

## The biological activity of native and modified humic acids

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Chemical modification with the aim of changing the composition of humic acids (HA) and introducing new functional groups into their structure is a promising direction for improving and obtaining the necessary properties of humic substances. The greatest attention is drawn to their biological activity, which is associated with the ability of HA to participate in redox reactions in a plant cell, depending on the content of various structural groups (quinoid, phenolic), the degree of aromaticity, and the ratio of hydrophilic and hydrophobic fragments [1,2].

The purpose of the study is to evaluate the biological activity of native and modified humic acids isolated from brown coal of the Tisulsky deposit of the Kansk-Achinsk basin (TC) and its naturally oxidized form (TCO). The humic acids were modified with hydrogen peroxide and n-butanol. The change in the functional and structural composition during the modification was studied using EPR, <sup>13</sup>C NMR CPMAS.

Tests were conducted to determine the biological activity of HA in the form of sodium humates (0.005% aqueous solutions) obtained from native and modified humic acids using "Iren" wheat seeds. Biological activity was evaluated by three test functions - seed germination energy (GE), root length (RL), seedling height (SH) and the phytoactivity index (FI) was calculated, which reflects the deviation of the test function from the control (seed germination in water) .

Initial HA showed bioactivity in relation to wheat seeds. FI humic acids TC exceeded the control experience by 12%, series TCO by 20%. There is a tendency for indicators of all test functions to exceed control. For example: SH excess by 17% (HA TC) and 33% (HA TCO). When using HA modified with hydrogen peroxide of various concentrations, the dependence of the FI on the concentration of paramagnetic centers (PMC) in humic acids was found. Modification with hydrogen peroxide leads to a decrease in the content of PMC and a decrease in the biological activity of HA. When using HA modified by n-butanol alkylation, FI was 1.14 and 1.24; SH exceeded control by 29 and 37% for TC group and TCO group respectively. Humic preparations obtained from modified by n-butanol alkylation of HA can be considered promising for subsequent tests in field experiments.

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### References

1. Kuharenko T.A. // SFC. 1976. 2:24–31.
2. Dobbs L.V. et al. // J. of Agric. Food Chem. 2010. 58(6): 3681–3688.