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Review on Major Bacterial Zoonotic Diseases of Fish and the Case of Ethiopia

Temesgen Sendekie* **and Habtamu Tassew**

Department of Veterinary Science, Bahir Dar University, Bahir Dar, Ethiopia

Abstract

Increased seafood consumption in general, and fish consumption in particular, has sparked some interest in food safety, despite a lack of understanding of the precautions that must be taken to avoid dangers. Physical contact with fish, as well as eating it, might expose the people to bacterial pathogens that are harmful to health. The goal of this review study is to provide a broad overview of the four bacterial infections that affect both fish and humans. When handling infected fish water, bacterial infection is most commonly obtained by abrasions, cuts, or deep lesions in the skin. *Mycobacterium* species, *Streptococcus iniae*, *Aeromonas specieces*, and *Vibrio vulnificus* are among the most well-known zoonotic bacteria acquired from fish. Consumption of raw infected fish and fish products, and contact with contaminated water or infected fish, the existence of zoonotic bacteria in fish in Ethiopia could provide a potential risk to human health. Despite the fact that fish pathogens receive less attention, zoonotic bacteria are found all across the world, including Ethiopia. The main prophylactic methods for minimizing the risk of exposure are basic hygiene and complete hand washing promptly after handling seafood. Veterinarians, their employees, and their clients should always take precautions to avoid exposing open cuts and abrasions to water. Most of the reviewed articles are done by taking tissue samples, including skins, gills, intestines, swim bladders, kidneys, and livers. Biochemical tests are the most widely used technique to identify pathogens. Both natural water bodies and aquaculture are covered by the studies, unlike studies done in Ethiopia, which are entirely on lakes and rivers. Their findings also varied across species, countries, diagnostic techniques, etc. More research is needed to demonstrate the presence of risk factors as well as the method of transfer from the aquatic environment (fish) to humans.

Keywords: Abrasions • Consumption • Bacteria • Fish • Zoonotic

Introduction

Increased seafood consumption in general, and fish consumption in particular, has sparked some interest in food safety, despite a lack of understanding of the precautions that must be taken to avoid dangers. As a result of public health significant bacterial infections, both physical contact and ingestion of fish pose risks. These bacterial diseases have been classified as fish-borne zoonoses based on epidemiological and phenotypic evidence [1]. Zoonotic bacteria have the interesting feature of infecting both people and animals, causing sickness in both [2].

Bacterial isolates in fish internal organs are highly varied between species under normal settings, with little change between maturation stages and sex groups. The intestinal isolates are more variable than the kidneys of fish. This variation in bacterial makeup in the fish gut is due to differences in digestive system complexity between species, growth stage, and environmental conditions such as salt content and bacterial contamination of the water [3].

When contacting diseased fish or fomites (water), bacterial infection is most commonly obtained by abrasions, cuts, or piercing lesions in the skin. For such bacteria, integrated systems are frequently employed as an excellent growth medium. Because most germs are present in fish even when there are no symptoms, wearing Personal Protective Equipment (PPE) such as gloves is often recommended. Although certain gram-positive bacteria are also zoonotic, the majority of these bacteria are gram negative [4].

Aeromonas hydrophila, *Edwardsiella tarda*, *Erysipelothrix rhusiopathiae*, *Mycobacterium marinum* (related with aquarium hobists), *Streptococcus iniae* (newly developed zoonoses), *Vibrio vulnificus*, and *Vibrio damsela* are the most commonly acquired bacteria through abraded skin of fish. *Streptococcus iniae* has lately surfaced as an aquaculture-related public health threat. Bacteria are

***Address for Correspondence:** Temesgen Sendekie, Department of Veterinary Science, Bahir Dar University, Bahir Dar, Ethiopia, Tel: 251818207118; E-mail: tomsensha@gmail.com*

