EXAMINATION OF HUMIC SUBSTANCES OF COMPOSTS AND DIFFERENTLY AGED SOIL-CHARCOAL SYSTEMS

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Introduction

The organic residues are transformed in the soil by microbiological activity. During the degradation process the macromolecular compounds are transformed to smaller components, while CO_2 and water are produced. (Stefanovits et al., 1999). The poorly degradable compounds are polymerized, linked to nitrogenous substances, and transformed to macromolecular, dark-colored compounds, ie. humic substances (Németh, 1996).

The ratio of optical densitiy or absorbance of dilute, aqueous HA and FA solutions at 465 and 665 nm (E_4/E_6) are widely used for the characterization of these materials. E_4/E_6 ratio is related to the degree of condensation of the aromatic carbon network, carbon content, and molecular weight of humic substances (Konova, 1966; Schnitzer and Khan, 1972).

The nutrient and toxic element buffering capacity of soils are highly dependent on the organic fraction of soil (Sposito, 1989). The level of OM content in soils can be increased by using composts or pyrolyzed organic materials (biochar). Both materials have high carbon content. The mineralization and transformation of composts in soils are faster (~10 years), while the pyrolyzed organic matter (charcoal, bonechar) are only slightly degrading over a century (Lehman et al., 2009).

The objective of our research was to determine the absorbance ratios at 465 and 665 nm in some high organic content soil improvers (compost, charcoal, bonechar) and in the soils treated with them. From the obtained E_4/E_6 results, we would like to draw conclusions about the quality of the organic matter.

Materials and methods

For our examinations brown forest soils (Gödöllő and Trizs from Hungary), and topsoil of three brown forest soils collected from charcoal burning piles that were used 25, 35, and 80 years ago; compost made of green wastes; bonechar, and charcoal were used (Table 1).

Table 1. Parameters of the samples used in our research

	Soil Gödöllő	Soil Trizs	25-year-old Soil-charcoal	35-year-old Soil-charcoal	80-year-old Soil-charcoal	Compost	Charcoal	Bonechar
pH_{KCl}	5,7	3,9	5,0	4,7	3,9	8,3	8,3	7,6
C (%)*	0,75	4,4	12	10	5,1	20	80	10

*carbon content determined by Loss on ignition method)

The preparation of the samples was carried out in two steps: **1.** Karbonátok kioldása HCl-al. **2.** The organic matter extraction using 0.5 mol/dm^3 NaOH solution. The absorbance of the solutions were measured 465 and 665 nm (Konova 1966, Chen 1977). The measurements were carried out by Jenway 6405 UV/Vis Spectrophotometer. The analyses were carried out on three replicates and the results were statistically tested. (Sváb, 1981, Szabó et al., 2013).

Results and discussion

The charcoal and the bonechar do not have significant amount of acidic humus substances ellentétben a 2. ábrán látottakkal. The colour of the NaOH extractions were almost colourless. The E4/E6 ratio could not be evaluated since their absorbance on these two wavelength (465, 665 nm) was nearly zero. This is understandable, since during the pyrolysis of the wood, the small-sized organic molecules disappear in a gaseous form, and the chemical structure of the remaining carbonated material is basically a large molecule, consisting of condensed, aromatic rings. Its molecular structure is nonpolar, it contains only a few functional groups and it does not have acidic character.

In case of the bone char, the high phosphate content of the bone forms calcium phosphate due to pyrolysis, which is only soluble in acids.

The E4/E6 ratio was 4,93 for charcoal, and 1,40 for bonechar, which, however, cannot be due to the organic substances present.

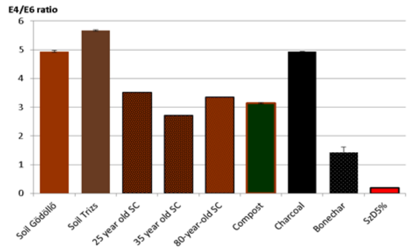

Figure 1. E_4/E_6 values

The colour of the other NaOH extracted samples was brown, which means that all samples contained some acidic humus material. The E_4/E_6 values of all the samples were below 6, which indicate the presence of humic acids. Since the extraction was carried out by 0,5 M NaOH solution, we do not have to consider great pH-dependence of the E_4/E_6 ratios of the fulvic acids (Chen et al., 1977). The E_4/E_6 ratio of the brown forest soils (Gödöllő, Trizs) were 4,94 and 5,67, respectively, which indicate high amount of fulvic acid compared to the soils treated with charcoal and compost. The humus substances with complicated structure and lower E_4/E_6 values formed in composts (E_4/E_6 = 3,14) and in soil-charcoal system with different ages (E_4/E_6 = 2,71-3,51) can be due to the intensive microbial activity.

The lowest E_4/E_6 value was in case of the 35 year-old soil-charcoal system ($E_4/E_{6(35yr)}$ = 2,71), which might be due to the fact that humification process was the most intensive and the most progressed.

Conclusions

The E4/E6 ratio of the organic substances, which were formed under different circumstances, differed significantly. The forest soil samples had higher (4,97-5,67) E4/E6 ratios, while the soil-charcoal systems and the composts (2,71-3,51) had lower E4/E6 ratios. This can be explained by the intensive biological activity. In case of the soil-charcoal systems, the charcoal provides an excellent habitat for the microorganisms, since it has high surface area, high nutrient and water holding capacity. In case of the composts, the large-scale controlled processes of composting provide optimal circumstances for the decomposition and transformation processes of the organic matter. Among the examined samples, the 35 year-old soil-charcoal system had the lowest E4/E6 ratio, from which we concluded that the humification processes were the most intensive and progressed in this sample.

The charcoal and the bonechar do not have significant amount of acidic humus substances, the E4/E6 ratio could not be evaluated since their absorbance on these two wavelength (465, 665 nm) was nearly zero.

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