THE MONITORING ENVIRONMENTAL CONDITIONS AND THE HEALTH STATUS OF FISH MATERIAL IN A FISH FARMING – BRĂILA COUNTY

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Abstract

This study aims to analyze the environmental conditions and the health status of the fish material from the fishery arrangement, located in Brăila County. The study was conducted from April 2023 to March 2024 and included measurements of the physico-chemical characteristics of the water, such as temperature, pH, dissolved oxygen, and nutrient concentrations, including nitrogen and phosphorus. The examination of the fish pathology of carp revealed specific lesions of erythrodermata, pale gills, and the presence of myxospordia in one of the examined fish. This research highlights the importance of continuous monitoring of environmental conditions and the health of fish to prevent potential ecological and economic associated with fishery practices. Regardless of the quantitative structure and seasonal diversity, their low values indicate a reduced food source for the fish in this aquatic ecosystem.

Key words: *water quality, environmental conditions, fish health*

INTRODUCTION

In aquaculture, water quality, the availability of natural food or formulated feed, and the physiological condition of fish constitute the three fundamental components of production technologies. Optimal performance in aquaculture systems is achieved by maintaining an equilibrium between environmental parameters, feed quality and input levels, and the biomass structure and health status of the cultured stock.

Water quality management aims to ensure a stress-free environment that meets the physical, chemical, and biological requirements necessary for maintaining fish health and achieving high production efficiency [1-5].

The objective of the present study was to monitor water quality, evaluate the sanitary condition of the cultured stock, and assess the natural productivity of a fish farming facility located in Brăila County, Romania.

The species and age composition of the ichthyofauna was as follows: 5% *Silurus glanis* (European catfish), 5% other predatory fish species, 30% *Carassius gibelio* (Prussian carp), 40% *Cyprinus carpio* (common carp) of various age classes, and 20% phytophagous species.

MATERIAL AND METHOD

Between March 2023 and March 2024, samples were collected from the facility. Three sampling stations were established to ensure representative coverage: Northeastern, Central, and Southern station. Water samples for physico-chemical analysis and hydrobiological samples to

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determine natural productivity were collected monthly, while sediment samples were collected quarterly. Fish health was monitored through ichthyopathological examinations, with three *Cyprinus carpio* specimens analyzed in May.

Water sample analyses were conducted following the protocols outlined in the current standardized methods for surface water analysis, as well as methods described in specialized literature [6-11].

Dissolved oxygen was determined using an oxygen meter or the Winkler method, based on the oxidation of divalent manganese hydroxide to trivalent manganese hydroxide by molecular oxygen in a strongly alkaline medium, with results expressed in mg/L. Water pH was measured using a digital pH meter.

Organic matter content was assessed volumetrically (redox) by the chemical oxygen demand (COD) method using potassium permanganate ($KMnO_4$), with results expressed in mg $KMnO_4$ per liter of water.

Chlorides (Cl^-) were determined volumetrically by precipitation, with results expressed in mg/L.

Nitrates (NO_3^-) were quantified spectrophotometrically, and nitrites (NO_2^-) were assessed photocolorimetrically, both expressed in mg/L.

Free ammonia (NH_3) was measured photocolorimetrically using the Nessler method, taking into account the initial pH, with results expressed in mg/L.

Ammonium ions (NH_4^+) were determined colorimetrically by the Nessler method, with results expressed in mg NH_4^+/L.

Alkalinity was assessed volumetrically through neutralization reactions using HCl as the titrant in the presence of phenolphthalein, with results expressed in mg/L.

Sediment samples were partially processed to obtain an aqueous extract (soil-to-solvent ratio of 1:10), which was then analyzed using current chemical analysis methods as well as procedures described in the specialized literature to determine the main parameters relevant for chemical quality assessment.

The remaining portion of the samples was used to determine moisture content as a percentage by oven drying, while humic substances, hydrolytic acidity, and exchangeable acidity were measured on air-dried, ground, and sieved soil [12-15].

The sanitary status of the fish stock was evaluated through macroscopic examination, which serves as a preliminary diagnostic tool. The body surface, eyes, gills, and internal cavity were inspected with the naked eye or using a magnifying lens.

This examination allowed the identification of altered areas, including necrosis, cysts, hypo- or hypersecretion of mucus, hypertrophy or atrophy of organs, changes in coloration, and the presence of macroscopic parasites [16-18].

