The Influence of Organic Amendments on the Heat Capacity of Soils

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Introduction

While it is known that the incorporation of organic amendments enriches soil organic matter and enhances soil health and fertility, the mechanisms of their action are not clearly understood[1].

This study explores the mechanisms of interaction between organic amendments and soils by measuring the heat capacities of amended soils and compare with the calculated values. Any deviations in the measured heat capacity from the calculated value can reveal important information about the molecular interactions and changes occurring within a mixture[2].

Materials and Methods

Materials

Soil samples were collected from Southern Utah, and the Utah-Arizona border. Humic acid was isolated by alkali method from Leonardite material purchased from International Humic Substances Society[3]. Biochar sample was purchased from Fisher Scientific[4].

Methods

Two grams of soil, 50 mg of humic acid or biochar, and 10 mL of DI water were stirred for seven days. Samples were then centrifuged and the supernatant was discarded. The residue was dried in the oven at 104 C.

The heat capacities of the residues were measured by TA DSC 250 instrument, in the temperature range of 20 to 50 C, by using the ASTM three runs method (baseline, sapphire reference, sample).

The measured values were compared to the calculated ones by the additivity rule.

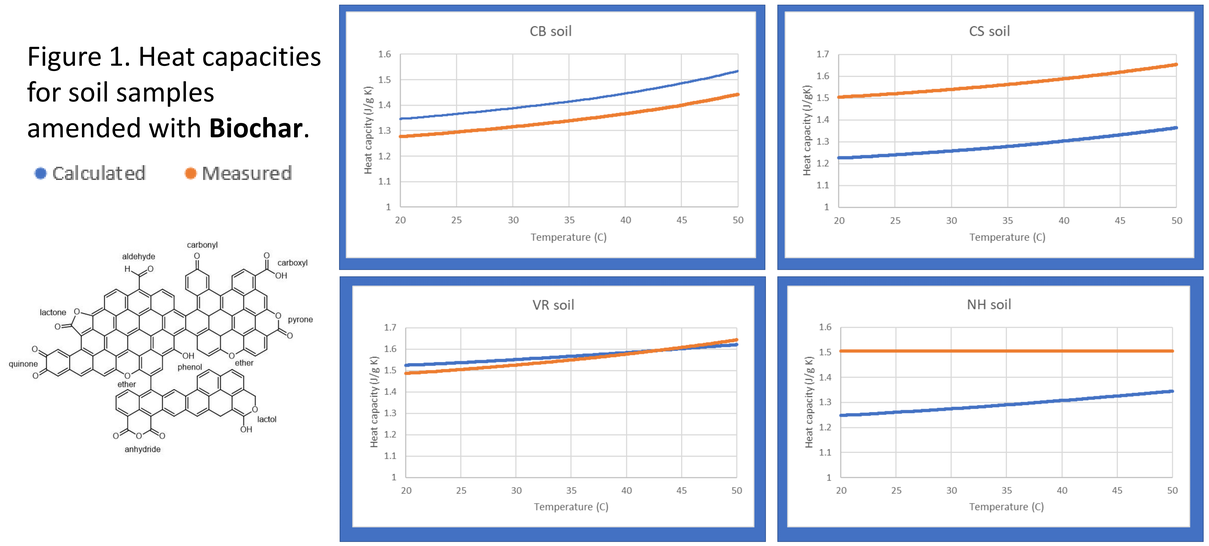
$Cp_{mixture} = x_{soil} * Cp_{soil} + x_{org} * Cp_{org}$

where x represent the mass fraction of the component and Cp is the heat capacity.

Results

Soil	VR (Virgin River)	NH (North Hurricane)	CS (Chinle Shales)	CB (Chinle Blue Clay)
Description	Clay sediments deposited in shallow pools on the Virgin River flood plain.	Sands collected near "Cinder Pits".	Fine lake sediments, mostly quartz with some feldspar, and a little bit of clay.	Fine clays ("Blue clays") collected from Washington County.
% Carbon	3.59 ± 0.62	1.01 ± 0.11	2.43 ± 0.02	0.76 ± 0.22

Figure 1. Heat capacities for soil samples amended with **Biochar**.



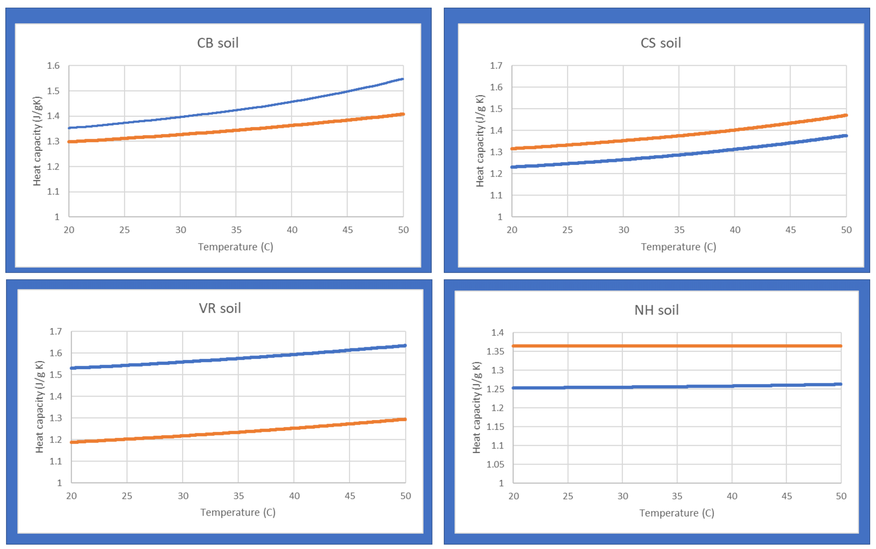


Figure 2. Heat capacities for soil samples amended with **Humic Acid**.

Summary

- The differences between heat capacities values calculated and measure are between 1 and 25%; the experimental errors for measuring heat capacity are bellow 3%.
- The measured heat capacities for CS and NH soil samples are greater than the calculated ones suggesting interactions between components, such as repulsive forces that increase the freedom of movement of molecules beyond what is seen in the pure states.
- The measured heat capacities for CB and VR soil samples (rich in clays) are less than the calculated ones suggesting interactions between the components, such as attractive forces (e.g., hydrogen bonding, ionic bonding) that restrict the movement of molecules or the formation of a more ordered structure within the mixture compared to the pure components.

References

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