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# Review of Brucella in Fish and Aquaculture Environments

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## Abstract

Brucellosis is the zoontic disease mainly connected with land mammals and brought about by bacteria of the genus Brucella. This paper unifies recent data on fish brucellosis emphasizing its epidemiology, clinical signs, individual treatment approaches, and public health importance. In this region, there is a typical habit of throwing carcass waste in the Nile channels which can bring zoonotic pathogens such as Brucella melitensis to the aquatic environment thereby exposing fish to infection. This work was carried out to isolate and identify B. Melitensis from Nile catfish (Clarias gariepinus). Skin swabs and internal organ samples (liver, kidney, spleen) were taken from all seropositive fish to attempt the isolation of B. Melitensis biovar 3. Polymerase Chain Reaction (PCR) was carried out as confirmation for the bacterial identity. To the best of our knowledge, this is the first reported isolation of B. Melitensis biovar 3 from brackish water fish species; this finding may indicate a potential role in the transmission and epidemiology of brucellosis pertaining to reservoirs in aquatic environments Public awareness campaigns and responsible citizens should address issues related to jettisoning animal waste into water bodies and consider its implicit involvement through fish as a source of fatal infection.

**Keywords**: Antibiotic; Brucella; Fish; Public health

## Introduction

Aquaculture and fish product are increasing contributions to the ecosystem, food security, and nutrition of the population (Choudhary, *et al*., 2025). According to the Food and Agriculture Organization (FAO) fish consumption has significant growth contributed to bettered diets encyclopedically by furnishing a different and nutritive food source (Thilsted, *et al*., 2014).

Infections can jump from animals to humans or vice versa, which is what we call zoonotic diseases (Shaheen and M.N., 2022). Zoonotic pathogens encompass a variety of bacteria, parasites, viruses, fungi, and protozoa (Rahman *et al*., 2020). One well-known bacterial pathogen with zoonotic potential is brucellosis, an infection caused by the Brucella species, which can affect both cold-blooded and warm-blooded animals, including humans (Madzingira and O., 2021). Brucellosis is specifically caused by Brucella bacteria (Moreno *et al*., 2020). These bacteria are coccobacillary in shape and stain gram-negative (Uluçay and O., 2023). The Brucella genus consists of six species: Brucella melitensis, Brucella abortus, Brucella suis, Brucella canis, Brucella neotomae, and Brucella ovis. Brucellosis bacteria can survive inside host cells, which make it tough for antibiotics to penetrate and work effectively (Qureshi *et al*., 2023). Currently, there are no standardized treatments specifically approved for fish brucellosis (Qureshi *et al*., 2023).Brucellosis, caused by colorful Brucella species, is a complex zoonotic complaint that requires accurate and early opinion, likes Culture, maldi- tof ms, elisa, luminescence Polarization Assay, Western Blotting to control outbreaks and initiate effective tre atment(Qureshi, *et al*., 2023).

In recent years, there's been growing evidence that Brucella species can also infect marine and underwater creatures, including fish (Dadar *et al*., 2022). Fish brucellosis is becoming a significant concern for marine animal health and has implications for both aquaculture and public health (Zhang *et al*., 2024). While infections in fish are relatively rare compared to those in mammals, they have been reported in various parts of the world (Simpson *et al*., 2021). The aim of this study review was to explore the prevalence, pathogenic traits, and potential zoonotic risks of Brucella species in fish. It focuses on identifying sources of infection, evaluating the impact on marine health and food safety, and aims to enhance our understanding of how Brucella spreads in aquatic environments, ultimately informing relevant biosecurity and public health measures.

## Literature Review

### History of Fish Brucellosis

Fish brucellosis is a relatively recent finding in the world of animal diseases, especially when you compare it to classical brucellosis, which has been under the microscope for much longer (Moreno, *et al*., 2022). While we've known that Brucella spp. can be harmful to both, livestock and humans, their impact on aquatic life, particularly fish, has only come to light in the last few decades (González-Espinoza, *et al*., 2021). The genus Brucella was first linked to "malta fever" in humans back in the late 19th century (Moreno, and E., 2021). For many years, it was believed that brucella only affected mammals like cattle, sheep, and goats (Godfroid, *et al*., 2012). However, in the 1990s and 2000s, new species such as brucella setty and brucella pinpadialis




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were discovered, expanding the range of hosts to include not just marine mammals but also terrestrial species.

## Epidemiology of Fish Brucellosis

In Egypt, researchers conducted a study that isolated Brucella Melitensis Biover 3 from Neel Catfish (Clarias gariepinus) in both wild and farmed populations (Henshaw *et al*., 2025). Serological tests revealed that approximately 9.2% of the wild catfish tested positive for antibodies against the bacteria. The bacteria were successfully cultured from various tissues, including the skin, liver, kidneys, and spleen (Dakar and D.R., 2019).

