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Decomposition of soil organic matter by ectomycorrhizal fungi studied by infrared spectroscopy

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Boreal forests accumulate a fifth of the global soil organic matter (SOM) pool and play an important role in the carbon cycling. Most trees in these boreal forests live in symbiosis with ectomycorrhizal fungi (EMF) that sheath the plant root tips. In the symbiotic relationship, EMF provide nutrients from the soil to plants such as nitrogen and phosphorous, and trees give carbon in return to the fungi. When foraging for these nutrients, EMF use different strategies to explore the soil matrix. Long-distance exploration types grow far into the soil surroundings of the roots, while short-medium distance exploration ones grow close to the root tips. Despite these morphological differences among EMF, there is still little evidence of their functional role in the SOM decomposition.

In this study, two ectomycorrhizal fungi *Paxillus involutus* and *Laccaria bicolor*, which belong to long and medium-distance smooth exploration types respectively, were grown in axenic cultures on SOM extracted from forest litter. To trigger the fungal decomposing activity, the extracts were supplemented with glucose. Chemical analysis and infrared spectroscopy were used to analyze the organic matter and chemometric tools such as principal component analysis (PCA), two-dimensional (2D) correlation analysis and multivariate curve resolution-alternating least squares (MCR-ALS) analysis were applied to further understand the chemical changes in the SOM.

The first principal component of PCA explained 77% of the total variability and separated the treatments based on two infrared spectral regions: polysaccharides (970-1,150 cm^{-1}) and carbonyl region (1,620-1,800 cm^{-1}). Moreover, the 2D correlation analysis showed that the polysaccharides region in both treatments was negatively correlated with the carbonyl region, suggesting the production of oxidized compounds such as ketones during the uptake of glucose. The 2D correlation analysis also revealed that the diminution of intensity in the polysaccharides region occurred faster than the increase in the carbonyl region and that this change in the SOM was larger with *Paxillus involutus*. The MCR-ALS analysis resulted in at least three major components, which showed different time-response along the experiment. These components might be attributed to different compound classes such as polysaccharides, quinones or carboxylic acids, giving evidence of the transformation of the SOM with time.

Overall, these results demonstrate that combination of infrared spectroscopy and chemometrics can help to elucidate our understanding about the role of EMF in SOM decomposition.