

The effect of HA preparations of different soils on the physiological processes of the *Chlorella vulgaris* algae

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Physiological activity is one of the important environmental functions of humic acids (HA). We are studying the physiological effect of HA preparations on the unicellular green alga *Chlorella vulgaris*. To assess the effect of HA preparations on algae, indicators such as photosynthesis, respiration, cell numbers and sizes were used.

The structural and functional properties of HAs isolated from contrasting soils vary greatly. This is due to the specific bio-hydrothermal conditions of humification, which determines the molecular structure of the preparations. The content of aromatic structures in HA molecules was determined by ¹³C-NMR. The content of free radicals was evaluated by method ESR.

The study of the rate of photosynthesis and respiration of *Chlorella vulgaris* was carried out by the oxygen content in the light and in the dark. The duration of the interaction of algae cells with HA ranged from 1 to 5 days. The size and abundance of the algal cell culture were estimated by direct counting under a microscope using a computer program for analyzing graphic images (in Python), as well as a Shimadzu SALD-2201 laser diffractometer.

During the research, it was found that HA preparations favorably affect the physiological processes of the culture of the alga *Chlorella vulgaris*. In the range of concentrations from 0.001 to 0.007%, HA concentrations of up to 0.003% are optimal. At HA concentrations of more than 0.003%, a negative effect of HA is observed for all preparations: photosynthesis decreases in *Chlorella vulgaris* cells and destructive processes increase sharply, causing an increase in oxygen consumption.

The positive effect of the aromaticity of the preparations and the concentration of free radicals of chernozem HA on the acceleration of photosynthesis of *Chlorella vulgaris* was shown. HA of sod-podzolic soils with low aromaticity and low content of free radicals stimulate mainly the processes of reproduction.

As a result of the studies, a tendency of a positive effect of aromaticity and concentration of free radicals of HA preparations on the acceleration of photosynthesis of *Chlorella vulgaris* was noted. On the contrary, the stimulation of the processes of the *Chlorella vulgaris* culture reproduction can be associated with a low concentration of free radicals and a small fraction of aromatic fragments in the HA molecules.

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