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INTRODUCTION

The Department of Analytical Chemistry (DAC) at the Connecticut Agricultural Experiment Station (CAES) provides regulatory enforcement analysis of pesticide residues, mycotoxins, total arsenic, toxic metals, and chemical adulterants found in domestic and imported food sold within the state for the Connecticut Department of Consumer Protection (DCP).

The pesticide residue surveillance program ensures: 1) that pesticides on food products are used in accordance with their label and 2) that the public is protected from the deliberate or accidental misuse of pesticides. Failure to apply pesticides in accordance with their labels, whether in excessive amounts or on unapproved crops is a violation of federal law. For an overview of the agencies involved, their roles, and a discussion of tolerances refer to Krol *et al.* 2006¹. Tolerance levels for pesticide residues in food are established by the FDA and apply to both human and animal food.

Melamine and cyanuric acid are known adulterants of food and feed products used to artificially increase measured protein content. Melamine and/or cyanuric acid adulteration has led to multiple recalls, including the 2007 recall of pet foods manufactured using adulterated wheat gluten and rice protein, and the adulteration of

infant formula in 2008. Ingestion of melamine is known to cause kidney stones, renal failure, and death.

Additionally, the FDA has issued action level recommendations for arsenic in bottled water², rice cereals for infants⁴, and apple juice³. Laboratory results are forwarded to the DCP for all submitted samples.

The Food Safety Modernization Act (FSMA)⁵ strongly encouraged accreditation for regulatory testing laboratories. It is widely recognized that accreditation is a rigorous assessment, conducted by an independent science-based organization, which assures the capability and competency of a laboratory and its management systems. The DAC at the CAES gained initial accreditation for chemical testing to the International Organization for Standardization (ISO) / International Electrochemical Commission (IEC) ISO/IEC 17025:2005(E) standard in 2016 for pesticide and arsenic analysis in food. Subsequently, the laboratory gained accreditation to the updated ISO/IEC 17025:2017 standard in 2019. The laboratory is assessed on a biennial basis to ensure adherence to the ISO/IEC 17025:2017 standard. The DAC is currently accredited by the American Association for Laboratory Accreditation (A2LA) for: 1) Pesticide Residues in Food, 2) Aflatoxin Analysis in Animal Food, 3) Percent Crude

Fat Analysis in Animal Feed, 4) Percent Crude Protein in Animal Feed, and 5) Total Delta-9 tetrahydrocannabinol (THC) and Cannabidiol (CBD) Analysis in Hemp (Cannabis Sativa) and 6) THC, tetrahydrocannabinolic acid (THCA), CBD, and cannabidiolic acid (CBDA) in food, plant material, and consumer products⁶.

The current work reports upon the 181 human food samples tested during the 2024 calendar year for pesticide residues, toxic metals, and melamine. All samples were collected and submitted by the CT DCP as part of the manufactured food regulatory program standard (MFRPS) and the laboratory flexible funding model (LFFM) cooperative agreement testing programs and were tested in accordance with the ISO/IEC 17025:2017 standard.

METHODS

Pesticide Residues

The sample extraction and cleanup procedure is based on quick, easy, cheap, effective, rugged, and safe (QuEChERS) chemistry. Following homogenization and extraction, samples are analyzed using a liquid chromatograph with a high-resolution mass spectrometer (LC-HRMS) and a gas chromatograph coupled to a tandem mass spectrometer (GC-MS/MS). Findings are reported to DCP in mg/kg (ppm). Based on FDA enforcement history and enforcement levels in the European Union (EU), CAES defines its Limit of Reporting (LOR) at 0.010 mg/kg (ppm). Limits of Detection (LOD) levels and measurement uncertainty have been established for all pesticides reported.

Melamine

Samples are extracted using a 10:40:50 solution of diethylamine, water, and acetonitrile. Following centrifugation and filtration, extracts are derivatized using a silylating agent and analyzed using a gas chromatograph with a mass selective detector. The reporting limit for melamine was set to 0.50 mg/kg.

