Organic matter of Haplic Chernozem under contrast land use: chemical vs physical fractions (^{13}C CP/MAS NMR comparative study)

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Despite a flood of reports on the use of modern high-resolution methods to investigate soil organic matter (OM) nearly in situ, various chemical and physical fractionations (and their combinations) coupled with physico-chemical methods of analysis remain the most common. Fractionation makes it possible to isolate more homogeneous preparations by their solubility in acids and alkalis (the classic version of humic substances analysis), or by density, or by density and particle size both, i.e. by degree of association with soil minerals (densitometric and granulodensitometric methods). The parallel use of these two approaches to the same soils provides complementary data, but such studies are scarce. Here we aimed to investigate the relationship between the distributions of OM components in chemical and physical fractions by comparing the contributions to the soil TOC, hydrolyzability and structural features of humic acids (HA), humin, and fraction "acid soluble OM + fulvic acids (FA)", separated by alkaline extraction with the same characteristics of the OM of granulodensitometric fractions: light fraction occluded inside the aggregates (LF_{occ}), clay (Clay) and residue after separation of light fraction and clay (Res). Haplic Chernozem of two contrasting land use were chosen for the study: steppe and long-term permanent bare fallow. The variants are characterized by maximum differences in C content. Due to the territorial proximity and high spatial homogeneity of the Chernozem of the study area, the virgin soil can be considered as the initial/native soil condition for the fallow one. The study of long-term bare fallow allows the properties of the stable OM prevailing in it to be investigated and the direction of degradation changes in the OM structure (transformation of mature OM) to be identified separating them from the transformation processes of fresh and/or intermediate OM. The results of the study revealed that for the virgin soil the proximity of the OM structure of the following pairs of fractions is observed: HA - LF_{occ}; "acid-soluble fraction + FA" - Clay; humin - Res. For OM of the indicated pairs of chemical and physical fractions, the contributions to C_{org} and C/N ratios are also close. For the fallow soil sample the structural composition of OM of the above chemical and physical fractions is also close, but their contributions to C_{org} and C/N value are notably different. A comparison of C content of the chemical fractions of the two studied soils showed that all fractions are lost during soil degradation, but the greatest losses are observed for humin. At the same time LF_{occ} is most wasted among the granulodensitometric fractions. Thus, there is a preferential association of the chemical fractions in concern with the corresponding granulodensitometric ones in undisturbed steppe soil, whereas in degraded soil of long term bare fallow, whose OM is distinctively more hydrophobic and aromatic, this distribution is disturbed.