Microscopic examination of the fish material provides diagnostic value. Samples were collected directly from live fish and consisted of: Scrapes, both superficial and deep, from the examined area, usually gills, skin, or intestinal mucosa. The scrape was placed on a microscope slide, a drop of distilled water was added, and a coverslip was applied, with immediate observation under the microscope [19-22].

Squash preparations, which could be performed on any tissue, involved crushing a small portion between slide and coverslip to obtain a thin, translucent layer suitable for microscopic examination. Results were evaluated at the microscopic field level through identification of etiological agents.

The study of hydrobiological and ichthyological parameters involved three main steps: collection of samples, laboratory analysis, and processing of the data obtained from the analyses [23-25].

Qualitative and quantitative analyses of phytoplankton and zooplankton were conducted at the species level using numerical and gravimetric assessments.

For phytoplankton studies, water was collected in 300 mL glass bottles from the surface layer (20 cm). Samples were preserved with Lugol's iodine and sodium acetate (Utermöhl method). Samples were centrifuged for 20 minutes at a moderate speed of 1200 rpm to concentrate the organisms. After sedimentation, the supernatant was removed using a pipette, leaving 1 cm³ of concentrate in the tube. From the well-homogenized concentrate, a 0.03 mL aliquot was taken with a micropipette, placed on a microscope slide, covered with a coverslip, and examined microscopically.

Phytoplankton biomass was calculated by converting the number of individuals per liter into biomass (g/m³), taking into account the total cell volume, representing the mean cell volume of each species.

Total biomass was calculated according to the Utermöhl method. To express the total phytoplankton biomass at each sampling station over the study period, monthly quantitative development data (average biomass per sample in g/m³) and mean monthly cell volume were considered.

For the determination of zooplankton community structure, samples were collected from the surface layer (20 cm) at the previously established stations. After collection, 10 liters of water were concentrated by filtration using a plankton net made of silk mesh No. 25 (mesh size 40–50 µm). The concentrated zooplankton was transferred to 100–150 mL glass bottles. The new concentrate was added to previously collected samples in the same bottle, and the combined sample was preserved with 4% formalin.

In the laboratory, samples were concentrated by slow sedimentation over three weeks, after which the supernatant was removed following the same method without agitating the sample.

Zooplankton from the processed samples was analyzed qualitatively and quantitatively using a stereomicroscope and microscope in Kolkwitz-type cells.

Qualitative identification of the main taxonomic groups—Rotifera, Cladocera, Copepoda—and zooplankton species was performed following [26-27].

Following identification, a faunistic conspectus of the constituent taxa was compiled.

Numerical density was calculated by counting all individuals belonging to each species. The number of individuals for each taxonomic group was then summed, resulting in the total number of individuals in the analyzed sample. Final results were expressed as individuals per liter or cubic meter, taking into account the initial volume of water filtered.

Zooplankton biomass was calculated on a wet weight basis. The number of individuals of each species was multiplied by the corresponding mean individual biomass. Total biomass per taxonomic group was then obtained, followed by total biomass per sample, with results expressed in grams per unit volume.

Benthic samples were collected using a Marinescu II dredge and washed through a sieve with a mesh size smaller than 250 µm per side. The material retained in the sieve after washing was transferred to airtight plastic containers previously fixed with 4–5% formalin. In the laboratory, samples were sorted under a binocular microscope, separating the organisms from the remaining material retained by the sieve. The number of organisms was accurately determined for each species and group.

Biomass was estimated by directly weighing the organisms found in each sampling unit using an analytical balance. Data processing was carried out using standard statistical methods, calculating the arithmetic mean, while population size was expressed in terms of numerical density (number of organisms per m²) and biomass (grams of wet weight per m²).

RESULTS

The interpretation of the results was carried out in accordance with the provisions of the Normative on the Classification of Surface Water Quality for the Assessment of the Ecological Status of Water Bodies (Order MMGA No. 161/2006) and correlated with data from specialized literature for waters intended for fishery use. According to this legislation, surface waters are classified into quality classes as follows: Class I – waters with very good ecological status; Class II – waters with good ecological status; Class III – waters with moderate ecological status; Class IV – waters with poor ecological status; and Class V –waters with very poor ecological status.

