

A Review of Fungal Pollution in Aquatic Ecosystems from Agricultural and Aquaculture Wastewater: The Nagavali River Case Study, India

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Abstract

Human activities—such as agricultural runoff, insufficient wastewater treatment, and industrial discharge—substantially contribute to fungal contamination in surface water bodies. This pollution poses serious health risks to humans and animals, particularly in rivers, lakes, and reservoirs. Pathogenic fungi like *Aspergillus*, *Candida*, and *Fusarium* are linked to numerous infections. The Nagavali River serves as an example of the localized effects of fungus pollution on public health. While regional insights are crucial, a global, integrative response is essential to address this growing issue. We advocate for a forward-looking strategy that blends advanced technologies with stringent environmental policies. Emerging tools—such as environmental DNA (eDNA) sampling, high-throughput and next-generation sequencing, biosensors, CRISPR-based diagnostics, microfluidics, artificial intelligence (AI), and machine learning—enable rapid, accurate detection and real-time tracking of aquatic fungal pathogens. Predictive analytics further enhance outbreak forecasting. To mitigate health risks, we propose a multifaceted global framework involving: Integrated Water Quality Management, Interdisciplinary Collaboration, Public Engagement, and Policy Innovation. Novel diagnostics and proactive measures not only safeguard water quality but also enhance food security and reduce disease burden. The Nagavali River case underscores the urgent need for sustainable, cooperative solutions that prioritize innovation and resilience in waterborne fungal disease management.

Keywords: eDNA sampling, fungal contamination, public health, waterborne infections, water treatment

Introduction

Water pollution is a new sort of pollution that is a major worldwide concern. It is harmful to both human and animal health. Chemical contaminants and waterborne illnesses are to blame for this (Lin et al., 2022). Fungi are a less well-known danger to water. Water safety and quality may be negatively impacted by them (Novak Babič et al., 2017). Fungus contamination in water is an increasing threat to human and animal health, according to recent research (Seidel et al., 2024). Human fungal infections are on the rise worldwide. The capacity of fungus to adapt and generate resilient spores is the reason for this.

Aquatic fungus infects humans, animals, and amphibians. It spreads via water. Species that look more animal-like are especially problematic. They may spread zoonotic diseases. These fungal diseases have far-reaching effects. They threaten individual health, ecosystems, and agriculture. They also harm public health systems. This study aims to gather the latest information on fungal infections in aquatic settings. It will cover their effects, traits, and geographic distribution. This is to provide a thorough grasp of this important problem.

According to Shearer et al., (2006), fungi are adaptable. They can live in both freshwater and saltwater. A key to their survival is their ability to produce hardy spores. Scientists have identified several fungi in aquatic environments. Which include species of *Aspergillus*, *Candida*, *Fusarium*, and *Cryptococcus* (Shearer et al., 2006; Bhat et al., 2022). Many studies have shown that these fungi exist in diverse settings and hosts (Shearer et al., 2006; Bhat et al., 2022). It is possible for most fungi to be opportunistic pathogens. They may infect humans and animals (Shearer et al., 2006).

Fungi live in many aquatic habitats. Including freshwater and marine ecosystems (Shearer et al., 2006). According to Shearer et al., (2006), their biofilms on surfaces boost their tolerance to stress and antifungal treatments. Water bodies' traits, such as depth, temperature, and salinity, impact the aquatic fungi. And other factors like dissolved oxygen levels, nutrients, and hydrodynamics (Ferrario et al., 2020). Most basidiomycetes are absent from aquatic environments. Most fungal species there have evolved to complete their life cycles in water. According to Shearer et al. (2006), fungi help produce humic compounds and recycle nutrients, like phosphorus and nitrogen, in water. Some fungi harm aquatic life. Others may improve water quality by bio transforming heavy metals and xenobiotics (Pietryczuk et al., 2017).

Fungal infections of aquatic species, especially fish and amphibians, are a serious threat. *Batrachochytrium dendrobatidis* and *Aphanomyces invadans* cause death in these cases. Recent studies have highlighted the ecological effects of these infections. The main focus on saprolegniosis in fish and chytridiomycosis in amphibians caused by *Batrachochytrium*. These infections are threaten aquaculture and biodiversity (Gozlan et al., 2014; Costa and Lopes 2022; Gozlan and Combe, 2023). These stress needs integrated methods. These findings are key to understanding and controlling fungal disease outbreaks in aquatic environments. Fungal infections can devastate aquaculture firms. Aquatic fishes in Asia and worldwide suffer from Epizootic

Ulcerative Syndrome (EUS). It's caused by *Aphanomyces invadans* (WOAH Aquatic Manual 2023). As such, fungi that live in freshwater and marine environments can pose a greater infectious threat to humans. They are the causative agents of the dermatophytosis, candidiasis and aspergillosis diseases. These disproportionately affect those who are immune compromised (Pradhan et al., 2020).

India's ecosystems, one of the major river Ganges to its coasts, favor aquatic fungi. They are diverse and varied. Research in the nation raises concerns about public health. It was recently even defined as an emerging river-, lake- and faucet-fungus (Mishra et al., 2023). Recent research has identified pathogenic genera such as *Aspergillus fumigatus*, in freshwater ecosystems of India. They are *Candida albicans* and *Cryptococcus neoformans*. These organisms cause diseases in humans and aquatic life (World Health, 2020). A 2014 study by Singh et al. It adds to the evidence that these microorganisms are in the country's freshwater ecosystems. It found a great diversity of aquatic fungi on the banks of the Ganges River in Varanasi, Uttar Pradesh. Fungal diseases are now a major global issue, per scientific literature. Their spread is hardly a natural occurrence. It is by all accounts the result of direct human action and climate change. Such pathogens can be very finely-tuned in the long term to acute pressures from a changing environment. As Lahlali et al. (2024) point out, warmth and moisture conditions (especially underwater) create an ideal environment for these pathogenic fungi to grow. In doing so, it increases the likelihood that they will inevitably go on to incur profound harms, both to our delicate aquatic ecosystems and by way of progressively more permissive regulations, our human healthcare systems as well. Runoff from both agricultural and urban development areas carries nutrient pollution, the excess of nutrients in our waterways, into our bodies of water. It fosters the growth of fungi. The mycotic virus chytridiomycosis is a prime example of this. It is wreaking havoc on frog populations and speeding up their global decline (Chew et al., 2024). Research shows we must develop systems to check and control waterborne fungal diseases. These illnesses are less studied than bacterial and viral threats. Their public health effects are unknown. Yet, they have a much greater impact on animals (Van Rooij et al., 2015).

Fungi are common and harmful in aquatic environments. But there is not enough research on their impact on human and animal health worldwide. Aquatic fungi vary in their geographic range, virulence, and adaptability. This research aims to Meta-analyze the health risks of aquatic fungal diseases. This study aims to gather and combine data on fungal infections in water. It will cover their prevalence, risk factors, and effects. It will use research from India and other countries. To find research gaps, it does a meta-analysis of existing data. This might help public health authorities better handle a new threat: invasive fungus.

Material and Methods

This study investigates fungal contamination in surface water through a systematic review and meta-analysis—widely recognized methodologies in environmental health

research. The objective is to elucidate the risks posed by pollution-driven fungal infections, which represent a significant threat to both human and animal health. Specifically, the study focuses on characterizing the occurrence and potential impacts of fungal pathogens in the Nagavali River, India.

