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STUDY OF FUNGUS IMPACT ON ZEBRA FISH IN AQUARIUM WATER

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ABSTRACT

Fungal infections pose a substantial threat to zebra fish *(Danio rerio)* aquariums, affecting both the well-being of the fish and the whole aquatic habitat. A total of 120 zebrafish were gathered. Fungal species were isolated and identified utilizing both morphological and molecular techniques. Zebra fish, highly valued for their robustness and utilization as model organisms in scientific investigations, are susceptible to fungal diseases like Saprolegnia. These pathogens might appear as white, cotton-like growths on the zebra fish's skin, fins, and gills. These illnesses not only harm the physical well-being of the fish but also weaken their immune systems, making them vulnerable to more infections and overall stress.

Keywords: Fungi, Health, Water quality, Infections, Saprolegnia

I. INTRODUCTION

The effect of fungus on zebra fish the quality of aquarium water is of great importance to both aquarists and researchers. Zebrafish (*Danio rerio*) are well-known for their robustness and striking stripes, which make them popular in domestic fish tanks and an essential model organism in scientific investigations. These little freshwater fish, indigenous to the waterways of South Asia, have garnered attention owing to their genetic resemblance to humans, their translucent embryos that enable research on development, and their low-maintenance requirements. Nevertheless, it is vital to keep ideal water quality in order to guarantee their well-being and lifespan. Fungi are a significant concern among the several illnesses that may impact aquarium ecosystems. They pose substantial risks to zebra fish by causing infections and disrupting the overall ecological balance.

Fungi are commonly found in water situations, where they typically coexist without causing harm as a component of the natural plant life. However, in some circumstances, such as when water quality is poor, there is overcrowding, or the health of the fish is weakened, fungus can take advantage and become harmful pathogens. Zebra fish are mostly affected by fungal infections produced by species such as Saprolegnia, which can result in significant health problems. Saprolegniasis, a prevalent fungal infection, presents as white, cottony proliferations on the skin, gills, or fins of the fish. This disease not only inflicts physical harm on the fish but also serves as a conduit for subsequent bacterial infections. Fungal infections can induce stress in zebra fish, leading to immunosuppression and increased vulnerability to other illnesses, so greatly affecting their general health and welfare.

The environmental factors that promote fungal development in aquariums are diverse but frequently interrelated. Elevated concentrations of organic materials, such as unconsumed sustenance and excretory byproducts, can facilitate the rapid growth and spread of fungi. Inadequate filtration and infrequent water changes can result in the buildup of these organic substances, which can serve as a favorable environment for the growth and reproduction of fungus. Moreover, variations in water temperature and pH can induce stress in fish, rendering them more susceptible to diseases. It is crucial to maintain proper water conditions in order to prevent fungal outbreaks. Consistently checking the quality of water and properly maintaining the tank are essential in reducing the potential dangers caused by fungus.

Furthermore, the existence of fungus in aquarium water can disturb the fragile equilibrium of the tank's micro-ecosystem, in addition to directly affecting the health of zebra fish. Aquariums are intricate, self-contained ecosystems where diverse microorganisms perform vital functions in preserving water quality. Beneficial bacteria play a vital role in the nitrogen cycle by transforming the hazardous ammonia found in fish waste into less dangerous nitrates. Uncontrolled growth of fungal populations can outperform or disturb these advantageous microbial communities, resulting in the decline of water quality and additional strain on the fish. The ecological imbalance has the potential to initiate a detrimental loop in which fish health deteriorates and water conditions worsen.

Furthermore, fungal infections in zebra fish can have further ramifications that extend beyond the animal's immediate health. Fungal infections can undermine the accuracy and consistency of experimental findings in research settings that employ zebrafish as model animals for studying human illnesses, developmental biology, and genetics. The presence of polluted water and fish carrying infections can result in inaccurate data, squandered resources, and extended durations for study. Hence, it is imperative to both avoid and effectively handle fungal infections, since this is not only vital for the well-being of the fish but also for maintaining the credibility of scientific research that depends on healthy zebra fish populations.