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nearly entirely regarded as zoonotic germs that infect fish [5,6]. Being a fisherman or woman is one of the jobs with the most health risks in the world. Failure to diagnose and treat these rare bacterial pathogens in a timely manner may result in a high infection rate and death. Wounds from fishing and seafood manipulation are two activities that frequently result in infection. The condition can produce a wide range of symptoms, from moderate cellulitis to lethal necrotizing fasciitis, and even sepsis, unless a major surgical operation is undertaken. The genetic identity of human and fish isolates is not fully understood. *Mycobacterium* spp., *Streptococcus iniae*, and *Vibrio vulnificus* are among the most well-known zoonotic bacteria acquired from fish. Many bacteria have been identified as possible fishborne zoonotic agents, but molecular investigations are needed to fully understand how they cause infection [7].

Objective

The review articles were prepared in response to the possible public health threat, global prevalence, and information gap in Ethiopia. As a result, the purpose of this review study is to highlight the most commonly isolated zoonotic bacterial infections in fish, as well as the status of these infections in Ethiopia.

Literature Review

Major bacterial zoonotic diseases of fish

People, who come into physical contact with fish, as well as those who eat it, may be exposed to bacterial diseases that are harmful to human health. These bacterial illnesses have been identified as fish-borne zoonoses based on epidemiological and phenotypic evidence. Eating raw or undercooked infected fish tissue, as well as fish tissue contaminated with infected fish faeces, is one example of ingestion. Orally transmitted zoonoses make up 46.15 percent of all zoonoses found in fish (Figure 1) [8].

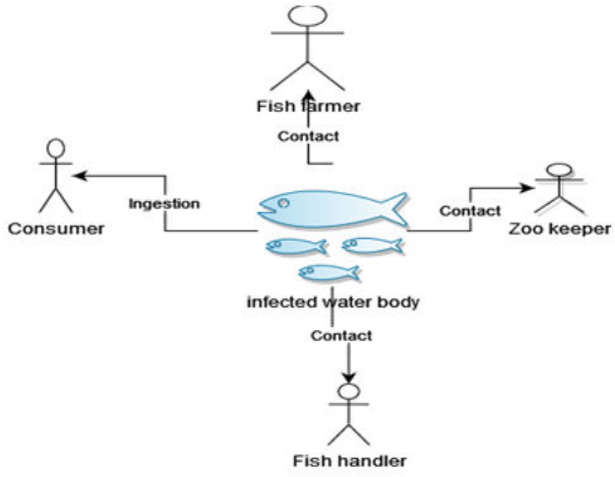

Figure 1. A simple pathway showing the fish-borne infection.

Mycobacterium infection

Fish mycobacteriosis is a chronic, progressive illness caused by Non-tubercolous Mycobacteria (NTM), a common acid-fast bacillus [9]. *Mycobacterium marinum*, *Mycobacterium fortuitum*, and *Mycobacterium ulcerans* are the most common fishborne zoonoses, with *Mycobacterium marinum*, *Mycobacterium fortuitum*, and *Mycobacterium ulcerans* being the most common [10]. The exact mechanism by which *M. marinum* spreads between fish is uncertain. Ingestion of contaminated dead fish and direct contact with infectious fish were the most common ways for infection to spread [11].

The induced tuberculosis in the zebra fish has clinical symptoms that are identical to active human tuberculosis, with necrotizing granulomas being the primary lesion during late stages of infection [12]. In the world, mycobacteriosis is a known life-threatening chronic condition with a wide range of symptoms, as well as its public health significance. There is no effective treatment for this condition. As a result, developing a vaccine rather than treatment strategies is a preferable alternative for preventing the disease (Figure 2) [13].

