

Review Article

Common Diseases Frequently Encountered in Fish of the Order Cypriniformes, Control Measures and Prevention

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Abstract

This article investigates the diversity of fish belonging to the order Cypriniformes, their main biological characteristics, and various diseases affecting them. The main aim of the study is to provide a general characterization of fish species belonging to the order Cypriniformes, determine their distribution patterns and economic importance, and investigate the parasitic, viral, bacterial, and fungal diseases occurring in these fish. The first chapter presents the general characteristics and systematic position of the order Cypriniformes, as well as information about its major representatives. Their diversity and biological characteristics are also analyzed. The second chapter examines the main diseases observed in fish belonging to the order Cypriniformes. Information is provided on the causes, causative agents, transmission routes, and effects of these diseases on fish health. In addition, the characteristics of parasitic, viral, bacterial, and fungal diseases, their economic impact on fish farming, and measures for disease control are discussed. Based on the results of the study, it was determined that the implementation of preventive measures is of great importance for protecting fish belonging to the order Cypriniformes from diseases, detecting diseases at an early stage, and preventing their spread. The article also provides recommendations concerning compliance with sanitary and hygienic requirements in fish farms, monitoring water quality, regular veterinary supervision, and the timely implementation of disease control measures.

Keywords: Cypriniformes, fish, species diversity, parasitic diseases, viral diseases, bacterial diseases, fungal diseases, prevention, fish farming.

1. Introduction

As integral components of aquatic ecosystems, fish play a crucial role in preserving biodiversity and ensuring food security, economic development, and social well-being—factors of strategic importance to human societies. Their importance, particularly as a source of high-protein food, has grown; consequently, aquaculture and commercial fishing have become significant economic sectors in many countries, including Azerbaijan. In this context, cyprinid fish belonging to the order Cypriniformes—such as common carp, bream, kutum, and other species—are regarded as commercially viable species that are widely cultivated in aquaculture. Their high adaptability, feed conversion efficiency, and reproductive performance ensure successful rearing in both natural and artificial environments (lakes, reservoirs, and breeding farms). However, the intensification of the aquaculture sector, high population densities, inadequate zoohygienic conditions, and deteriorating water quality have increased the prevalence of infectious diseases of various origins among cyprinid fish. In addition to causing reduced productivity and economic losses, these diseases can also disrupt the ecological balance in water bodies. Therefore, the study and prevention of infectious diseases in catfish remain relevant from both scientific and practical perspectives [1].

The primary objective of this study is to investigate infectious diseases affecting cyprinid fish (Cypriniformes), their causative agents, and the conditions of their spread; to identify clinical manifestations and key risk factors and to analyze modern preventive and therapeutic measures on a scientific basis. The primary objective of this study is to investigate infectious diseases affecting cyprinid fish (Cypriniformes), their causative agents, and the conditions of their spread, to identify clinical manifestations and key risk factors, and to analyze modern preventive and therapeutic measures on a scientific basis, to provide a general classification of bacterial, viral, parasitic, and fungal diseases found in catfish-like fish; to analyze the most common disease-causing agents (*Aeromonas hydrophila*, KHV, *Ichthyophthirius multifiliis*, etc.) and their biological characteristics; to identify the key environmental and technogenic factors influencing the spread of diseases (water temperature, oxygen content, ammonia levels, etc.); to summarize existing scientific information on the diagnosis, clinical signs, and treatment methods of diseases; to investigate modern preventive approaches, including the potential application of molecular diagnostics, vaccination, and alternative treatment methods.

2. Materials and Methods

Analytical and scientific research methods based on various sources were employed in conducting the research. Interrelationships between the causes and consequences of various diseases have been established, and scientific findings have been synthesized. Mechanisms of action and routes of transmission were compared across different disease groups (bacterial, viral, parasitic, fungal). The effectiveness of modern preventive and therapeutic methods (probiotics, plant-based antimicrobial agents, etc.) was evaluated through analysis.

3. Results and Discussion

This article is a study dedicated to a detailed scientific analysis of diseases affecting sturgeon-like fish, systematically summarizing the biological characteristics of the causative agents, clinical manifestations, and conditions of spread. Unlike previous studies, this work investigates diseases of diverse origins collectively and presents a comprehensive overview of modern diagnostic and therapeutic approaches. In addition, the transmission mechanisms and risk factors of certain diseases (e.g., KHV and SVC) have been analyzed within the context of local conditions. At the same time, information regarding the potential application of plant-based antimicrobial agents, probiotics, and alternative preventive approaches has been summarized in such detail for the first time within the context of Azerbaijan.