Temporal variations of these parameters can be followed in Figures 1–3 for water and Figures 4–6 for sediments, which allow the characterization of the physico-chemical conditions of water and sediments in the fishery basin and highlight the living conditions for aquatic organisms.

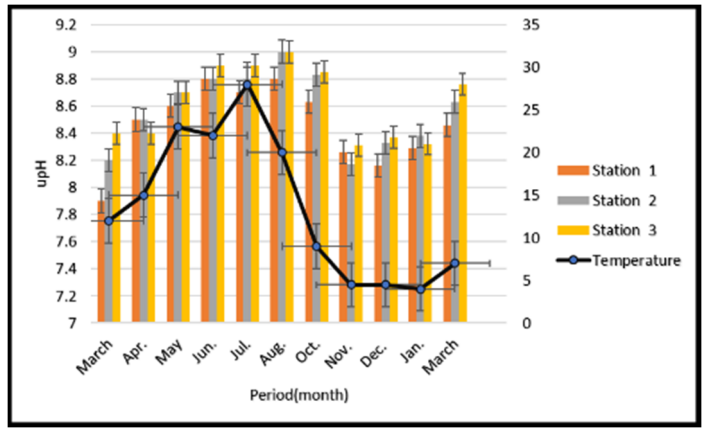


Fig. 1 Evolution of pH and temperature during March 2023 – March 2024 at the fish farm

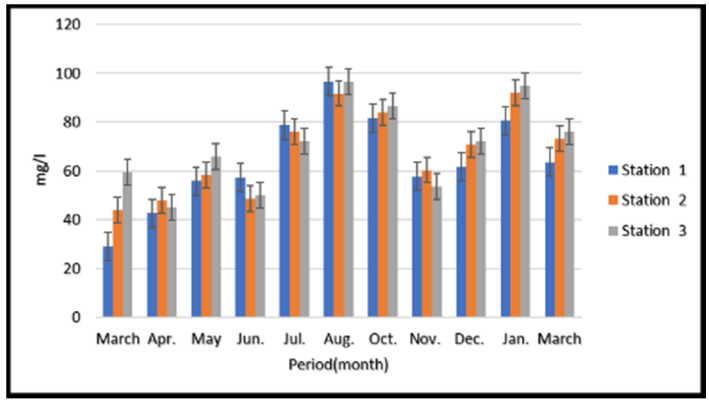


Fig. 2 Evolution of organic matter during March 2006 – March 2007 at the fish farm

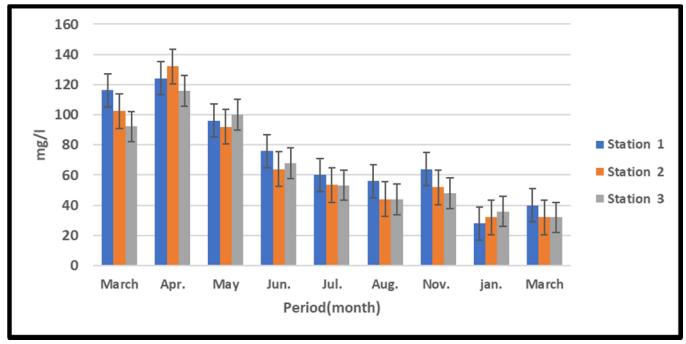


Fig. 3 Evolution of calcium ions concentration in water between March 2023 and March 2024

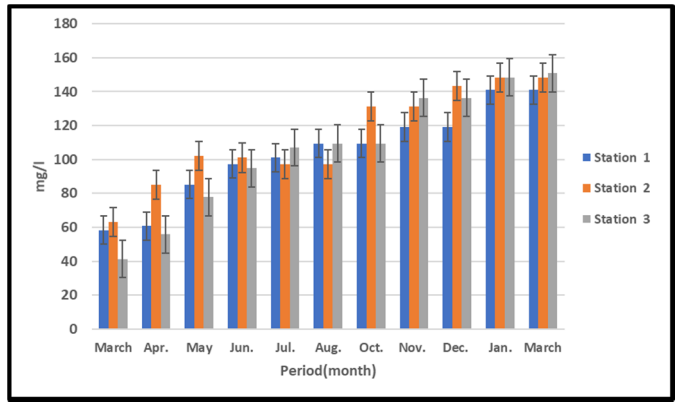


Fig. 4 Evolution of magnesium ions concentration in water between March 2023 and March 2024 at the Fish Farm

