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Thermal properties of plant tissues, soil organic matter, and black carbon measured by Differential Scanning Calorimetry: Indicators to rank biochemical stability?

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The resistance of organic matter against microbial decomposition in soil is largely determined by i) biochemical recalcitrance of the input materials and the microbial products, ii) chemical stabilisation by organo-mineral association, and iii) physical protection within soil aggregates. The aim of this study is to test whether the thermal stability of organic materials is linked to their biochemical stability by using Differential Scanning Calorimetry (DSC) in conjunction with spectroscopic and isotopic methods and with measurements of biological activity. Activation energies and 50% burnoff values derived from repeated DSC runs at different heating rates under synthetic air were taken as thermal stability indicators and measured for untreated and HCl-hydrolysed mineral soil samples, black carbon (BC) reference materials, and plant tissue of different stability and degree of decomposition. First results showed, that for HCl-treated soil samples, their lower biochemical availability relative to the untreated soils corresponds to higher 50% burnoff temperatures and higher Ea values. Soils with high shares of charcoal, coal, and pure soot samples had significantly higher 50% burnoff temperatures and Ea values than any of the uncontaminated soil samples. Plant tissues varied widely in DSC parameters, with wood and bark being much more stable than grass tissue (mainly cellulosic), and an increase in thermal stability was observed during composting of the latter. Besides the chemical composition of the material, the degrees of polymerisation and crystallinity appear to be important factors in determining thermal stability. Though there is yet no consistent relationship between thermal and biochemical stability, the results indicate a certain coupling between the two.