The theoretical significance of the study lies in the systematic scientific investigation of etiology, clinical presentation, causes of spread, and treatment methods of diseases affecting sturgeon-like fish. This establishes a solid theoretical foundation for future scientific research by creating a reliable database for researchers in the fields of biology and veterinary science. The practical significance of the research may prove beneficial for specialists working in water management, veterinarians, and managers of aquaculture enterprises. The diagnostic methods, treatment measures, and preventive approaches outlined here offer practical opportunities for the timely prevention of diseases, the maintenance of healthy fish populations, and the enhancement of farm productivity. Thus, this research can contribute to the sustainable and sound management of aquatic bioresources, both scientifically and in the practical sphere.

3.1. Species Diversity of Cyprinids

The order Cypriniformes is one of the most widely distributed and species-rich groups among bony vertebrates. Fish belonging to this group primarily inhabit freshwater environments and account for approximately 80% of the world's freshwater fauna. Although their natural distribution ranges are largely confined to Eurasia and North America, certain species have subsequently spread to other regions due to anthropogenic influences [2].

The Cyprinidae family is considered the largest among freshwater fish in terms of the number of species. In these fish, the scales are small and cycloid in structure. In some representatives, however, scales are absent, and the skin is naked. The length of most members of the Cyprinidae family ranges from 20 to 40 cm. Among some of the

larger species such as grass carp and thicklip grey mullet. There are various ecological groups of catfish based on their habitat. Semi-anadromous, migratory, and freshwater species are the most widely distributed among these ecological groups. Thus, common carp, bream, roach, kutum, and Caspian roach are classified as semi-anadromous species; shemaya, asp, and poru as anadromous species; while broadhead, rudd, topmouth gudgeon, gudgeons, khramulya, golden nase, and black bream are freshwater species. Freshwater species themselves are divided into two groups: rheophilic and limnophilic species. Rheophilic fish travel to flowing water to spawn. Examples of these include gudgeons, loaches, golden nase, and naked loaches. Limnophilic species, on the other hand, do not require flowing water for spawning and lay their eggs directly in their usual habitat. Examples of these include broadhead, rudd, mudfish, tench, and perch [2].

Carp also vary in their feeding habits. Shemaya and silver bream mainly feed on plankton; asp, being a predatory species, feeds on fish and other aquatic organisms smaller than itself; khramulya and topmouth gudgeon feed on detritus; common carp, bream, and roach feed on benthic organisms; grass carp feeds on higher aquatic plants; while thicklip grey mullet feeds on both lower and higher algae [2], [3].

Several groups of Cypriniformes are distinguished based on their reproductive habits. These include phytophiles, lithophiles, pelagophiles, and ostracophiles. One of the distinctive and interesting characteristics of carp species, compared with other fish, is the occurrence of interspecific fertilization. New, hybrid forms arise during this type of fertilization. The most widespread examples of interspecific fertilization are the hybridization of kutum with roach and the hybridization of roach with bream. Such fish are of considerable importance to fisheries because this type of hybridization produces more resilient hybrid forms. The family currently comprises 220 genera and 2,420 species [2].

3.2. Parasitic diseases of fish belonging to the Cyprinidae family

Parasites found in freshwater and saltwater fish spend part or all their lives in these organisms and act as pathogenic agents of disease in the fish. Since natural aquatic environments cover vast areas and fish populations are widely distributed, it very rarely becomes pathogenic to fish in natural waters. However, they frequently cause diseases in agricultural enterprises and lead to significant financial losses. Fish parasites are unicellular (protozoa) and multicellular (metazoa) organisms. They are found as ectoparasites (external parasites) on the skin, gills, and fins, and as endoparasites (internal parasites) in internal organs and tissues. While some are indirect causes of disease, many are considered direct pathogens for fish. However, parasitic diseases make fish susceptible to other pathogens (bacteria, viruses, and fungi). Their biology is straightforward; the life cycles of some include fish or small aquatic organisms (typically invertebrates). Furthermore, certain parasites found in fish manifest as zoonoses in humans and cause various diseases [4], [5].