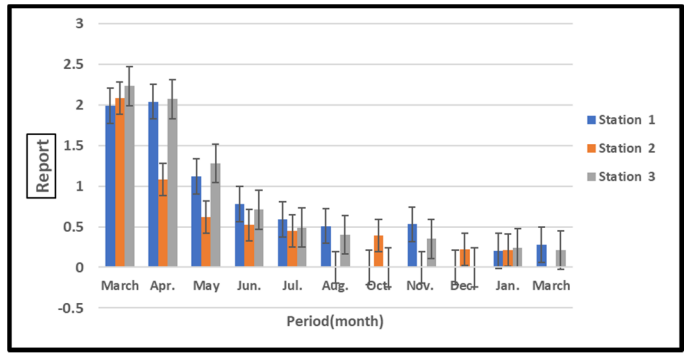
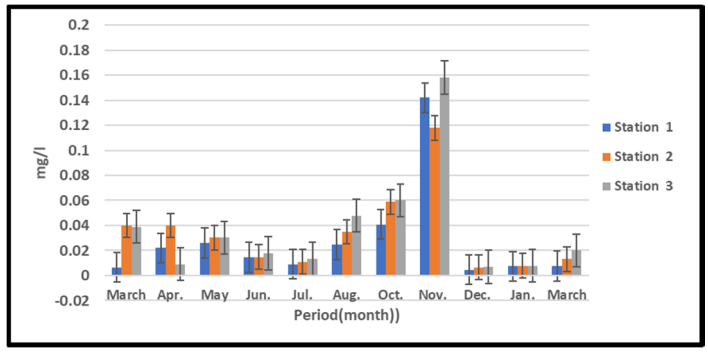


Fig. 5 Evolution of the ratio of calcium and magnesium ions in water between March 2023 and March 2024 at the Fish Farm



Fig, 6 Evolution of ammonia during the period March 2023 – March 2024 at the Fish Farm

The configuration of phytoplankton and zooplankton, as revealed by these investigations, serves to evaluate biomass in the studied ecosystems. Biodiversity within a biocenosis is primarily related to the number of constituent species; the higher the number of species, the greater the diversity. Hydrobiological samples were collected simultaneously with hydrochemical samples from the same stations.

Microscopic analysis of water samples revealed that phytoplankton included representatives of the following algal groups: diatoms, chlorophytes, cyanophytes, euglenophytes, pyrophytes, and chrysophytes. Diatoms predominated at both stations, especially during spring and autumn when water temperatures were low.

Observed species included genera such as *Anabaena*, *Oscillatoria*, *Merismopedia*, *Aphanizomenon* (Cyanophyceae), *Nitzschia*, *Synedra*, *Navicula*, *Melosira*, *Cyclotella*, *Diatoma*, *Stephanodiscus*, *Surirella*, *Amphora* (Bacillariophyceae), *Chlorella*, *Pediastrum*, *Ankistrodesmus*, *Crucigenia*, *Scenedesmus* (Chlorophyceae), *Euglena*, *Phacus*, *Trachelomonas* (Euglenophyceae), *Cryptomonas* (Pyrophyceae), and *Mallomonas* (Cryptophyceae) (Figures 7–10).

