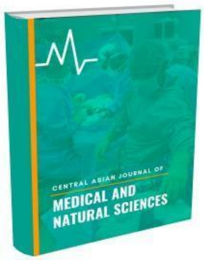

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Article

Analysis of Saprolegniosis Dynamics in Cyprinid Fish and Influencing Hydrobiological Factors in Water Bodies of the Samarkand Region

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Abstract: This article investigates the impact of bio-ecological water factors on the prevalence of saprolegniosis in cyprinid fish, using fish farms in the Pastdargom district of the Samarkand region as a case study. The study determines those environmental stressors such as water acid (pH 5.46.8), relative oxygen deficiency (5.7 6.1 mg/L) and the excessive amounts of ammonia compounds as main conditions that trigger the disease. Further, the paper breaks down the seasonality of the disease and offers feasible suggestions on how the environment can be fixed. It is suggested to use calcium hypochlorite and slaked lime to sanitise the aquatic medium and to use probiotic called Innoprovit that may potentially help strengthen the general resistance and immunity of the fish community.

Keywords: Saprolegniasis, Cyprinid Fish, Ph Level, Ammonia Nitrogen, Bio-Ecological Factors, Liming, Probiotic, Hydrochemical Analysis

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1. Introduction

Significance of the Study

The rapid expansion of aquaculture is of vital importance in ensuring global food security by supplying high-quality and affordable animal protein. However, the intensification of fish farming systems is frequently accompanied by an increased incidence of infectious and invasive diseases, which significantly reduce productivity and cause substantial economic losses. Of these diseases, it is possible to note saprolegniosis, a fungal infection caused by water molds of one of the genera Saprolegnia, which is among the most widespread and destructive issues in cyprinid fish farming on the global scale and in Uzbekistan, in particular [1].

Saprolegniosis is a fish disease that mostly involves the skin, gills and fins of the sick fish causing typical cotton-text growths, tissue necrosis and secondary bacterial attacks. Under the intensive culture condition, the disease tends to spread at a fast rate, leading to a mass mortality of fish and particularly the fingerlings and the stressed adult fish. Such pathogenesis is strongly connected with the adverse conditions of the environment that undermine the natural protection of fish and provide the best environment in which the Saprolegnia species can nourish itself [2].

At the fish farms of the Samarkand country and especially in the Pastdargom district, chronic interruptions of the hydrochemical regime have occurred. These are a reduction in pH value, acid shift, dissolved oxygen depletion and an increase in nitrogenous compounds, i.e. free ammonia (NH_3), ammoniacal nitrogen, and nitrites. Such deviations from optimal parameters (pH 7.2–8.0, dissolved oxygen 7–9 mg/L) act as powerful stressors, suppressing fish immunity and promoting fungal proliferation. It is evident that anthropogenic factors, namely the excessive application of organic and mineral fertilisers during the spring months, the unregulated discharge of livestock waste, and the improper management of ponds, serve to further exacerbate the already existing problems of organic pollution and nutrient imbalance in water bodies[3].

Various investigations conducted in Uzbekistan have reported epizootiological aspects on saprolegniosis on the local cyprinids. These works have highlighted the importance of both environmental correction and biological enhancement of fish resistance approaches that can be combined to provide integrated control measures. The disease has pronounced seasonal patterns, showing maxima at the end of winter-early spring in adult fish, and at the springsummer junction in fingerlings. These goose bumps often are mixed up infections with opportunistic bacteria and ectoparasites [4].

The purpose of the study is to examine the distribution and seasonal patterns of saprolegniosis in cyprinid fish, (mainly common carp, Cyprinus carpio and silver carp, Hypophthalmichthys molitrix) in fish farming industry of Pastdargom district. Moreover, the research considers the impact of the main bio-ecological and hydrobiological variables on the pathogenesis of diseases, therefore, scientifically explaining the efficacy of the chemical remediation (slaked-lime-calcium hypochlorite liming) and biological prevention (enriching the diet with the probiotic Innoprovit) [5]. The present study proposes a novel approach to address the challenge posed by the fungal pathogen, with the objective of enhancing the sanitary and hygienic status of ponds, and concomitantly reducing economic losses. This is achieved by integrating hydrochemical monitoring with experimental feeding trials on 5-month-old carp fingerlings. The resulting evidence-based recommendations offer practical solutions to address this issue [6].

2. Materials and Methods

The present study was conducted at the "Durmonsoy Baliqlari" fish farm located in the Pastdargom district of the Samarkand region, Republic of Uzbekistan. This farm represents a typical intensive cyprinid aquaculture system in the arid zone of Central Asia, where common carp (*Cyprinus carpio*) and silver carp (*Hypophthalmichthys molitrix*) are the dominant species. The research combined field observations, hydrochemical monitoring, clinical and pathological examinations, and controlled experimental trials to analyze the dynamics of saprolegniosis and the influence of key bio-ecological and hydrobiological factors.

