Design of Biochars for Nutrient Removal and Recycling

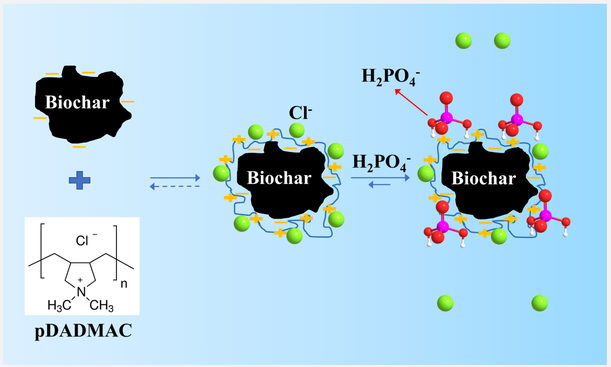
Philip Wang and Joe Pignatello, Department of Environmental Sciences, CAES

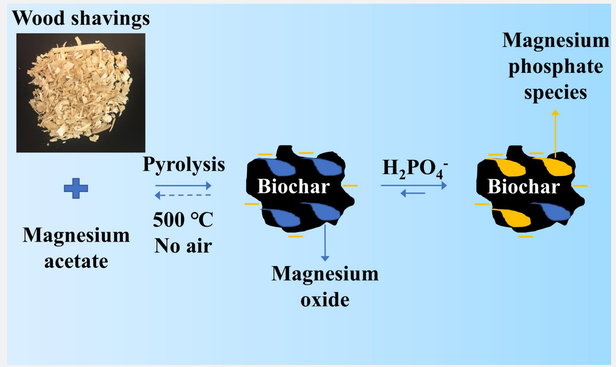
The 110th Plant Science Day

CAES
The Connecticut Agricultural Experiment Station
Putting Science to Work for Society since 1875

Introduction

- Manures contain excess nutrients in highly leachable forms.
- The objective was to design modified biochars that bind excess nutrients, rendering them less leachable but still bio-available to plants after the composted manure is applied to fields.
- One modification is coating with poly dimethyldiallyl ammonium chloride (pDADMAC), a cationic polymer that reverses the biochar surface charge and attracts phosphate anions.
- Another modification is coating with nano-films of magnesium oxide, which can strongly bind phosphate.
- We examined binding and release of ortho phosphate (salts of H_3PO_4) and the effects of natural dissolved substances in manure waters.





Methodology

- Biochar is made by heating vegetation wastes at high temperature without air (in this case, wood shavings at 500 ℃).
- The polymer-coated biochar was made by mixing the biochar with a water solution of the polymer (pDADMAC).
- Magnesium-coated biochar was made by first soaking the wood shavings in a water solution of magnesium acetate before charring.
- Binding of phosphate was measured using a 3-day equilibration time.
- Release of phosphate was studied by removing a portion of the liquid and adding pure water, then allowing re-equilibration for 3 days. This was repeated 1-3 times.

Results and Conclusions

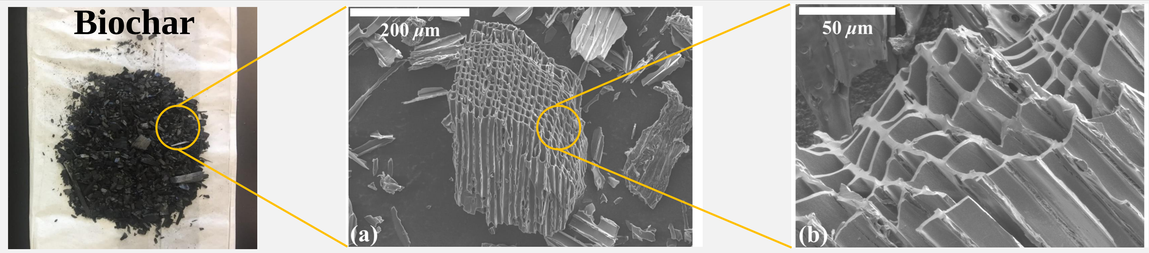
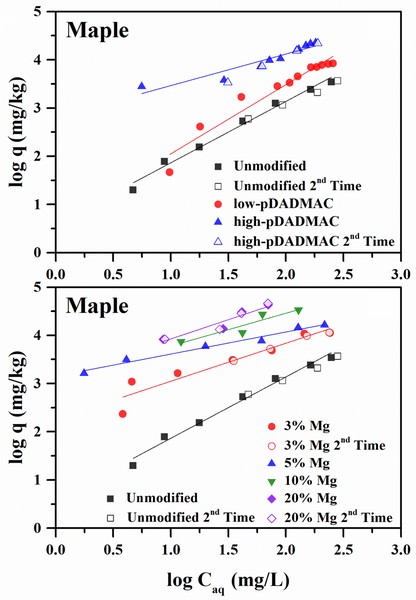


Figure 1. A picture and scanning electron microscopic images of pDADMAC-coated biochar showing its highly porous nature.

Figure 2. Binding of phosphate increases dramatically with increasing coating density of pDADMAC or magnesium (Mg) oxide.



(plotted on logarithmic scale)

Figure 3. Phosphate is less reversibly-bound—therefore, less bio-available—by magnesium (Mg)-coated than pDADMAC-coated biochars.

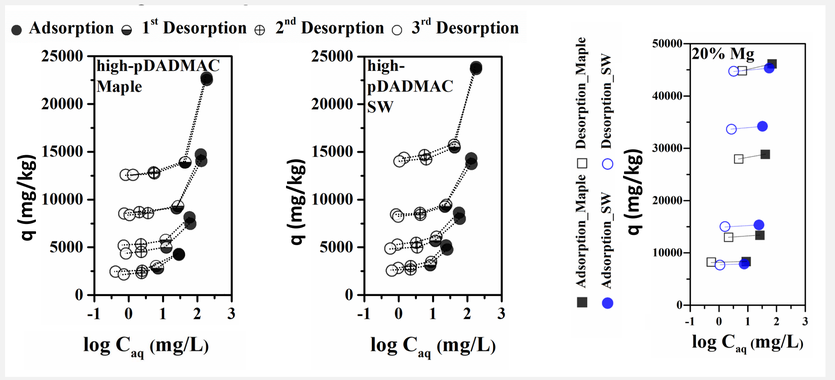
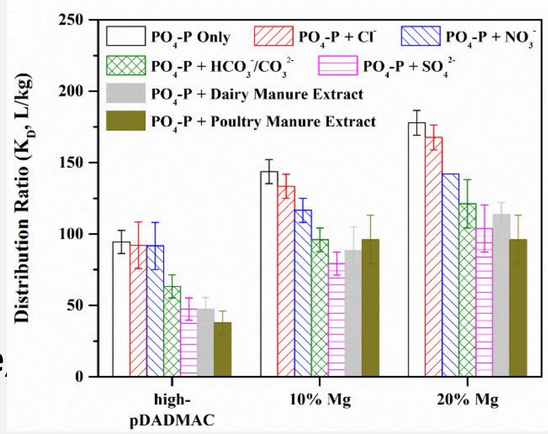


Figure 4. Binding of phosphate is unaffected by nitrate or chloride, but moderately inhibited by carbonate, sulfate, and dairy manure extract.



Future Work: 1) Modified biochars are being tested in potting trials.
2) Removal & recycling strategies for ammonium and nitrate will be studied.

Acknowledgement: funding was provided by USDA NIFA program.