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Chemical composition regulates the biodegradation processes of dissolved organic matter from various sources

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Dissolved organic matter (DOM) chemistry and reactivity are markedly altered by anthropogenic activities and global environmental change. However, the information regarding the biodegradability of DOM with different chemistries remains insufficient and this hinders the understanding of DOM biogeochemical dynamics in aquatic ecosystems. This study involved a two-month incubation experiment using DOM extracted from different terrestrial sources including: forest soil, peat and leonardite, all with distinct chemical compositions. The dissolved organic carbon (DOC), total dissolved nitrogen (TDN) contents, respiration (headspace CO_2 production) were measured on specific days throughout the incubation. DOM composition was characterized using solution-state ^{1}H nuclear magnetic resonance (NMR) and ultraviolet-visible (UV-VIS) analyses, and microbial biomass and community structure was analyzed with phospholipid fatty acid (PLFA). DOM extracted from the forest soil and peat samples demonstrated high biodegradability and declined DOC concentrations, higher CO_2 production rates and higher microbial biomass abundance. Forest soil-derived DOM composition exhibited decreases in resonances associated with aliphatic, and carbohydrates and peptides in the early and late stages, respectively. Peat-derived DOM exhibited decreases in carbohydrates and peptides and increases in carboxyl-rich alicyclic molecules (CRAM). In contrast, CRAM and aromatic enriched leonardite-derived DOM demonstrated low biodegradability indicated by low CO_2 production and microbial biomass, as well as no substantial changes in DOM chemical composition over time. Spearman correlation analysis suggested that CO_2 production, microbial biomass abundances and DOM degradation indices were directly related to carbohydrate and peptide contents, while these indices were negatively correlated with CRAM, aromatic and phenolic components. Overall, these findings unequivocally demonstrate that more persistent and chemically recalcitrant DOM components, namely aromatics and CRAM, were more resistant to biodegradation. Moreover, carbohydrate and peptide abundances may be a more important regulator and predictor for DOM biodegradation processes than other components. Lastly our work illustrates that DOC chemical composition and bio-lability/recalcitrance exert a critical control on the biogeochemical dynamics of DOM in water.