Study Design and Objects

The experimental part involved 5-month-old common carp fingerlings with an average initial weight of 25–35 g. Two experimental groups and one control group were formed, each consisting of 200 fish stocked in separate earthen ponds of similar size and depth (approximately 0.8–1.2 m). The study duration was 90–120 days, covering the main growing season from spring to autumn. Fish were fed extruded compound feed three times daily at a rate of 3–5% of body weight, adjusted according to water temperature and fish activity.

Group I received feed supplemented with 3.0% "Innoprovit", a universal probiotic. Group II received feed supplemented with 0.1% "Innoprovit", a probiotic. The control group was administered unsupplemented standard extruded feed.

Growth parameters (body weight, length, specific growth rate), feed conversion ratio, survival rate, and clinical signs were monitored at 15–20 day intervals. Following the conclusion of the experiment, pathomorphological examinations were conducted on a random selection of fish from each group in order to assess the condition of the gills, skin, and internal organs.

Hydrochemical and Hydrobiological Monitoring

Water quality parameters were systematically monitored two to three times per month from April to July, with additional measurements during critical seasons (late winter, spring, and autumn). Samples (200 mL) were collected from the surface and bottom layers at multiple points in each pond using standard hydrobiological sampling techniques. The following key parameters were analyzed both in situ and in laboratory conditions:

- **pH** — measured with a portable digital pH meter (accuracy ±0.1);
- **Dissolved oxygen (DO)** — determined by the Winkler titration method or portable oxygen meter (mg/L);
- **Temperature** — recorded with a digital thermometer (°C);
- **Ammonia forms** (free NH_3, total ammoniacal nitrogen, nitrites) — analyzed spectrophotometrically using standard colorimetric methods;
- **Other parameters** — including hydrogen sulfide (H_2S), hardness, and organic load indicators.

All measurements were compared against optimal hydrochemical standards for cyprinid aquaculture (pH 7.2–8.0, DO 7–9 mg/L, free ammonia <0.02–0.1 mg/L). Seasonal observations included visual assessment of phytoplankton and macrophyte activity, which influence pH and ammonia conversion.

Diagnosis of Saprolegniosis

Clinical diagnosis was based on characteristic external signs: white cotton-like mycelial growth on skin, gills, and fins, accompanied by tissue necrosis and behavioral changes (lethargy, surfacing, loss of appetite). A mycological examination was performed to do laboratory validation. Affected samples were taken in a sterile fashion and inoculated in selective media (e.g. glucose-yeast extract agar or Sabouraud dextrose agar). They were then incubated at 20- to 25oC. Morphological identification of isolated Saprolegnia spp. under light microscopy followed the existing mycological taxonomic keys. In instances of mixed infections, bacteriological and parasitological analyses were conducted to detect opportunistic microflora and ectoparasites.

Pathological material was fixed in 10% neutral formalin for histopathological examination. Sections were stained with hematoxylin-eosin to evaluate gill lamellae damage, epidermal necrosis, and inflammatory responses.

Environmental Remediation Measures

Seasonal preventive and remedial protocols were tested and evaluated:

- Summer: Slaked lime ($Ca(OH)_2$) applied at 100 kg/ha in suspension form, Subsequently, a solution of 65% calcium hypochlorite, comprising 5–6 kg of the substance dissolved in 150–200 L of water, was applied 24 hours later.
- Spring: The utilisation of calcium hypochlorite and slaked lime in conjunction has been demonstrated to be an effective method of achieving and maintaining a pH level within the desired range of 7.0–7.4. Furthermore, the implementation of cytogas filters at the water inlets has been shown to enhance the stability of the pH level.

- Autumn: Ponds were drained by February, bottoms plowed and exposed to air and sunlight for sterilisation before restocking.
- Winter: The implementation of a flow-through water regime in stocked ponds is imperative, while vacant ponds are to be plowed and left to freeze.
- The effectiveness of these measures was assessed through pre- and post-treatment hydrochemical analysis and a reduction in disease incidence.

3. Results and Discussion

We looked at the information about how the fish grew how many survived and the quality of the water. We used statistical methods to understand the numbers. We calculated the values, how much the numbers varied and if the differences between groups were important. We used tests like Students t-test or one-way ANOVA to see if the differences were real. We showed the results in tables and graphs to make it clear.

We made sure to follow the rules for treating animals in fish farming research and the laws of the Republic of Uzbekistan about animal health. Our method combined ways of checking water quality with new ways of using probiotics to see how the environment, bad germs and the fish interact with each other in cyprinid fish farming [7].