II. IMPACT ON ZEBRAFISH HEALTH

Infections caused by fungi can have a devastating effect on the health of zebrafish:

Physical damage to tissues and organs

Zebrafish commonly have apparent lesions or growths on their exterior surfaces, including as fins, gills, and the body, as a result of fungal infections. These lesions frequently manifest as white or cotton-like patches, suggesting the invasion of fungal infections on the fish's integumentary system. These physical signs indicate both the immediate presence of infections and underlying tissue damage. Fungi, such as Saprolegnia spp. and Achlya spp., have the ability to infiltrate the outermost layers of skin and underlying layers of skin in zebrafish, resulting in tissue death and the formation of ulcers. The deterioration of tissue integrity not only hampers the fish's capacity to maintain osmotic balance and thermoregulation but also undermines their

overall structural integrity. Fungal infections can advance internally in extreme cases, impacting critical organs such as the liver, kidneys, and spleen. The penetration of fungal hyphae into these organs might disturb their regular operation, resulting in organ failure and ultimately death. Hence, the detrimental effects of fungal infections on the physical well-being and survival of zebrafish are emphasized.

Impaired respiratory function

The respiratory function is vital for zebrafish, as they depend on effective absorption of oxygen from water to sustain metabolic activities. Fungal infections can directly hinder respiratory function by blocking gill filaments or affecting their respiratory epithelium. Fungal hyphae attaching to gill surfaces can hinder the movement of water through the respiratory membranes, resulting in a decrease in the efficiency of oxygen transport. As a result, zebrafish that are infected may show symptoms of respiratory distress, including heightened opercular movement, gasping at the water surface, or decreased swimming activity caused by a lack of oxygen. Extended periods of hypoxic environments might worsen the physiological strain on zebrafish, resulting in metabolic imbalances and reduced overall fitness. Therefore, the negative effect on the ability to breathe caused by fungal infections is a serious outcome that can greatly affect the health and survival of zebrafish in aquariums.

Secondary bacterial infections

Zebrafish with fungal infections are more likely to get secondary bacterial infections, which worsen their health problems and make the sickness more severe. Fungal infections compromise the fish's immunological systems, facilitating the growth of harmful microorganisms in favorable environments. Some common bacterial infections that are often seen alongside fungal infestations include Aeromonas spp., Pseudomonas spp., and Flexibacter spp., among other types of bacteria. These bacteria have the ability to cause more damage to tissues, worsen inflammation, and trigger systemic infections that further weaken the health of zebrafish. The symbiotic connections between fungal and bacterial pathogens give rise to a cycle of intensifying disease severity, which poses difficulties in treatment and leads to higher death rates in fish populations that are afflicted. Hence, the interaction between fungal and bacterial illnesses highlights the intricate dynamics of disease in aquarium ecosystems and stresses the significance of comprehensive techniques for managing diseases.

Reduced reproductive success

Zebrafish reproductive performance can be greatly affected by fungal infections, leading to disturbances in breeding habits and reducing fertility rates in tank populations. Infected individuals frequently indicate altered behavior, including diminished courting displays, reduced nest-building effort, or avoidance of possible mates. These changes in behavior can interrupt the coordination of reproduction and reduce the overall success of mating among breeding couples. Moreover, fungal infections can cause physiological stress that hampers the

development of reproductive organs, the generation of gametes, and the viability of embryos. This, in turn, results in reduced rates of successful hatching and survival of larvae. The combined impacts of decreased reproductive success can have significant consequences for preserving genetic variety and ensuring the long-term viability of confined zebrafish populations. Hence, it is imperative to tackle fungal infections in aquaculture environments, since this is crucial not just for protecting the health of individual fish, but also for promoting favorable reproductive results and ensuring long-term population resilience.

Increased stress and susceptibility to other diseases

Zebrafish experience considerable strain from fungal infections, which elicit physiological reactions that might compromise their immune system and heighten vulnerability to other illnesses. Fungal infections trigger the fish's stress response pathways, causing the production of cortisol and other stress hormones that regulate immune function. Persistent stress can inhibit immunological responses, compromising the fish's capacity to establish efficient defenses against fungal and other opportunistic infections. As a result, zebrafish who are diseased may become more susceptible to viral infections, parasite infestations, or environmental stresses, which can further weaken their health and capacity to recover. The combined effect of stress and increased vulnerability to diseases highlights the interdependence of physiological stressors in aquarium environments. This emphasizes the significance of comprehensive disease management strategies to reduce health risks and enhance the overall well-being of zebrafish populations.

