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Wildfires Enhance Soil Organic Matter Biodegradability

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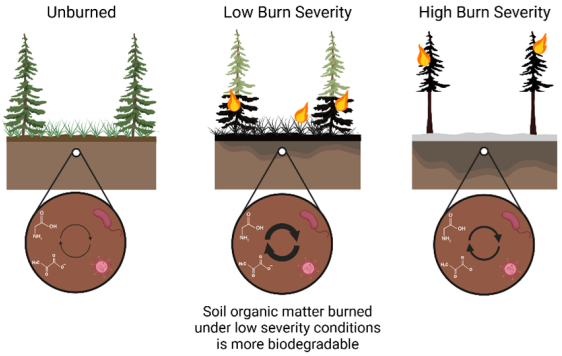

Wildfire activity has increased since the 1970s and is expected to escalate throughout the 21st century as climate change intensifies [1]. Wildfires alter the composition of soil organic matter (SOM): a complex mixture of organic molecules containing key nutrients for microbial metabolism [2]. Microbes consume biodegradable SOM in burned soil to fuel microbial activity and drive post-fire soil and forest recovery. However, the impact of wildfires on SOM biodegradability and the presence of key metabolites (such as organic and amino acids) in burned soil remain largely unknown. Here, we sampled soil from unburned, low burn severity, and high burn severity areas from a 2024 wildfire in Colorado approximately 1.5 months post-fire to assess SOM biodegradability and identify metabolites in burned soil. Field-based soil gas flux measurements revealed that, on average, 1.3x and 2.3x more carbon dioxide was released from the low burn severity and high burn severity soils, respectively, compared to unburned soil. Laboratory-based biological oxygen demand incubations exhibited 2.5x and 2.0x greater microbial metabolism of low and high burn severity SOM, respectively, compared to unburned SOM. These gas flux and incubation results suggest that SOM from burned soil is more biodegradable than unburned soil. The metabolite contents of the burned and unburned soil were distinct, and metabolites, such as citric acid and glycine, were identified in the burned soil using gas chromatography-mass spectrometry. This multidisciplinary study synthesizes data from bacterial and fungal analyses, multiple mass spectrometry techniques, laboratory incubations, and field-based gas flux measurements. Overall, these results demonstrate that SOM from burned soil may be more biodegradable than previously presumed. This heightened SOM biodegradability could result in greater nutrient cycling, microbial metabolism, and greenhouse gas emissions from wildfire-impacted soil.

[1] McLauchlan, K. K. et al. Fire as a fundamental ecological process: Research advances and frontiers (2020), *Journal of Ecology* 108, 2047-2069.

[2] Roth, H. K. et al. Effects of burn severity on organic nitrogen and carbon chemistry in high-elevation forest soils (2023), *Soil & Environmental Health* 1, 100023-100032.