How Stress Fuels Disease in Fish: A Hidden Threat to Aquaculture

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ABSTRACT

Physiological stress and physical injury are the primary contributors to disease and mortality in aquaculture fish. Stress from overcrowding, poor water conditions, inadequate nutrition, and handling weakens fish immune systems, making them more vulnerable to pathogens. Stress triggers physiological responses that initially help fish cope but eventually lead to energy depletion and compromised immune defenses. Damage to the protective mucus, scales, and skin further increases susceptibility to infections. Prolonged stress weakens the production of antibodies, hindering the fish's ability to fight off diseases.

INTRODUCTION

Physiological stress and physical injury are the main factors leading to disease and mortality in fish within aquaculture systems. Stress refers to any physical or chemical elements that provoke bodily responses, potentially resulting in illness or death. While various disease-causing pathogens are constantly present in water, soil, air, or on fish themselves, wild fish are typically able to resist these pathogens and seek out optimal living environments. However, in commercial aquaculture settings, fish are confined to production units and often experience stress, which compromises their ability to resist disease. Stressors in these environments include overcrowding, suboptimal water conditions (such as low oxygen levels, unsuitable temperatures or pH, and elevated concentrations of carbon dioxide, ammonia, nitrite, hydrogen sulfide, and

organic matter), physical injuries from handling (such as during capture, sorting, or transportation), inadequate nutrition, and poor hygiene standards.

These conditions can weaken the fish's immune system, making them more susceptible to diseases and parasitic infestations. When fish experience stress or injury, it initially triggers a "fight or flight" response, which leads to several physiological changes. One of the key reactions is an increase in blood sugar due to the release of hormones from the adrenal gland, causing liver glycogen to break down. This provides a quick energy boost to help the fish cope with the perceived emergency. However, the same hormones also suppress the inflammatory response, which is the fish's natural defense against invading pathogens.

Additionally, stress affects the fish's ability to regulate water and electrolyte balance (osmoregulation). In freshwater fish, this leads to excessive water absorption (overhydration), while saltwater fish experience water loss (dehydration). As a result, more energy is required to maintain osmoregulation. Other stress responses include increased respiration, elevated blood pressure, and the release of reserve red blood cells into the bloodstream, all of which are part of the fish's effort to adapt to the stressful situation (Ciji & Akhtar, 2021)

Fish can tolerate stress for a certain period and may continue to appear and behave normally. However, over time, their energy reserves become exhausted, and hormonal imbalances develop. This weakens their immune system, making them more vulnerable to infections and diseases.

Mucus, or the slime layer, serves as the fish's first line of defense against pathogens, acting as a physical barrier that prevents harmful organisms from entering the body. Additionally, it functions as a chemical barrier, containing enzymes and antibodies that can destroy invading pathogens. Mucus also helps lubricate the fish for smoother movement through water and plays a critical role in maintaining proper osmoregulation.

However, handling-related injuries (such as during capture or transport) and exposure to certain chemicals (including poor water quality or disease treatments) can damage or remove this protective layer. When the mucus is compromised, its ability to act as a barrier against infections is diminished, just when the fish needs it most. This damage not only reduces the slime layer's chemical defenses but also leads to excessive water absorption in freshwater fish and dehydration in saltwater fish. With reduced lubrication, fish must exert more energy to swim, further depleting their already low energy reserves.

Scales and skin serve as a vital physical barrier that protects fish from external threats. These protective layers are often damaged by handling, contact with rough surfaces in tanks or cages, and conflicts caused by overcrowding or reproductive behavior. Parasite infestations can also lead to injury to the gills, skin, fins, and loss of scales.

When scales and skin are damaged, fish become more vulnerable to infections. The damage also results in osmotic stress, where freshwater fish absorb too much water and marine species lose excessive amounts of water. In cases of severe parasitic infestation, fish are at higher risk of bacterial infections, as these pathogens can enter the body through the compromised areas of the skin. This can lead to increased mortality if not properly managed.

Inflammation is a natural immune response by the body's cells to foreign invaders such as bacteria, viruses, parasites, fungi, or toxins. It is marked by swelling, redness, and impaired function, and serves as a protective mechanism

that attempts to isolate and destroy the invading organism.

However, stress can trigger hormonal changes that weaken the inflammatory response. Temperature-related stress, especially from cold, can even halt immune activity altogether, removing this crucial defense against infections. Extremely high temperatures are also harmful to fish, making them more susceptible to diseases. Warmer water can promote rapid growth of certain pathogens while also reducing oxygen levels in the water. This, combined with an increase in the fish's metabolic rate and oxygen demand, further compromises their ability to fend off infections.