III. REVIEW OF LITERATURE

Özcan, Filiz & ARSERİM, Neval. (2021) Over the past two decades, fungal infections affecting fish have gained significant importance. The traditional 'fungi' consist of representatives from many taxonomic kingdoms. There is a growing number of other environmental fungi that are being documented in ill fish, which further confirms the opportunistic behavior of many fungi. Fungal pathogens present in aquatic environments infect both young and mature fish, resulting in the deterioration of eggs and larvae. Fungal infections, typically occurring as a secondary infection in fish populations, take hold in lesions induced by mechanical harm from initial agents such as bacteria, viruses, and parasites. This subsequently alters the illness prognosis. Nevertheless, fungi have the potential to induce illness in several different situations. Certain individuals may exhibit a higher level of aggression and take on a more prominent role. Fungi can manifest as either exterior or interior infections, and can sometimes affect the entire body (systemic infections). Fungi can adversely affect reproduction by infecting fertilized eggs in spawning. Some types of fungus have the ability to thrive in improperly kept food and generate mycotoxins. Fungal illnesses, in general, are highly resistant to management or treatment once they have established themselves. Proactive measures are consistently the most effective remedy. Enhanced understanding of fundamental biology will aid in directing therapy and management strategies. This review

research aimed to offer insights into the fungal infections affecting wild or farmed fish that are brought to the market.

Younis, Gamal et al., (2019) This study aimed to examine the presence of fungi in the skin/fins, gills, and internal organs of two economically important freshwater fish species in Egypt. The identification of Saprolegnia parasitica was done using the amplification of Internal Transcribed Spacer (ITS1-ITS4) regions of ribosomal DNA, which is considered the reference method. A total of 500 samples from Oreochromis niloticus and Clarias gariepinus were analyzed for mycological investigations. The results showed that 148 (29.6%) fungal isolates were identified, belonging to 6 different genera. The most dominant species was Aspergillus niger, accounting for 51.3% of the isolates. Other genera identified included Saprolegnia spp. (16.2%), Penicillum spp., Alternaria spp. (10.8% each), Cladosporium spp., and C. albicans (5.4%). In addition, the skin and fins were the most impacted region, accounting for 55.4% of the total. The gills were the second most affected area, accounting for 18.9%. The internal organs were also affected, with the liver being impacted the most at 10.8%, followed by the kidney at 10.2%. The eyes and spleen were less affected, accounting for 2.7% and 2% respectively. The fall season had the highest prevalence of fungal infections (41.7%), followed by the winter season (36%). The groups of C. gariepinus that were challenged intraperitoneally with A. flavus, C. albicans, A. niger, and Cladosporium spp. showed the highest cumulative mortality rates, with percentages of 100%, 80%, 70%, and 70% respectively. On the other hand, the groups of intramuscularly challenged C. gariepinus with A. flavus, A. niger, and C. albicans exhibited the highest mortality rates, with percentages of 60%, 50%, and 50% respectively. Moreover, the preliminary identification of the 24 isolates indicated that they were likely Saprolegnia species. Thus, the combination of PCR test and partial sequencing of the ITS gene verified the identification of 9 representative strains of S. parasitica. This discovery validated the presence of medically relevant fungus species in freshwater fish species that are affected by illness.

As, Patel et al., (2018) In modern times, fish are utilized for both biomedical research and as a source of sustenance. The presence of chemical pollutants in marine habitats is a significant cause for worry. Like other plants and animals, fish can also suffer from a variety of illnesses. Freshwater fish provide as a significant protein source for populations in several regions. The practice of fish farming has experienced a significant surge in many regions around the globe during the past decade. The most common fish illnesses in pond fishes are bacterial hemorrhagic septicemia, lernaeasis, saprolegniasis, and anoxia. Fungal infections are a common occurrence in temperate fish. Water mould infections result in significant losses of freshwater fish and their eggs in both wild and industrial fish farms. While infection caused by microbial contamination does not commonly lead to disease, ecological stress can disrupt the equilibrium between potential pathogens and their hosts. Proactive measures are consistently the most effective remedy. The majority of infections may be effectively treated if detected in the early stages.

Liew, Nicole et al., (2017) Aquatic chytrid fungus pose a significant danger to global amphibian biodiversity due to their capacity to quickly spread across different regions and infect a diverse array of hosts. To address this risk, it is necessary to comprehend the spectrum of hosts that the chytrid fungus may infect. This understanding will help in identifying possible sources of infection and implementing improved biosecurity measures to protect unaffected areas. In this study, we expand our understanding of the types of hosts that the chytrid Batrachochytrium dendrobatidis may infect by showing that it can infect a non-amphibian vertebrate host, specifically the zebrafish. We have observed that mortality increases as the dose of chytrid increases. Additionally, we have demonstrated that chytrid is capable of infecting and reproducing on zebrafish tissue. Additionally, we demonstrate that infection characteristics, such as fin erosion, cell apoptosis, and muscle degeneration, are direct manifestations of the infection. The ability to infect the zebrafish is reliant on disturbing the microbiome of the fish. This emphasizes that, similar to what is commonly observed in amphibians, the presence of beneficial bacteria provides defense against this particular virus. Overall, our discoveries significantly broaden the limited range of tools that may be used to investigate the development of disease and the way the host organism responds to chytrid infection.

