

The Effect of silver nanoparticles synthesized by macroalga *Cystoseira indica* on selected immune parameters of common carp (*Cyprinus carpio*)

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Abstract

The application of silver nanoparticles (AgNPs) in aquaculture has received considerable attention in the recent years due to their antimicrobial, antifungal, and antiviral properties, as well as their potential to modulate the immune system of aquatic organisms. Although biologically synthesized nanoparticles are considered environmentally friendly due to the use of natural compounds in their production, it is essential to evaluate their potential effects on aquatic organisms. This study aimed to investigate the impact of silver nanoparticles (AgNPs) biosynthesized by the macroalga *Cystoseira indica* on the immune parameters of common carp (*Cyprinus carpio*). The fish were exposed in the laboratory for 14 days to three sublethal concentrations of AgNPs corresponding to 10%, 25%, and 50% of the LC₅₀. Immune indices including lysozyme activity, complement activity, respiratory burst, peroxidase activity, white blood cell count, total protein, and immunoglobulin levels were assessed on days 1, 3, 7, and 14. Transmission electron microscopy revealed that the synthesized nanoparticles were spherical with an average size of 42.31 nm. The results indicated that, compared to the control group, exposure to 25% LC₅₀ significantly increased lysozyme activity but decreased complement, respiratory burst, and peroxidase activities on day 14. Additionally, the lysozyme activity significantly reduced in the fish exposed to 50% LC₅₀ on day 14. White blood cell counts increased significantly at all exposure concentrations relative to. Although total protein and immunoglobulin levels exhibited some fluctuations, no significant differences were observed compared to the control group. The findings indicated that only 25% LC₅₀ concentration of silver nanoparticles had a measurable effect on the immune indices of common carp, whereas other concentrations produced no significant alterations, and therefore no clear concentration-dependent trend was detected.

Key words: Silver nanoparticles, *Cystoseira indica*, Immune index, Common carp

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