Literature Search Strategy

In order to identify relevant published primary research studies, we conducted a systematic search in the bibliographic databases Web of Science, Scopus and EBSCO. To ensure a comprehensive search, we included a wide variety of key terms and covered a broad range of target group interventions. We searched these terms into the combinations listed above, using truncation symbols (*) and Boolean operators “AND” and “OR” to form our search strings. Most illuminating in this overview were the exploratory keywords “organic farming practice,” “ecologic farming practice,” and “biodynamic agriculture” as these were largely the spaces that have been most integral to the foundation’s and our collective long-term vision. For our hypothetical illustrative agricultural systems, we opted for straightforward language and named them “industrial agriculture,” and “ecological agriculture.” We would love to see a strong, deep culinary culture of all sorts of staple cereal crops — grown, eaten, celebrated — ranging from wheat, barley, oat, spelt, rye, rice, emmer, buckwheat, millet, triticale, fonio and quinoa. We got hands-on with a bunch of other fungal baddies, like... Deoxynivalenol, aflatoxin, beauvericin, fumonisin, ochratoxin + a ton more!

To make the search more targeted to include only more applicable studies, articles published in the English language within the timeframe of January 1992–November 2024 were included in the database search. (a) Each of the key studies was screened for further citations, and (b) authors of the included studies were contacted to inquire as to whether they had published results, or new data, publicly available. Excludes non-post 1992 publications cited in post 1992 citations. Our Supporting Information reference list 1 has a detailed list of all the contributing publications to the meta-analysis. Papers that were not in English were translated, either by authors or by scientific colleagues. There was no language restriction, meaning all published articles—even those published outside of English—were captured.

Inclusion and exclusion criteria for surface water opportunistic fungal studies

Studies using experimental, observational, or case-control techniques that investigated the virulence, prevalence, and ecological effects of opportunistic fungus in surface waters were the main focus of this review. Evaluations of fungal diversity, contamination patterns, and risk factors for infections related to taxa including *Aspergillus*, *Fusarium*, and *Candida* were all analyzed. Studies that used subpar techniques, included non-aquatic fungus, or lacked information necessary to identify fungal species were not included in the study. Descriptive-only studies were excluded, although all included research included results like fungus prevalence, species

diversity, and health impacts. Sensitivity analyses were conducted in situations of missing data, and any unclear information was discussed with the authors whenever feasible to guarantee a thorough comprehension of the dangers posed by aquatic fungus, which will be further explained.

Nagavali River- Case Study

The Nagavali River (formerly Langulya River) originates in the Eastern Ghats, Kalahandi district, Odisha, and flows 256 km, with 95 km in Andhra Pradesh before reaching the Bay of Bengal near Kallepalli village and Ganagalavani peta village (Figure 1). It is vital for irrigation and domestic use but faces environmental challenges. This study assesses water quality through sampling at Ganagalavani Peta village, The research area's latitude and longitude are (18.86250°N, 83.48083°E to 18.21360°N, 83.93222°E) (Figure 2).

This research evaluates the effects of water contamination in Ganagalavani Peta on the health and ecology of the area's residents. The source of the pollution is the Nagavali River. Primarily motivated by the key action illustrations we showcased from Figure 3, our first strategy was participant observation. Proven on thousands of contaminants & independently tested against NSF/ANSI 401 So, you know, you have to offset that with the gut wrenching conversations, a lot of this was it with a lot of the local stakeholders, farmers, aquaculture. What we found was a nightmare scenario—water samples from the river and nearby wells showed contamination from raw sewage and fertilizers. To what extent did the local community understand the risk? To find out, we conducted a number of surveys to get a handle on the level of knowledge that people had around waste management and water pollution. After this, we also had some very illuminating conversations with residents of the area. And then we dug into some local health records to see if any number of waterborne illnesses had a connection to the pollution issue. Our work, using both social and statistical methods, sought to understand the breadth of this troubling public health problem and its relationship to the area's wider social and economic context.

Result and Discussions

A total of twelve fungal species were identified across different seasons during a study conducted along the Nagavali River in the Srikakulam District of Andhra Pradesh (Table 1). These fungi exhibited opportunistic behavior, with the majority belonging to the genera *Aspergillus* and *Penicillium*. All isolated species possess pathogenic potential, particularly in immunocompromised individuals, where infection may occur primarily through ingestion or inhalation of fungal spores.

Key Opportunistic Fungi Identified

***Aspergillus* species identified**

flavus, a highly lethal fungus, produces potent carcinogenic aflatoxins. If this bacterium when fully grown can mature into food borne contaminate. Marketed as

the drug VENTODIL, it is the causative agent of invasive aspergillosis, a lethal lung infection in immune compromised hosts.

niger is a fungus found in soil and decaying plants. These species exhibit a remarkable ability to colonize the host's respiratory tract and, in some instances, the integumentary system. Although generally considered less virulent than *Aspergillus fumigatus*, they remain among the primary etiological agents of opportunistic infections in immunocompromised individuals.

fumigatus is one of the most aggressive *Aspergillus* infections. Of particular concern is invasive aspergillosis, which poses a high fatality risk in individuals with weakened immune systems or underlying pulmonary conditions such as cystic fibrosis. This is especially alarming in communities already burdened by health disparities, where morbidity and mortality rates remain disproportionately high. The heightened transmissibility of *Aspergillus* is largely attributed to its airborne spores, which are forcibly discharged into the environment, facilitating widespread inhalation and infection.

Other *Aspergillus* Species: Researchers have also identified several lesser-known *Aspergillus* species, which, under favorable environmental conditions, can pose significant risks to human health. These species inhabit ecological niches similar to those of the more commonly studied *Aspergillus* pathogens.

Penicillium species identified

Penicillium expansum produces a mycotoxin known as patulin, which poses a health risk when ingested through contaminated fruits. In addition, inhalation of its spores may trigger allergic reactions and respiratory complications in susceptible individuals. *Penicillium chrysogenum* is best known for its pivotal role in the discovery of the first antibiotic, penicillin. However, despite its medical significance, it can also act as an opportunistic pathogen, capable of causing cutaneous and pulmonary infections—especially in immunocompromised individuals.

Penicillium commune is commonly found in both indoor and outdoor environments. Among indoor molds, it is considered particularly hazardous due to its ability to produce potent mycotoxins—some of which rank among the most toxic known natural compounds. Prolonged exposure, especially through inhalation, may lead to serious health effects, particularly in immunocompromised individuals.

Penicillium funiculosum is a rare opportunistic fungal pathogen. While not typically considered highly transmissible, it poses a risk of infection, especially in individuals with weakened immune systems. Its clinical relevance has increased in the context of immunocompromised conditions, including post-viral immune suppression such as seen in severe COVID-19 cases.

Other Fungal Genera

Fusarium species are filamentous fungi known to cause fusariosis, which can manifest as localized cutaneous infections or, in more severe cases, invasive systemic infections.

These fungi produce mycotoxins such as trichothecenes and fumonisins, which pose significant health risks to humans and are detrimental to agricultural crops. Immunocompromised individuals are particularly vulnerable to *Fusarium*-related diseases due to the pathogen's aggressive nature and resistance to many antifungal agents.

Rhizopus species, belonging to the order Mucorales, are primary causative agents of mucormycosis, a fulminant fungal infection that typically affects the sinuses, lungs, and skin. This infection is especially life-threatening in individuals with diabetes mellitus, neutropenia, or other forms of immunosuppression.

Mucor species, also members of the Mucorales order, similarly induce mucormycosis, characterized by rapid tissue invasion and necrosis. The disease progresses quickly in immunocompromised hosts and often requires prompt medical and surgical intervention due to its high mortality rate.

Acremonium species are opportunistic pathogens that can cause rare but severe infections, including onychomycosis (fungal nail infection) and keratitis (corneal infection). These infections are predominantly reported in immunocompromised patients, where the fungus exploits host immune deficiencies to establish infection.

Health Implications

The fungi in the Nagavali River pose serious health risks. This is especially true for those who drink or use untreated river water. Opportunistic fungi, like *Aspergillus*, are dangerous. They absorb their spores with ease. They can cause invasive aspergillosis in the lungs. Also, some *Fusarium* and *Penicillium* species can cause illnesses, infections, and allergies. Immunocompromised people face a high risk from Mucorales fungi, like *Rhizopus* and *Mucor*. They can develop life-threatening mucormycosis.