Ichthyobodosis

Agent: *Ichthyobodo necator*. It is a primitive unicellular (protozoan) organism. The areas it inhabits are the gills, skin, and particularly the dorsal fins in fish. It has a worldwide distribution. The parasite, which is more common in fish fry, can cause disease in fish of all age groups. Although the disease occurs in every season, fish are more prone to it during the summer and autumn months [5]. It causes hyperplasia in the epithelium and the formation of dark-colored spots on the skin. These areas of the skin appear grayish. Areas of scaling and minor erosion develop symmetrically on both sides of the dorsal fin. Increased mucus production, erosion, and fraying occur on the fins. Loss of appetite, weakness, and sluggish movement are observed in sick fish. Although the disease occurs throughout the year, severe infections are most frequently encountered in late spring and early autumn. If the agents are present in the aquatic environment, the first symptoms in fish begin to appear after two weeks. In infected fish, parasites are predominantly found on the skin surface. If parasites are not removed from the water, a monthly fish mortality rate of 1% in the facilities is inevitable [5].

Anisakiasis

Agent is a helminth belonging to the genus *Anisakis*. They include *Anisakis simplex*, *Pseudoterranova decipiens*, *Contracaecum osculatum*, and *Anisakis pegreffii*. They develop in various species of fish and mammals within the aquatic food chain. It is found in the digestive system, muscles, and on the surface of internal organs of marine

fish, particularly cyprinids [6]. In infected fish, rapid weight loss and mortality may be observed because of tissue destruction in the liver, pyloric caeca, and blood vessels caused by the parasite. The disease occurs when humans accidentally consume raw or undercooked fish (sushi, sashimi, etc.) infected with these parasites. Infection caused by anisakid larvae is generally confined to the stomach and intestines, but in some cases, it can be invasive and cause allergic symptoms, nausea, vomiting, diarrhea, abdominal pain, and gastrointestinal discomfort in humans. It has been established that freezing fish at -20°C for 24 hours, cooking it (to an internal temperature of 76°C), or salting it for more than 24 hours is sufficient to kill anisakids [6].

Diphylllobothriasis

Agent: They are tape-like helminth worms belonging to the genus *Diphylllobothrium*. The adult form lives in the small intestines of fish-eating mammals (cats, dogs, foxes) and birds, as well as humans. *Diphylllobothrium dendriticum* and *D. ditremum* plerocercoids inhabit various locations in salmonid fish—such as the body cavity wall, muscles, liver, and the surface of reproductive organs—and are found within cysts (resembling pearls). The *D. latum* plerocercoid migrates into muscle tissue but does not reside in cysts; it is typically found lying freely beneath the skin [7]. It can result in weakness, weight loss, stunted growth, swimming near the water's surface, and even fish death. In addition to causing liver damage, plerocercoids also lead to abdominal swelling in fish. Severe muscle degeneration sometimes occurs; the fish's head twists to one side due to spasm, and the dead fish assume an "S" shape [7].

3.3. Viral diseases affecting fish of the Cyprinidae family

Spring viraemia of carp (SVC)

The agent, which has a very wide distribution range in Europe, belongs to the genus *Vesiculovirus* of the family Rhabdoviridae. This is a highly contagious and serious infection that causes disease in carp worldwide. The SVC virus was listed as a notifiable pathogen in the list published by the OIE in 2011. The virus is sensitive to ether, heat, and acid. The optimal pH for replication is 7.0–10.0. While the mortality rate is significantly high during the spring months—when water temperatures range from 10°C to 17°C —at higher temperatures, the humoral antibodies produced by infected fish can halt the virus's spread and protect against reinfection [8]. The agent causing the fatal infection shows an affinity for capillary endothelial cells, nephrons, and hematopoietic structures. The clinical manifestations of the virus in the tissues are generally hemorrhagic formations and tumors. The congregation of fish at the pond inlets in production facilities can be considered an early sign of SVC. Signs include unbalanced and erratic swimming behavior and an acidic, bloody fluid discharge from the anal region of the fish when removed from the water [9]. Although the SVC virus can infect other freshwater fish, its primary impact is on carp (*C. carpio*). External examination may reveal hemorrhages in the skin and eyes, exophthalmos, and abdominal distension; internal examination may show peritonitis, ascites, catarrhal and hemorrhagic enteritis, and hemorrhages in the skeletal muscles and swim bladder walls. The agent was also isolated from the kidneys and spleen of infected fish [8], [9]. The infection can be diagnosed based on clinical findings; additionally, the indirect fluorescent antibody test (IFAT) and enzyme-linked immunosorbent assay (ELISA) are used for isolation and identification. To protect against the pathogen, fish farms infected with the disease must be placed under quarantine, and the movement of fish in the area must be halted. In our country, this is a notifiable disease under the Law on Veterinary Medicine.