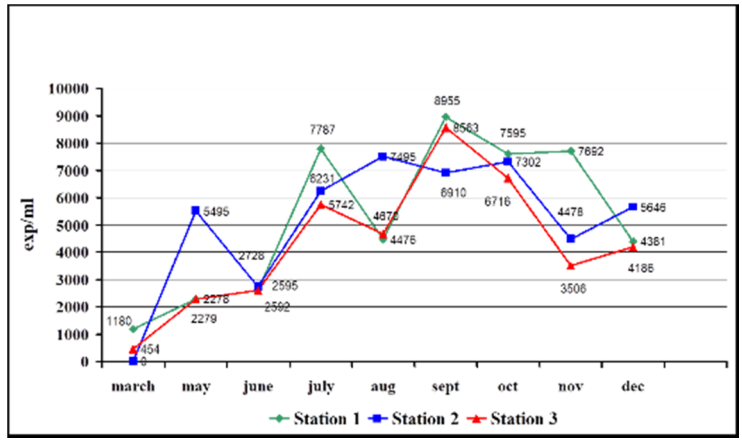


Fig. 7 Quantitative variation of phytoplankton in 2023

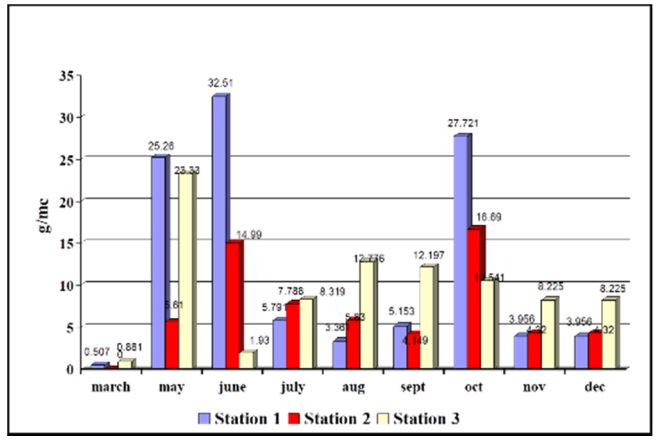


Fig. 8 Biomass of phytoplankton organisms in 2023

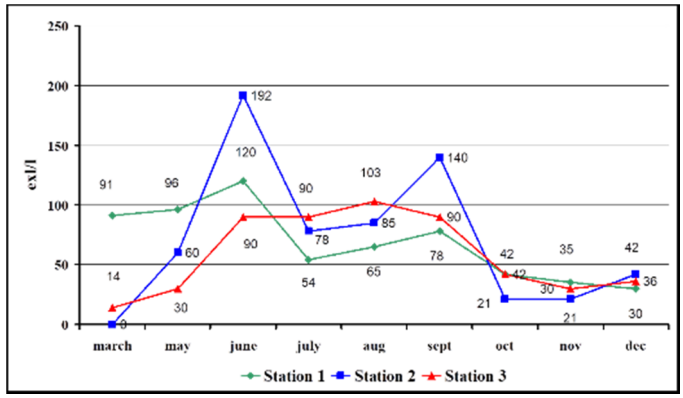


Fig. 9 Quantitative variation of zoooplankton in 2023

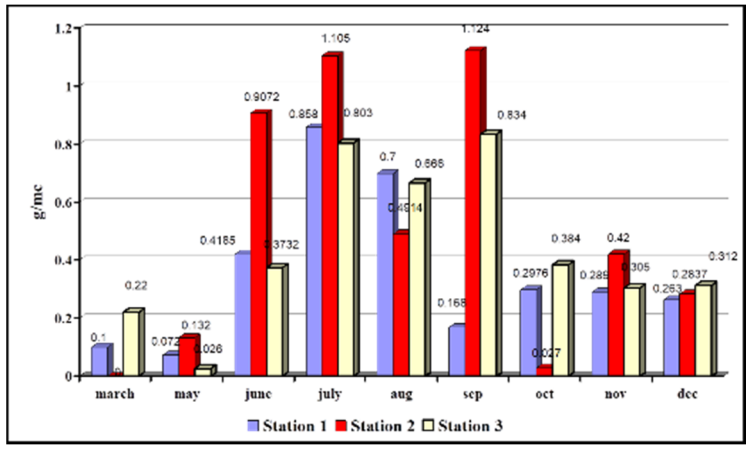


Fig. 10 Biomass of zoooplankton organisms in 2023

DISCUSSIONS

pH represents the concentration of hydrogen ions in water, which determines its acidic or alkaline character. pH values range from 0 to 14, and for the protection of aquatic organisms, water with a pH between 6.5 and 8.5 is recommended. The water generally exhibited an alkaline reaction. At Station 1, pH ranged from a minimum of 8.16 in December to a maximum of 8.8 in August; at the Central Station, the minimum was 8.17 in November and the maximum 9.0 in August; at Station 3, pH varied between 8.31 in November and 9.0 in August. Higher-than-optimal pH values were observed, particularly during the summer, especially in August. Sediment samples showed a slightly alkaline reaction, with pH ranging from 7.7 at Station 1 in April to 8.5 in August.

Dissolved oxygen values in water were within the optimal range for the survival of aquatic organisms.

