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Extraction in alkali without nitrogen significantly alters physico-chemical properties of humic acids from compost

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Humic acids (HA) are formed during biotransformation of organic residues in the diversity of the environments and represent polydisperse and heterogeneous compounds enriched in polar functional groups. Alkaline extraction with subsequent acidification is traditional way to obtain HA preparations from soils and sediments. However, alkaline treatment is criticized for the possibility of creating artifacts, such as oxidation of phenolic constituents, hydrolysis of ester groups, etc. International Humic Substances Society has recommended to perform alkaline extraction under the atmosphere of inert gas (e.g. nitrogen). However, extraction under N_2 is rarely used in humus chemistry and is ignored when HA are obtained for commercial purposes. Compost is one of the sources of commercial HA. It represents relatively fresh organic material if compare with peat, coal and soil humus. The aim of this work was to study the physico-chemical properties of HA from compost extracted by 0.1 M NaOH in absence or presence of oxygen.

Compost prepared from leaves and grass with the time of composting of about 10 years was used as a source of the HA. Compost material was air dried and passed through 2 mm sieve. Extraction of the HA was performed by three consequtive treatments with 0.1 M NaOH (1 hour each) under the N_2 atmosphere (HA-N_2) or without it (HA-O_2). The pH of each extract was adjusted to 7.0, extracts were pooled and purified by membrane filtration (0.22 mm). HA were then obtained by acidification and air-dried.

The infrared spectra of the preparations were identical as well as their molecular weight distributions on Sephadex-G-75 gel. However HA-O_2 was characterized by higher O:C and C:N ratios (0.6 and 13.6 respectively vs 0.5 and 12.5 in HA-N_2), higher optical density at 465 nm ($E^{0.001\%}$ 0.04 vs 0.03 in HA-N_2), higher E4/E6 ratio (5.5 vs 4.7 in HA-N_2), lower contribution of CHn fragments and higher contribution of CHn-O ones (17.3 and 21.2% respectively vs 22.9% and 16.7% in HA-N_2). The content of OC-O(N) (acetale) fragments was also higher in HA-O_2. The content of functional groups titrated in the regions of pH 5-8 and 8-10 were 4 and 2 times higher in the HA-O_2 suggesting an increase in the content of COOH-groups and in the content of OH-groups in this preparation.

Thus, we have shown that alkaline extraction of HA from relatively fresh humic material (compost) significantly alters physico-chemical properties of HA if no N_2 is applied. Most significant changes occur in the functional groups content and in the content of aliphatic O-containing fragments. We hypothesize that changes occur in the functional properties of the HA as well. Alkaline treatment under O_2 may enhance HA complexing and antioxidant capabilities and can be used as targeted modification of the HA preparations. We are testing this hypothesis in our current research.

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