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Sorption and Microbial Uptake of Alanine, Glucose and Acetate in Soil

H. Fischer (1,2), J. Ingwersen (1), and Y. Kuzyakov (2)

(1) University of Hohenheim, Institute of Soil Science and Land Evaluation, Germany (hfischer@uni-hohenheim.de), (2) Department of Agroecosystem Research, BayCEER, University of Bayreuth

Low molecular weight organic substances (LMWOS), e. g. amino acids, sugars, and carboxylic acids, are C compounds that are most rapidly turned-over in the C cycle of soil. Despite of their importance it is still unknown how sorption to the soil matrix affects their turnover in soil solution. The goals of this study were (1) to describe the dynamics of the fluxes of LMWOS (10 μmol l-1) in various pools (dissolved, adsorbed, decomposed to CO2, incorporated into microbial biomass) and (2) to assess the LMWOS distribution in these pools in dependence of very wide range of concentration (0.01 to 1000 μmol l-1). Representatives of each LMWOS group (glucose for sugars, alanine for amino acids, Na-acetate for carboxylic acids) uniformly labeled with 14C were added to sterilized or non-sterilized soil and analyzed in dif-ferent compartments between 1 min and 5.6 hours after addition. LMWOS were almost completely taken up by microorganisms within the first 30 min. Microbial uptake was much faster than the physicochemical sorption (estimated in sterilized soil), which needed to reach quasi-equilibrium 60 min for alanine and about 400 min for glucose. Only sorption of acetate was instantaneous (>1 min). While for acetate the maximum sorption capacity was reached at 100 μmol l-1 no such maximum was found for glucose and alanine in the studied concentra-tion range. At the concentration of 100 μmol l-1, microbial decomposition after 4.5 h hours was higher for alanine (76.7$\pm$1.1%) than acetate (55.2$\pm$0.9%) and glucose (28.5$\pm$1.5%). On the contrary, incorporation into microbial biomass was higher for glucose (59.8$\pm$1.2%) than for acetate (23.4$\pm$5.9%) and alanine (5.2$\pm$2.8%). Within 10 to 500 μmol l-1 the pathways of the three LMWOS transformation changed: at 500 μmol l-1 alanine and acetate were less mineralized and more incorporated into microbial biomass than at 10 μmol l-1, while glucose incorporation decreased. Consequently, the concentrations of alanine, glucose, and acetate in soil solution were the most important factor affecting the fate of the respective LMWOS. We conclude that for all three substances representing the three main groups of LMWOS in soil the most rapid process is microbial uptake which was mainly finished within 30. Thereafter, microbial utilization led to further distribution of the metabolized products and their sorption by soil matrix.