Toxic Metals

Samples are prepared for analysis using Closed Vessel Microwave acid digestion then analyzed using Inductively Coupled Plasma Mass Spectrometry, ICP-MS

Quality Assurance and Reproducibility

Calibration standards are prepared from reference materials that are traceable to the point of manufacture. Analyte spike-recoveries are evaluated with each batch of samples tested. All systems used for analysis are verified prior to use. Balances are calibrated annually and verified when used to ensure accuracy. Verification weights are traceable to the National Institute of Standards and Technology (NIST). Trends in the data produced are reviewed and analyzed. Overall method uncertainty (MU) has been established and is documented. Batch acceptability is determined by using various quality control samples (QCS).

RESULTS AND DISCUSSION

Pesticide Residue Program

The 2024 findings for human food provided by the DCP are summarized in Table 1. Samples were collected between July 22, 2024, and October 8, 2024, from 17 cities and towns throughout the state. The samples included in this bulletin were collected from Connecticut farms and grocery stores. A total of 83 samples were tested for pesticide residues and 37 (45%) were found to contain at least one pesticide residue greater than the 0.010 mg/kg (ppm) reporting limit. Of the 37 samples that tested positive for pesticide residues, there were 24 different pesticides, and no residue violations. Of the 37 positive samples, 25 were found to contain multiple residues. The most commonly occurring residues were Acetamiprid and Captan. The remaining samples did not contain reportable residues.

The pesticide residue monitoring program has a historical violation rate of approximately 3–4%. This includes over tolerance and no tolerance violations. The absence of violations during 2024 is consistent with previous years and continues to demonstrate the safety of produce purchased in the state of Connecticut.

The results of all analysis performed at the CAES are reported to the DCP. All regulatory enforcement of illegal residues where CT is the source are performed by the CT DCP, CT DoAg, and/or DEEP. In those cases where illegal residues are reported on samples whose source is outside of CT, the DCP will forward the results to the FDA for enforcement. The Enforcement actions (or

lack thereof) taken are not always communicated back to CAES.

Melamine in Protein Supplements

For 2024, 25 samples of protein powders were analyzed for the presence of melamine and cyanuric acid. None of the samples tested contained melamine or cyanuric acid about the reporting limit of 0.50 mg/kg. The samples tested are shown in Table 2.

Toxic Elements Testing Program

Toxic metals, such as arsenic, cadmium, chromium, mercury, and lead (As, Cd, Cr, Hg, Pb), are naturally occurring elements widely found in nature and may be present in foods, depending on the environment. The FDA has issued regulatory limits for arsenic in bottled water², and action levels for inorganic arsenic in rice cereals for infants⁴, and apple juice³. The FDA has also issued limits for lead in bottled water¹⁰, action levels for processed foods intended for babies and young children¹¹ and has proposed action levels for lead in juice¹².

In 2024 a total of 83 food samples were tested for toxic metals as part of the CAES contract with DCP. Of these, 50 spices, 10 foods intended for infants and babies, 10 dried fruits, 10 syrups and 3 green powder dietary supplements were analyzed.

Three cinnamon products (MM-825, MM-835, and MM-836) were referred to the FDA for elevated levels of lead. The FDA subsequently issued health warnings on July 30, 2024, for all three products.¹³ ALB Flavor Ground Cinnamon (MM-836) was recalled by the ALB-USA Enterprises, Inc. on July 26, 2024.¹⁴ Compania Indillor Orientale Scortisoara Macinata (Ground

Cinnamon) (MM-835) was recalled July 29, 2024.¹⁵

Zaarah Herbals Shatavari Powder (DS-57) was referred to the FDA for elevated lead as well. The product was recalled on January 27, 2025, by New York Wholesale Group.¹⁶ The manufacturer (Falcon System of Ayurvedic Products) of the product and the product itself were put on Import Alert 99-42 Detention without Physical Examination (DWPE) of Foods due to Heavy Metal (Toxic Element) Contamination on May 8, 2025.¹⁷

Note that in the elemental results, some results are labeled “trace”. This is a designation given to values that are between the Limit of Detection and the Limit of Quantification for the method.

CONCLUSIONS

Nearly all the food we eat, except for organically grown produce, has been intentionally treated with pesticides during production. If pesticides used during food production have been applied in accordance with the approved use of the product, the levels resulting in the food will be below the EPA tolerance. The results of this work allow the consumer to gain a better understanding of the prevalence and levels of pesticide residues in the food they consume.

