper (Jour. russ, phys. Chem. Ges. 30, 302), the substance which he describes under this designation corresponds very closely with our fractions C.3, D.1, D.2 and D.3, whose mean rotation and other properties are the same as those given for albumin II.

These fractions we have shown to be mixtures of ovalbumin, conalbumin and ovomucoid.

Ovomucoid. After separating all the proteids coagulable by heat, Neumeister (Zeit. f. Biol. N. F. 9, 369, 1890), found in the white of eggs a substance which he called pseudopeptone. Later Mörner (Zeit. f. physiol. Chem. 18, 525, 1893), showed this to be a glycoproteid and named it ovomucoid, under which name it is now generally known.

In Table I it is to be noticed that all the fractions following those of the crystallized ovalbumin show an increasing value for  $[a]_D$  and proportional thereto an increasingly greater content of sulphur. This is chiefly due to ovomucoid associated with these fractions. In connection with the detection of sugar in the albumin molecule, it is important to recognize the difficulty with which ovomucoid can be separated from ovalbumin by fractional precipitation with ammonium sulphate.

As we have just shown, fraction F.I contained 12.2 p. c., F.3 23.7 p. c. and F.2.a. 20.4 p. c. of ovomucoid. These fractions were obtained from those immediately following the separation of the crystalline ovalbumin, and F.I was precipitated by simply adding an equal volume of saturated ammonium sulphate solution to the solution of these fractions.

We have obtained two preparations of ovomucoid in sufficient quantity for analysis and have found them, when dried at IIO°

to have the following composition, which agrees with that given by Zanetti\* and by Mörner.†

## COMPOSITION OF OVOMUCOID.

	E.4	D.3.3	Zanetti*		Morner
Carbon	49.02	48.90	48.94	48.75	
Hydrogen	6.45	6.61	6.94	6.90	
Nitrogen	12.71	12.16	12.46		12.65
Sulphur	2.38	2.34	2.22		2.20
Oxygen	29.44	29.99	29.44		
	100.00	100.00	100.00		

The specific rotation was found to be E.4, —61° 38′; D.3.3 —61° 10′; F.3.3 —61° 20′; K.3.3 —61° 30′.

<sup>\*</sup> Ann. di Chim. e Farmac No. 12, 1897.

<sup>†</sup> Zeit. f physiol. Chem. 18, 525.

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# CORRECTIONS.

Page I	. First	line,	for	1898	read	1899.
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- Page 7. In alphabetical list, after Dennis, read E. C.
- Page II. Second line after Tucker's, read Special.
- Page 13. First line under Analyses of Fertilizers for four hundred and fifty-nine, read four hundred and sixty.
- Page 19. First line of last paragraph, for 109 read 117.
- Page 20. Second line from top, for 107 read 115.
- Page 21. In the Summary for 459 read 460.
- Page 40. Last line, after Quinnipiac Co. for Hartford read Boston.
- Page 47. Ninth line, for Fairfield's, read Fairchild's.
- Page 55. Analysis of the National Fertilizer Co's Complete Fertilizer, last column, the guaranteed potash is 6 per cent. and not 10 per cent.
- Page 87. Sixth line from the top, for 91 read 92; tenth line from top, for 14.1 read 13.1.
- Page 156. Third line from bottom, the nitrogen-free extract in Honduras bananas is 83.02, not 87.02, as stated.
- Page 163. Fourth line from the bottom, the average percentage of fat in Atlantic gluten meal is 1.9, not 7.9.
- Page 208. In the ninth and also in the fifth line from the bottom, insert hard, before raw.