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PAPER

THE MAIN ION SATURATION OF WATER IN FISHERY PONDS AND THEIR INTERRELATIONSHIP

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Abstract

This study is aimed at investigating the chemical composition of water in fishery reservoirs, particularly focusing on the concentration of major ions and their interrelationships. Water quality in fishery ponds is a crucial factor determining the survival, growth, and reproduction of fish. The chemical composition of water, especially the presence of major ions such as chloride (Cl^-), sodium (Na^+), potassium (K^+), magnesium (Mg^{2+}), and calcium (Ca^{2+}), plays a key role in maintaining the stability of the aquatic environment. These ions are integral components of dissolved mineral salts and contribute to the overall mineralization level of water.

Key words: fisheries, lake, potassium, soil, natural and artificial water, groundwater.

Introduction

At present, the rational use of water resources and the protection of aquatic ecosystems have become one of the major global environmental challenges. In particular, the ecological condition of water in fishery farms directly affects the growth, development, and productivity of fish. Therefore, studying the hydrochemical characteristics of fishery water bodies and scientifically analyzing their interrelationships is of great importance.

In recent years, significant efforts have been made to improve the management system of the fisheries sector, ensure the efficient use of natural and artificial water bodies, introduce scientifically grounded methods and intensive technologies for fish farming, and increase production volumes through innovative approaches. A number of legislative acts have been adopted to regulate the sector, and measures are being taken to ensure their effective implementation [1,2].

This study focuses on analyzing the chemical composition of water in fishery reservoirs, particularly the concentration of major ions and their ratios. Water quality in fishery ponds is a determining factor for fish survival, growth, and reproduction. The chemical composition of water, especially major ions such as chloride (Cl^-),

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sodium (Na^+), potassium (K^+), magnesium (Mg^{2+}), and calcium (Ca^{2+}), defines the stability of the aquatic environment. These ions form part of dissolved mineral salts and determine the overall mineralization level of water.

The saturation of water with major ions is influenced by various factors, including surface and groundwater inflows, the mineral composition of soils and rocks, atmospheric precipitation, and biological processes. The concentration and balance of these ions determine the hydrochemical characteristics of water, including hardness, electrical conductivity, and biological productivity [3].

The proportional balance of major ions in fishery water bodies is of particular importance, as it ensures ecological stability and directly affects the physiological processes of fish. Therefore, regular monitoring and analysis of the ionic composition of water in fishery ponds are essential for maintaining water quality, enhancing fish productivity, and ensuring the stability of aquatic ecosystems.

The saturation of water with major ions and their interrelationships in fishery ponds represent key factors determining the chemical stability of the aquatic environment. The presence of ions such as chloride (Cl^-), sodium (Na^+), potassium (K^+), magnesium (Mg^{2+}), and calcium (Ca^{2+}) shapes the level of mineralization, hardness, and overall hydrochemical properties of water.

The concentration and balance of these ions create favorable conditions for fish survival, growth, and reproduction. Any imbalance in ionic composition may negatively affect the chemical properties of water, biological processes, and the vital activity of fish organisms.

Therefore, continuous monitoring of the ionic composition of water, maintaining the balance of major ions, and controlling hydrochemical parameters in fishery ponds are of critical importance. This contributes to ensuring the stability of aquatic ecosystems, increasing fish productivity, and improving the overall efficiency of fishery management systems.

Literature Review

The studies were carried out using generally accepted hydrochemical, photometric, titrimetric, potentiometric, and colorimetric methods, as well as standards for water color and quality assessment [4,5,6]. In particular, water hardness, namely calcium content in the studied artificial lakes, was determined by the conventional method [4] through titration using Trilon B solution. Chromogenic black indicator and fluorexon indicators were applied, and the evaluation was based on the color transition from red-violet to blue [5,6]. In addition, bicarbonates were determined using generally accepted hydrochemical methods [7]. In particular, chloride content was determined by argentometric titration using silver nitrate, nitrate ions were determined using Griess reagent, and sulfate ions were determined using a mixed reagent consisting of barium chloride and ethyl alcohol solution of glycol. The samples were treated with hydrochloric acid to remove impurities and neutralize the medium (hydrocarbonate and carbonate ions) [6].

The mechanical (granulometric) composition of soil was evaluated based on the classification of mechanical elements proposed by N.A. Kachinskiy [8,9]. The mineralization level of groundwater (seepage water) was studied using the classification developed by V.A. Priklonskiy and improved by O.K. Komilov and A.U. Axmedov [10,11]. The level of soil salinity was determined according to the classification proposed by Komilov and Axmedov [11].

Research Methodology

The studies were carried out using generally accepted hydrochemical, photometric, titrimetric, potentiometric, and colorimetric methods, as well as standards for water color and quality assessment [4,5,6].

Analysis and Results

According to scientific data, electrolytes play an important role in the life of hydrobionts actively developing and permanently living in aquatic environments. Therefore, it is advisable to study osmoregulation in aquatic environments and its influence on fish productivity, as well as its relationship with natural food sources of fish. In particular, sodium and chloride electrolytes play an important role in preventing excessive accumulation of water in fish cells and ensuring the balance between input and output values.