While some amount of heavy metals are naturally occurring in our food, high levels pose a risk to human health. Through the results of surveillance work such as this, natural levels of trace elements may be established, making elevated concentrations easier to identify. Additionally, these results

facilitated regulatory action, both locally and nationally, therefore improving the safety and quality of the products found in our food supply. The data continues to inform what products and types of food to surveil in future years for heavy metal contamination.

Table 1: Human Food Samples Tested for Pesticide Residues in 2023.

Sample ID	Commodity	Town Collected	Pesticide Found	Amount (mg/kg)
DS-7	Kohlrabi	Hamden		
DS-8	Green Beans	Hamden		
DS-9	Green Squash	Hamden		
DS-10	Sterling Peas	Hamden		
DS-11	Cucumbers	Hamden	Thiamethoxam	0.013
DS-12	Blueberries	Cheshire	Acetamiprid	0.027
			Indoxacarb	0.017
DS-13	White Peaches	Cheshire	Acetamiprid	0.059
			Fenbuconazole	0.034
DS-14	Yellow Squash	Cheshire		
DS-15	Green Squash	Cheshire		
NMS-02	Cucumber	Wallingford		
NMS-03	Tomatoes	Wallingford		
NMS-04	Zucchini	Wallingford		
NMS-05	Corn	Wallingford		
NMS-06	Dill	Southington	Cyazofamid	4.8
			Cypermethrin	1.032
			Cyprodinil	4.46
NMS-07	Napa Cabbage	Southington	Cyazofamid	0.048
NMS-08	Yellow Squash	Southington	Clothianidin	0.013
			Thiamethoxam	0.039
NMS-09	Garlic Scape	Southington	Cyazofamid	0.014
NMS-10	Green Beans	Southington		
NMS-11	Fresh Peaches, Flat Donut Type	Middlefield	Acetamiprid	0.091
			Cyprodinil	0.11
			Fenbuconazole	0.030
NMS-12	Fresh Pears, Bartlett	Middlefield	Acetamiprid	0.012
			Captan	0.039
			Fludioxonil	0.11
NMS-13	Fresh Apples, Red Delicious	Middlefield	Acetamiprid	0.041
			Captan	0.157
			Pyraclostrobin	0.011
NMS-14	Fresh Apples, Crispin	Middlefield	Acetamiprid	0.02
			Captan	0.128
NMS-15	Peaches	Middlefield	Acetamiprid	0.02
			Cyprodinil	0.021
NMS-16	Fresh Apples, Jona Gold	Middlefield	Acetamiprid	0.04
			Captan	0.278
			Pyraclostrobin	0.012
NMS-17	Tomatoes	Naugatuck		
NMS-18	Green Peppers	Naugatuck		
DS-20	Leeks	Colchester	Boscalid	0.014

Table 1: Human Food Samples Tested for Pesticide Residues in 2024, continued.

Sample ID	Commodity	Town Collected	Pesticide Found	Amount (mg/kg)
DS-21	Onions	Colchester		
DS-22	Cucumbers	Colchester		
DS-23	Potatoes	Colchester		
DS-24	Tomatillo	Colchester		
DS-26	Garlic	Colchester		
DS-27	Green Beans	Colchester		
DS-28	Turnips	Colchester		
DS-29	Onions	Colchester		
DS-30	Red Leaf Lettuce	Guilford	Imidacloprid Mandipropamid	0.011 0.042
DS-31	Green Oak Leaf Lettuce	Torrington		
DS-32	Peaches	South Glastonbury	Cyfluthrin Cyprodinil Difenconazole Pyraclostrobin	0.055 0.053 0.013 0.012
DS-33	Butterhead Lettuce	Torrington		
NMS-19	Cubanelle Peppers	Cheshire		
NMS-20	Peaches	Cheshire	Captan Trifloxystrobin	0.174 0.021
NMS-21	Green Bell Peppers	Farmington		
NMS-22	White Onions	Farmington		
NMS-23	Carrots	Farmington		
NMS-24	Beets	Farmington	Bifenthrin	0.22
NMS-24T	Beet Tops	Farmington	Azoxystrobin Bifenthrin Difenconazole	0.015 0.118 0.123
NMS-25	Eggplant	Farmington		
NMS-26	San Marzano Tomatoes	Farmington	Cyhalothrin, lambda Cyprodinil	0.016 0.043
NMS-27	Corn	Farmington		
NMS-28	Plums	Ellington	Captan Cyhalothrin, lambda Fenbuconazole	0.199 0.018 0.014
NMS-29	Peaches	Ellington	Captan Cyhalothrin, lambda Fenbuconazole	4.035 0.059 0.152
NMS-30	Blueberries	Ellington	Captan Cyhalothrin, lambda Fenbuconazole	0.401 0.014 0.118
DS-34	Gala Apples	Southington	Captan Cyprodinil Indoxacarb	0.357 0.018 0.028