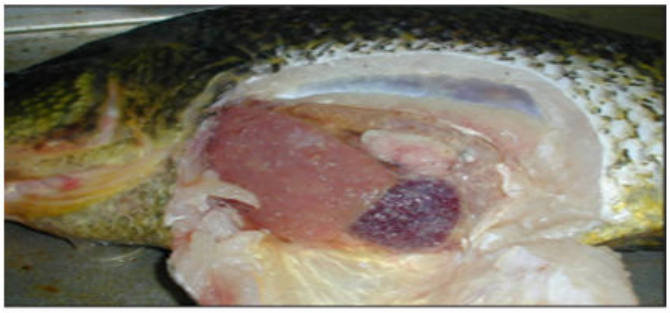

Figure 2. Small gray nodules visible within the spleen of a black crappy during necropsy.

Mycobacterium marinum enters the skin by abrasion, which can occur while resting elbows near a fish pond or while processing or preparing seafood [14]. "Fish handler's illness," "tank granuloma," and "fish fancier's finger" are some of the nick names for clinical condition caused by human infection. The severity of the infection varies from self-limiting to significant skin lesions that can be treated [15]. Until it was changed to "*Mycobacterium marinum*," the cause of these lesions was known as "*Mycobacterium balnei*" [16]. Atypical mycobacteriosis can cause widespread infections, which can lead to death in people with weakened immune systems [16].

The restricted capacity of *Mycobacterium* species to infect humans and propagate to deeper tissues is likely due to their inadequate tolerance for hot temperatures. Because *M. marinum* can only grow at temperatures below body temperature, most human infections are localized to the extremities [17]. *Mycobacterium* is a genus of non-tuberculous mycobacteria with documented pathogenic potential, including the ability to transmit and infect humans [18]. A combination of two medications, namely ethambutol and rifampicin, is indicated for treating infected people with a sporotrichoid (subcutaneous lesions) distribution pattern (Figure 3) [19].

a b

Figure 3. (a) Red, circular lesion on the hand from atypical mycobacteriosis infection, (b) Sporotrichoid spread of nodules.

Aeromonas infection

Aeromonas species are widespread bacteria that have emerged as major zoonotic pathogens, causing gastroenteritis, soft-tissue infections, septicemia, and skin illnesses in humans. Because of contaminated water in the aquatic environment, the *Aeromonas* disease epidemic resulted in high economic, societal, and public health costs. *Aeromonas* infections and normal endemic exposure to aquatic pathogens in underdeveloped nations may be overlooked, resulting in exceptionally frequent occurrences (Figure 4) [20].

Figure 4. (A) the legs of the patient look red and swollen and then after treatment (B) lesion starts to recover.

Aeromonas hydrophila is a prevalent foodborne pathogen that poses a public health risk and is spread from animal to human. *Aeromonas* is the most prevalent isolate linked to gastrointestinal and extraintestinal illnesses in people. Virulence factors such as enterotoxins, cytotoxins, or hemolysins, as well as antibiotic resistance factors, may be found in *Aeromonas* strains. *Aeromonas* capacity to grow at low temperatures (5°C) makes them a possible public health threat. Aerolysin, a virulence factor found in *Aeromonas hydrophila*, has a role in infection pathogenesis. Fish, in addition to chicken, play a key role in the transmission of this bacterium to humans. *Aeromonas* infection is dangerous to people's health, especially those who are immunocompromised, young people, and the elderly. Raw frozen fish consumption, which could be a major source of *Aeromonas* species, could possibly be a zoonotic risk.

Aeromonads disease outbreaks in freshwater farmed fish are becoming increasingly widespread around the world. For fish producers to avoid losses, information on the severity of infection and the characteristics of the etiological agent is crucial. The disease is characterized by abnormalities such as a congested liver with bleeding and an enlarged gall bladder with hemorrhagic spleen on necropsy of fish. The diseased fish exhibit a variety of clinical signs and symptoms. Exopthalmia with stomach distention, as illustrated in Figure 2. Hemorrhagic lesions in the gill cover, ocular clouding, and huge mortality are all symptoms of hemorrhagic septicemia (Figure 5).

Figure 5. Clinical sign and postmortem finding of diseased Nile tilapia.

