



The influence of phenolic acids on microbiological activity of soils

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Phenolic acids are non-specific organic compounds of soil organic matter (SOM). These compounds are formed during the decomposition of plant residues or are released within root exudation. The concentration of phenolic acids in soil depends on microbial uptake rate, fixation by soil matrix and microbial decomposition. Phenolic acids are known to be of great significance in the regulating of plant growth and soil microorganisms activity, take part in biosynthesis of lignin, regulating the cycles of the nutrients (the processes of nitrification and denitrification). Despite phenolic acids being bioactive substances may cause the stimulating and inhibiting effects on microorganisms and they may utilize phenolic acids as a carbon source. Nevertheless on the broad spectrum of ecological functions, the influence of the phenolic acids on majority soil decomposers is largely unknown. The main hypothesis of our work was that some natural organic substances derived from plant residues in autumn may depress the activity of SOM decomposers.

To prove this hypothesis we used samples of soil (0-5 cm) and litter collected in autumn 2009 under 2 vegetation types: coniferous forest (*Picea abies*) and broadleaf forest (*Acer platanoides*). Soil samples were sieved (2.0 mm) and stored at 5 °C.

We studied the quantitative and qualitative composition of phenolic acids of the soils and litter under deciduous and coniferous trees using HPLC and GC-MS. The dominant substances were: *p*-hydroxybenzoic, vanillic, salicylic and benzoic acids. The amount of these phenolic compounds in the maple and spruce litters ranged from 0.6 to 85.3 mg kg⁻¹ for individual acids and the concentration of these compounds in maple litter was higher than in the spruce litter. The patterns of phenolic acids composition were similar in soils under the spruce and maple trees.

The effect of phenolic acids on soils microbial activity was determined in two types of laboratory experiments: i) addition of the individual phenolic acids to the soil samples or ii) to the prokaryotes suspension, which were prepared from investigated soils by nystatin addition. The concentrations of phenolic acids were based on their qualitative and quantitative composition in litter and in the soil solution. On days 6 and 14, the soil samples treated with phenolic acids were analyzed for CO₂ efflux, microbial biomass C (method of substrate induced respiration), protein-degrading enzyme activity and total enzyme activity. The maximum rate of microbial growth of prokaryotes was the main parameter of analyzed effect of phenolic acids in the second experiment.

Protein-degrading enzyme activity for the soil spruce samples on day 6 was higher than under maple. The protein-degrading enzyme activity in soil spruce samples decreased for 1.2 times from 6 to 14 day. Similar effects were observed under the maple. The total microbial activity on days 6 and 14 was higher under the spruce site 1.5 and 2 times, respectively in comparison with the maple site. In contrast to the enzyme activities the spruce prokaryote community was stimulated by individual phenolic acids and their mixture. Microbial biomass in the soil spruce samples also increased. Vanillic and salicylic acids stimulated the maple soil prokaryote community. Benzoic, *p*-hydroxybenzoic acids and the mixture caused an inhibition effects on prokaryote community of the soil under the maple trees, but microbial biomass in the maple soil samples was not suppressed or even increased by the addition of these substances.

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