## Clinical Manifestations in Fish

While we don't know a lot about how brucellosis impacts fish, we do know that we can find bacteria in various parts of their bodies, suggesting they could be dealing with infections throughout their system (Rothschild, *et al*., 2023). It's also worth noting that marine mammals can suffer from Brucella infections (Dryland, *et al*., 2018). These infections can lead to issues with reproduction, brain function, and overall health in marine mammals (Vargas-Castro, *et al*., 2023).

## Public Health Implications

The presence of Brucella spp. in fish raises concerns about the potential for zoonotic transmission to humans, particularly through the consumption of contaminated or undercooked fish products (Ziarati *et al*., 2022). Frequent outbreaks can damage the reputation of aquaculture producers or regions, leading to long-lasting economic consequences (Ranches-Fernandes *et al*., 2022). The introduction of Brucella to aquatic life can be exacerbated by the practice of dumping animal waste into water bodies in areas where brucellosis is prevalent in livestock, such as Egypt (Henshaw *et al*., 2025). If fish from an infected region are perceived as unsafe, it could lead to a decline in consumer confidence, resulting in lower demand and prices (Bedane *et al*., 2022).

## Brucella Shedding in Human Waste

When it comes to active or untreated infections, people infected with Brucella spp. can actually shed the bacteria through their urine and feces (Thendji, and M.L., 2023). Factors like open defecation, overcrowding, and unregulated fish farming raise the chances of fish coming into contact with these bacteria (Harikrishnan, *et al*., 2024). Areas that are peri-urban or resemble slums, where humans, fish, and animals coexist closely, are especially vulnerable (Battersby, *et al*., 2024). Unfortunately, due to a lack of proper monitoring, we don't have precise data on the human population levels that correlate with fish infection rates in these regions; however, it's likely that fish are experiencing higher rates of infection (Bondad-Reantaso, *et al*., 2023).

## Impact of Hospitals on Fish Brucellosis

Hospitals can play a surprising role in spreading or maintaining pathogens in our water systems, mainly through things like wastewater discharge, antibiotic pollution, and poor biohazard management (Yuan *et al*., 2023).

These issues can have a negative impact on fish health and the balance of ecosystems, which might increase the risk of opportunistic infections such as fish brucellosis (Samsing *et al*., 2024).

## Environmental Impact of Fish Brucellosis

Fish brucellosis, caused by Brucella species or similar organisms, is becoming a growing concern not just for the health of fish but also for its broader ecological and environmental effects (Shields, and M.M., 2025). When wild fish populations get infected, it can lead to chronic illnesses, reproductive issues, or increased mortality rates, all of which can disrupt population dynamics (Chapman, *et al*., 2021). Endangered or at-risk fish species might be particularly susceptible, especially in ecosystems already stressed by factors like pollution and temperature changes (Bănăduc, *et al*., 2022). Brucella can also affect other aquatic life, including marine mammals and invertebrates, either through food web connections or by acting as reservoirs (González-Espinoza, *et al*., 2021). While still not fully understood, several effects have been observed or are believed to pose risks to ecosystems, which ultimately impact fish health and the economic sustainability of fisheries and aquaculture (Ibáñez, *et al*., 2023). Additionally, the environmental antimicrobial resistance (AMR) can arise from the overuse of antibiotics to treat these infections (Bungau, *et al*., 2021).

## Livestock Exposure Pathways

Livestock often drink directly from canals or rivers that are contaminated with the remains or waste of infected fish (Al-Kaabi, *et al*., 2024). When livestock graze near fish ponds or canals, they might come into contact with infected plants or soil (Madsen, *et al*., 2015). In some regions, fish or fish byproducts are added to the feed for poultry or ruminants, which could potentially introduce pathogens (Alao, *et al*., 2017). The risk of spreading pathogens increases when animal enclosures are situated close to fish ponds, open water systems, and when biosecurity measures are lacking (Subasinghe, *et al*., 2023). While Brucella spp. are usually associated with land animals, the discovery of Brucella in fish raises the possibility of transmission from aquatic to terrestrial environments, particularly in areas where water sources are shared by both livestock and aquatic ecosystems (Bowden, and S.E., 2016).

## Impact of Abattoirs on Fish Brucellosis

Slaughterhouses, also known as abattoirs, play a crucial role in the meat industry, but they also contribute significantly to environmental pollution, especially when waste isn't managed properly (Ovuru, *et al*., 2024). Brucella spp. are commonly found in livestock, particularly in cattle, sheep, goats, and pigs, making slaughterhouse waste a potential source of these bacteria entering the environment—and possibly affecting aquatic systems where fish could be at risk (Sattar, *et al*., 2023). If cattle are infected, the waste produced, including wastewater, blood, fetal tissues, and internal organs, often contains high levels of Brucella (Pal, *et al*., 2020). The rise and spread of fish brucellosis are significantly influenced by abattoirs through environmental pollution, poor waste management, and interactions with integrated aquatic systems (OCHIENG, and G.O., 2023).