Community awareness and thorough surveillance should be used to prevent the infections. It must also be kept separate from patients who have symptoms of gastrointestinal disease, such as dysentery, after a common exposure. Because of the disease's expanding and emerging importance, it should be prevented as soon as possible.

Dehydration is prevented with oral fluid electrolyte substitution, and severe *Aeromonas* outbreaks are treated with broad-spectrum antibiotics. A number of demographical, sociological, environmental, and physiological emerging factors are expected to play a role in increasing the frequency of pathogen transmission to hosts, and the rising trend in antibiotic resistance in bacteria necessitates more research into the bacterium.

Vibrio infection

Vibrio vulnificus, *Vibrio parahaemolyticus*, and *Vibrio alginolyticus* are the most common zoonotic *Vibrio* species. In various countries, *Vibrio parahaemolyticus* is the most prevalent foodborne gastroenteritis-causing bacteria, with roughly 25% of cases reported in co-infection with other *Vibrio* species.

Human foodborne infection is caused by the contamination of seafood with pathogenic *Vibrio* species. *Vibrio parahaemolyticus* causes vibriosis globally in many marine fish and results in sepsis, gastroenteritis, and wound infection in people. *Vibrio vulnificus* is a marine bacterium also associated with human and fish worldwide known as vibriosis. Human septicemia is caused by *Vibrio vulnificus*, a zoonotic siderophilic bacteria whose virulence factor is connected to blood iron levels. A zoonotic strain of this bacteria produces septicemia only when blood iron levels are high enough for it to form a capsule, allowing it to grow and induce sepsis, followed by death.

Both man and fish vibriosis are caused by the public health-critical serovars of *Vibrio vulnificus* (known as biotype 2 serovar E). This pathogen is a fish infection that may infect humans through a variety of mechanisms, resulting in sepsis and death. Humans get infected with *Vibrio vulnificus*, which causes septicemia, gastroenteritis, and necrotized wound infections (Figure 6).

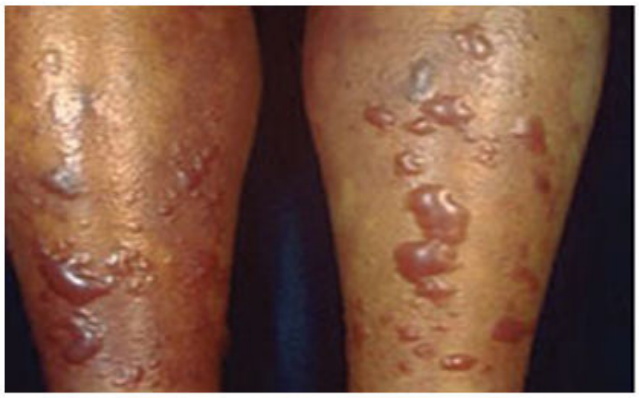

Figure 6. *Vibrio vulnificus* infection presenting as edema; ecchymoses; and hemorrhagic, serous bullae on the lower legs.

In the case of fish although clinical indicators vary depending on whether the infection is spread through the mouth or through contact, the main symptoms include abdominal petechiae, hemorrhages at the base of the dorsal and anal fins, and redness in the operculum region (Figure 7).

Figure 7. Massive mortalities caused by vibriosis in different developmental stages with visible haemorrhages.

Humans can become infected with *V. vulnificus* after eating contaminated fish or coming into touch with a wound. In patients with chronic hepatitis, the condition has a 50% mortality rate, making it highly pathogenic. It is more common in some coastal cities in the United States, Japan, and Taiwan. Appropriate and quick therapy is critical following early diagnosis. The US Centers for Disease Control and Prevention (CDC) recommends using three-generation cephalosporins in combination with tetracyclines to treat *V. vulnificus* infections.