Unlike inflammation and other non-specific defense mechanisms, antibodies are specific compounds produced by the body to target and fight particular foreign proteins or pathogens. When a fish is first exposed to a pathogen, it begins to produce antibodies that help protect it from future infections by the same organism. Exposure to non-lethal levels of pathogens is essential for developing a strong immune system, as animals raised in sterile environments tend to have weaker defenses against disease. Young fish may have less developed immune responses than older ones, making them more vulnerable to environmental pathogens (Eissa and Wang, 2016)

Stress can hinder the production and release of antibodies. Temperature stress, especially sudden changes in temperature, significantly weakens the fish's ability to produce antibodies, allowing pathogens time to multiply and overwhelm the host. Prolonged stress further diminishes immune function, increasing the likelihood of infection by disease-causing organisms.

PREVENTIVE MEASURES

Effective management includes maintaining optimal water quality, minimizing injury and stress during handling, ensuring proper nutrition, and implementing good sanitation practices. The following management strategies can help reduce stress and prevent fish mortality.

WATER QUALITY

1. Avoid exceeding the fish carrying capacity in ponds and tanks.
2. Regularly monitor water quality parameters.
3. Keep dissolved oxygen levels above 5 mg/L. Although low oxygen levels may not be instantly lethal, they can stress fish and lead to delayed mortality.
4. Prevent the buildup of organic matter, nitrogenous wastes (such as ammonia and nitrite), carbon dioxide, and hydrogen sulfide.
5. Ensure pH, alkalinity, and temperature are suitable for the specific fish species.

HANDLING AND TRANSPORTING FISH

1. Use methods that reduce stress and physical injury during capture.
2. Whenever possible, opt for knitted mesh nets over knotted ones to prevent injury and loss of scales.
3. Handle fish swiftly and gently, prioritizing their well-being.
4. Limit the frequency with which fish are lifted from the water, and transfer them quickly when necessary.
5. Carry out harvesting, handling, and transporting during periods when fish are less vulnerable to stress and disease.

6. Ensure transport and holding tanks are spacious enough for fish to move freely and free of sharp edges or corners that could cause injury.

7. Maintain ideal water quality while capturing, transporting, and handling fish, particularly by ensuring high levels of dissolved oxygen for faster recovery after handling.

8. A salt concentration of 0.3% to 1.0% can be added to the transport water to help reduce osmotic stress and lower the risk of bacterial infections in freshwater fish.

9. Adding ice to the water during transport helps keep water temperatures from rising, which would otherwise reduce the water's oxygen-holding capacity and increase the fish's metabolic rate, thereby increasing oxygen demand.

NUTRITION GUIDELINES:

1. Provide a high-quality diet that fulfills the specific nutritional needs of the species.

2. Ensure an appropriate feeding rate, avoiding both overfeeding and underfeeding to maintain fish health.

SANITATION

1. Prevent disease-carrying fish from inhabiting the hatchery water source, such as reservoir ponds, springs, or streams. Promptly remove any dead fish from the production system as soon as they are detected.

2. Maintain proper sanitation by keeping equipment, ponds, and tanks clean. Disinfect containers, nets, and other tools to reduce the spread of parasites and diseases between fish populations.

3. Quarantine all new fish and monitor them for any signs of mortality, sending samples to a diagnostic lab to check for parasites and assess for viral and bacterial infections (Stevens *et al*., 2017)

CONCLUSION

Stress weakens a fish's natural defenses against pathogens, making them more vulnerable to disease. When an outbreak occurs, it's important to identify and address both the stress factors and the disease-causing organism. Resolving the stress factors should either precede or coincide with any chemical treatments for the disease. Such treatments are merely temporary solutions to slow the infection, giving the fish's immune system time to recover. Ongoing stress will lead to persistent disease issues. Preventing disease outbreaks is more cost-effective than trying to treat infected or dying fish.

REFERENCES

Ciji, A., & Akhtar, M. S. (2021). Stress management in aquaculture: A review of dietary interventions. Reviews in Aquaculture, 13(4), 2190-2247.

Eissa, N., & Wang, H. P. (2016). Transcriptional stress responses to environmental and husbandry stressors in aquaculture species. Reviews in Aquaculture, 8(1), 61-88.

Stevens, C. H., Croft, D. P., Paull, G. C., & Tyler, C. R. (2017). Stress and welfare in ornamental fishes: what can be learned from aquaculture? Journal of fish biology, 91(2), 409-428.