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# Effect of metal oxides on the stabilization of soil organic matter

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Soil organic matter (SOM) is protected from decomposition by three mechanisms: 1) biochemical stabilization through the accumulation of recalcitrant SOM compounds, 2) physical stabilization, i.e. spatial inaccessibility of SOM for microbes, and 3) chemical protection of SOM through intimate interaction with minerals and metal oxides. The latter mechanisms suggest that added organic substances (i.e. post-fermentation sludge) can be stabilized by metal oxides to increase C sequestration in soil. The aim of this study was to determine the effects of $Fe_2O_3$ - one of the dominant metal oxides in soil - on the sequestration of post-fermentation sludge C in soil by separately tracing the decomposition of sludge and of SOM to carbon dioxide ($CO_2$).

To determine changes in SOM turnover after the addition of post-fermentation sludge without/with $Fe_2O_3$, the isotopic signatures of both C sources (SOM and post-fermentation sludge) were used. Using differences in the $^{13}$C natural abundance of the soil ($C_3$ originated, $\delta^{13}C$ = -26‰) and the post-fermentation sludge ($C_4$ originated, $\delta^{13}C$ = -18‰), the $CO_2$ fluxes arising from both C sources were tracked.

Addition of post-fermentation sludge to the soil increased the $CO_2$ production by 30% compared to soil without sludge. $\delta^{13}C$ analysis of the total $CO_2$ efflux revealed that post-fermentation sludge decreased SOM decomposition. $Fe_2O_3$ slightly suppressed sludge decomposition, and therefore increased C sequestration in soil. Only 30% of the post-fermentation sludge had been mineralized after one month of incubation in the soil.

The collective results of my study reveal that application of post-fermentation sludge suppresses SOM decomposition, suggesting its use as a fertilizer could positively influence long-term soil quality. Finally, the success of the $^{13}$C natural abundance microcosm labeling approach in my study supports its use as an effective method of analyzing the effects of various fertilization techniques on soil nutrient retention. Such results were only possible by partitioning of the total $CO_2$.