Organic matter content, expressed in mg $KMnO_4$/L, ranged from below the maximum admissible value for fishery waters (60 mg $KMnO_4$/L) to values exceeding this threshold. At Station 1, minimum and maximum values were 42.53 mg $KMnO_4$/L in April and 96.63 mg $KMnO_4$/L in August, respectively; at the Central Station, 48.03 mg $KMnO_4$/L in April and 91.95 mg $KMnO_4$/L in January; at Station Stăvilar, 45.03 mg $KMnO_4$/L in April and 96.63 mg $KMnO_4$/L in August.

Chemical oxygen demand (COD-Mn), determined by the potassium permanganate method and expressed in mg O_2/L, showed a similar trend, varying between 10.63 and 24.16 mg O_2/L, placing the water in quality classes II–IV according to Order MMGA No. 161/2006. Organic matter content peaked at all stations in August, likely due to increased algal and aquatic vegetation growth. Sediments exhibited organic matter values ranging from 23.76 mg $KMnO_4$/100g soil at Station 1, in April to 130.31 mg $KMnO_4$/100g soil in March 2023, with intermediate values at other stations.

Chloride concentrations in water were high at all three sampling stations compared to the optimal range for fishery waters; however, this is characteristic of the area and does not pose a risk to fish. Concentrations were relatively stable, ranging from 276.82 mg/L in April at the Central Station to 392.34 mg/L in December at the same station. Chloride levels in sediments varied between 16.61 mg/100g soil in August at Station 1 and 128.8 mg/100g soil in March at Station 1.

Nitrite levels remained below the maximum admissible value at all stations, often being absent, with the highest value of 0.132 mg/L recorded at Station 1, in December.

From this perspective, water quality falls within classes I–III. In sediments, nitrites were present in all samples, ranging from 0.008 mg/100g soil in November at the Central Station to 0.132 mg/100g soil in April at all stations.

Ammonia concentrations in water remained below the toxic threshold for fish (0.2 mg/L), with minimum and maximum values of 0.0046–0.142 mg/L at Station 1, 0.0066–0.118 mg/L at the Central Station, and 0.007–0.158 mg/L at Station 3.

Ammonium ion concentrations ranged from 0.0468–1.882 mg/L across the stations, with maximum values approaching the safety limit of 2 mg/L. Elevated pH conditions increase the proportion of toxic ammonia in water.

According to ammoniacal nitrogen content and Order MMGA No. 161/2006, water quality ranged from classes I to IV over the study period.

In sediments, ammonium ions showed highly variable concentrations, with peaks in March and especially November at Stations 1 and 2, reflecting elevated ammonia in water.

Nitrate concentrations in water ranged from 0.50 to 1.09 mg/L, indicating low nutrient levels, with water classified as class I according to Order MMGA No. 161/2006,

but considered nutrient-poor for fish culture. Nitrate levels in sediments were highly variable, absent in some samples, and reaching a maximum of 1.085 mg/100g soil in August at Station 1, below values for productive sediments.

Phosphate concentrations in water were low, ranging from 0.017 to 0.070 mg/L, below the maximum admissible values for fishery waters, placing water in class I quality. Sediments contained similarly low phosphate levels, with the minimum at 0.070 mg/100g soil at Station 3 and the maximum at 0.515 mg/100g soil at the Central Station. Low nutrient content indicates reduced productivity of the basin.

Sulfate concentrations in water ranged from 260–482 mg/L, exceeding maximum admissible levels for fishery waters and placing water in class V quality. High sulfate content is characteristic of the study area. Sulfate levels in sediments were lower and variable, occasionally undetectable, with a maximum of 65.17 mg/100g soil in August at the Central Station, below the admissible limit.

Hydrogen sulfide concentrations in water ranged from trace amounts in August to maximum values of 0.11 mg/L at Station 1 and 0.12 mg/L at the Central and Station 3, measured in January. Maximum values approached the upper limit of admissibility.

Calcium, expressed in mg/L, is essential for fish development and nutrition. Concentrations ranged from 28 to 124 mg/L at Station 1, 32 to 132 mg/L at the Central Station, and 32 to 116 mg/L at Station 3. With few exceptions, these values were below the optimal range for fishery waters, indicating low productivity.

Calcium in sediments also exhibited low values, ranging from 26.60 mg/100g soil in November at the Central Station to 80.64 mg/100g soil in April at the same station.

Magnesium, important for aquatic plants and as a component of chlorophyll, plays a key role in nitrogen fixation and fish development. Concentrations in water ranged from 60.77 to 140.99 mg/L at Station 1, 63.20 to 148.29 mg/L at the Central Station, and 55.91 to 150.72 mg/L at Station 3, often exceeding the maximum allowable limits for fishery waters.