Streptococcus iniae infection

In the year 2000, *Streptococcus iniae* was identified as an emerging zoonotic pathogen spread by food animals. *Streptococcus iniae* is an invasive pathogen that causes meningitis and other symptoms in a variety of fish species. Furthermore, it is a new agent that causes cellulitis in humans. *Streptococcus iniae* is a financially important bacterium that is typically linked to significant losses in fisheries, in addition to its invasive infection of humans. Exophthalmos, irregular swimming, ascites, and melanosis are all symptoms of *S. iniae* infection in aquaculture fish. Isolates from the fish's kidney, brain, and liver produced beta-hemolytic gram-positive cocci colonies (Figure 8).

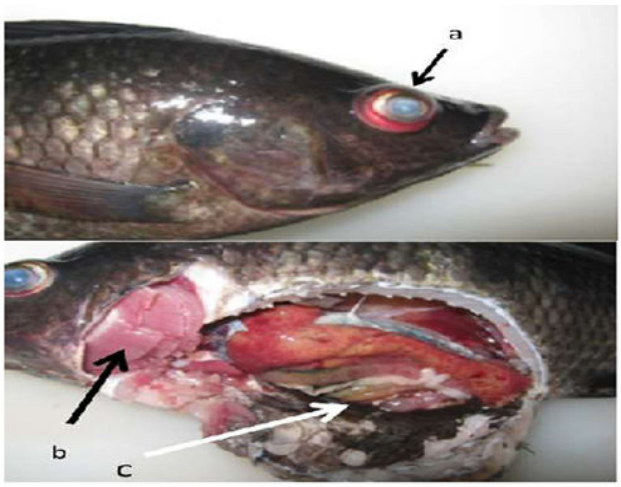

Figure 8. Nile tilapia (*Oreochromis niloticus*) showing gross clinical signs of streptococcosis. a) Exophthalmus, opaque, and haemorrhagic eye, b) Pale gill, and c) Ascites in abdominal cavity.

With the expansion of aquaculture and the growing global reliance on seafood, the occurrence of *S. iniae* infection is projected to climb even faster than it is now, in tandem with the rise in fish production. Human infection with *Streptococcus iniae* can be avoided by taking necessary precautions when handling entire, raw fish. In both fish and humans, the clinical symptoms of *S. iniae* infections are nearly identical to those caused by numerous human specific streptococcal infections.

Discussion

In the United States, Canada, and Asia, *Streptococcus iniae* has been discovered as a zoonose. Its zoonotic significance is primarily opportunistic, affecting the elderly and immunocompromised through puncture wounds caused by contaminated fish handling. Although the disease was initially discovered in a captive Amazon freshwater dolphin in South America in 1976, it is more common in Japan. Warm-water finfish aquaculture can be found all over the world. *S. iniae*, like other betahaemolytic encapsulated streptococcus bacteria, has been resistant to immunization due to serotypic polymorphism. As a result, antibiotic treatment is frequently utilized to prevent economic losses and eliminate the death rate (Table 1).

Study area	Pathogen	Fish species	Samples	Identification technique	Prevalence (%)
Czech Republic	*Mycobacterium*	Ornamental Fish	Gills, muscle and intestine	Molecular	41.7
Czech Republic	*Mycobacterium*	9 different species	Gill, muscle, liver, intestine and skin	Molecular	1.7