Environmental and Public Health Concerns

The discovery of dangerous fungus in river water raises concerns about water quality. It shows the need for regular monitoring and mitigation strategies. Untreated water sources may have harmful fungi. They can infect vulnerable people through ingestion, touch, or inhalation. We recommend better water treatment, more monitoring, and public awareness. This is especially true for areas that rely on untreated river water. The Nagavali River research shows we must always monitor water sources for pollutants. Also, controlling these fungi is key to reducing illness in communities that use river water. We must improve water treatments, education, and health laws to reduce exposure to these fungi.

Animal Health Impacts

Fungal pollutants in water, especially rivers like the Nagavali, threaten cattle. Aquaculture effluent and agricultural runoff affect these rivers. By producing mycotoxins, pathogenic fungi can pose a serious risk to animal health.

Respiratory Diseases in Livestock

Livestock, like cattle, goats, and poultry, are vulnerable to tainted water. It can cause fungal infections that harm their lungs. Fungal spores can become airborne and be breathed in. This can cause fungal pneumonia or other respiratory illnesses. It is especially true for those caused by *Aspergillus* and *Penicillium*. *Aspergillus fumigatus* is a major pathogen in humans and animals. It often causes invasive aspergillosis, especially in stressed or immunocompromised people. Oliveira et al., (2023) say this species is a top pathogen in the *Aspergillus* complex. It causes serious infections in vulnerable hosts.

Animals with lung disease or weak immune systems are more vulnerable to *Aspergillus* infections. This raises morbidity and mortality rates (Seyedmousavi et al., 2015). These infections can range from minor respiratory irritations to severe aspergillosis. The biggest threat to immunocompromised people is fungal infections (Dagenais and Keller, 2009). Also, *Penicillium* species, linked to respiratory infections, may worsen existing issues. They might contribute to long-term respiratory disorders (Reid et al., 2007). Notably, studies show that better therapies for humans and animals depend on knowing *A. fumigatus*' pathogenicity (Earle et al., 2023).

Gastrointestinal Issues Due To Mycotoxin Contamination

Some fungi, like *Penicillium*, *Fusarium*, and *Aspergillus*, create mycotoxins. These can cause severe gut issues in animals. Awuchi et al., (2022) found that Patulin, a mycotoxin from *P. expansum*, causes severe stomach pain. Awuchi et al., (2022) found that aflatoxins from *A. flavus* can cause gastrointestinal issues and liver damage after eating contaminated feed and water. Also, trichothecenes from *Fusarium* species harm the immune system and gut (Zain, 2011).

In agricultural settings, mycotoxins represent a serious health risk. Even at low levels, mycotoxins can harm cattle. Prolonged exposure to them is dangerous. Aflatoxins weaken immune responses. This makes animals more prone to infections. It also reduces their growth and reproduction (Zain, 2011). Also, animals affected by *Fusarium* species that produce trichothecenes may suffer severe gastrointestinal issues, like vomiting, diarrhea, and anorexia (Mavrommatis et al., 2021). Furthermore, these pollutants upset the oxidative balance. They worsen animal health (Xu et al., 2022).

Studies by Navale et al., (2021) and Khan et al., (2024) show that mycotoxins from fungi like *Aspergillus* and *Penicillium* can harm an animal's liver and kidneys, causing systemic poisoning. This is especially problematic in Andhra Pradesh. Animals there are more susceptible to harmful compounds in water polluted by farm runoff. Implementing appropriate water treatment and management strategies is so crucial.

Population Survey and Fungal Disease Prevalence

The 540-person survey aimed to find the rate of fungal infections by age and gender. The sample's demographics were: 243 females (45%) and 297 males (55%). We created three age groups from the participants: under 20, 20 to 40, and over 40 (see Table 2).

This approach helps us see the spread of fungal illnesses by age and gender. It may reveal patterns of vulnerability related to age or gender.

Fungal infections vary by gender and age. They depend on biological, behavioral, and environmental factors. 8.89% of the 540 participants in the study had a positive fungal infection test. The frequency was lower in females (3.33%) than in males (5.56%). Most young adults (under 20) likely got skin infections from more outdoor activities. Adults aged 20–40 were more likely to have infections, like onychomycosis and candidiasis. This may be due to job risks, hormone changes, and long exposures to various lifestyles. Older adults (over 40) are more at risk for fungal infections. This is due to age-related factors. These include weakened immune systems, circulatory problems, and chronic illnesses. To reduce the risk of fungal infections, we must implement public health measures. These include hygiene education, quick identification, and preventative treatment tailored to these communities.

Pathogen Relevance

Environmental contamination may contribute to local fungal infections. Fungal pathogens in infected people closely resemble those in the Nagavali River.

Having *Aspergillus versicolor* on your body.

Onychomycosis is a fungal nail infection. It usually causes discoloration, thickening, and distortion of the nail.

Dermatophytes are the main culprits. Non-dermatophyte molds, like *Aspergillus versicolor*, can also cause this illness.

A. versicolor is a member of the *Aspergillus* genus. Researchers find it in soil and water. It feeds on decomposing organic materials and is linked to mycotoxins like sterigmatocystin. Egbuta et al., (2017) state that it is a common opportunistic infection. It mainly affects people with weakened immune systems. In those with damaged skin, it can cause a cutaneous infection. This may develop into a nail infection (Jurjevic et al., 2012).

The Nagavali River probably holds *A. versicolor*. Its waters contain the pathogen. *Aspergillus* and other opportunistic fungi often thrive in water. Infections can spread through water channels. Fungi can enter the body through broken skin or mucosal membranes. They can also enter through contact with contaminated water, such as while bathing or drinking it. This proves a link between fungal diseases and environmental pollution (Richardson and Rautemaa-Richardson, 2019).

A link exists between pollution and human fungal infections. A river had the same *A. versicolor* strain as infected humans. This link raises the possibility that tainted water might spread disease. It is a concern in areas with poor sanitation. They are at risk of waterborne fungal illnesses like onychomycosis. These results show the serious health risks of fungal contamination of water sources. This is especially true in areas with poor water management (Mukherjee et al., 2022).

Candidiasis: *Candida albicans* is a yeast found in human mucosal membranes, especially in the vagina, gut, and mouth. It is usually harmless. In some cases, like immune suppression, long-term antibiotics, or hormonal issues, it may change into its pathogenic form. This change encourages the growth of *C. albicans*. It can cause deadly systemic infections and localized infections like genital candidiasis and oral thrush. The host microbiota largely controls the pathogenicity of *C. albicans* (Mayer et al., 2013; Macias-Paz et al., 2023; Li et al., 2022).

Science says: *C. albicans* can cause serious infections and mucosal disorders, like vulvovaginitis and oral thrush. Immunodeficiency, unhygienic environments, and disturbance of the host microbiota are contributing causes. Most *C. albicans* infections come from within the body. They are not caused by environmental exposure, which can sometimes lead to infections. Depending on the degree of sanitation in each place, the risk of infection may differ. Infections' development and severity stem from a dynamic interaction among the fungus, microbiota, and host (Lopes and Lionakis, 2021; d'Enfert et al., 2021).

Environmental Transmission: Polluted water sources, including rivers, may spread infections. *C. albicans* isolates have genetic links to those from infected people. Due to easier colonization, poor sanitation raises the risk of contact with polluted water. This puts females at higher risk of vaginal candidiasis. It shows we must improve water quality and hygiene to reduce risk. It also highlights the role of pollution in spreading fungal illnesses (Talapko et al., 2021).

The same strain of *C. albicans* was found in both river water and affected people. This emphasizes the role of water in spreading the infection. These results support previous research. It linked tainted water to fungal diseases. Increased public health measures reduce infection risks. This is vital in communities with poor sanitation and water treatment (Cottier and Hall, 2019; Akinbobola et al., 2023; Talapko et al., 2021).

