

Economic loss by koi virus in aquarium fishes: their control in food security, Pakistan

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ABSTRACT

The highly infectious viral outbreak known as cyprinid herpesvirus 3 (CyHV-3) affects common carp and koi carp causing significant economic losses and put Pakistan's aquaculture and food security at high risk. The virus primarily affects fish farmers and traders by spreading in warmer water and producing significant mortality rates in both ornamental koi fish and feeding fish. This article provides a comprehensive overview of the symptoms, economic impact and control measures related to KHV focusing on its effects in Pakistan. Lethargy, respiratory distress, skin lesions and high mortality within days are all symptoms of infection in fish which can cause epidemics that wipe out entire populations. The trade in ornamental fish where koi are a valuable and common carp aquaculture which is essential for producing affordable protein are severely impacted economically. The effects on food security as fish prices are affected by KHV caused shortages and limiting low-income populations' access to vital protein. Strict biosecurity procedures, early detection in quarantines, active vaccination research and other control measures are required to reduce the effects of KHV and ensure the long-term viability of Pakistan's aquaculture sector.

Keywords: Viral infection, Cyprinid herpesvirus3 (CyHV3), Sustainable aquaculture, *cyprinus carpio*, Gill necrosis

Introduction

A highly infectious virus known as koi herpesvirus (KHV) or cyprinid herpesvirus 3 (CyHV-3) adversely affects both koi carp (*Cyprinus carpio koi*) and common carp (*Cyprinus carpio*) [1]. Since its first discover in the late 1990s, KHV spread throughout the aquaculture industry across the world leading to economic losses in the production of both decorative and food fish [2]. For example, in Pakistan, where carp is a popular species for aquaculture and a vital source of protein for millions of people this disease seriously threatens the aquaculture industry's long-term survival [3]. The virus is more common in warm water environments and can cause high mortality rates in infected fish populations exceeding 80–90%. Pakistan's increasing dependence on aquaculture for food security and economic growth the outbreak of KHV presents a significant challenge to the country's aquaculture and ornamental fish trade [4].

Life span of koi fish

In ideal conditions, koi carp can live for over 25 to 35 years with some specimens surviving for over 50 years [5, 6]. They are highly valuable in the ornamental fish trade because of their longevity as well as their vibrant colors and unique patterns. Raised for ornamental purposes, koi carp also have symbolic meaning in many cultures, symbolizing power, prosperity, and good fortune. Koi fish are being raised for ornamental purposes more and more in Pakistan. On the other hand, common carp are an essential component of Pakistan's aquaculture industry. Thousands of fish farmers make their living from carp farming, which offers local populations an inexpensive source of protein [7]. Any disease that affects common or koi carp has a significant impact on the nation's food security as well as the decorative fish trade.

Disease outbreak

Overcrowding, poor water quality, environmental stresses, and sudden fluctuations in temperature in the water are common causes of koi herpesvirus (KHV) outbreaks [8]. Via direct contact with diseased fish, contaminated water and shared equipment, the virus is extremely dangerous. Virus can also be introduced into healthy populations by infected koi carp that don't exhibit any symptoms as ornamental fish are traded globally. This is an important concern for countries like Pakistan which import large quantities of ornamental fish without stringent quarantine measures [9]. In warm water environments with temperatures between 18°C and 28°C KHV can spread rapidly once it is introduced into a population. High stocking numbers in fish farms where stress levels are already high can make these outbreaks worse. The initial symptoms of infection appear within a few days and if nothing is done immediately an entire population can completely decline in a few weeks [10].

Prevalence of KHV

Koi herpesvirus or Cyprinid herpesvirus 3 (CyHV-3) poses a major hazard to both common carp and koi carp and causes higher economic losses in aquaculture. This virus was the primary cause of the Koi herpesvirus disease (KHVD) in the late 1990s, a condition marked by significant mortality rates

among infected fish. This virus is part of the *Alloherpesviridae* family has been reported in Iran since 2021 and has a wide host range [11]. KHVD manifests with severe gill necrosis, skin lesions and abnormal swimming behavior in affected fish. CyHV-3 has a large genome of approximately 295 kbp encoding several unique genes and proteins. Despite advances in understanding its molecular characteristics and genomics the virus' rapid spread and high infectivity pose ongoing challenges. Effective biosecurity measures and monitoring are crucial to mitigate the impact of CyHV-3 on the aquaculture industry and protect against its further spread [12, 13].

