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

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Transformation of low molecular weight organic substances (LMWOS) organic substances in soil is one of the most important processes in the turnover of organic matter, as all high molecular substances pass this stage during their decomposition. Microbial utilization is the most important process for the transformation of LMWOS in soil and thus is an important process in the turnover of organic matter. Position-specific labeling combined with compound-specific 13C analysis of microbial biomass allows a closer look on the mechanisms of LMWOS transformation in soil.

We assessed short-term (3 and 10 days) transformations of the amino acids by adding position-specifically labeled 13C and 15N alanine and glutamic acid to soil in a field experiment. We quantified the microbial utilization of the different functional groups by 13C- and 15N-analysis of microbial biomass with the chloroform-fumigation-extraction method. A more specific look on the utilization of individual C positions by distinct microbial groups was gained by 13C-PLFA analysis.

Microbial degradation was fastest with the highly oxidized carboxylic groups of the amino acids, whereas more reduced C positions showed a higher utilization by microbial anabolism. Microbial groups revealed different incorporation of specific C positions into their PLFA. The highest incorporation was reached by the prokaryotic groups, especially the gram-negatives. Whereas alanine was metabolized similar by different microbial groups glutamic acid C showed different utilization of the individual C positions for distinct microbial groups. This may arise from the use of glutamic acid as a general N transport molecule in bacterial metabolism. Hence, position-specifically labeled glutamic acid may act as a tracer of bacterial N metabolism.

The application of position-specifically labeled substances opens a new way to investigate the microbial transformations of amino acids 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. To our knowledge, this is the first combination of position specific labeling and compound specific isotope analysis.