

WORMS AND MINERALS INFLUENCE THE BIOGEOCHEMISTRY AND TURNOVER OF COMPOSTED ORGANIC MATTER

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Introduction

Organic matter management and in particular increasing their content in soils is one of the societal challenges of the 21st century. Soil organic matter (SOM) increase may be a solution to improve soil quality, while at the same time mitigating global change. Recycling of organic wastes and their transformation into organic amendments could be one avenue towards this goal. However, during recycling procedures, such as composting, high amounts of CO₂ are emitted to the atmosphere. We aimed to reduce such emissions thanks to the combined use of minerals and worms in order to generate stabilised organic matter, less susceptible to microbial decay (Barthod et al., 2016). In this study, we investigated the influence of both factors on the C mineralisation and biogeochemical parameters of the organic amendment.

To this end, we produced composts with and without worms and minerals during 6 months in the laboratory. Composts (without worms) and vermicomposts (with 8 worms) were produced with 500 g of a mixture of common organic wastes (salad, maize residues, card board, coffee grounds, apples). We added 15% of clay minerals (montmorillonite (clay 2 :1), kaolinite (clay 1 :1)) alone or in mixture (15%:15%) with an iron oxide (goethite). We monitored the CO₂ emissions during composting as well as after the exposure of the produced materials to soil incubation and determined the materials' lignin and carbohydrate signatures as well as their bulk molecular composition using ¹³C CPMAS NMR spectroscopy and analytical pyrolysis.

Results

During composting the highest amounts of CO₂ were emitted in the presence of worms, regardless the added mineral. After exposure to soil, CO₂ emissions of vermicomposts were lower than those of regular composts. Indeed, a close correlation was found between both emissions (Fig. 1). This shows that commuting and processing of organic matter by worms is intense, thereby accelerating the transformation and stabilisation processes of organic matter through organic transformations as well as through interactions with minerals. Montmorillonite appeared to reduce CO₂ emissions more than kaolinite.

The addition of kaolinite + goethite shows opposite effects in treatments with and without worms (Fig. 1): in the absence of worms, this mixture induces a higher mineralization than the traditional compost, conversely in the presence of worms, this mixture decreases the amount of mineralized carbon.

Principal component analyses of chemical parameters showed that the presence of worms during composting increased final product C mineralisation in soil and nitrate content, but on the other hand decreased the microbial biomass and the soluble carbon fraction (DOC). The presence of clay during composting overall decreased the amount of mineralized carbon, as well as the final product conductivity (CEC) and the DOC. Analyses of biogeochemical

parameters were in line with these results, showing lower contribution of lignin and higher amounts of polysaccharides and N-containing compounds in vermicomposts. Different minerals had specific effects on the biogeochemical composition of the resulting materials.

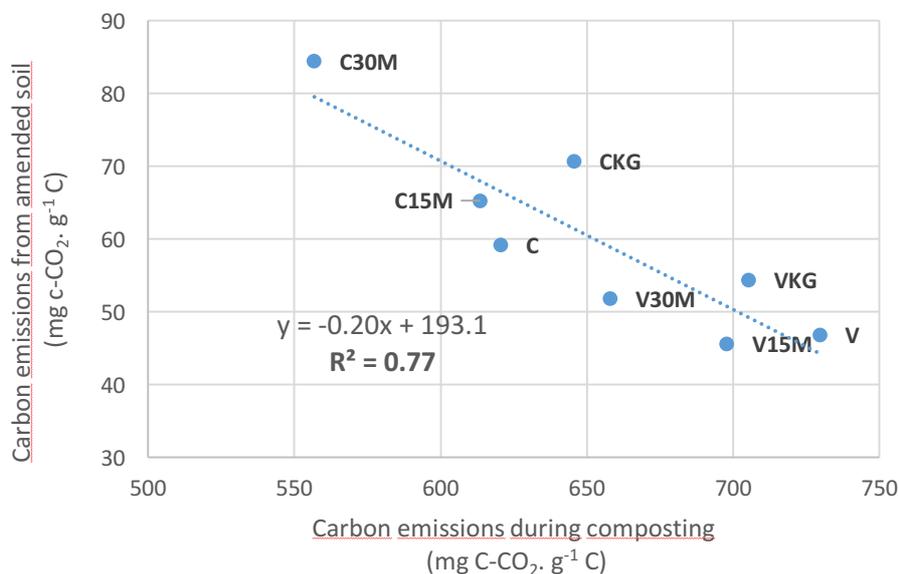


Figure 1 Relationship between CO₂ emissions during composting and after addition of compost materials to soil (C30M – compost+30% Montmorillonite; C15M – compost+15% Montmorillonite; C-compost; CKG-compost+15%Kaolinite+15%Goethite; VKG-vermicompost+15%Kaolinite+15%Goethite; V15M-vermicompost+15%Montmorillonite; V30M-vermicompost+30%montmorillonite; V-vermicompost)

Conclusions

Addition of minerals and worms had contrasting effects on C mineralisation during composting as well as on the biogeochemical composition of the resulting materials. These results suggest that the presence of worms and / or minerals influences the product properties with several mechanisms: (1) by changing the product microbial biomass, (2) by acting on the formation of organo-mineral associations (quality and quantity) and (3) by changing the OM degradability.

References

Barthod, J., Rumpel, C., Paradelo, R., Dignac, M.F.: The effects of worms, clay and biochar on CO₂ emissions during production and soil application of co-composts. *Soil*, 2, 673–683.