Nigeria	*Vibrio parahaemolyticus*	*Parachonna africana Chrysichthys nigrodiaitatus* and *Hippoptamytus pictus*	Skin, intestine and gills	Biochemical	13
	Vibrio vunificus				1
United States of America (USA)	*Streptococcus iniae*	Tilapia	Swab specimens of the brain and kidneys skin (mucus)	Biochemical	4.34
Egypt	*Vibrio parahaemolyticus* and *Vibrio alginolyticus*	6 fish spp. including Nile tilapia	Meat	Molecular	30.67
Trinidad	*Aeromonas* spp.	Tilapia	Kidney, liver, heart, spleen, swim bladder and gills were taken	Biochemical	44
Egypt	*Aeromonas*	Nile tilapia	Liver and kidney	Molecular	33.3
Egypt	*A. hydrophila*	Nile tilapia	-	Molecular Identification	19.2
Tanzania	*Aeromonas*	Nile tilapia	Liver, heart and kidneys and gills	Molecular	24.6
Egypt (El Fayoum and El Sharkia)	*Aeromonas hydrophila*	Nile tilapia	Kidney, liver, brain and spleen	Biochemical	73.33 and 29.72
	V. vulnificus				0 and 16.22
Nigeria	*Aeromonas hydrophila*	Nile tilapia	Intestine	Biochemical	34
Egypt	*Aeromonas hydrophila*	Nile tilapia	Liver, spleen, and kidney	Biochemical	6=Wild stock
					10=Cultured stock
Uganda	*Aeromonas hydrophila*	Nile tilapia and African catfish)	Kidney, liver, brain and spleen	Biochemical	43.8
	Streptococcus spp.			Biochemical	6.3

Table 1. Summary of reviewed prevalence studies globally.

Bacterial zoonotic diseases of fish in Ethiopia

In Ethiopia, parasitic infections of fish receive greater attention than bacterial pathogens, including germs that are crucial for public health. During a stressed aquatic environment, opportunistic fish infections such as *Aeromonas* and *Vibrio* species discovered in Ethiopia in the internal organs of fish may produce an outbreak. The discovery of such zoonotic diseases in fish serves as a reminder of the necessity of hygienic fish handling and avoiding raw fish eating, especially among Ethiopians who are immunocompromised.

Fish is a great source of high-quality protein as well as a variety of vitamins and minerals that are important for food security and economic prosperity. However, the nutritional composition of the product raised concerns about the safety of major bacterial infections that affect both fish and people. Because of potential risk factors such as consumption of raw infected fish and fish products, and contact with contaminated water or infected fish, the presence of zoonotic bacteria in Ethiopian fish could constitute a potential risk to human health. The lack of studies on the infection's zoonotic significance in Ethiopia demonstrates that it is one of the country's most neglected fish infections.

Edwardsiella tarda is one of the most important bacterial diseases wreaking havoc on the fishing industry. The disease also has public health consequences for individuals in the fishing business, as well as those who rely on fish products for a living and consumers. As a result, the isolation of *E. tarda* from a wild fish population in Lake Zeway destined for human consumption suggests that *E. tarda* poses a risk to both the fishery and human health.

A pond in Sebeta, Ethiopia, saw an outbreak of white nodular lesions throughout the body and hemorrhage in the skin of African catfish (*Clarias gariepinus*) fingerlings. *Aeromonas hydrophila* infection with *Ichthyophthirius multifiliis*, a holotrichous ciliate, was eventually detected histopathologically. The fish population in Lake Hayiq, Ethiopia, was also cultivated with commonly isolated bacterial pathogens from fresh water fish. The majority of these microorganisms are beneficial to both the environment and humans. *Aeromonas* species and the major isolated bacterial pathogens, such as *Edwardsiella* species, were found to be indications of the existence of zoonotic pathogens of public health importance. Further research into fish diseases, water quality, and other possible consequences on the aquatic ecosystem should be backed up by such baseline findings. Furthermore, to prevent associated outbreaks, fishermen, handlers, and consumers must be educated about the public health implications of such diseases (Table 2 and Figure 9).

