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Thermo-chemical characterisation of organic matter in agricultural soils subjected to long-term chemical or organic fertilisation

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Abstract:
Any agricultural practice that increases organic matter (OM) inputs into soils has a positive effect on C stocks, either directly through organic amendments, or indirectly through the stimulation of plant biomass by chemical fertilisation. However, the mechanisms involved are not yet clearly understood, which is why it is important to be able to assess the influence of organic or chemical fertilization on the nature and chemical properties of OM that are linked to their dynamics in soils. In this study, soil samples were collected from Ultuna's experimental fields in Uppsala, Sweden. The plots have been cultivated with cereals since 1956 and have received different types of fertilisation (mineral and/or organic), including bare soil, unfertilised, fertilised with calcium nitrate, amended with straw, straw + calcium nitrate, green manure, manure, peat and sludge. Organic fertilisation is applied every other year (autumn) in the form of 8 tons of fresh OM per hectare. Mineral fertilisation is applied every year (spring) with 80 kg of nitrogen per hectare. A series of analyses were carried out to determine the abundance, genetic and catabolic diversity of the microorganisms (Lerch et al., 2013; Blaud et al., 2015; Changey et al., 2020). In addition, incubations under controlled conditions were carried out to obtain OM mineralisation kinetics. These data suggest strong changes in microbial communities, both structurally and functionally. These were related to soil pH and changes in OM quality. Rock-Eval® thermal analysis revealed that treatments that had increased the most the C content over the last 50 years (peat, sludge or manure) were related to soil OM with the highest hydrogen index (HI). Mid-infrared spectrometry (MIRS) and solid-state nuclear magnetic resonance (^{13}C-NMR) analyses also suggest that the chemical quality of OM influences its decomposition by microbial communities. GC-MS pyrolysis allowed to estimate the relative contribution of the different families of molecules as a function of the treatments. Here, we observed that the biogeochemical stability of soil OM was related to higher proportion of lipids and aromatic compounds.