The Use of Biochar in Composting

By Marta Camps, Massey University; and Thayer Tomlinson, International Biochar Initiative
February 2015; for more information, please see www.biochar-international.org.
Reviewed by Mariluz Cayuela and M.A. Sánchez-Monedero

Both compost and biochar production are methods to utilize and recycle organic wastes. This paper provides information on the use of biochar in composting and highlights the potential benefits, which include the ability to accelerate the process of composting and reduce the loss of nutrients, among others.

- ***Composting*** is a technology for the treatment and disposal of biodegradable waste. Almost any food waste, industrial food waste, and sewage sludge can be composted. The main advantages of successful composting are a decrease in waste volume; the elimination of most organic toxic compounds, pathogens and pests (potentially present in the original waste); the transformation of organic matter; and associated nutrients into a product that acts as a slow release fertilizer (referred to as 'stabilization' in the compost literature).

- ***Biochar*** is a solid material obtained from the thermochemical conversion of biomass in an oxygen-limited environment. It has a greater persistence than the uncharred precursor biomass. Biochar can be used as a product itself or as an ingredient within a blended product, with a range of potential applications as an agent for soil improvement. When the right biochar is added to the right soil, biochar can, among other benefits, improve resource use efficiency, remediate and/or protect soils against particular environmental pollution, and become an avenue for greenhouse gas (GHG) mitigation[1].

Compost and Biochar: In Competition for Feedstocks?

Although both biochar and compost use organic wastes as feedstocks, the two operations do not have to be an either/or option; instead, they can be combined for synergistic production and utilization. For example, many materials that make good compost, such as food waste and wet manures, are not easily used for biochar production since a large amount of heat would be needed to dry the materials prior to producing biochar. Ideal feedstocks for composting have from 60 – 70% moisture, high nutrient levels, and low lignin content[2]. Ideal feedstocks for biochar have 10 – 20% moisture and high lignin content, such as field residues or woody biomass.

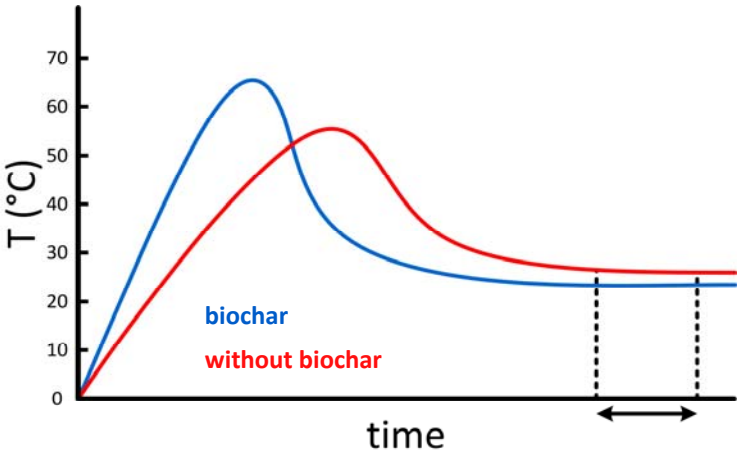
Biochar Benefits to the Composting Processes

Based on current findings, the benefits of adding biochar to the composting process may include shorter compost times; reduced rates of GHG emissions (methane, CH_4 and nitrous oxide, N_2O); reduced ammonia (NH_3) losses; the ability to serve as a bulking agent for compost; and reduced odor. For the biochar material itself, undergoing composting helps to charge the biochar with nutrients without breaking down the biochar substance in the process.

Adding biochar can enhance the composting process through:

- Accelerating the composting process
- Reducing GHG emissions
- Reducing ammonia loss
- Serving as a bulking agent for the compost
- Reducing odor

A wide range of biochar application rates to compost have been tested, from 5 – 10% to 50% (mass basis) or higher[3, 4]. A biochar dose higher than 20 – 30% (mass basis) is not recommended as an excessive amount relative to the composting material could interfere with biodegradation. At adequate doses, biochar has been found to accelerate the composting process—mainly through improving the homogeneity and structure of the mixture and stimulating microbial activity in the composting mix. This increased activity translates to increased temperatures and a shorter overall time requirement for compost development[5]. This may have important economic implications since accelerated composting is a desirable effect.



Biochar increases the temperature in a compost process, accelerating the time needed for material decomposition[4, 6, 7]

One challenge to compost operations is the loss of nutrients and the emission of GHGs during the composting process—specifically CH_4 and N_2O. Adding biochar at 3% (mass basis) to a pig manure, wood chips, and sawdust compost mixture was found to reduce N_2O emissions by 26%[8]. For methane, a recent study found that the addition of biochar reduced CH_4 emissions from poultry manure composting piles[9]. However, other studies have shown that biochar has no impact on the overall GHG emissions since these emissions were offset by the enhanced microbial activity on the composting mix containing biochar[10]. In those cases there may not be a net impact on GHG emissions.

The porous nature of biochar can reduce the bulk density of compost and facilitate aeration in the composting mix. For compost feedstocks that are high in nitrogen (N), such as animal manures, biochar offers the opportunity to reduce the overall N loss over the process, especially that of NH_3. The odor problems caused by NH_3 loss during composting are not only unpleasant, but can reduce the acceptance of a composting facility by a community. A 20% (mass basis) biochar addition to poultry litter reduced the NH_3 concentration in the emissions by up to 64% and N losses by up to 52% without negatively influencing the composting process[11, 12].

A common problem during the composting of manure is the formation of big lumps upon drying that stops the process. The addition of 3% (mass basis) of wood biochar to poultry manure co-composted with straw was able to significantly reduce the formation of big lumps in the pile, improving the composting process and the overall structure of the final compost[13].

Biochar and Compost: Looking Ahead for Wider Commercial Use

Although initial publications show measurable benefits on the impact of biochar on composting, the number of studies is still very limited. Many of the traditional indices used for evaluating the quality ('stability') of compost (e.g., the carbon/nitrogen, C/N, ratio) are not valid when biochar is included in the mixture (6), since biochars have very different properties than the rest of the composting material (e.g. high C/N ratio, which will not decrease during the composting process in contrast to the remaining organic material) and may even influence compost quality assays if controlled for biochar (e.g., water-soluble C may adsorb to biochar). Establishing compost quality indices that take the benefits of biochar into account could help increase the commercial use of this activity.

At this time there is not a significant industry for compost amended with biochar, even though many current biochar producers sell a biochar/compost blend. The 2013 *IBI State of the Industry Report* found that compost was the most common additive to biochar when biochar was sold as part of a blend[14]. There are a few companies that are actively taking a leading role in commercializing biochar-amended compost blends by producing biochar onsite and utilizing those feedstocks for biochar production which would be less ideal for composting.

Increasing the use of biochar in compost operations requires education on the benefits of biochar to producers, not only on emissions and odor reductions, but also on the potential economic benefits of accelerated composting time to offset the additional price of producing/purchasing biochar.

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