Skin Infections: Dermatophytes

Dermatophytes are a class of fungi. They invade keratinized tissues, like human skin, hair, and nails. These microbes cause infections linked to tinea, like jock itch, ringworm, and athlete's foot. They thrive in warm, humid conditions. Polluted water or surfaces increase the risk of infection. A thorough grasp of the host and environment is vital for diagnosing and treating these illnesses (Moskaluk and VandeWoude, 2022; Jartarkar et al., 2021).

Dermatophytes generate keratinases. They break down keratin, the main protein in skin, nails, and hair. The three genera most linked to dermatophytic infections are *Trichophyton*, *Microsporum*, and *Epidermophyton*. The main ways to spread these fungi are: direct contact with an infected person and contact with contaminated surfaces. Furthermore, they can spread more easily through environmental reservoirs like tainted water. To prevent and treat effectively, we must understand the direct and environmental transmission routes (Moskaluk and VandeWoude, 2022; Deng et al., 2023).

Environmental Transmission: Dermatophytes in Nagavali River water may indicate a waterborne disease. Ashbee and Evans (2002) say that waterborne illnesses may allow fungal spores to enter a person's body through wounds or damp areas. So, the Nagavali River's water might hold these infections. They may spread dermatophytes in the area.

Link to Infection: The finding of dermatophytes in samples suggests a link. It is between follicular infections and tainted river water. We must control environmental sources of dermatophytes to reduce skin diseases. This is vital in areas with poor water treatment and sanitation (Raman et al., 2015). Mycopathogens in Nagavali River water may cause fungal diseases. Waterborne infections link to them (Table 3). This is troubling when people use domestic water for recreation, agriculture, and drinking.

Environmental Reservoirs: This river is an important ecosystem. It can transmit diseases to people, including *A. versicolor*, *C. albicans*, and dermatophytes.

Mode of Transmission: Fungal diseases spread via contaminated water from poor sanitation. Infection rates are higher in rural, poor areas. This is due to unequal exposure to contaminated water (Kumar et al., 2022; Manetu and Karanja, 2021). We must implement public health initiatives to reduce waterborne illnesses. This will lower fungal infections in vulnerable groups (Shayo et al., 2023).

We must monitor water quality and start initiatives to avoid fungal diseases. To prevent waterborne fungal illnesses, we must improve sanitation. This means treating polluted water and teaching locals good hygiene.

Source of Water and Infection Rates Table 4 lists fungal diseases linked to various drinking water sources. The lowest prevalence, at 2.78% (5 cases), was from tap water. Bore water had a 5.00% rate (8 cases), and Nagavali river water had a 17.50% rate (35 cases). The Nagavali River's many users likely spread fungal infections. Sewage, industrial waste, and farm runoff may have introduced them. Bore water is less dangerous, even if it's somewhat polluted. It has less surface water penetration. Filtration and chlorination make tap water the safest. It has the lowest rate of fungal infections. It highlights the need for better water management and public health. This is vital for populations that rely on untreated water. It also stresses the importance of clean water to prevent fungal infections.

Fungal Infections in Livestock

This study examines how water contamination affects human and animal health. The results are important. They show that fungal infections are common in many animals. Buffaloes have the highest infection rates. The survey samples included 185 animals: sheep, cows, and buffaloes. They aimed to find the fungal infection patterns. The frequency of fungal infections was 21.62%. There were 40 confirmed positive cases across all animal species (Table 5).

Sheep: 80, Buffaloes: 65, Cows: 40. The prevalence rate was 21.62%. It came from 40 positive fungal infections in all reported animal species (see Table 6). The human

survey's early findings show that river water is a major source of fungal contamination. Contaminated water, soil, or plants can infect animals that graze in open spaces, drink from, or bathe in exposed water. Dermatophytosis, candidiasis, and onychomycosis are fungal illnesses. They spread by direct contact with contaminated surfaces or water. Dermatophytes, for instance, are the agents that cause dermatophytosis. They spread easily in the damp, agricultural conditions. This is especially true near tainted water sources with animals.

Species-Specific Differences In Prevalence

Buffaloes: Their outdoor exposure may make them more susceptible. Fungal infections thrive in the wet, moist environments that buffaloes are housed in, like flooded pastures or stagnant water. Also, buffaloes are more likely to contact tainted water while bathing or grazing (Table 5). Cows have higher infection rates than buffaloes. In dry climates or regulated housing, they may get longer fungal infections (Table 6).

- **Sheep:** They had a lower infection rate. This may be due to differences in behavior or exposure to the environment. Sheep may be less likely than cows or buffalo to approach polluted water. Their natural wool coat may protect against skin illnesses (Table 6).

Types of Fungal Diseases and Pathogen Transmission

The most prevalent mycotic illness in animals is dermatophytosis. It spreads easily and is very infectious. It is worse in dirty, crowded places with animals. Dermatophyte spores can persist in the environment for a long time. This allows for ongoing transmission (Table 6). Candidiasis: Animals with weak immune systems are more prone to Candida infections. Stress, malnutrition, or underlying medical conditions can often lead to this susceptibility. Buffaloes have a high rate of candidiasis. It may be due to environmental factors. These include exposure to tainted water or a weakened immune system.

Onychomycosis is a fungal nail infection. It is caused by dermatophytes or other fungi that thrive in wet conditions. Onychomycosis is less common than dermatophytosis. It especially affects animals with weak immune systems. It also harms those in wet environments for long periods.

The study found that animals often get fungal diseases. Buffaloes have the highest infection rate (Table 7). Researchers think that pollution, especially of the Nagavali River, spreads fungal diseases. These include dermatophytosis, candidiasis, and onychomycosis. The findings show it is vital to improve the environment and water quality. This will reduce fungal infections in people and animals.

We need more research on the link between pollution and animal health. To lessen exposure to harmful fungus, we must implement mitigation strategies. These include better water management and veterinary treatments to prevent animal diseases.

Awareness Program

The study article's proposed awareness program is vital. It aims to address aquaculture wastewater and its impact, especially fungal contamination (Figures 4 and 5).

Goals and Target Audience

The program aimed to educate three local groups: schoolchildren, on wastewater treatment, environmental health, and ecosystem preservation.

- **Farmers in agriculture:** to educate people about government water rules and the effects of dumping wastewater on crops and livestock.
- **Aquaculture pond farmers:** For aquaculture practitioners, these farmers provide the main water source. To prevent pollution, the program taught them wastewater treatment techniques.

Environmental Responsibility and Government Policy

A key element was India's policy to, before release, treat wastewater, especially from aquaculture. Wastewater must be treated to prevent contamination of soil, groundwater, and surface waterways. This is required by the Water (Prevention and Control of Pollution) Act of 1974 and other environmental laws. Untreated wastewater can cause serious ecological and public health problems. It can develop fungal diseases in aquatic habitats. This is due to contaminants like organic matter, chemicals, and pathogens. The campaign aimed to raise awareness of a legal need: to treat wastewater. It sought to show the community's growing duty to keep water sources clean. Untreated effluent, a frequent result of aquaculture, often has high nutrient levels. This includes phosphates, nitrogen, and organic waste. It also contains chemicals from fish farming feed, drugs, and pesticides. This is due to insufficient treatment. If this wastewater is not controlled, aquatic ecosystems can suffer. Eutrophication can occur, and harmful bacteria and fungi can thrive.

Useful tips for treating wastewater.

Also, the program suggested methods to help the aquaculture industry treat wastewater.

- **Physical treatments:** Filtration removes big particles, like fish waste and leftover feed. Biological therapies include: bioreactors, artificial wetlands, and aerobic and anaerobic processes. They break down organic matter and reduce nutrients that pollute water.
- **Chemical Treatments:** Using chemicals to neutralize dangerous pollutants. But, care must be taken to avoid further contamination.

For aquaculture pond owners, the seminar likely covered ways to reduce untreated effluent. Besides natural filters like aquatic plants and biofilters, it could have involved settling ponds. They let sediments settle in the water before releasing them. These tactics aimed to educate farmers about the dangers of untreated wastewater. They also sought to share affordable ways to reduce those risks.

