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Polyphenols as enzyme inhibitors in different degraded peat soils: Implication for microbial metabolism in rewetted peatlands

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Recently, more than 30,000 ha of drained minerotrophic peatlands (= fens) in NE Germany were rewetted to restore their ecological functions. Due to an extended drainage history, a re-establishment of their original state is not expected in the short-term. Elevated concentrations of dissolved organic carbon, ammonium and phosphate have been measured in the soil porewater of the upper degraded peat layers of rewetted fens at levels of one to three orders higher than the values in pristine systems; an indicator of increased microbial activity in the upper degraded soil layers. On the other hand there is evidence that the substrate availability within the degraded peat layer is lowered since the organic matter has formerly been subject to intense decomposition over the decades of drainage and intense agricultural use of the areas. Previously however, it was suggested that inhibition of hydrolytic enzymes by polyphenolic substances is suspended during aeration of peat soils mainly due to the decomposition of the inhibiting polyphenols by oxidising enzymes such as phenol oxidase. Accordingly we hypothesised a lack of enzyme inhibiting polyphenols in degraded peat soils of rewetted fens compared to less decomposed peat of more natural fens.

We collected both peat samples at the soil surface (0-20 cm) and fresh roots of dominating vascular plants and mosses (as peat parent material) from five formerly drained rewetted sites and five more natural sites of NE Germany and NW Poland. Less decomposed peat and living roots were used to obtain an internal standard for polyphenol analysis and to run enzyme inhibition tests. For all samples we determined the total phenolic contents and in addition we distinguished between the contents of hydrolysable and condensed tannic substances.

From a methodical perspective the advantage of internal standards compared to the commercially available standards cyanidin chloride and tannic acid became apparent. Quantification with cyanidin or tannic acid led to a considerable underestimation (up to 90%) of polyphenolic concentrations in peat soils. As hypothesised we found that highly degraded peat contains far lower levels of total polyphenolics (factor 8) and condensed tannins (factor 50) than less decomposed peat. In addition we detected large differences between different plant species with highest polyphenolic contents for the roots of Carex appropinquata that were more than 10-fold higher than Sphagnum spp. (450 mg/g dry mass vs. 39 mg/g dry mass). Despite these differences, we did not find a significant correlation between enzyme activities and peat degradation state, indicating that there is no simple linear relationship between polyphenolic contents and microbial activity.