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XANTHINE OXIDASE ACTIVITY PARTICIPATING IN CYCLE OF NITROGEN IN PEAT PROFILE OF KUSOWO BOG

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SUMMARY

Enzymes, the important indicators of microbial metabolism, are of great importance in peatland systems. The aim of our investigations was to evaluate the xanthine oxidase activity of peat profile of Kusowo bog in the region of “Bory Tucholskie” National Park, UNESCO - Natural Reserves. Peat samples were collected from four depth: 0-25 cm, 25-50 cm, 50-75 cm and 75-100 cm. The obtained results have revealed the impact of four depths of peat profile on xanthine oxidase activity. However, the increase of xanthine oxidase activity at the depth from 0-25 cm was observed.

KEY WORDS: xanthine oxidase, raised bog

INTRODUCTION

Ombrotrophic peatlands (or raised bogs) are usually considered as valuable repository of high-quality climatic signals because their sole source of water is from precipitation and surface moisture therefore depends only on the balance between inputs from precipitation and losses from evaporation and runoff. Surface moisture affects communities of living organisms, which are preserved in the peat (Lamentowicz *et al.,* 2008a, b). Decomposition processes of organic materials in raised-bogs are very slow because of the low pH and temperature of the soil. Cellulose and lignin are the two most important organic compounds found in peatlands. Bacteria plays an important role in the degradation of these components. Both cellulose and lignin compounds come from plant residues and are degraded to mono- and disaccharides respective to phenol (Szentes *et al.,* 2011).

Bogs and fens are the dominant wetland classes globally. They are particularly important to the global carbon (C) cycle, because they accumulate peat, a heterogeneous assemblage of partially decomposed plant materials (about 45%-50% C), on annual through millennial time scales. Peat chemistry varies with depth in a peatland and among different peatlands as a result of botanical composition and degree of decomposition. Peat is decomposed predominantly by fungi in the oxygenated peat horizon (acrotelm) and by bacteria in the anoxic peat horizon (catotelm). The degradation of organic matter is often viewed as a process of facilitation, whereby species of a particular fungal community alter the substrate sufficiently to allow other fungal species to become established and continue the degradation

process. Such a succession has been shown in various upland and wetland plant species. Competition and antagonism within fungal communities are also factors at each stage of decay. Consequently, different fungal communities are responsible for the degradation of the varying components of peat, largely as a result of the differing abilities of fungi to synthesize the enzymes required to degrade organic matter (Thormann *et al.*, 2007).

Decomposition is a fundamental process in ecosystem carbon flux and nutrient cycling. In nutrient limited environments, such as many wetlands, the continued availability of nutrient resources depends on microbial decomposition of detritus. The role of extracellular enzymes in controlling the rate of decomposition has long been recognized. These enzymes are required to catalyze the processing of high-molecular-weight organic matter into assimilable subunits, thus enabling heterotrophic bacteria to obtain suitable substrates. The acquisition of nutrients released by extracellular hydrolysis depends to a large degree on the quality of the decomposing detritus. This degradation requires the involvement of many hydrolytic enzymes. Activities of key enzymes have been used as indicators of microbial nutrient acquisition and the relationships between microbial extracellular enzymes and litter decomposition have been explored. There is a general consensus that studying extracellular enzymes involved in decomposition may provide valuable information about the cycling of nutrients in ecosystems (Rejmánková and Sirová, 2007).
The aim of our investigations was to evaluate the xanthine oxidase activity of peat profile of Kusowo bog in the region of “Bory Tucholskie” National Park, UNESCO - Natural Reserves.

MATERIALS AND METHODS

Kusowo bog is located in the West Pomeranian Voivodship (53°48'57.83" N, 16° 32'42.03" E). The Bagno Kusowo is likely the best preserved in Poland the Baltic type raised bog. The “Bagno Kusowo” Nature Reserve was established in w 2005 year to protect the major part of the bog and its adjacent dystrophic pond. The area of the Reserve is 326.56 ha being entirely included into the “Jeziora Szczecineckie” Natura 2000 proposed Site of Community Importance. The bog is adjacent to the Wielatowo Lake which is the most naturally interesting and on its southern side also to the Buczyny Wielatowskie (Wielatowo Beech Woods) forest complex. On the East, the bog lies close to the lakes of Wielatowo and Brzeźno. In the northern part of the site there is also a small dystrophic lake surrounded by pine and birch bog forests. Peat deposit of the post-lacustrine origins is underlain by gyttja layer on which a thin deposit of fens and transition peat is spread. Up to 12 m thick pure raised peat is deposited thereon. The vegetation of Kusowo bog is dominated by: *Drosera rotundifolia, D. anglica, Vaccinium uliginosum, Empetrum nigrum, Trichophorum cespitosum, Carex limosa, Sphagnum balticum, S. centrale, S. compactum, S. fuscum, S. obtusum, S. russowi, S. tenellum, S. magellanicum* (Herbichowa *et al.*, 2007).

The peat samples were taken for analyses in October 2010 with the peat profile from peatland of Kusowo bog. Peat samples were collected from four depth: 0-25 cm, 25-50 cm, 50-75 cm and 75-100 cm. Peat from each collection was treated separately; the surface layer of vegetation was removed and the peat gently homogenized by hand for 10 min in order to reduce spatial heterogeneity. For analyses of xanthine oxidase activity fresh peat from two sites were pooled together to give the so-called average mixed sample. Xanthine oxidase activity was determined by Krawczyński method (Krawczyński, 1972, Szajdak *et al.*, 2011a, b).

RESULTS

Xanthine oxidase catalyses the oxidation of hypoxanthine to xanthine and of the latter to uric acid, although it has a low substrate specificity, oxidising also several purines and aldehydes, at a lower rate. Xanthine oxidase participates in the last step of the degradation of purine derivatives from nucleic acids and is assumed to be a rate-limiting step in purine metabolism. This enzyme oxidizes hypoxanthine and xanthine to uric acid in the purine catabolic pathway and participants in the cycle of nitrogen in soils. Xanthine oxidase is formed from xanthine dehydrogenase under oxidative conditions (Battelli *et al.,* 1999; Masuoka and Kubo, 2004). Studies indicated high of xanthine oxidase activity at the depth of 0-25 cm (30.99 μmol $h^{-1}g^{-1}$). Furthermore, our investigation have shown a decrease of the activity of this enzyme at the depth 25-50 cm and 25-100 cm (from 14.29 to 25.87 μmol $h^{-1}g^{-1}$) (Table 1).

Table 1. Xanthine oxidase activity in peat soil of Kusowo bog

Sampling sites depth [cm]	Xanthine oxidase activity [μmol $h^{-1}g^{-1}$]
0-25	30.99
25-50	14.29
50-75	22.82
75-100	25.87

CONCLUSION

The obtained results have revealed the impact of four depths of peat profile on xanthine oxidase activity. However, the increase of xanthine oxidase activity at the depth from 0-25 cm was observed.

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