Magnesium in sediments showed heterogeneous values, ranging from 11.51 mg/100g soil in August at Station 1 to 252.68 mg/100g soil in November at the same station.

The calcium-to-magnesium cation ratio, a dimensionless parameter recommended at 5:1 for productive waters, ranged from 0.2 to 2.08 across the stations. Most values were below unity due to the limanic, salt-rich nature of the basin.

During the study period, calcium ions tended to decrease while magnesium ions increased, leading to an imbalance between these cations.

Total water hardness (°D) ranged from 28.6 at the Central Station in August to 39.27 at Station 3 in January and March, exceeding the maximum admissible value of 20 °D due to local geology. Carbonate concentrations ranged from trace amounts to 18 mg/L, while bicarbonates varied between 317.2 and 418.8 mg/L, falling within the optimal range reported in the literature. Water alkalinity ranged from 5.6 to 6.9 mval HCl/L, oscillating near the maximum considered acceptable for fishery waters.

Potential acidity of sediments, due to hydrogen, iron, and aluminum ions, was composed of hydrolytic and exchangeable acidity. Hydrolytic acidity, expressed in mL NaOH/100g soil, ranged from 1.25 in August at the Central Station to 5.75 in November at Station 1, from which calcium requirements (kg CaO/ha) were estimated between 105 and 483.

Exchangeable acidity ranged from 0.5 mL NaOH/100g soil in August to 2.75 mL NaOH/100g soil in November at Station 1. Humic substances in sediments, expressed in g/100g soil, ranged from 0.82 to 5.7 across stations and sampling months.

Combined with organic matter content, these values indicate moderately productive and heterogeneous sediments. Sediment moisture varied between 23.08% and 66.36%.

In May 2023, three carp specimens were examined for pathological analysis. Ichthyopathological examination revealed lesions characteristic of erythrodermatitis, pale gills, and the presence of myxosporidia in one specimen. Additional specimens exhibited similar symptoms without affecting the overall fish population.

Microscopic analysis of water samples revealed that phytoplankton included representatives of the following algal groups: diatoms, chlorophytes, cyanophytes, euglenophytes, pyrophytes, and chrysophytes. Diatoms predominated at both stations, especially during spring and autumn when water temperatures were low.

Observed species included genera such as *Anabaena*, *Oscillatoria*, *Merismopedia*, *Aphanizomenon* (Cyanophyceae), *Nitzschia*, *Synedra*, *Navicula*, *Melosira*, *Cyclotella*, *Diatoma*, *Stephanodiscus*, *Surirella*, *Amphora* (Bacillariophyceae), *Chlorella*, *Pediastrum*, *Ankistrodesmus*, *Crucigenia*, *Scenedesmus* (Chlorophyceae), *Euglena*, *Phacus*, *Trachelomonas* (Euglenophyceae), *Cryptomonas* (Pyrophyceae), and *Mallomonas* (Cryptophyceae).

Quantitative analysis of phytoplankton showed that in early spring (March), when temperatures were low, organism abundance was minimal-1180 ex./mL at Station 1-rising to 8955 ex./mL in September. At Station 2 (Central), values ranged from 2728 ind./mL in May to 7495 ex./mL in August, while Station 3 recorded 454 ind./mL in March and a maximum of 8563 ind./mL in September. Higher water temperatures in early September corresponded to increased phytoplankton abundance at Stations 1 and 3.

Across the year, diatoms were dominant in all stations, except in May. Following diatoms, chlorophytes, cyanophytes, and euglenophytes were the next most abundant, whereas pyrophytes and cryptophytes were represented by few species.

Chlorophytes predominated in May at all sampling stations. Phytoplankton biomass peaked in June (32.51 g/m³) and October (27.721 g/m³), with the lowest values in March.

Zooplankton was represented by a limited number of species grouped into Rotatoria, Copepoda, and Cladocera. Rotifers dominated in both stations, including genera such as *Brachionus*, *Keratella*, *Polyarthra*, and *Asplanchna*. Copepods were mostly juveniles (nauplii) at various developmental stages, less numerous than rotifers both in taxa number and individual abundance. At Station 1, copepod density peaked at 120 ex./L in June and was minimal at 30 ex./L in December. Station 2 recorded two maxima, 192 ex./L in June and 140 ex./L in September, with a minimum of 21 ex./L in November. Zooplankton species richness was low throughout the study period.

