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Microbial utilization of sugars in soil assessed by position-specific labeling and compound-specific 13C-PLFA-analysis

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For the transformation of low molecular weight organic substances (LMWOS) in soil, which is an important process in the turnover of organic matter, microbial utilization is one of the most important processes. Position-specific labeling combined with compound-specific 13C-PLFA-analysis allows a closer look on the mechanisms of LMWOS transformation in soil.

We assessed short- (3 and 10 days) and long-term (half year) transformations of monosaccharides by adding position-specifically 13C labeled glucose and ribose to soil in a field experiment conducted on an agriculturally used luvisol located in north-western Bavaria. We quantified the microbial utilization of the different functional groups by 13C-analysis of microbial biomass with the chloroform-fumigation-extraction method (CFE). 13C-PLFA analysis enabled us to distinguish individual microbial groups and compare their C-utilization.

Preferential degradation of glucoses C-3 and C-4 respectively C-1 position enabled differentiation between the two main hexose metabolic pathways – glycolysis and the pentose phosphate pathway. Microbial groups revealed different incorporation of specific C positions into their PLFA. The highest incorporation was reached by the prokaryotic gram- negative groups.

The application of position-specifically labeled substances, coupled with compound-specific 13C-PLFA analysis opens a new way to investigate the microbial transformations of LMWOS in soil. Observing single C atoms and their utilization by specific microbial groups allow conclusions about the mechanisms and kinetics of microbial utilization and interaction between these groups and therefore will improve our understanding of soil carbon fluxes.