Symptoms of koi herpesvirus (KHV)

Koi herpesvirus (KHV) infection in koi carp and common carp presents with a variety of Symptoms often result in rapid mortality. Affected fish typically become lethargic, showing reduced activity and abnormal swimming behavior moving erratically or appearing disoriented. One of the early signs is respiratory distress marked by rapid gill movement or gasping for air at the water's surface as the virus primarily targets the gills causing them to become pale, patchy or necrotic [14]. Physical symptoms include sunken eyes (enophthalmos), excessive mucus production and skin lesions around the gills and fins. These lesions may appear as red or ulcerated patches. Infected fish lose their appetite, weakening them and accelerating the progression of the disease. The combination of respiratory distress, physical deterioration and behavioral changes leads to high mortality rates exceeding 80-90% within a few days of the onset of symptoms [15].

Economic losses in Pakistan

KHV has an adverse effect on both the ornamental fish industry and aquaculture in Pakistan. The country's koi trade is still growing heavily from KHV outbreaks as koi is high-value ornamental fish. Farmers can lose entire stocks in days leading to substantial financial losses. Koi farming involves years of selective breeding to produce fish with specific appealing color patterns so an outbreak can destroy years of effort [16]. The losses are not limited to ornamental fish. The common carp is one of Pakistan's most important aquaculture species due to its adaptability and contribution to food security. A single KHV outbreak can wipe out large populations of carp reducing the supply of protein in local markets. This creates financial strain on fish farmers who must replace their stock invest in biosecurity measures and deal with lost income during recovery periods [17]. Direct losses in KHV affect export opportunities. Countries with stringent biosecurity regulations often ban imports of fish from regions experiencing KHV outbreaks [11].

Implications for food security

As affordable fish is the main source of protein for low-income population KHV directly affects Pakistan's food security. The KHV outbreaks have caused a significant decrease in common carp production which has reduced fish supply in local markets, increased prices and decreased availability to fish for those who need it most [18]. This is particularly challenging in rural regions where fish farming provides food and income. Protein consumption in the diet decreases when fish supplies decline, leading to deficiencies in nutrition in vulnerable communities. Pressure on the countries' food supply chains could increase if fish prices rise and people

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become more dependent on other options or less sustainable protein sources like chicken or red meat [6].

Control measures

Monitoring KHV outbreaks requires a diverse strategy. The first line of defense is biosecurity which requires strict protocols to prevent the virus from being introduced and spreading. Since stress and unfavorable conditions promote the growth of KHV fish farms should make sure that the water quality is ideal and avoid overcrowding in ponds [19]. To stop infected carriers from spreading the virus new or imported fish must be quarantined for at least 4 to 6 weeks before being introduced into existing populations [20]. Regular monitoring of water temperature and maintaining it below 15°C can help to control the virus, it does not eliminate it entirely. While several experimental vaccinations have shown potential in decreasing mortality rates research into KHV vaccines remain ongoing and vaccine access in Pakistan remains limited [4]. Regular health tests are essential for early detection since they enable the isolation of diseased fish and stop the spread of the infection [21]. To stop KHV outbreaks fish farmers need to get public education and training on biosecurity precautions, disease detection and optimal farm management techniques [20]. In countries such as Pakistan that import koi carp from areas where KHD disease is common international cooperation and regulation are required to implement quarantine guidelines for imported ornamental fish [22].

Conclusion

Pakistan's aquaculture and ornamental fish industries are seriously threatened by the koi herpesvirus (CyHV-3) which might result in major economic losses and risk of food security. High mortality rates in common carp and koi carp affect both the common carp farming industry and the decorative trade lowering the supply of fish and higher prices. It is essential to implement strict biosecurity measures including as quarantine, water quality control and early identification. The development of vaccinations gives hope for long-term management. To preserve livelihoods and ensure the population has access to affordable protein fish stocks must be protected from KHV.

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