Engagement with Medical Officers and Local Government: Another key part of the initiative was working with medical professionals and local officials. This lets the program share the study's results with them. • Raise awareness at the government level: It's vital to involve local authorities. This will help ensure public support for laws on environmental health and wastewater treatment. Government support is needed to implement long-term policies. It is also needed to motivate aquaculture farmers to improve waste management.

• More audits and actions. The program, with local medical staff, assessed health risks from contaminated water. It sought to identify fungal diseases in people and animals. Routine audits of agricultural systems and water sources are needed. They will track wastewater treatment projects and find areas for improvement. • Encourage community involvement: Local medical officials can bridge scientific research and public health education. They may help the community see the link among fungal infections, water pollution, and their health.

Sustainability of Agricultural and Aquacultural Practices

Environmental health and sustainability in aquaculture and agriculture are closely interconnected. Aquaculture wastewater can be high in nutrients, pathogens, and toxins. It can harm biodiversity, soil health, and nearby aquatic life. • Agriculture: Excess fertilizers in wastewater can harm soil and crops. Environmental degradation may lower agricultural yields. This would make farming a less reliable food source. Aquaculture: Poor waste management can create toxic pollutants. They can harm aquatic life, cause fish diseases, and reduce fish populations. Also, tainted seafood can harm people's health and aquaculture.

The initiative promotes sustainable farming and aquaculture. These methods support long-term food security, protect the environment, and improve human health. It also educates locals on the benefits of wastewater treatment.

Public Health and Well-Being: The program aims to reduce fungus infections and other illnesses linked to contaminated water. The study says that both humans and animals can catch fungal diseases. These include *Candida*, *Aspergillus*, and dermatophytes. They are more likely to get them in places with polluted water. Contaminated water is linked to many illnesses, including fungal infections of the skin and lungs. In places with poor wastewater treatment and sanitation, these illnesses can spread quickly. • **Community Well-Being:** This initiative aims to reduce illness by fixing the causes of water pollution. It aims to raise citizens' general quality of life by enhancing health outcomes.

Trends in patents and technological innovations in aquatic opportunistic fungi

There are many new patent applications. They use aquatic opportunistic fungi to create novel, sustainable technologies. These technologies have ecological, biomedical, and industrial applications. Fungi are being patented for bioremediation methods in the environmental field. They can break down complex pollutants, including heavy

metals, polymers, and hydrocarbons. The goal is to create scalable, eco-friendly water treatment substitutes. Aquatic fungi's secondary metabolites aid in making new drugs. They are antifungal, antibacterial, and anticancer. These medications are vital for treating serious, resistant infections, like *Aspergillus* and *Candida*. Patents in industrial biotech highlight using enzymes in food processing, biofuels, and biopolymers. These enzymes include cellulases and lipases. Furthermore, the identification of harmful fungus is being transformed by diagnostic technology. This area of patents focuses on advanced CRISPR methods. It also includes portable, fast tests for detecting harmful germs in water. Bioactive nanoparticles and modified fungi are patentable technologies. They boost metabolites or bioremediation. Innovations are creating integrated fungal-microbial systems for wastewater treatment. They also include hybrid solutions that combine fungal biotech with AI tools. These tools monitor aquatic fungal diversity and predict epidemics. These advances combine computational science, proteomics, and genomics. They enable sustainable, high-impact technologies. This strategy aims to preserve biodiversity and water quality. It also opens up commercial opportunities. It establishes aquatic opportunistic fungus as key to future scientific and industrial advances.

Future Research Directions

Many recent advancements aim to improve the quick, accurate diagnosis of dangerous infections and fungi. These breakthroughs include eDNA, NGS, HTS, AI, ML, and microfluidic systems. As these cutting-edge technologies improve, pathogen detection is becoming faster, more accurate, and cheaper.

Artificial intelligence (AI) and machine learning (ML):

By making it easier to analyze genetic and environmental data, developments in artificial intelligence (AI) and machine learning (ML) are improving pathogen identification. In datasets that conventional approaches would miss, AI-based algorithms quickly find patterns, forecast pathogenicity, and reveal correlations (Suster et al., 2024; Gao and Liu, 2024). Deep learning algorithms are very successful at recognizing novel diseases using sequencing data, hence increasing outbreak prediction. The use of next-generation sequencing scales microbiological diagnoses and eliminates the need for manual input (Guo et al., 2023; Shelke et al., 2023). These developments support studies on antibiotic resistance and pathogen genomes (Li et al., 2024).

Microfluidics and lab-on-a-chip technologies:

Pathogen detection has been transformed by microfluidic platforms, which combine laboratory operations into small, effective devices. Real-time sample analysis throughout the diagnostic procedure is made possible by these devices. Even in situations with limited resources, microfluidics shows great potential for on-site, quick diagnostics when artificial intelligence (AI) is incorporated. Results can be obtained in

a matter of hours using portable equipment that examine environmental samples from crops or water. Point-of-care advancements in distant locations can be substantially improved by this combination of microfluidics and AI (Jagannath et al., 2022; Lehnert and Gijs, 2024; Mairhofer et al., 2009; Wang et al., 2022; Sekhwama et al., 2024).

CRISPR-based diagnostics:

Because CRISPR-Cas systems were first developed for gene editing, they have extraordinary promise for pathogen identification. SHERLOCK and DETECTR are examples of CRISPR-based diagnostic tools that use CRISPR-Cas9 proteins to detect pathogen genetic material with high sensitivity and specificity. These techniques may therefore identify a variety of diseases, including bacteria and fungus, and are portable and reasonably priced. As a result, CRISPR technology offers a quick and easy way to track dangerous infections in agricultural and aquatic settings, which might completely change pathogen detection (Myhrvold et al., 2018; Gootenberg et al., 2017).

Biosensors and Nanotechnology

Biosensors, especially those that use nanotechnology, provide another promising pathogen detection approach. These sensors provide data in a matter of seconds and allow the identification of infections at very low concentrations. Rapid optical, electrochemical, or fluorescence-based readouts are made possible by functionalizing nanoparticles—such as gold or silver nanoparticles—with particular antibodies or DNA sequences that bind to the pathogens of interest. These sensors enable precise identification of fungal diseases by recognizing distinct biomarkers or metabolites that the fungus produces (Ahamed et al., 2023).

Cloud computing and big data:

Pathogen monitoring systems can effectively gather enormous volumes of environmental and genetic data when used in tandem with big data analytics and cloud computing. Real-time monitoring and prompt reactions to new disease risks are made possible by this technology. Big data improves epidemic prediction models, improves sampling techniques, and yields useful information on the virulence and spread of pathogens. Furthermore, cloud-based platforms provide synergy in tackling aquatic animal health issues by providing worldwide pathogen surveillance networks, which promote collaborative research (Bohara et al., 2023).

Wearable and remote sensing technologies

Future developments in wearable technology and AI-powered remote sensing tools will make it easier to detect pathogens in a variety of ecosystems and monitor environmental parameters continuously. Thus, IoT-enabled smart sensors mounted on drones or satellites might offer extensive monitoring of agricultural and aquatic ecosystems, offering real-time information on pathogen prevalence and water quality. By enabling proactive measures against pathogen threats and fostering sustainability

in aquaculture and agriculture, such innovations will revolutionize ecosystem management (Popescu et al., 2024; Rajak et al., 2023; Abdullah et al., 2024).

Concluding insights

We need to act urgently. Opportunistic aquatic fungi are a serious threat to human and animal health. Human activities, like agricultural runoff and industrial waste, pollute rivers, lakes, and reservoirs. This lets pathogenic fungi thrive. Food security and water safety are at risk from some fungi. *Aspergillus*, *Candida*, and *Fusarium* species are linked to various illnesses.