Table 1: Human Food Samples Tested for Pesticide Residues in 2024, continued.

Sample ID	Commodity	Town Collected	Pesticide Found	Amount (mg/kg)
DS-35	Ginger Gold Apples	Southington	Captan	0.765
			Cyprodinil	0.013
			Indoxacarb	0.023
DS-36	Early Mac Apples	Southington	Captan	1.993
			Cyprodinil	0.016
			Indoxacarb	0.021
DS-37	Eggplant	East Granby		
DS-38	Corn	Shelton	Chlorantraniliprole	0.011
DS-39	Mini Bell Peppers	Shelton	Chlorothalonil	0.357
DS-40	Bell Peppers	Shelton	Chlorothalonil	0.142
DS-41	Italian Frying Pepper	Shelton	Chlorantraniliprole	0.012
			Chlorothalonil	0.181
DS-42	Tomato	Shelton	Chlorothalonil	0.776
DS-43	Red Frying Pepper	Shelton	Chlorothalonil	0.323
DS-44	Cabbage	Shelton		
DS-45	Tomatillo	Shelton		
DS-46	Potatoes	Shelton		
DS-47	Garlic	Shelton		
DS-48	Onions	Shelton	Boscalid	0.02
NMS-42	Zucchini	Somers		
NMS-31	Cabbage	Cheshire		
NMS-32	Yellow Squash	Cheshire		
NMS-33	Eggplant	Cheshire	Imidacloprid	0.015
NMS-34	Zucchini	Cheshire		
NMS-35	Tomatoes	Cheshire		
NMS-36	Roma Flat Beans	Cheshire		
NMS-37	Cherry Hot Peppers	Cheshire		
NMS-38	Yellow Bell Peppers	Cheshire		
NMS-39	Green Bell Peppers	Cheshire		
NMS-40	Green Long Hot Peppers	Cheshire		
NMS-41	Corn	Cheshire		
DS-49	Corn	Durham		
DS-50	Empire Apples	North Branford	Acetamiprid	0.082
			Captan	0.35
DS-51	Mcintosh Apples	North Branford	Acetamiprid	0.093
			Captan	0.547
DS-52	Cortlan Apples	North Branford	Acetamiprid	0.058
			Captan	0.5
			Phosmet	0.023

Table 2 Protein Powder Supplements Tested in 2024.

