Physical disintegration of charcoal: Comminution can dwarf microbial and chemical degradation processes

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Abstract

Biochar is a form of black carbon (BC) that has been documented to be resistant to both microbial and chemical degradation pathways as well as simultaneously sequestering atmospheric carbon (C) and postulated to act as a soil fertility agent by providing critical inorganic plant nutrients. Much attention has been focused on the stability of BC in soil, especially mineralization by microbial activity and modifications by chemical (abiotic) reactions. On the other hand, less is known about the impact of comminution with subsequent solubilization and transport of dissolved black carbon (DBC) fragments. This physical deterioration is hypothesized to be important for directly impacting the longevity of BC in soils as well as its mobilization into fluvial systems. However, no data exists to support this claim for C loss from biochar. Here we present data on the physical disintegration of biochar. Despite its documented recalcitrant nature to microbial reactions, biochar is extremely susceptible to physical deterioration, abrasion, and subsequent dissolution by water. By examining a set of biochars that were exposed to a 24-hr water extraction (1:20; biochar:di. water), the amount of biochar lost into solution ranged from 4 to 17% (w/w) of the initial mass. To put this loss in perspective, less than 0.09% of biochar C was mineralized by soil microbes over a 100 d incubation (1% w/w amendment in an agricultural soil). It is important to note that not all biochars were equally susceptible to disintegration by water. We offer that physical comminution is a previously overlooked loss mechanism of BC and should be accounted for in predictions of biochar C sequestration potential and the interpretations of BC presence in the archeological/geologic record.