This study looks at the health and environmental effects of fungus pollution in surface waters. It uses the Nagavali River as a case study. It details fungal contamination issues and talks about scalable, community-based remedies. We must combine advances in several fields to meet this challenge. They are: environmental DNA, high-throughput sequencing (HTS), next-generation sequencing (NGS), CRISPR diagnostics, and AI/ML biosensors. They help avoid waterborne fungal illnesses, diagnose diseases early, and monitor water pollution. This study shows the need for strict regulations, public awareness campaigns, and water quality checks. We must address these transdisciplinary issues. They affect safe water, public health, and aquatic ecosystems. We can reduce the threats of these silent invaders. We can protect the health of people and animals. We can do this by using advanced technologies and community solutions.

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Table 1: Fungal Strain Distribution in Water Samples (n = 90) Collected from Different Locations in the Ganagalwani peta village, India. This table presents seasonal and locational details of fungal species isolated from 90 water samples collected across aquaculture discharge areas, ponds, river canal pits, agricultural waste sites, and upstream river regions near Gangallavanipeta village. The number of fungal strains detected per sample is also recorded, highlighting both contaminated and uncontaminated water sources.

Sample No.	Location No.	Location Type	Season	Fungal Species Isolated	No. of Strains Found
1	1	Aquaculture wastewater discharge	Summer	Fusarium sp., Aspergillus terreus	2
2	2	Aquaculture wastewater discharge	Summer	Aspergillus fumigatus, Mucor sp., Fusarium sp., Aspergillus flavus	4
3	3	Aquaculture wastewater discharge	Summer	Aspergillus fumigatus	1
4	4	Aquaculture wastewater discharge	Summer	Penicillium chrysogenum, Mucor sp., Aspergillus terreus	3
5	5	Aquaculture pond water	Summer	Acremonium sp.	1
6	6	Aquaculture pond water	Summer	None Detected	0
7	7	Aquaculture pond water	Summer	Rhizopus sp., Penicillium funiculosum, Penicillium chrysogenum	3
8	8	Nagavali canal water pit	Summer	Aspergillus fumigatus, Acremonium sp., Mucor sp.	3
9	9	Nagavali canal water pit	Summer	None Detected	0

10	10	Nagavali canal water pit	Summer	None Detected	0
11	11	Nagavali canal water pit	Summer	None Detected	0
12	12	Agricultural waste dumping site	Summer	Penicillium expansum, Rhizopus sp., Aspergillus terreus, Aspergillus niger, Penicillium commune	5
13	13	Agricultural waste dumping site	Summer	Fusarium sp., Penicillium funiculosum	2
14	14	Agricultural waste dumping site	Summer	None Detected	0
15	15	Upstream river canal	Summer	None Detected	0
16	16	Upstream river canal	Summer	None Detected	0
17	1	Aquaculture wastewater discharge	Summer	Aspergillus terreus, Rhizopus sp., Penicillium chrysogenum, Mucor sp., Aspergillus flavus	5
18	2	Aquaculture wastewater discharge	Summer	None Detected	0
19	3	Aquaculture wastewater discharge	Summer	None Detected	0
20	4	Aquaculture wastewater discharge	Summer	None Detected	0
21	5	Aquaculture pond water	Summer	None Detected	0
22	6	Aquaculture pond water	Summer	Penicillium chrysogenum	1
23	7	Aquaculture pond water	Summer	Acremonium sp., Aspergillus flavus, Penicillium funiculosum, Fusarium sp.	4
24	8	Nagavali canal water pit	Summer	None Detected	0

25	9	Nagavali canal water pit	Summer	Aspergillus flavus	1
26	10	Nagavali canal water pit	Summer	None Detected	0
27	11	Nagavali canal water pit	Summer	Mucor sp.	1
28	12	Agricultural waste dumping site	Summer	None Detected	0
29	13	Agricultural waste dumping site	Summer	Aspergillus niger, Acremonium sp.	2
30	14	Agricultural waste dumping site	Summer	Acremonium sp., Penicillium chrysogenum, Penicillium commune, Aspergillus fumigatus, Penicillium funiculosum	5
31	15	Upstream river canal	Monsoon	None Detected	0
32	16	Upstream river canal	Monsoon	Penicillium commune, Aspergillus fumigatus	2
33	1	Aquaculture wastewater discharge	Monsoon	Rhizopus sp., Fusarium sp., Aspergillus flavus	3
34	2	Aquaculture wastewater discharge	Monsoon	Aspergillus fumigatus	1
35	3	Aquaculture wastewater discharge	Monsoon	Penicillium expansum, Aspergillus niger, Penicillium funiculosum	3
36	4	Aquaculture wastewater discharge	Monsoon	Acremonium sp., Aspergillus niger, Mucor sp., Rhizopus sp., Fusarium sp.	5
37	5	Aquaculture pond water	Monsoon	None Detected	0
38	6	Aquaculture pond water	Monsoon	Rhizopus sp., Penicillium expansum, Mucor sp., Aspergillus flavus, Aspergillus niger	5

39	7	Aquaculture pond water	Monsoon	Penicillium funiculosum, Aspergillus flavus, Fusarium sp., Aspergillus terreus, Acremonium sp.	5
40	8	Nagavali canal water pit	Monsoon	Mucor sp., Aspergillus terreus, Aspergillus niger, Penicillium expansum, Aspergillus fumigatus	5
41	9	Nagavali canal water pit	Monsoon	Aspergillus niger, Acremonium sp.	2
42	10	Nagavali canal water pit	Monsoon	Penicillium chrysogenum	1
43	11	Nagavali canal water pit	Monsoon	Penicillium expansum	1
44	12	Agricultural waste dumping site	Monsoon	None Detected	0
45	13	Agricultural waste dumping site	Monsoon	Aspergillus niger	1
46	14	Agricultural waste dumping site	Monsoon	Rhizopus sp., Fusarium sp., Mucor sp., Aspergillus terreus, Aspergillus flavus	5
47	15	Upstream river canal	Monsoon	Mucor sp., Penicillium commune, Aspergillus flavus, Penicillium chrysogenum, Aspergillus terreus	5
48	16	Upstream river canal	Monsoon	None Detected	0
49	1	Aquaculture wastewater discharge	Monsoon	Rhizopus sp., Penicillium funiculosum	2
50	2	Aquaculture wastewater discharge	Monsoon	None Detected	0
51	3	Aquaculture wastewater discharge	Monsoon	None Detected	0
52	4	Aquaculture wastewater discharge	Monsoon	Rhizopus sp., Aspergillus niger, Mucor sp., Aspergillus fumigatus, Fusarium sp.	5

53	5	Aquaculture pond water	Monsoon	Penicillium funiculosum, Aspergillus fumigatus, Penicillium commune	3
54	6	Aquaculture pond water	Monsoon	Fusarium sp., Mucor sp., Acremonium sp., Aspergillus flavus, Rhizopus sp.	5
55	7	Aquaculture pond water	Monsoon	Penicillium funiculosum, Aspergillus terreus, Penicillium commune, Aspergillus flavus, Fusarium sp.	5
56	8	Nagavali canal water pit	Monsoon	Aspergillus fumigatus	1
57	9	Nagavali canal water pit	Monsoon	None Detected	0
58	10	Nagavali canal water pit	Monsoon	Penicillium commune, Penicillium chrysogenum, Fusarium sp., Mucor sp., Aspergillus flavus	5
59	11	Nagavali canal water pit	Monsoon	Fusarium sp., Penicillium funiculosum, Rhizopus sp., Mucor sp., Penicillium expansum	5
60	12	Agricultural waste dumping site	Monsoon	None Detected	0
61	13	Agricultural waste dumping site	Winter	Penicillium chrysogenum, Aspergillus flavus, Rhizopus sp., Penicillium commune	4
62	14	Agricultural waste dumping site	Winter	None Detected	0
63	15	Upstream river canal	Winter	Rhizopus sp.	1
64	16	Upstream river canal	Winter	Mucor sp., Aspergillus flavus, Penicillium funiculosum, Acremonium sp., Aspergillus fumigatus	5
65	1	Aquaculture wastewater discharge	Winter	Fusarium sp., Penicillium chrysogenum	2