The next part talks about what we found out. Our study about saprolegniosis in cyprinid fish showed that the main reason for this infection is the environment. In the fish farms near the Pastdargom district we saw some problems with the water quality. The water was too acidic it was 5.4, which's much lower than the ideal range of 7.2 to 8.0. This made it easy for the Saprolegnia fungi to grow and make the fish sick [8].

We also found out that there was much nitrogen in the water way more, than what is safe.

- Free ammonia (NH_3): levels reached 0.3–0.7 mg/L or higher.
- Ammoniacal nitrogen concentrations were found to exceed 3.0 mg/L.
- Levels of nitrite were observed to be above 0.4 mg/L.

The research further established that the deterioration of the aquatic environment was largely due to anthropogenic factors. During the spring season, farm personnel administered excessive amounts of organic and mineral fertilisers. Furthermore, the unregulated discharge of waste from proximate livestock farms into the reservoirs contributed to the accumulation of organic matter, thereby triggering the rapid development and spread of saprolegniosis within the fish population [9].

Seasonal Dynamics of Saprolegniosis. The progression of saprolegniosis across different seasons was monitored, and the specific environmental triggers for each period were identified. The findings are summarized in Table 1.

Table 1. The present study investigates the seasonal development of saprolegniosis in fish ponds, and the associated environmental changes that occur in these bodies of water

Season	Observations and Pathological Changes
Autumn	High prevalence of saprolegniosis was observed in silver carp (*Hypophthalmichthys molitrix*) and common carp (*Cyprinus carpio*) of various age groups during intensive cultivation.
Spring	The disease often presented as a mixed infection involving Saprolegnia fungi, opportunistic microflora, and ectoparasites. In 3–4 month-old fingerlings, the peak incidence was recorded during the spring-summer transition.
Summer	Cases of endogenous ammonia poisoning and non-infectious branchial necrosis were prevalent. High water pH and low dissolved oxygen levels inhibited the excretion of metabolic ammonia through the gills, leading to its accumulation in the organism and subsequent gill damage.

Winter	In adult fish, saprolegniosis reached its peak intensity in late winter and early spring. These winter stressors served as a primary catalyst for the widespread development of infectious and parasitic diseases as temperatures began to rise.

The Pathogenesis and Environmental Triggers.

The findings of this study indicate that during the latter half of the winter period and the onset of spring, cases of saprolegniosis are most prevalent among domesticated carp groups. The disease characteristically follows a chronic course, eventually manifesting as systemic saprolegniosis. The onset of the infection was directly correlated with the deterioration of the aquatic environment during the winter months. In response to these stressors, fish initially exhibit signs of heightened agitation (stress response), which are followed by a period of lethargy. Fish will then congregate near the water surface or inlets. This behavioral shift is a reaction to oxygen depletion and the accumulation of toxic metabolites, including ammoniacal nitrogen, hydrogen sulfide (H2S), and other environmental toxins[10].

The spring outbreak of saprolegniosis was predominantly observed in cyprinid fingerlings (young-of-the-year). The study confirmed that, under specific ecological conditions driven by the activity of macrophytes and phytoplankton, ammoniacal nitrogen transforms into its toxic free ammonia (NH_3) form. This process has been shown to trigger the disease. This chemical shift is exacerbated by the photosynthetic activity of aquatic vegetation, which, while increasing dissolved oxygen levels, simultaneously raises the pH, facilitating the conversion of ammonium ions into lethal free ammonia.

Table 2. Seasonal prevention strategies and environmental management in fish ponds

Season	Preventive and Remedial Measures Implemented
Summer	Application of slaked lime at a rate of 100 kg/ha in suspension form. After 24 hours, a treatment of 5-6 kg of 65% calcium hypochlorite (dissolved in 150-200 L of water) was applied to the reservoir.
Spring	Chemical agents including 65% calcium hypochlorite and slaked lime were used to stabilize the biochemical state of the water. Cytogas filters were installed at water inlets, maintaining an optimal pH range of 7.0–7.4.
Autumn	For intensive cultivation, ponds were drained by February. The pond bottoms were plowed (exposed to air) and sterilized before transferring fish to sanitized reservoirs.
Winter	The ponds were maintained through the implementation of a continuous flow-through system, ensuring a constant influx and efflux of water. In the context of water management, the practice of plowing and freezing vacant ponds during winter has been employed as a method of pathogen elimination.

The experimental studies were conducted at the "Durmonsoy Baliqlari" fish farm in the Pastdargom district, using 5-month-old common carp fingerlings (Cyprinus carpio)[11].

