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Stabilization of glucose-C in microbial cell membranes (PLFA) and cell walls (amino sugars) evaluated by 13C-labelling in a field experiment

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Microorganisms control carbon (C) cycle and strongly contribute to formation of soil organic matter. Strong differences in the turnover of microbial groups and cellular compounds complicate the assessment of their contribution to microbial food webs and C sequestration in soil in situ.
The uptake and incorporation of 13C labeled glucose by microbial groups were traced during 50 days after the labeling under field conditions. 13C was analysed: i) in the cytosolic pool by chloroform fumigation extraction, ii) in cell membranes by phospholipid fatty acids (PLFA), iii) in cell walls by amino sugars, and iv) remaining in bulk soil. This allowed tracing C in microbial groups as well as cellular compounds.
Mean residence times (MRT) of C in PLFA and the cytosol were 47 and 150 days, respectively. Such long cytosol MRT depends on its heterogeneous composition, which includes high and low molecular weight organics. Amino sugars were mainly originated from microbial residues and thus, observation periods higher than 1 year are required for estimation of their MRT.
Relative 13C incorporation (13C portion in total pool C) was the highest for PLFAs ($\sim$1.5% at day 3), whereas 13C content of the cytosol and amino sugars was one and two orders of magnitude less, respectively. Relative 13C incorporation into amino sugars of living microorganisms showed only 0.57% on day 3. Therefore, the turnover of cell membrane components is two times faster than that of cell walls, even in living microorganisms.
Both PLFAs and amino sugars showed that glucose C was preferentially used by bacteria. 13C incorporation into bacterial cell walls and membranes decreased with time, but increased or remained constant for fungi, reflecting faster turnover of bacteria than fungi. Consequently, bacteria contribute more to the decomposition of low molecular weight organics, whereas fungi consume bacterial products or necromass and contribute more to long-term C stabilisation.
Thus, tracing of 13C in cellular compounds with contrasting turnover provides key information to C fluxes through the soil microbial food-web and elucidates the role of distinct groups as well as individual cellular compartments in SOM formation and C sequestration.