INFLUENCE OF GOLD AND SILVER NANOPARTICLES ON THE SYNTHESIS OF PHYCOBILIPROTEINS IN RED MICROALGA *PORPHYRIDIUM CRUENTUM*

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The biological properties of nanoparticles are determined by their size, shape, and surface characteristics. The study of the effect of nanoparticles on microalgae as biotechnological objects is one of the topical areas of modern research. Similar to the action of complex chemical compounds, the stimulating nature of the action of nanoparticles is based on reversible oxidative stress caused by the mechanisms of adaptation of a microalgae culture to cultivation conditions. Phycobiliprotein pigments, as the major light-harvesting pigments of red microalga *Porphyridium cruentum*, are involved in the cellular response to the presence of nanoparticles in the cultivation medium.

The influence of 10 and 20 nm citrate-stabilized gold and silver nanoparticles on the synthesis of phycobiliproteins in red alga *P. cruentum* was determined. Nanoparticles were added to the culture medium from the first day of the life cycle. At the end of the experiments, an increase in the content of phycobiliproteins in the biomass was determined due to the cellular response of microalgae, which manifested itself depending on the size of nanoparticles and their concentration.

AgNP(Citrate) 10 nm in size showed a strong direct correlation (r=0.855) between the concentration of nanoparticles in the cultivation medium and the content of phycobiliproteins in microalgal biomass. Thus, concentrations of 0.025, 0.05 and 0.25 μM stimulated the accumulation of phycobiliproteins in *P. cruentum* biomass by 18-29%. In the case of a concentration of 0.5 μM AgNPs, an increase in phycobiliproteins in algal biomass by almost 64% was estimated compared to the control, reaching a level of the content of these biologically active compounds in porphyridium biomass of 21%.

A similar effect was recorded for AuNP(Citrate) 10 nm in size. Concentrations of 0.05-0.1 μM of these nanoparticles increased the content of phycobiliproteins in porphyridium biomass by 26 - 28%. In this case, a strong direct correlation was also established between the concentration of nanoparticles and the values of phycobiliproteins, Pearson's correlation coefficient was r=0.812.

A response to stimulate phycobiliprotein synthesis was also established for AuNP(Citrate) and AgNP(Citrate) with a size of 20 nm, in this case showing dose-dependent reverse effects. In the case of application of 20 nm AgNP(Citrate) nanoparticles, stimulating concentrations ranged from 0.001 to 0.25 μM with an increase in the content of phycobiliproteins in biomass by 26-49%. The concentration of 0.5 μM AgNPs slightly enhanced phycobiliproteins in algal biomass. The correlation between the concentration of 20 nm AgNP(Citrate) nanoparticles in the culture medium and the content of phycobiliproteins in porphyridium biomass in this case revealed a moderately negative predictive relationship (r=-0.573).

For AuNP(Citrate) of 20 nm in diameter, a strong negative correlation (r=-0.719) was found between the concentration of nanoparticles in the culture medium and the content of phycobiliproteins in porphyridium biomass. It should be noted that at concentrations of AuNP(Citrate) of 20 nm in size in the range of 0.0025-0.02 nM, the increase in the content of phycobiliproteins in porphyridium biomass was 42 - 48% compared to control sample.

Thus, the stimulating effect of citrate-stabilized gold and silver nanoparticles in the tested sizes and within the selected concentrations was the result of their involvement in the biosynthetic activity of algae cells and depended on the nanoparticle size and concentration. The type of nanoparticles is a little determining factor for the synthesis and, accordingly, the accumulation of phycobiliproteins, which changed as a result of the response of microalgae cells to stress induced by the composition of the cultivation medium.

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