66	2	Aquaculture wastewater discharge	Winter	Acremonium sp.	1
67	3	Aquaculture wastewater discharge	Winter	Acremonium sp.	1
68	4	Aquaculture wastewater discharge	Winter	Mucor sp., Penicillium expansum	2
69	5	Aquaculture pond water	Winter	None Detected	0
70	6	Aquaculture pond water	Winter	Acremonium sp., Penicillium funiculosum, Rhizopus sp.	3
71	7	Aquaculture pond water	Winter	Penicillium commune, Mucor sp., Aspergillus fumigatus, Rhizopus sp., Aspergillus niger	5
72	8	Nagavali canal water pit	Winter	None Detected	0
73	9	Nagavali canal water pit	Winter	Rhizopus sp., Mucor sp., Penicillium chrysogenum, Aspergillus flavus, Penicillium funiculosum	5
74	10	Nagavali canal water pit	Winter	Aspergillus flavus, Penicillium funiculosum, Aspergillus niger, Mucor sp., Fusarium sp.	5
75	11	Nagavali canal water pit	Winter	Mucor sp., Aspergillus niger, Penicillium funiculosum, Aspergillus terreus	4
76	12	Agricultural waste dumping site	Winter	Aspergillus terreus, Fusarium sp.	2
77	13	Agricultural waste dumping site	Winter	None Detected	0
78	14	Agricultural waste dumping site	Winter	Penicillium commune, Aspergillus terreus	2
79	15	Upstream river canal	Winter	None Detected	0

80	16	Upstream river canal	Winter	Penicillium expansum, Aspergillus flavus, Penicillium chrysogenum, Aspergillus terreus	4
81	1	Aquaculture wastewater discharge	Winter	Penicillium chrysogenum, Aspergillus fumigatus	2
82	2	Aquaculture wastewater discharge	Winter	Fusarium sp., Rhizopus sp.	2
83	3	Aquaculture wastewater discharge	Winter	Rhizopus sp., Penicillium funiculosum, Penicillium chrysogenum	3
84	4	Aquaculture wastewater discharge	Winter	Aspergillus flavus, Penicillium funiculosum, Rhizopus sp., Mucor sp., Penicillium chrysogenum	5
85	5	Aquaculture pond water	Winter	Penicillium funiculosum, Mucor sp., Aspergillus fumigatus, Aspergillus niger	4
86	6	Aquaculture pond water	Winter	None Detected	0
87	7	Aquaculture pond water	Winter	Aspergillus terreus, Penicillium expansum, Penicillium funiculosum, Aspergillus niger, Aspergillus fumigatus	5
88	8	Nagavali canal water pit	Winter	Rhizopus sp., Acremonium sp., Aspergillus terreus	3
89	9	Nagavali canal water pit	Winter	None Detected	0
90	10	Nagavali canal water pit	Winter	None Detected	0

Table 2: The distribution of fungal infections by age and gender in the population surveyed close to the Nagavali River. A comparison of infection rates by the gender and the age that provides information on demographic patterns and due environmental factors that may affect a local residents susceptibility to fungal infections, such as proximity to the Nagavali River.

Age Group	Number Examined	Positive Cases (%)	Male (%)	Female (%)
<20 years	240	32 (13.33%)	20 (8.33%)	12 (5.00%)
20-40 years	190	36 (18.95%)	23 (12.11%)	13 (6.84%)
>40 years	110	18 (16.36%)	11 (10.00%)	7 (6.36%)
Total	540	86 (15.93%)	54 (10.00%)	32 (5.93%)

Table 3: Distribution of Fungal Infections in the Population Surveyed Near the Nagavali River in Ganagalavanipeta Village.

Disease	Positive Cases	Percentage (%)
Skin Infection (Tinea/Ringworm)	65	12
Onychomycosis (Nail fungus)	13	2.41
Candidiasis (Oral/Genital)	8	1.48
Total	86	15.93

Table 4: Ganagalawanipeta Village's Comparative Fungal Infection Prevalence by Water Source: An Examination of the Nagavali River. For each water source such as Nagavali River water, bore water, and tap water, result provides information on the total number of people survey, the number of positive fungal infection cases, and the estimated prevalence rate. The considerably higher prevalence rate in the Nagavali River water raises the possibility of negative effects on the environment and human health associated with this main water source.

Water Source	Number Examined	Positive Cases	Prevalence (%)
Nagavali River Water	250	64	25.60%
Bore Water	185	15	7.69 %
Tap Water	95	7	7.37 %
Total	540	86	15.93%

Table 5: the frequency of fungal infections in local animal species that live in Ganagalavanipeta village near the Nagavali River. The result show that cows, buffaloes, and sheep have different rates of infection, the impact of the river on livestock health. The prevalence is seen in buffaloes, which are followed by cows and sheep. This result information about possible river-related environmental factors and how they affect the health of local livestock.

Animal Species	Positive Cases	Prevalence (%)
Cows	10	25.00%
Buffaloes	18	27.69%
Sheep	12	15.00%
Total	40	21.62%

Table 6: This result shows the frequency of how fungal infections that affect animals in Ganagalavanipeta village, which is close to the Nagavali River. there is a notable prevalence of dermatophytosis, candidiasis, and onychomycosis in the animals, which is probably caused by their exposure to the ecosystem of the river.

Fungal Disease	Positive Cases	Prevalence (%)
Dermatophytosis	20	10.81%
Candidiasis	12	6.49%
Onychomycosis	8	4.32%
Total	40	21.62%

Table 7: Thorough examination of fungal infections in various animal species close to the Nagavali River in Ganagalavanipeta village. This data demonstrates the prevalence of dermatophytosis, candidiasis, and onychomycosis in sheep, cows, and buffaloes, exposing particular trends in the distribution of fungal diseases in these animal groups. The prevalence rates offer details about the biological and environmental factors influencing these infections in this ecosystem along the river.

Animal Species	Dermatophytosis	Candidiasis	Onychomycosis	Total Positive Cases
Cows	5	3	2	10
Buffaloes	9	5	4	18
Sheep	6	4	2	12
Total	20	12	8	40

