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Preferential Sequestration of Microbial Amino Sugars in Subsoils of a Glacial-Landscape Toposequence, Dane County, WI

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Introduction

Interest in transformation and sequestration of soil organic carbon (SOC) has dramatically increased in recent years due to its importance to the global carbon (C) cycling. Dynamics of the terrestrial C pool are heavily influenced by the catabolic and anabolic activity of microbes. Alternatively, synthesized microbial metabolites have been suggested as parts of stable C pool, relevant for the long-term sequestration of C in soil and consequently for the role of soils as a terrestrial C sink within the global C cycling. NMR techniques also indicate a far greater role for incorporation of microbial biomass into soil stable C pools (via microbial byproducts and senesced microbial biomass) than previously believed.

The depth distribution of SOC is asymmetric, with more than 50% of the Organic C in a 1-meter profile contained in deeper horizons (below 25 cm). Through the soil depth profile, research on pedogenesis and variation of soil C have been traditionally conducted, more recently including variation in microbial biomass and communities. Despite the important contribution of microbial residues to the stable C pool, and confirmed C sink and proposed large C stabilization potential in deeper soil, little is known about how the contribution of these residues to soil C storage varies as a function of depth.

To this end, varied pedogenic horizons from six soil profiles (UW-arboretum site and Picnic Point site) were subjected to amino sugar biomarker analysis. We expect to further current knowledge of microbial contribution (fungi and bacteria) to SOC sequestration, as well as of the influence of pedogenic process on microbes involved.

Materials and Methods

Sampling Sites:

UW-arboretum (N 43.02; W 89.25, WI, USA): same elevation level (262 meter); close geographic proximity with *ca.* 240 meter apart.

Pit 1, Pit 2, Pit 3

Picnic Point (N 43.05; W 89.25, WI, USA): a typical hill slope; close geographic proximity with *ca.* 84 meter apart.

Pit 4, Pit 5, Pit 6

Both sites are primarily Precambrian igneous and metamorphic rock overlain by Paleozoic sedimentary rocks. Six pits are excavated as models for PEDOLOGY education of soil science dept. in Univ. of Wisconsin - Madison.

Experiment Methods:

Amino sugar analysis using GC-FID following aldonitrile acetate derivatives.

C and N using LECO total CNS analyzer.


Fig. 1. UW-arboretum Soil Pits


Fig. 2. Picnic Point Soil Pits

Results and Discussion

1. Total amino sugar amounts in soils have positive linear correlativity to SOC and total N (Fig. 3). In comparison with respective sub-horizons, the A horizons of 6 pits all contain marked amino sugars, organic C and total N.
2. Although the total amino sugar amounts decreased downward through the profile as organic C did, the rate of decrease was significantly lower (Fig. 4)
3. The proportion of amino sugars to SOC increased along the depth gradient (from top to bottom), with the exception of Bg horizon associated with high water table (Fig. 4).
4. Amino sugar ratios of glucosamine (GluN) to muramic acid (MurA) in both sites show different tendencies (Fig. 4).

Conclusion

Each pit has an A horizon enriched with amino sugars and SOM, where there is also the most appreciable organic input from litters and plant roots;

In spite of the redox microenvironment created by the water table, microbial amino sugars preferentially accumulated in subsoils comparing with general organic C;

Amino sugar ratios alone aren't enough to elucidate how bacteria and fungi contribute to C storage, since each site bears distinct characteristics resulting in distinct dynamic.

Our study supports the hypothesis that microbial residues are refractory and that they contribute to terrestrial C sequestration directly.

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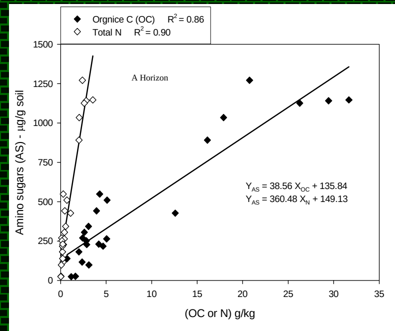

Fig. 3. Relationship between amino sugar contents in soils and organic C or total N

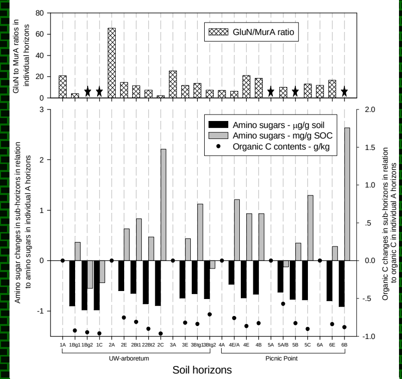

Fig. 4. GluN/MurA ratios in each horizons and changes in amino sugars and SOC in sub-horizons compared to those in respective A horizons of six pits in UW-arboretum and Picnic Point, WI, USA. The pit number was put in front of pedogenic letter. Star represented MurA < detection limit.

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