Also, potassium ions, together with sodium, play an important role in regulating fish muscle systems and nerve impulses, and serve as an important factor in sensitivity to environmental variability, external influences, and adaptation.

The balanced presence of calcium and magnesium ions in the aquatic environment is an important factor in determining the overall hardness of water. In addition, the sufficient presence of calcium in water prevents excessive loss of beneficial salts from fish organisms and increases their resistance to stress conditions. At the same time, the normal level of magnesium in water ensures the stable presence, moderate growth, and development of zooplankton and phytoplankton, which serve as the main natural food sources for fish. In particular, the optimal level of magnesium in water stimulates the photosynthesis process of microalgae and plays an important role in enriching water with oxygen.

However, the proportional balance of these ions is extremely important, as any imbalance may lead to ionic stress in the aquatic environment. In particular, an increase in potassium ions negatively affects the absorption of sodium ions. Therefore, studying the composition of mineral substances in water and identifying the patterns of their interrelationships is of great scientific and practical importance.

For this reason, during the study, the processes of annual mineralization of newly established lakes with major electrolytes were investigated. In particular, the level of saturation of lake water with chloride (Cl^-) ions was studied (Figure 1).

When analyzing the obtained results, it was found that in lakes No. 3 (4617 mg/L), No. 9 (4680 mg/L), No. 11 (4540 mg/L), and No. 20 (5555 mg/L), the level of saturation with chloride ions exceeded the standard scale several times (Figure 1a). In particular, chloride ions exceeded the standard level by 1.54 times in lake No. 3, 1.56 times in lake No. 9, 1.51 times in lake No. 11, and 1.85 times in lake No. 20.

Also, in lakes No. 8 and No. 7, the average annual chloride ion saturation ranged from 2550 mg/L to 2773 mg/L, and these lakes were identified as being on the verge of entering a hazardous zone according to the standard scale. Therefore, it is advisable to pay attention to wastewater inflow sources and prevent mineralization in these lakes.

Since these lakes receive wastewater from the same drainage source, their results differ from other lakes. At the same time, a very low level of chloride ion saturation was recorded in lake No. 10 (111.8 mg/L), which indicates a disturbance in the ion balance of the aquatic environment. According to the obtained results, the disturbance of ionization levels in lakes No. 3, No. 9, No. 11, and No. 20 may be related to their greater depth and proximity to groundwater.

In order to comprehensively analyze the obtained results, the chlorination indicators of the lakes were examined. It is well known that in artificial lakes, chlorination is carried out to maintain the balance of microalgae and cyanobacteria, thereby reducing oxygen consumption and ensuring the normal functioning of physiological and biochemical processes in fish.

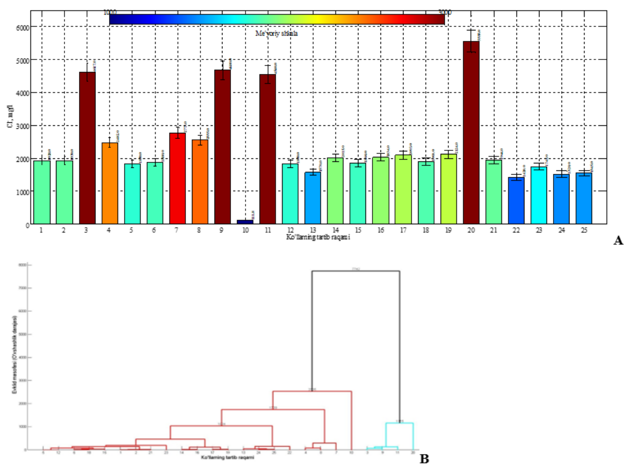

Figure 1. Contamination level of artificial lakes with chloride ions (Cl^-) (A) and clustering of the aquatic environment based on Cl^- concentration (B)

Based on the above data, the study was continued under the assumption that artificial mineralization sources may also be associated with irregular chlorination practices, carried out without considering the hydrochemical properties of water, and instead relying solely on the visual change of water color (greening) as an indicator.

Conclusion

During the analysis of the results, it was found that the chlorination indicators of the studied 25 lakes were generally within the standard range; however, in some lakes, significant deviations beyond the permissible limits were observed (Figure 1- a,b).

In particular, chloride salinization was recorded in lakes No. 3, No. 9, No. 11, and No. 20, while the aquatic environments of lakes No. 1, No. 2, No. 4, No. 7, and No. 8 were characterized by moderate sulfate-chloride salinity.

However, lake No. 10, which showed values significantly below the standard range, was characterized by the highest sulfate content and the lowest level of chloride contamination. Therefore, this lake should be classified as a sulfate-type salinity system.

Accordingly, lake No. 10 can be defined as a specifically (distinctively) saline lake, lake No. 20 as highly chloride-saline, and lakes No. 3, No. 9, and No. 11 as strongly chloride-sulfate saline water bodies. The results also indicate that the overall hydrochemical composition of the studied lakes is shifting from a hydrocarbonate type toward chloride and sulfate types. Moreover, the simultaneous increase in chloride and nitrate concentrations suggests the presence of additional pollution sources beyond the primary water supply.

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