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Effects of Herbicide Exposure on the Gills of Common Carp (Cyprinus carpio)

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Abstract

Agriculture is a vital part of Kazakhstan's economy, playing a crucial role in meeting domestic food needs and stimulating export growth. However, the intensive use of modern chemical methods for weed control raises serious concerns about environmental and public health. This issue is especially pressing as Kazakhstan's water resources, which are essential for drinking water, biodiversity, and economic activity, are increasingly threatened by agricultural runoff that pollutes water bodies and adversely affects aquatic flora and fauna. The response of living organisms allows us to assess the anthropogenic impact on the environment in biologically meaningful terms. To assess the impact of herbicides on living organisms, bioindication methods are used, based on the reaction of living organisms (bioindicators), which allows us to assess the anthropogenic impact on the environment in terms of indicators that have biological meaning. At the level of organisms and ecosystems, the impact of stress factors is discernible only through the appearance of external symptoms of damage. Studying aquatic organisms in polluted water areas helps to identify and determine the types of harmful and toxic substances, so that all possible measures can be taken to eliminate their source. This is crucial not only because such pollution significantly deteriorates the flora and fauna of the water body, but also because it has a direct negative impact on the health of the local population. The aim of this study is to assess the impact of herbicides on the health of common carp (Cyprinus carpio) using a model experiment that evaluates histopathological changes in the gills. The object of the study was the common carp (Cyprinus carpio) one-year-old common carp who were acclimated in the laboratory and then exposed to Roundup solution at concentrations of 100 mg/L and 150 mg/L of glyphosate (with the toxic dose starting at 50 mg/L). The experiment was conducted over 48 hours, in triplicate, with two groups of 5 fish each. A third group, also consisting of 5 fish, served as a control. Histopathological examinations were carried out after the series of experiments. Gill samples were collected, fixed in a 10% formalin solution, and subjected to standard histological processing. The results revealed significant histopathological changes in the gills. In the first group, at a concentration of 100 mg/L of glyphosate, toxic effects resulted in the fusion of gill plates, epithelial hypertrophy, and cartilage edema, along with the adhesion of the respiratory epithelium of the gill lamellae, edema, and the accumulation of inflammatory infiltrates. At a concentration of 150 mg/L of glyphosate, acute exposure caused more severe damage, including epithelial necrosis and the destruction of secondary gill lamellae. These results highlight the potential risks associated with glyphosate-based herbicides, emphasizing the need for stricter regulations, the adoption of safer agricultural practices, and the development of water treatment technologies to protect aquatic ecosystems. The presence of these histopathological changes in the vital organs of fish serves as an early warning sign of ecotoxicological threats, underscoring the importance of continuous monitoring and protection of water resources in Kazakhstan.

Keywords: pollution, herbicide, histology, toxicology, Common Carp (*Cyprinus carpio*)