The effectiveness of the universal probiotic "Innoprovit" was evaluated through a series of experiments. To this end, two experimental groups were established, with each group consisting of 200 fish. The feeding protocols were defined as follows:

- Group I: Received extruded compound feed supplemented with 3.0% "Innoprovit" probiotic, administered three times daily.

- Group II: They got a feed with a small amount of "Innoprovit" in it which is 0.1%. They had this feed three times a day [12].

The experiment went on for a long time it was 90 to 120 days. During these days the people, in charge checked on the growth of the Group II how they were developing, what they were eating. If they had any health problems. They did these checks every 15 to 20 days.

Environmental. Management. The people taking care of the experiment wanted to keep the water healthy so they put fertilizers in all the ponds every 20 to 30 days. They used a mix of fertilizers that were made from minerals and organic things [13].

To investigate the environmental catalysts for saprolegniosis, water quality was rigorously monitored:

Laboratory Analysis: Water samples (200 mL) were collected monthly and analyzed under laboratory conditions. The results were benchmarked against standard hydrochemical indices.

Stressors: I noticed that when fertilizer is not used correctly or at the right time it can cause a drop in calcium and dissolved oxygen levels. At the time it hurts the natural food that the fish eat, like tiny plants called microalgae. These things can make the fish get sick with something called saprolegniosis [14].

Nutritional Stress: When the water is often polluted and there is not natural food it is very bad, for the carp. If the fish do not get the food they need and the water is not fertilized properly it makes them more likely to get sick because their immune system is weak.

Table 3. Hydrochemical parameters of the water environment at the "Durmonsoy Baliqlari" farm (April–July)

Month	Inspection Cycle	pH Level	Dissolved Oxygen (mg/L)
April	1st Inspection	6.4	5.7
	2nd Inspection	6.7	5.9
May	1st Inspection	6.6	6.1
	2nd Inspection	6.8	5.9
June	1st Inspection	6.8	6.0
	2nd Inspection	6.5	5.8
July	1st Inspection	6.6	5.7
	2nd Inspection	6.6	6.0

Based on the water samples collected two to three times per month from April to July, the environmental parameters at the “Durmonsoy Baliqlari” fish farm were systematically evaluated. The analysis of dissolved oxygen (DO) levels revealed significant deviations from established technological standards. In April, the first and second inspections showed DO levels of 5.7 mg/L and 5.9 mg/L, respectively. In May, the values were 6.1 mg/L and 5.9 mg/L. The June monitoring recorded an initial 6.0 mg/L, which subsequently decreased to 5.8 mg/L. Finally, in July, the concentrations were measured at 5.7 mg/L and 6.0 mg/L. When compared to the optimal fishery standards of 7–9 mg/L, the recorded oxygen levels in these ponds were consistently below the required threshold. Such chronic hypoxia (oxygen deficiency) acts as a primary physiological stressor for cyprinids, weakening their immune systems and creating a high susceptibility to fungal infections like saprolegniosis [15].

4. Conclusion

The results of this study convincingly demonstrate that the occurrence and intensity of saprolegniosis in cyprinid fish are strongly determined by disruptions in the hydrochemical balance of aquaculture ponds. Chronic hypoxia, which is when the water has oxygen levels of 5.7 to 6.1 milligrams per liter and acidic water pH levels of 5.4 to 6.8 and the buildup of toxic ammonia compounds with free ammonia reaching 0.3 to 0.7 milligrams per liter or more create conditions that are good for Saprolegnia fungi to grow and spread and at the same time make the fish weaker.

The time when the most fish got sick was during the half of winter and early spring when the water was cold and the fish were under stress, which made it easier for the fungi to damage the gills and cause infections and sometimes other microbes made the infection worse. Some things that people can do to help like putting lime in the water at 100 kilograms per hectare using 65 percent calcium hypochlorite installing cytogas filters draining and plowing the ponds and keeping the water flowing helped to keep the pH of the water between 7.0 and 7.4 which's good and reduced the amount of bad things in the water and stopped the growth of bad microbes.

Also giving the fish a supplement called Innoprovit at 3.0 percent of their food made them healthier helped them grow better and reduced the number of fish that died from fungal infections in groups of young carp. These results show that it is very important to use a combination of methods to control Saprolegnia fungi including watching the water making changes to the pond when necessary and using safe methods to keep the fish healthy. If people follow these recommendations it will not reduce the economic impact of the disease but it will also help the aquaculture industry in the Samarkand region and other places, with similar climates to be more sustainable.Ultimately, maintaining optimal water quality remains the cornerstone of effective disease prevention, ensuring higher productivity and welfare of cyprinid fish populations in intensive farming systems.

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