## Importance of Pet Animals in Fish Diseases

When we think about pet animals like cats, dogs, and even decorative fish, we don't usually link them to the spread of fish diseases. However, they can play a significant role—both directly and indirectly—in the epidemiology and management of these diseases (Ziarati, *et al*., 2022). For instance, cats and dogs that have access to

seafood waste, fish ponds, or aquariums can act as carriers of diseases (Duman, *et al*., 2024).

### Impact of Migratory Birds on Fish Brucellosis

Migratory birds embark on incredible journeys, traversing vast distances across various ecosystems and continents. Along the way, they often make pit stops at fish farms, lakes, rivers, and wetlands (Donnelly, *et al*., 2021). These birds, moving between areas that are infected and those that are not, can link distant ecosystems and serve as carriers for diseases (Ishtiaq, *et al*., 202). This migration might even expand the geographical reach of Brucella species or similar organisms that can infect fish or contaminate water (Waldrop, and S.G., 2020). By spreading pathogens across different regions, polluting water sources, and disrupting bio-secure aquaculture systems, migratory birds could play a role in the environmental spread and indirect transmission of fish brucellosis (Pinto J, *et al*., 2020).

### Impact of Rain on Fish Brucellosis

Rainfall plays a significant role in shaping the ecology and the spread of infectious diseases in aquatic environments (Yadav *et al*., 2023). It influences both, direct and indirect factors that can lead to the emergence, persistence, or spread of Brucella species (Darbandi *et al*., 2023). Heavy rain can cause runoff from nearby farms, slaughterhouses, sewage systems, or animal facilities into rivers, ponds, or aquaculture systems (Yadav *et al*., 2023). This runoff can carry Brucella bacteria or fecal matter from infected land animals into fish habitats (Paruch *et al*., 2022). By facilitating the introduction of pathogens, lowering host tolerance, and disrupting regulated systems like aquaculture farms, rainfall heightens the risk of fish brucellosis as an environmental factor (Mugwanya *et al*., 2022). As climate change continues to increase rainfall variability, the risks associated with rain-driven disease outbreaks may escalate, underscoring the need for integrated water management and biosecurity strategies in aquaculture and fish health programs (Rub *et al*., 2024).

### Impact of Urbanization on Fish Brucellosis

Urbanization, which refers to the growth of cities, increased human activity, and environmental changes, significantly impacts fish health and aquatic ecosystems (Freeman, *et al*., 2019). This urban expansion can lead to the rise and spread of fish brucellosis through various management, environmental, and ecological factors (Negi, and S., 2024). Urban runoff often contains untreated sewage, industrial waste, animal excrement, and organic pollutants that may harbor Brucella spp. or other harmful pathogens (Polley, *et al*., 2022). In polluted waters, infectious agents can thrive, increasing the risk of exposure for both wild and farmed fish (Saha, *et al*., 2023). The development of urban areas often destroys vital natural habitats, such as spawning grounds and wetlands (Chakraborty, *et al*., 2023). If proper bio-security measures aren't implemented, Brucella and other pathogens can spread more easily among fish and potentially to humans (Subasinghe, *et al*., 2023).

### Impact of Deforestation on Fish Brucellosis

Deforestation, which refers to the large-scale clearing of forests for purposes like logging, development, or agriculture, has significant effects on ecosystems, including aquatic ones (Maurya, *et al*., 2025). While fish brucellosis is still a relatively new and not well-understood disease, deforestation changes environmental conditions, animal behaviors, and disease dynamics, potentially aiding in its spread and persistence (Biswas, *et al*., 2023). Bacteria like Brucella spp. can enter aquatic ecosystems through runoff, which carries organic waste, pathogens, and animal waste into rivers, lakes, or fish farms (Koyun, *et al*., 2023). The negative impacts of deforestation on natural aquatic environments include disruptions to food chains, increased sedimentation, and decreased water quality (Kong, *et al*., 2022).

These stressors weaken fish immune systems, making them more susceptible to diseases like brucellosis (Inbaraj, *et al*., 2022). Additionally, the removal of trees affects oxygen levels and water temperatures, putting further pressure on aquatic life (Wang, *et al*., 2022). When forests are cleared, animals such as wild ruminants or rats may venture closer to human settlements or water sources (Fackelmann, *et al*., 2021). Aquaculture operations that begin in deforested areas often lack proper biosecurity measures, share water with wild animals, and can create conditions that promote fish brucellosis if not carefully managed (Saba, *et al*., 2024).

