Do amino acid abundances and isotopic compositions in soil organic matter reflect climatic differences?

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Amino acids are an abundant, but poorly studied, component of soil organic matter (SOM). Most amino acids enter the soil from plant residues and root exudation. Utilizing the isotopic fractionations occuring during biosynthesis and evaporative transpiration, the hydrogen and carbon isotopic composition of amino acids from SOM may be valuable in tracing above- (litter) and below-ground (root) inputs as well as in recording wider scale environmental and climatic signals.

To investigate the relationship of amino acids (Phe, Ileu, Leu, Val, Lys, Glu, Pro, Thr, and Asp) to climate as well as the relative source of above- and belowground amino acid sources, we investigated the abundance, $\delta^{13}C$, and $\delta^{2}H$ of amino acids extracted from the roots, litter, and surface SOM from forests located on an elevation and climate gradient.

In SOM, roots, and litter, Glu and Leu were the most abundant amino acids. Whille total hydrolyzable amino acid concentrations increased with elevation (increasing MAP, decreasing MAT), the patterns of amino acid abundance between samples are similar among biosynthetic families (whether originating before or after the citric acid cycle).

The $\delta^{2}H$ of Lys, Leu, Ile, Val, and Asp from SOM displayed statistically significant correlations with climate (elevation, MAT, MAP), suggesting that these amino acids are influenced by precipitation through biosyntheis by plants or soil microbes. The $\delta^{2}H$ of Val, Ile, Asp, Lys, and Glu displayed some correlation to the bulk $\delta^{2}H$ of root, litter, or soil OM. Differences in $\delta^{2}H$-Pro between above- and belowground sources show potential as a tracer of SOM origins with linear discriminant analysis of Pro and Glu ($\delta^{2}H$) effectively separating root and litter sources. A simple relationship with climate, however, was not observed with $\delta^{13}C$ of SOM amino acids or with the $\delta^{13}C$ and $\delta^{2}H$ of root and litter amino acids. Additionally, the $\delta^{13}C$ of the amio acids were not correlated to the bulk $\delta^{13}C$ of root, litter, or soil OM. These findings demonstrate that biosynthetic processes, as well as envrionmental parameters, are both important determinants of isotopic compositions of amino acids in complex soil organic matter reservoirs.