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Stability of root and needle-derived biomarkers during litter decomposition

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Up to now there is only a poor understanding of the relative contribution of the various sources of organic carbon in forest soils; especially the relative contribution of leaves and roots is unclear. Identification of compounds that are specific for leaves and roots could be a promising tool to quantify their contribution to soil organic matter (SOM).
A first step for accurate use of such plant part specific biomarkers is the determination of their stability and their (altered) decomposition products during litter decomposition. This information is necessary if we want to assess the dynamics of these compounds in soils and to use them for source quantification. Surprisingly, information about concentrations of root and leaf-derived biomarkers during litter decomposition is virtually non-existent.
We analyzed the chemical composition of samples from a 3-year litterbag decomposition experiment with roots and leaves of spruce, pine and birch which was conducted in Finland.
In this study we focused on the following questions:
(I) Which compounds are characteristic for certain plant parts (root vs. leaves) and plant species?
(II) How stable are these compounds during the first 3 years of litter decomposition?
In addition to determining mass loss, carbon and nitrogen contents, free lipids were extracted and analyzed with GC/MS, while ester-bound components were analyzed by TMAH Curie-point Pyrolysis followed by GC/MS. Additionally, ester-bound components were analyzed after KOH digestion.
We found mass loss to vary substantially between litter from different plant species, and always observed a larger mass loss for leaf-derived litter in comparison to root derived litter.
The increase of the ratio of vanillic acid to vanillin was negatively correlated to the mass loss of the samples over time. Lignin oxidation was stronger for leaves and needles than for roots per unit mass loss.
Dicarboxyl alkanoic acids proved to be the most suitable root biomarker. For needles omega fatty acids and di-hydroxy fatty acids showed to be specific.
In addition to the bulk material, the stability of the different biomarkers varied considerably. Therefore, information about concentrations of biomarkers in plant litter and in the soil alone do not suffice for a quantitative understanding of the sources of stable soil organic matter.