Sample	Brand	Product	Town Collected
DS-001	BodyTech	Protein (Cinnamon)	North Haven
DS-002	BodyTech	Protein (Chocolate)	North Haven
DS-003	BodyTech	Protein (Vanilla)	North Haven
DS-004	Isopure	Zero Carb Protein	North Haven
DS-005	KOS	Plant Protein (Vanilla)	North Haven
DS-006	Ryse	Protein (Cinnamon)	North Haven
MM-848	Orgain	Organic Protein Powder	Waterbury
MM-849	Vega	Original Protein Powder	Waterbury
MM-850	True Athlete	Natural Whey Protein (Chocolate)	Newington
MM-851	Raw	Itholate Protein (Chocolate Peanut Butter)	Newington
MM-852	Raw	Whey Protein Blend (Chocolate Milk)	Newington
MM-853	Vega	Protein (Dark Chocolate)	Wallingford
MM-854	Body Fortress	Super Advanced Isolate Protein (Chocolate)	Wallingford
MM-855	Orgain	Organic Protein (Creamy Chocolate Fudge)	Wallingford
MM-856	Pure Protein	100% Whey (Rich Chocolate)	Wallingford
MM-857	KOS	Plant Protein (Chocolate)	Wallingford
MM-858	PB 2	Peanut Protein with Dutch Cocoa Plant Powder	Wallingford
MM-859	Equate	Whey Protein Supplement (Chocolate)	Wallingford
MM-860	Equate	Whey Protein Supplement (Vanilla)	Wallingford
MM-861	Equate	Plant Protein Supplement Pea & Quinoa Blend (Chocolate)	Wallingford
MM-862	Purely Inspired	Organic Protein	Wallingford
MM-863	Alani	Whey Protein	Wallingford
MM-864	Optimum Nutrition	Standard Plant Protein (Rich Chocolate)	Wallingford
MM-865	Optimum Nutrition	Standard Plant Protein (Creamy Vanilla)	Wallingford
MM-866	Garden of Life	Organic Protein (Vanilla)	Wallingford

Table 3: Human Food Samples Tested for Toxic Metals in 2024.

Sample ID	Description	Brand	As µg/kg (ppb)	Cd µg/kg (ppb)	Cr µg/kg (ppb)	Hg µg/kg (ppb)	Pb µg/kg (ppb)
MM-772	Ground Cinnamon	Great Value	23	309		17 Trace	479
MM-773	Ground Black Pepper	Great Value	54	12 Trace	1314	11 Trace	141
MM-774	Ground Cumin	Lawry's	98	63		< 9	88
MM-775	Ground Cinnamon	Lawry's	17 Trace	278	112	< 10	128
MM-776	Oregano	Great Value	401	21		12 Trace	421
MM-777	Paprika	Great Value	150	47		< 10	169
MM-786	Ground Cinnamon	Great Value	24	388	271	17 Trace	520
MM-787	Ground Ginger	McCormick	589	365		23	751
MM-788	Chili Powder	Stonemill	350	59		< 8	420
MM-789	Ground Cinnamon	Stonemill	26	310	143	11 Trace	557
MM-790	Paprika	Stonemill	152	122		< 8	154
MM-791	Oregano Leaves	Stonemill	319	13 Trace	2049	< 10	428
MM-792	Organic Ground Turmeric	Stonemill	45	30	735	< 9	131
MM-793	Iodized Salt	Stonemill	< 10	< 10	< 10	< 10	69
MM-794	Pure Ground Black Pepper	Stonemill	25	10 Trace		< 9	54
MM-795	Sea Salt Adjustable Grinder	Stonemill	13 Trace	< 9		< 9	90
MM-800	Ground Cinnamon	Marcum	67	315		45	1495
MM-801	Ground Cumin	Marcum	183	82		< 8	386
MM-802	Basil	Marcum	78	29		< 9	480
MM-803	Chili Powder	Great Value	139	44		< 8	237
MM-804	Ground Cumin	Great Value	179	118		11 Trace	485
MM-805	Paprika	Great Value	159	49		< 8	203
MM-806	Salt	Great Value	< 10	< 10		< 10	48
MM-807	Black Pepper	Great Value	9 Trace	27		< 8	40
MM-808	Ground Cinnamon	Stonemill	18	326		10 Trace	526
MM-809	Ground Cumin	Stonemill	136	90		< 8	295
MM-810	Paprika	Stonemill	147	39		< 8	152
MM-811	Oregano	McCormick	449	19		11 Trace	278
MM-812	Chipotle Chili Powder	McCormick	144	105	2335	< 10	253
MM-813	Oregano	Lawry's	337	14 Trace		13 Trace	324
MM-814	Basil Leaves	Food Club	109	24		10 Trace	428

Table 3: Human Food Samples Tested for Toxic Metals in 2024.

