Organochemical Characterization of Peat Reveals Decomposition of Specific Hemicellulose Structures as the Main Cause of Organic Matter Loss in the Acrotelm

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Peatlands store carbon in the form of dead organic residues. Climate change and human impact impose risks on the sustainability of the peatlands carbon balance due to increased peat decomposition. Here, we investigated molecular changes in the upper peat layers (0-40 cm), inferred from high-resolution vertical depth profiles, from a boreal peatland using two-dimensional H-1-C-13 nuclear magnetic resonance (NMR) spectroscopy, and comparison to delta C-13, delta N-15, and carbon and nitrogen content. Effects of hydrological conditions were investigated at respective sites: natural moist, drainage ditch, and natural dry. The molecular characterization revealed preferential degradation of specific side-chain linkages of xylan-type hemicelluloses within 0-14 cm at all sites, indicating organic matter losses up to 25%. In contrast, the xylan backbone, galactomannan-type hemicelluloses, and cellulose were more resistant to degradation and accumulated at the natural moist and drainage site. delta C-13, delta N-15, and carbon and nitrogen content did not correlate with specific hemicellulose structures but reflected changes in total carbohydrates. Our analysis provides novel insights into peat carbohydrate decomposition and indicates substantial organic matter losses in the acrotelm due to the degradation of specific hemicellulose structures. This suggests that variations in hemicellulose content and structure influence peat stability, which may have important implications with respect to climate change.
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