Lin, Tao et al., (2013) The widespread usage of pharmaceutical chemicals has the potential to contaminate bodies of water located in densely populated regions. Three sulfonamides were examined using an extended zebrafish (*Danio rerio*) toxicity test to assess possible hazards to fish eggs. Researchers looked examined the bio-toxicity of antibacterial sulfonamides at low concentrations by seeing how they affected eggs and larvae. The results showed that sulfonamides were hazardous to embryos and larvae, causing abnormalities in their development as well as disrupting their normal functions including heartbeats, spontaneous movements, and hatching. Even at low concentrations (0.001 mg/L), sulfadimidine was hazardous to zebrafish eggs and larvae; furthermore, there was a statistically significant difference between the exposed and blank control groups. Typical abnormalities, including as pericardial edema, yolk sac edema, hemoglutinations, tail deformities, and swim bladder anomalies, were observed in animals exposed to low concentrations of sulfonamide.

IV. RESEARCH METHODOLOGY

Zebra fish skin and gill swabs and water samples were gathered from several aquariums that had either already had or were suspected of having fungal infection. The collection and transportation to the laboratory for examination of 120 zebra fish were done under sterile circumstances to avoid contamination. Isolation and identification of fungal species were accomplished via the use of morphological and molecular methods. We checked the zebra fish for skin blemishes, fin rot, death rates, and behavioral changes to make sure it was healthy. To compare results between the infected and control groups, data analysis made use of statistical approaches. The investigation adhered to ethical requirements to guarantee the well-being of the animals.

V. DATA ANALYSIS AND INTERPRETATION

Table 1: Fungal species identified from water and fish samples

Fungal Species	Prevalence in Water (%)	Prevalence in Fish (%)
Saprolegnia spp.	45	50
Fusarium spp.	30	35
Aspergillus spp.	15	20
Penicillium spp.	10	10

The frequency of several fungus species found in zebrafish aquarium water and fish samples is summarized in the table. With 45% in water samples and 50% in fish samples, Saprolegnia spp. showed the highest occurrence, suggesting its major presence and possible effect on zebrafish health. After Saprolegnia, Fusarium spp. was found in 30% of water samples and 35% of fish samples, indicating a noticeable although significantly decreased occurrence. The total prevalence rates of Aspergillus spp. and Penicillium spp. were 15% and 10% in water samples, respectively, whereas they were 20% and 10% in fish samples. These results show that Saprolegnia and Fusarium are the most common types of fungal infections in zebrafish tanks, which means that there needs to be a plan to control these infections so that the fish don't become sick.

Table 2: Health impacts on zebra fish infected with fungi

Health Parameter	Infected Zebra fish	Control Zebra fish
Skin Lesions (%)	60	5
Fin Rot (%)	45	2
Mortality Rate (%)	25	2
Behavioral Changes (%)	40	5

Table 2 shows that zebrafish infected with fungus had significantly worse health outcomes than control fish that were not affected. The percentage of infected zebrafish that displayed skin lesions was 60%, which is much greater than the control group's 5% and indicates significant fungal damage to the integumentary system. This trend was observed across all health indices tested. The extent of tissue destruction caused by fungal infections was highlighted by the fact that 45% of infected fish had fin rot, whereas just 2% of controls did. The devastating effects

of fungal infections were further demonstrated by the much greater death rate (25%) among infected fish compared to controls (2%). Compared to controls, 40% of infected fish showed behavioral abnormalities including lethargy or changed swimming patterns, suggesting that the infection had broader physiological implications beyond what could be seen. These results highlight the seriousness of fungal infections in zebrafish and the critical need for efficient disease control measures in aquatic environments.

VI. CONCLUSION

The effects of fungal infections on the health of zebrafish in aquariums are highlighted in this study. Fungal species including Saprolegnia spp. and Fusarium spp. are widespread and pose a hazard to fish populations. These species can cause skin sores, fin rot, higher death rates, and behavioral abnormalities, among other harmful health impacts. The significance of adhering to ethical norms in animal research techniques, detecting and treating infections early, and rigorously maintaining water quality are highlighted by these findings as effective disease control strategies. Scientists and aquarium keepers can protect zebrafish populations, which are important for studying aquatic life and preserving biodiversity, from fungal infections by focusing on these areas.

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