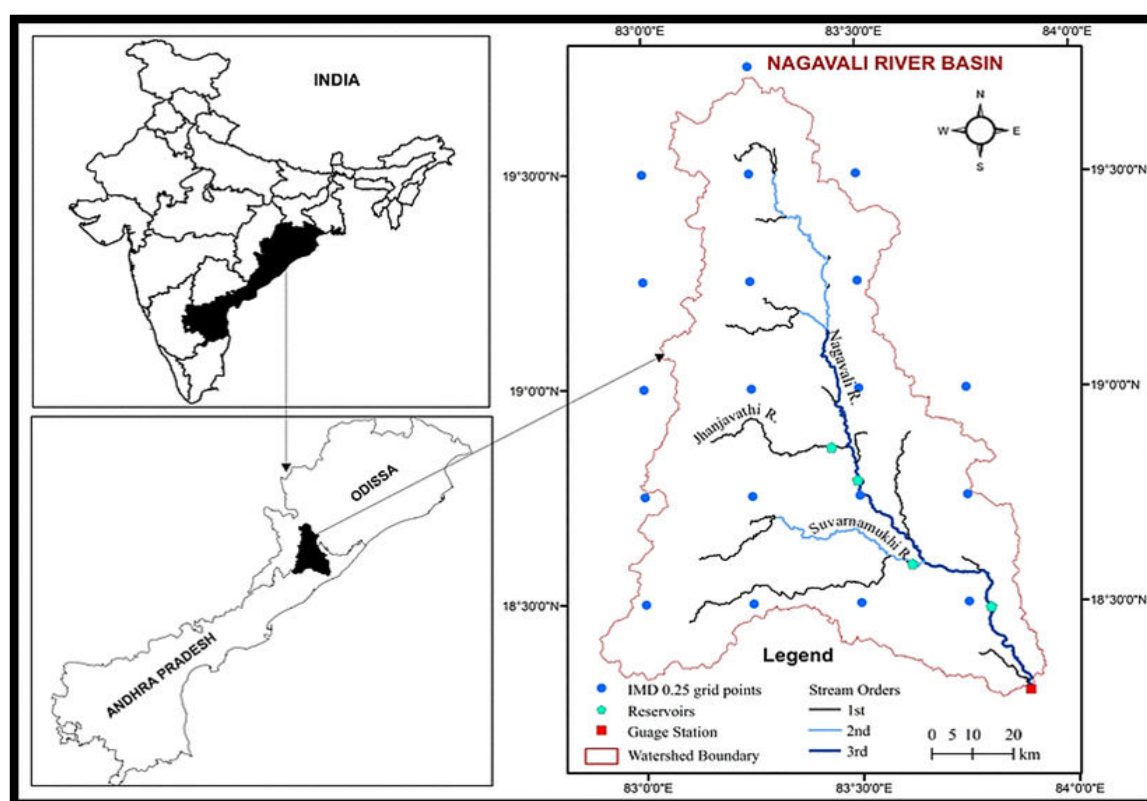


Figure 1: The Nagavali River (formerly Langulya River) originates in the Eastern Ghats, Kalahandi district, Odisha, and flows 256 km, with 95 km in Andhra Pradesh before it reaching the Bay of Bengal near Kallepalli village and Ganagalavani peta village. It is vital for irrigation and domestic use but faces environmental challenges.

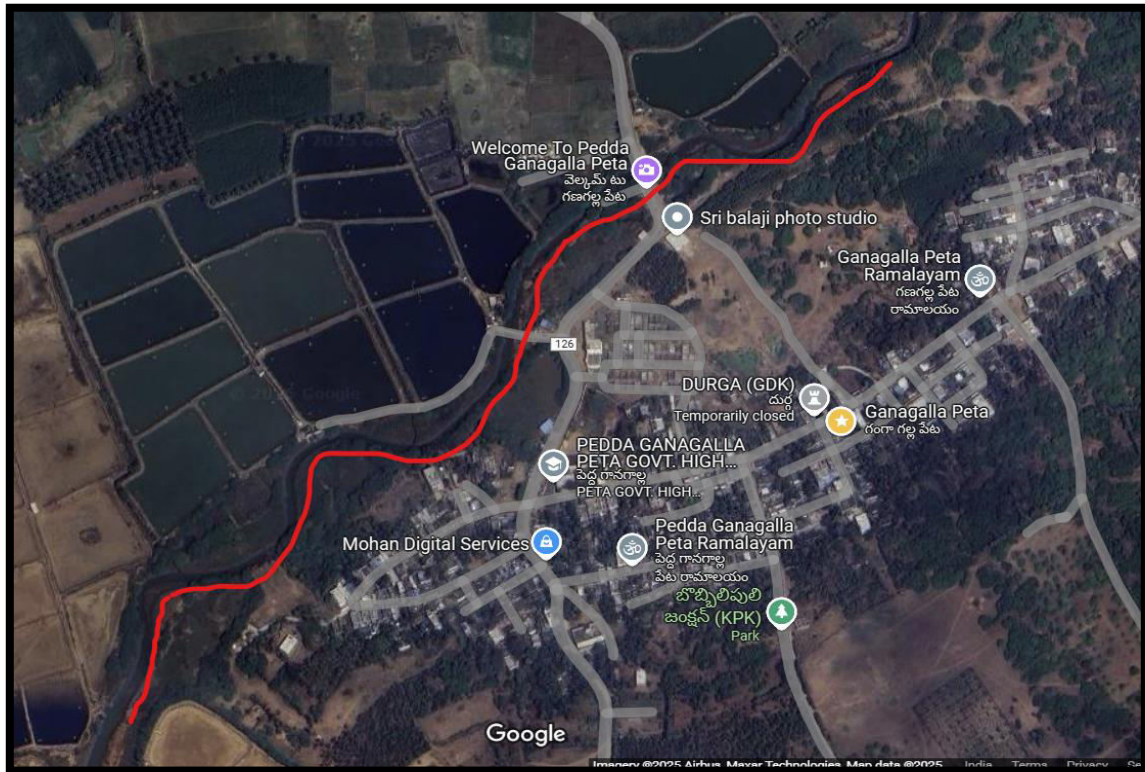


Figure 2: Google Map showing sampling at Ganagalavani Peta village, red line indicating Nagavali river canal passing through village (18.86250°N , 83.48083°E to 18.21360°N , 83.93222°E).



Figure 3: The discharge of untreated aqua cultre wastewater and agricultural activities significantly increases the fungal load in natural water bodies such as the Nagavali River. Wastewater contains rich organic matter and nutrients, creating ideal conditions for the proliferation of fungi.



Figure 4: An awareness program was conducted for local farmers and aquaculture workers on water contamination, safe drinking water, and hygiene.

కాలువ్యం బాలిన నాగావళి నటిజలాలు.. రేగేటి రవికిరణ్



శ్రీసూర్య, శ్రీకాకుళం : నాగావళి నటిజలాలు కాలువ్యం బాలిన పదదంతో ప్రజలకు తీవ్ర సుస్పృహవాలు కలుగుతున్నాయని సెంచరయన్ యూనివర్సిటీకి చెందిన పిహెచ్.డి విద్యార్థి కేగేటి రవికిరణ్ అన్నారు. రూరల్ మండలం గణగర్జనానిపేటలోని ప్రభుత్వ పాఠశాలలో విద్యార్థులకు నీటి ద్వారా వచ్చే శీలీంధ్ర వ్యాధులపై అవగాహన కార్యక్రమం గుండుదారం నిర్వహించారు. ఈ సందర్భంగా రవికిరణ్ మాట్లాడుతూ నదిలో మైకోటాక్సన్-ఉత్పత్తి చేసే శీలీంధ్రాల వల్ల కలిగే తీవ్రమైన ప్రమాదాల గురించి స్థానిక ప్రజలకు కచ్చితచే లక్ష్యంగా కార్యక్రమాలు చేపడుతున్నామన్నారు. ఇవి తీవ్రమైన నీటి ద్వారా సంక్రమించే వ్యాధులతో ముడిపడి ఉన్నాయన్నారు. నాగావళి నదిలోకి శుద్ధి చేయని వ్యవసాయ, ఆకాశకల్పర్ వర్ష జలాలను విడుదల చేయడం వలన తీవ్ర నీటి కాలువ్యం పెరుగుతుందని చెప్పారు. కలుషితమైన నీటిని నిరంతరం విడుదల చేయడం వల్ల ఫంగల్ ఇన్ఫెక్షన్తో సహా తీవ్రమైన ఆరోగ్య సమస్యలకు దారితీస్తుందని హెచ్చరించారు. పర్యావరణంలోకి వ్యర్థాలను విడుదల చేసే ముందు నలైన మురుగునీటి శుద్ధి వద్దతులను అవలంబించవలసిన అవసరాన్ని వివరించారు. ప్రజారోగ్యాన్ని పరిరక్షించడానికి, స్థానిక పర్యావరణ వ్యవస్థను శుద్ధి చేయని మురుగునీటి హానికరమైన ప్రభావాలు నుండి రక్షించడానికి ఈ చర్యలు చాలా కీలకమని రవికిరణ్ నొక్కి చెప్పారు. పాఠశాల విద్యార్థులతో సహా సంఘం నుండి చాలా సానుకూల స్పందన వచ్చిందన్నారు. ఈ కార్యక్రమంలో విద్యార్థులు, ఉపాధ్యాయులు, పాఠశాల సిబ్బంది పాల్గొన్నారు.






Figure 5: Conducted awareness programs on the importance of safe water and the risks of fungal infections, at government schools of Ganagalawani peta village. articles published in local printed media.