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Peatland hydrological legacy affects enzyme inhibition and potential DOC release

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Abstract

Peatland ecosystems have been drained for agricultural reclamation that has led to degradation and potential loss of a variety of ecosystem services including carbon sequestration. The impact of rewetting by ditch-blocking on dissolved organic carbon (DOC) release in peat bogs appears dependent on the length of time following rewetting but the mechanisms responsible are not fully understood. We examined the direct effect of laboratory manipulation in peat water content on extracellular enzyme kinetics, *in vitro* enzyme inhibition, and DOC release from peat collected from two depths from specific sites within the Geltsdale National Nature Reserve that differed in long-term legacy of hydrological condition and management. Four sites were chosen consisting of either unmanaged (wet pristine [WP] and dry eroded gully [EG]) or managed peatland (ditch-blocked < 2 years [DB2] and ditch-blocked < 7 years [DB7]). Baseline physicochemical results were generally consistent with aerobic (EG and DB2) and anaerobic (DB7 and WP) decomposition. Low baseline phenolics were associated with enhanced enzyme activities in the degraded EG site. Short-term drying and waterlogging caused a significant release of aromatic DOC and phenolics in the EG site associated with enhanced glucosidase activity but not phenol oxidase activity. Glucosidase inhibition was highest in the wet WP site but tyrosinase inhibition highest in the dry EG site. Uncompetitive inhibition of glucosidase activity occurred within surface peat, competitive inhibition within EG deep peat, and non-competitive inhibition within DB and WP deep peat. Discriminant function analysis shows that the type of enzymic inhibition was related to variation in humic substances and organic matter. Overall, these results show that rewetted degraded peatlands are susceptible to short-term carbon loss due to the enzyme latch mechanism and importantly that different types of enzymic inhibition may explain contradictory DOC results observed in studies of hydrological or climatic change.