Compost-biochar mixtures on New York farms: A new method for sustainable agriculture, waste management, and improved nitrogen use efficiency

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The Need: Composting is a simple, cost-effective way to dispose of biomass waste and recycle nitrogen; however, more than half of nitrogen can be lost as ammonia gas during composting. These emissions are an economic loss, and they can damage ecosystems and cause odor pollution. This project explored the merits of adding biochar during composting to reduce ammonia emissions. We combined detailed laboratory observations with composting experiments to develop a technology that could both lower ammonia emissions and increase nitrogen availability to new plants. Such a technology helps reduce environmental impacts from composting, raise the quality of compost, reduce fertilizer costs for agricultural producers, and increase community acceptance of composting by reducing odor.

The Approach: We investigated the properties and mechanisms that enable biochar to retain ammonia, and evaluated biochar’s ability to make retained ammonia available to new plants. Laboratory experiments demonstrated that acidity and electrostatic interactions are not the key to ammonia retention. Rather, cutting-edge spectroscopy techniques revealed that a variety of covalent bonds form between ammonia and biochar. We also conducted planting experiments using a homogenized potting mixture, and adding equal amounts of nitrogen from either conventional nitrogen fertilizer, or via biochar that had been exposed to ammonia gas. Preliminary results showed that nitrogen availability was comparable from both sources.

Impacts: Adding oxidized biochar to feedstock compost significantly reduces nitrogen loss in compost, resulting in lower air pollution and higher compost quality. We found that biochar is able to retain ammonia better than any unprocessed plant material and most animal manures, and that as biochar is oxidized, ammonia retention increases five-fold. Daily carbon dioxide emissions were significantly higher from compost with oxidized biochar, versus unoxidized biochar and compost feedstocks alone; this suggests that compost enriched with oxidized biochar enhances microbial activity and accelerates the compost rate. Results have been disseminated to the research community through submissions to peer-reviewed journals, formal presentations at conferences, and through informal conversations. The results have also been shared with the Innovation Center for US Dairy, and we are working with two private companies that are interested in commercializing our process.

Website: https://pyrolysis.cals.cornell.edu/ and http://www.css.cornell.edu/faculty/lehmann/index.html