Koi Herpesvirus Disease (KHVD)

The agent is Cyprinid Herpesvirus-3 (CyHV-3), a species of the genus *Alloherpesvirus* within the Herpesviridae superfamily. Sequence analyses show that CyHP-3 is closely related to the agents CyHP-1 and CyHP-2. Although mass mortality events caused by the koi virus were first reported in the USA and Israel in 1998, sample analyses indicated that the agent had been present in wild carp in Great Britain since 1996. Today, CyHV-3 is found in the rest of the world, except for South America, North Africa, and Australia. CyHV-3 is transmitted through direct contact with infected fish, as well as via the body fluids of infected fish, contaminated mud, water, and so on. The agent primarily enters the fish through the skin. KHV infection typically occurs during the spring months when the water temperature is between 16°C and 25°C , and the incubation period ranges from 7 to 21 days, depending on the water temperature. KHV disease, which has a 100% morbidity rate and an 80–90% mortality rate and can

affect carp of all ages, can cause inflammation, hyperplasia, and necrosis in the fish's gills. The organs most affected during KHV infection include the fins, kidneys, and spleen. Diagnosis of the infection can be made by examining typical clinical findings. However, histological examination reveals large-cell proliferation in the epithelium. Although the agent was isolated through inoculation of KF-1 cell cultures, the PCR method is far more effective than this technique. Although a safe and effective vaccine is not currently available, attenuated vaccines can be used to some extent in protecting fish. Although the vaccine stimulates the production of antibodies against the virus, the duration of protection it provides is uncertain. Based on a 2009 OIE study, it was observed that the local administration of liposome-based vaccines containing inactivated KHV protects against infection [10], [11].

3.4. Bacterial diseases affecting fish of the Siluridae family

Furunculosis

This is an infection characterized by the formation of furuncles on the bodies of fish and a septicemic course. It is quite widespread. The causative agent of the disease is *Aeromonas salmonicida*. Rainbow trout (*Oncorhynchus mykiss*) are resistant to this infection. This bacterium is one of the oldest known fish pathogens [12]. Furunculosis in fish manifests in acute, subacute, and chronic forms. The appearance of furuncles on the bodies of infected fish is a characteristic symptom. The incubation period of the disease varies depending on the number of bacteria ingested by the fish, the route of entry into the body, and environmental conditions. Acute cases are observed primarily in fish fry. The incubation period is very short. Deaths among the animals begin within 2–3 days, without any clinical signs. In the fish, lethargy, bleeding from the nostrils, hemorrhages on the body surface and fins, and numerous small lesions between the subcutaneous tissue and muscles occur. Boils on the body typically appear in large fish suffering from chronic disease; when these lesions rupture, they form ulcers with raised edges that discharge purulent, microbe-laden fluid [13].

Motile Aeromonas infections

Motile *Aeromonas* species cause significant hemorrhagic septicemia in freshwater fish. Aeromonads are characteristic freshwater bacteria. Due to their mobility, they are frequently encountered in the ecosystem. They are found in water and its microflora, as well as in various aquatic organisms, and are pathogenic to humans [14]. Among the motile *Aeromonas* species that cause infections in fish, the most common infections are caused by *A. hydrophila*. *A. hydrophila* has been identified as a pathogen in cyprinids, reptiles, amphibians, invertebrates, and many mammals, as well as in other marine and freshwater fish. When *Aeromonas* infections occur in fish alongside parasitic infections under unfavorable conditions, they frequently cause inflammation and lesions on the fish's skin. These lesions first appear on the fish's skin and gills, then spread to the muscles and subsequently to all internal organs, and their treatment takes a long time. Aeromonads cause infections in small ponds and lakes, particularly in colorful ornamental fish with high body resistance, and most frequently in carp [15].

Fungal diseases in fish belonging to the Cobitidae family

Aquatic fungal agents (eggs, zoospores, adult forms, etc.) cause diseases and mortality in fish at various stages of development. Fungal infections usually appear as secondary infections; by colonizing lesions caused by primary agents (bacteria, viruses, parasites), they alter the course of the infection. Even if fungal pathogens are present in the water, fungal diseases do not develop if the fish is healthy, there are no skin injuries, and the protective mucous layer on the skin is intact. Most aquatic fungi are saprophytes and sustain themselves by decomposing organic matter. When a fish sustains mechanical injury or contracts another infection, a fungal agent often infects the fish secondarily [16].