Sample ID	Description	Brand	As µg/kg (ppb)	Cd µg/kg (ppb)	Cr µg/kg (ppb)	Hg µg/kg (ppb)	Pb µg/kg (ppb)
MM-815	Salt	Food Club	< 8	< 8		< 8	133
MM-816	Ground Cinnamon	Food Club	24	301		13 Trace	520
MM-817	Paprika	Food Club	140	41		< 8	144
MM-818	Ground Ginger	McCormick	701	316		29	864
MM-819	Ground Thyme	McCormick	268	339		28	886
MM-820	Ground Cumin	McCormick	67	60		< 8	93
MM-821	Black Ground Pepper	Good & Gather	114	15 Trace		11 Trace	103
MM-822	Ground Paprika	Good & Gather	211	41		< 9	225
MM-823	Ground Cumin	Good & Gather	151	91		< 9	369
MM-825	Cinnamon Powder	Swad	89	431	765	23	2896
MM-828	Turmeric Powder	Laxmi	37	38	2461	< 9	111
MM-829	Garam Masala Powder		81	92		< 9	395
MM-830	Ground Cinnamon	Stop & Shop	15	253	130	< 8	127
MM-831	Black Pepper	Stop & Shop	56	11 Trace	267	9 Trace	80
MM-832	Turmeric Powder	Zara	208	78	625	< 9	250
MM-833	Garam Masala Powder	Three Rivers	235	89		< 8	437
MM-834	Cumin Powder	Swad	96	76	446	< 8	168
MM-835	Cinnamon Ground	Scortisoara Macinata	211	254	1526	44	2232
MM-836	Cinnamon Powder	ALB Flavor	227	387	2976	33	3934

Table 4: Human Food Samples Tested for Toxic Metals in 2024.

Sample ID	Description	Brand	As µg/kg (ppb)	Cd µg/kg (ppb)	Hg µg/kg (ppb)	Pb µg/kg (ppb)
DS-55	Green Powder Strawberry Kiwi	Bloom	122	43	< 9	82
DS-56	Green Powder Strawberry Kiwi	Bloom	114	41	< 9	84
DS-57	Shatavari Powder	Shatavari Powder	65	17 Trace	64	6496
MM-846	Raspberries	Good & Gather	< 9	21	< 9	13 Trace
MM-847	Mango Slices	Good & Gather	21	< 8	< 8	< 8
MM-867	Strawberries - Fruit Crisps	Great Value	< 9	< 9	< 9	22
MM-868	Apples	Great Value	< 10	< 10	< 10	< 10
MM-869	Freeze Dried Strawberries	Trader Joe	< 10	27	< 10	< 10
MM-870	Freeze Dried Mango	Trader Joe	< 9	< 9	< 9	< 9
MM-871	Freeze Dried Raspberries	Trader Joe	< 9	26	< 9	< 9
MM-872	Freeze Dried Banana Slices	Trader Joe	< 9	< 9	< 9	< 9
MM-873	Freeze Dried Fig Slices	Trader Joe	< 9	< 9	< 9	< 9
MM-874	Freeze Dried Blueberries	Trader Joe	16 Trace	< 9	< 9	10 Trace
DS-58	Organic Dark Maple Syrup	365 by Whole Foods	5	12	< 1	4
DS-59	Maple Syrup	Butternut Mountain Farm	4 Trace	2 Trace	< 1	2 Trace
DS-60	Maple Syrup	Shady Maple Farms	3 Trace	4	< 1	3 Trace
DS-61	Organic Golden Maple Syrup	365 by Whole Foods	9	3 Trace	< 1	< 2
DS-62	Maple Syrup	Crown Maple	15	< 2	< 1	< 2
NMS-60	Pure Maple Syrup	Stop & Shop	2 Trace	4 Trace	< 1	7
NMS-61	Organic Pure Maple Syrup	Nature's Promise	2 Trace	32	< 1	10
NMS-62	Organic 100% Pure Maple Syrup	Full Circle Market	6	3 Trace	< 1	< 2
NMS-63	Pure Maple Syrup	Jakeman's	6	3 Trace	< 1	8
NMS-64	Vermont Pure Maple Syrup	Pics	5	2 Trace	< 1	< 2

* The US FDA has established an action level of 100 µg/kg of inorganic arsenic in rice.

** The US FDA has proposed an action level of 10 µg/kg of inorganic arsenic in apple juice.

iAs indicates the value of inorganic As. As is total arsenic, organic and inorganic.

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