### Economic Significance of Brucellosis in Fish

When fish get infected, it can lead to immediate financial setbacks for fish farmers. This happens because of higher death rates, less efficient feed conversion, and slower growth (Mukaila, *et al*., 2023). A significant amount of resources is required for diagnosing, monitoring, and implementing biosecurity measures to stop the spread of Brucella spp. in aquaculture systems (Subasinghe, *et al*., 2023). If zoonotic pathogens like Brucella are found in fish products, it could lead to trade bans or restrictions from importing countries, which can seriously affect a nation's export revenue (Berhanu, *et al*., 2020). Frequent outbreaks can damage the reputation of aquaculture producers or regions, leading to long-term economic repercussions (Gosh, *et al*., 2022).

### Vaccine

Fish vaccines come in various forms, including DNA vaccines, bacterines, live-attenuated vaccines, virus-like particles, and protein-based options (Sivakumar, *et al*., 2023). A growing trend is the use of autogenous vaccinations, which can be given through intramuscular, intraperitoneal, or oral routes, as well as through feed using top dressing techniques. Attenuated vaccines are made from microbes that have been chemically or genetically weakened, leading to temporary immune responses in the host. These include live viruses and bacteria that have lost their ability to cause disease (O'Connell, *et al*., 2020).

Recombinant vaccines focus on using just the immunogenic parts of the pathogen to immunize a different host (de Pinho Favaro, *et al*., 2022). Interestingly, these recombinant vaccines can also be derived from genetically modified organisms (like bacteria or viruses) that are less harmful, making them both recombinant and attenuated (de Pinho Favaro, *et al*., 2022).

DNA vaccines, which consist of plasmids containing a pathogen's antigen, have gained attention as a potential way to boost fish immunity against diseases (Hølvold, *et al*., 2014). By injecting viral genes that produce surface glycoproteins into fish muscles, aquaculture researchers have been able to enhance resistance to VHSV and IHNV (Rathor, *et al*., 2024).

### Impact of Treatment on Fish Brucellosis

Fish brucellosis is a bacterial infection that poses serious challenges for antimicrobial resistance, disease management, and the sustainability of aquaculture (Mzula, *et al*., 2021). Brucella spp. are intracellular bacteria, which complicates the treatment of infected fish with standard antibiotics(Haenen, *et al*., 2023). Unfortunately, information about which antibiotics work against aquatic Brucella strains is often limited (Munang'andu, and M., 2024). Misuse of antibiotics in fish can lead to antibiotic resistance not just in Brucella, but also in other aquatic microorganisms (Haenen, *et al*., 2023). Moreover, antibiotics that are not fully utilized or are excreted can accumulate in sediments and water, potentially harming aquatic ecosystems (Maghsodian, *et al*., 2022).

## Diagnostic

### Serological

Detecting antibodies against Brucella spp. in fish serum is usually done through the Rose Bengal Test (RBT) and the Rivanol test (Riv T) (Masola *et al*., 2023). Various studies have assessed the seroprevalence of brucellosis in fish populations using these methods (Shi *et al*., 2021). Serological techniques play a crucial role in diagnosing brucellosis, with the strongest immunological responses noted in different hosts when using LPS smooth chains (Ren *et al*., 2021).

### Bacteriological culture

While blood culture remains the gold standard for diagnosing bacterial infections like brucellosis, this method proves to be quite effective (Qiangsheng, *et al*., 2023). To isolate Brucella spp. from fish tissues such as the liver, kidney, spleen, and skin, samples are cultured on selective media (Carvalho, *et al*., 2023). This technique allows for the detection and confirmation of the bacterium's presence.

### Molecular techniques

To get a definitive diagnosis, we amplify specific brucella DNA sequences through Polymerase Chain Reaction (PCR) tests. Interestingly, marine brucella species in fish have also been identified using real-time quantitative PCR, which provides both sensitivity and specificity (Liu *et al*., 2024).

## Conclusion and Recommendation

Fish brucellosis, which is caused by Brucella spp. or similar organisms, is a rising and often overlooked illness in our aquatic ecosystems. While it has typically been associated with land- based livestock and humans, new research shows that fish and other aquatic species can also be affected. This raises significant concerns for public health, wildlife conservation, and the aquaculture industry. As we look to the future, here are some key priorities to focus on:

- Better monitoring and early detection,
- Exploring the range of hosts and how the disease spreads,
- Developing targeted treatments and diagnostic tools for fish,
- Strengthening biosecurity measures in aquaculture,
- Promoting responsible waste management and protecting the environment.

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