Saprolegniosis

It is an external fungal infection frequently found in freshwater fish (especially trout and carp), marine fish, and fish eggs. It inhabits the head, eyes, mouth, gills, skin, and eggs of fish living in warm and cold waters. It occurs particularly in carp farming facilities. Although information is available on many species, the most widespread and well-known species are *Saprolegnia parasitica* and *S. invaderis* [17]. Clinically, lesions consisting of grayish-white patches on the skin are evident, caused by fungal spores and cotton-like, woolly structures extending outward from the body. The most noticeable initial sign is the appearance of white, cotton-like growths on the fish's skin

and gills. Depending on the mycelium's ability to trap sediments or algae from the water, the color of these lesions may appear red, brown, or green. Because the fungal mycelium grows not only in the skin but also in the subcutaneous and muscle layers, it causes necrosis in the tissues. If the mycelium covers 30–40% of the body surface, treatment is unsuccessful. Sometimes the infection spreads to the esophagus, while in other cases, it extends to other tissues and organs such as the liver, spleen, kidneys, swim bladder, eyes, and brain. Lethargy, loss of appetite, and loss of balance are observed in the fish, while the eggs exhibit an opaque appearance. In general, extensive skin necrosis, swelling, and hemorrhage are observed in the muscle tissue. In some cases, the starting point of the infection is the digestive system. In infections originating from the digestive system, hyphae developing in the stomach penetrate the stomach wall, muscle layer, and skin, growing outward; mycelial lesions are observed in the ventral region of the stomach during this process. A fungal infection has been detected in the internal organs [18].

Branchiomycosis

It is an acute fungal disease localized exclusively in the gills of freshwater fish. They are observed in temperate regions. They are in the capillaries as well as in the epithelium. In this infection, which is most frequently observed in carp and trout, the most common and well-known species are *Branchiomyces demigrans* (tuna, perch, rudd) and *B. sanguinis* (carp, rudd) [19]. Although the pathogenicity of both species is similar, *Branchiomyces demigrans* appears in the epithelium and blood vessels, whereas *B. sanguinis* is found on the inner surface of the gills. While *Branchiomyces demigrans* destroys epithelial tissue and proliferates externally, *B. sanguinis* develops solely within the blood vessels of the gills and does not tend to grow externally. As they cause respiratory distress, the most common signs observed in fish during subacute and acute infections are difficulty breathing or lethargy. This situation is typically observed in temperate regions during the summer months, when water temperatures exceed 20°C, and the mortality rate reaches 650. The disease rate can reach 100%, but not all fish have the same susceptibility. The progression of the infection is generally rapid and can worsen under conditions of overcrowding, algal blooms, and rising levels of un-ionized ammonia [20]. Complications in humans are caused by diseases affecting crustaceans, along with control measures and prevention strategies.

4. Complications in humans caused by diseases affecting crustaceans, along with control measures and prevention strategies

Fish play an active role in causing food poisoning, accompanied by diarrhea in humans. This situation leads to a loss of public confidence in these products and a decline in the demand for their consumption. Mussels and oysters are the primary food sources associated with enteritis, as their ability to filter-feed causes them to accumulate large quantities of microbes from sewage-contaminated water. Even if these foods contaminated with sewage-borne microorganisms are thoroughly cooked, pathogens within the internal organs may not be sufficiently destroyed. In this process, trace amounts of intestinal matter may remain in the food, and these substances cause illness after consumption [21].

Some bacteria pathogenic to humans are abundant in natural waters. These bacteria generally belong to the *Vibrio* and *Aeromonas* groups [22]. High levels of these agents in seafood pose a threat to public health. In seafood processing plants, workers contaminate products with pathogens such as *Staphylococcus aureus* during manual processing. A significant proportion of pathogens, particularly enteric viruses, are transmitted from produce to humans. Most fish parasites can cause disease while still in the larval stage. Fish parasites are transmitted to humans in various ways and have even been reported to cause death. Proper cooking and freezing methods prevent the transmission of pathogenic parasites to humans. The risk of spreading parasitic infections varies depending on the specific risks involved. We can list the disease-causing agents transmitted to humans through seafood that seriously harm human health as follows: bacterial agents, parasitic agents, and fungal agents [23].