Biomass values were highest in July (1.105 g/m³) and September (1.124 g/m³) and lowest in May (0.026 g/m³). Generally, copepods were less abundant than rotifers in both species number and individual counts, although their maxima and minima sometimes exceeded those of rotifers.

Cladocerans were observed less frequently, mainly during periods of elevated temperature, with adults appearing primarily in summer and autumn. Due to significant differences in species size and division rates between algal flora and zooplankton, no direct correspondence exists between density and biomass. High biomass often corresponded to low density, reflecting the predominance of large, slow-dividing species, and vice versa.

Benthic fauna was represented by a limited number of species from the class Vermes and insect larvae (Chironomidae), as well as bivalves of the genera *Physa*, *Planorbis*, *Dreissena*, *Lymnaea*, and *Vivipara*.

Qualitative and quantitative observations indicate that the role of benthos in the trophic chains of Lake is primarily determined by oligochaetes, chironomids, and gastropods through their biomass. Gastropods showed high density at certain stations, with a recorded biomass of 265.2 g/m³.

The distribution of benthic fauna was heterogeneous, reflecting the variability of local biotopes.

CONCLUSIONS

Aquatic biotopes frequently experience alternating redox conditions, variations in environmental pH, water composition, and mineralization, depending on seasonal, climatic, hydrological, biological, and anthropogenic factors.

The summer period emerged as the most sensitive, during which exceedances of key physicochemical indicators of water and sediment were observed. The upward trend in pH coincided with increasing water temperatures, when aquatic organisms and submerged vegetation begin to develop, leading to chemical processes and transformations that affect the acid–base balance of the pond.

This phenomenon is further enhanced by the high concentrations of mineral salts, including chlorides, sulfates, carbonates, and bicarbonates, which are characteristic of the region in which the studied lake is located.

The decrease in calcium concentration observed during the study period is primarily due to biogenic decalcification, in which soluble calcium ions, mostly as bicarbonates, precipitate as insoluble carbonates according to the carbon dioxide requirements of aquatic plants.

Consequently, the balance between immobilization and mobilization of calcium and, to a lesser extent, magnesium, and the buffering role of water and sediments, is dynamically complex.

Changes in calcium concentration are always accompanied by pH modifications, as calcium is the primary chemical element determining alkalinity in freshwater ecosystems.

Magnesium in water exists mainly as bicarbonates, sulfates, and carbonates. Relatively high magnesium concentrations are typical for saline soils where the lake is located. Analysis of a water source in the northern sector revealed a high magnesium content (192.05 mg/L), primarily in the form of sulfates, chlorides, and other salts, contributing to a high total hardness (49.93°D).

This may explain the increased magnesium concentrations observed during the study period.

The increase in magnesium ions in water was not accompanied by an increase in sediment magnesium or water hardness, indicating that this situation is not harmful to fish development. To reduce magnesium concentrations and increase calcium content, the addition of calcium salts is recommended, as magnesium ions are antagonistic to calcium ions. The health status of cultured fish is critical for achieving growth performance and is influenced by the quality of the aquatic environment.

Ihtiopathological examination of carp specimens from the lake revealed lesions consistent with erythrodermatitis, pale gills, and the presence of myxosporidia in one of the examined specimens.

Application of recommended treatments prevented the spread of the disease to other individuals, with only a few specimens displaying symptoms without negatively affecting the overall fish population.

The trophic base influences fish development through the quantity, quality, and size of trophic elements. Regardless of seasonal diversity, low values of these elements indicate a limited food supply for fish within this aquatic ecosystem.

Analysis of lake plankton indicated low quantities of both phyto- and zooplankton; therefore, during the vegetative period, the application of small amounts of manure, placed in piles in the water, is recommended to maintain trophic balance within favorable limits.

Water monitoring in Lake is advised to determine phytoplankton and zooplankton levels to guide appropriate manure application.

Examination of benthic fauna revealed a high proportion of the bivalve *Dreissena*, which is important as a food source for benthivorous fish (carp, crucian carp, roach) and plays a role in filtering suspended matter in the water. *Dreissena* also serves as an intermediate host for certain parasitic worms affecting fish, which may cause serious disease outbreaks.

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