Certain dishes prepared from fish, particularly those made with raw or undercooked fish, can pose certain risks to human health. Dishes such as sushi, sashimi, and carpaccio, which have become popular worldwide in recent years, are primarily made from raw fish; consequently, microbes, parasites, or harmful bacteria present in the fish can be directly transmitted to humans. Living in the intestine, these parasites can cause issues such as abdominal

pain, nausea, loss of appetite, weight loss, and allergic reactions. In some cases, these parasites can circulate through the body, leading to serious problems and sometimes even damage to internal organs. For example, microorganisms known by names such as *Aeromonas*, *Vibrio*, and *Salmonella* can cause gastrointestinal disorders, diarrhea, high fever, and sometimes even serious infections. These risks are particularly dangerous for children, the elderly, pregnant women, and individuals with weakened immune systems. These risks increase further when seafood products are not stored properly, sufficiently cleaned, or adequately cooked. Experts recommend that if raw fish is to be used, it must be frozen, purchased from a high-quality, certified source, and prepared in strict adherence to hygiene standards. Otherwise, certain infections transmitted by fish could pose a serious threat to public health. Therefore, it is important to approach the consumption of sushi and other raw fish dishes with caution and to be well-informed about the matter [24].

In fish farming, preventive measures are taken to prevent the occurrence of fish diseases. The implementation of preventive measures begins at the stage of farm design. Disinfectants and vaccination methods are primarily used during preventive measures. Disinfectants used for preventive purposes are considered highly effective substances for preventing disease outbreaks on farms, while being virtually harmless to fish. Disinfection in fish farms is primarily carried out using substances such as table salt, potassium permanganate, chlorinated lime, iodophores (Baticon, Vanodine), sodium hypochlorite, sodium hydroxide, and formaldehyde. Formaldehyde (formalin) is considered the most widely used effective agent for preventive purposes on farms. Based on international experience and considering the carcinogenic effects of malachite green and methylene blue—substances classified as disinfectants, the use of such agents during fish farming is not recommended [25].

5. Conclusion

Fish belonging to the order Cypriniformes are ecologically and economically significant species in the Caspian basin and associated water bodies. The biological diversity of the species included in this group and their large-scale cultivation in aquaculture simultaneously increase the risk of the spread of various infectious and parasitic diseases. Research results indicate that the most common diseases in cyprinids are of bacterial (aeromonosis, pseudomonosis, mycobacteriosis), viral (koi herpesvirus – KHV, fishpox), parasitic (ichthyophthiriosis, trichodinosis, myxosomatosis, diphyllbothriasis, anisakiasis), and fungal (saprolegniasis, ichthyosporidiosis, branchiomycosis) origin. The emergence of these diseases is closely linked primarily to deteriorating water quality, unsatisfactory zoohygienic conditions, unbalanced nutrition, stress factors, and weak immune response.

Anthropogenic changes in the environment, particularly pollution, the disruption of thermal regimes, and oxygen depletion, create conditions conducive to the activation of pathogenic microorganisms. In addition, intensive fishing activities and uncontrolled fish transfers play a significant role among the factors contributing to the epizootic spread of diseases. A comprehensive approach is required for control measures. Key methods include the use of antibacterial and antiparasitic drugs, disinfection of the aquatic environment, isolation of sick fish, and regular veterinary monitoring. However, these approaches are sometimes insufficient and result in pathogens developing drug resistance. However, these approaches are sometimes insufficient and result in pathogens developing drug resistance.

There are certain proposals listed below:

- The application of molecular and immunological methods for the diagnosis of diseases observed in catfish-like fish must be expanded.
- Biosecurity protocols must be developed for fish farms, and their implementation must be monitored.
- Veterinary inspection must be mandatory before fish products are placed on the market.
- An epizootiological monitoring system must be established at local and regional levels, and data on diseases must be collected and analyzed in real time.
- Strict control and awareness-raising measures must be implemented to preserve ecological balance, particularly to protect water bodies from anthropogenic pollution.

- Continuous training and professional development programs should be organized for fish farm owners and employees.
- Research activities and scientific collaborations should be expanded, and the exchange of information and technology with local universities and international institutes should be strengthened.

Ultimately, effective control of diseases affecting cyprinids is possible only through a comprehensive approach, scientifically grounded management, and preventive measures. This is also a crucial prerequisite for the sustainable development of the aquaculture sector and for supplying the population with healthy and safe fish products.

Author Contributions

The author conceived and designed the study, conducted the research, analyzed the data, and wrote the manuscript.

Conflict of Interest

The author(s) declare no conflicts of interest.

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