Study area	Pathogen	Fish species	Samples	Identification techniques	Prevalence (%)
Lake Tana	*Aeromonas hydrophila* *Edwardsiella tarda Vibrio* spp.	*Barbs* spp.	Kidney and Intestine	Biochemical tests	7.1
		C. gariepinus			2
		Garra spp.			7.8
		O. Niloticus			
		V. Beso			
Lake Hayiq	*Aeromonas* species	*Oreochromis niloticus*	Skins, gills, intestines, swim bladders, kidneys, and livers	Biochemical tests	2.3
	Edwardsiella species	*Cyprinus carpio* and			2.9
	Vibrio species	*Clarias gariepinu*			3.6
Lake Langanoo and Zeway	*Edwardsiella tarda*	*Clarias gariepinus* and *Oreochromis niloticus*	Liver intestine and kidney	Biochemical tests	9.68
Lake Hawassa and lakes around Bishoftu	*Edwardsiella tarda*-like species	*Clarias gariepinus* and *Oreochromis niloticus*	Kidney, liver and intestine	Biochemical tests	7.6

Table 2. Summary of reviewed articles studied on prevalence in Ethiopia.

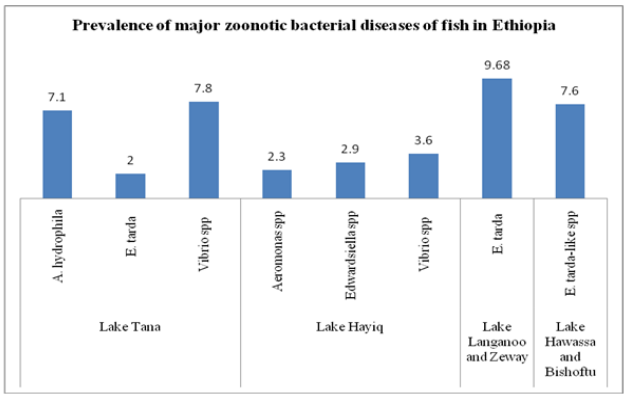

Figure 9. The graph illustration for the prevalence (%) of major zoonotic bacteria of fish studied at Ethiopian lakes.

General prevention mechanisms

The main prophylactic methods for minimizing the risk of exposure are basic hygiene and complete hand washing promptly after handling seafood. To minimize direct touch, it is better to utilize helping equipment such as brushes, scrubbers, and sprayers for possible operations such as cleaning and netting. Basic biosecurity protocols for an aquaculture facility are very vital in preventing disease entry. Another technique to ensure the detection of possible infections in a population is to conduct regular fish health monitoring. Finally, everyone who works with fish and seeks medical help for lesions or illnesses of unknown origin should inform their doctor about their participation with aquaculture.

All aquatic infections, including resistant atypical mycobacteria, can be killed by disinfecting contaminated surfaces by drying exposed surfaces. Veterinarians, their employees, and their clients should always take precautions to avoid exposing open cuts and abrasions to water. Disposable gloves can keep you safe while working. Clients have a responsibility to be informed, and veterinarians must act by demonstrating correct PPE use (Personal Protective Equipment). When working with fish, clients should be educated about zoonotic diseases. An informed customer will be able to provide a more detailed history to their physician if a possible fishborne zoonosis is suspected. During immune suppression, special attention should be paid to safeguarding the extremities and avoiding exposure.

The control of infections from fish requires better communication and medical diagnostic tools. It is an indispensable outcome to share zoonotic fact sheets with fish culturists and fish processors, hospitals, and veterinary services. Furthermore, diagnosticians must gain a better understanding of the characteristics of diseases in humans and fish, laboratory techniques, and appropriate treatment and prevention methods. It is also an appreciated task to detect and notify zoonotic diseases to the concerned international organizations such as WHO (World Health Organization) and OIE (World Organization for Animal Health).

Conclusion

The enhancing habit of seafood consumption raises concerns about the food safety of fish, even though it is still inadequate to overcome the possible hazards. Most of the bacterial pathogens are categorized as zoonoses based on epidemiological and phenotypic evidence rather than relational genetic identity between fish and human isolates. Their method of transmission of pathogens such as *M. marinum* between fishes is not well understood, and their mechanism of causing infection is not supported by molecular studies. The primary routes of infection are thought to be consumption of infected dead fish and direct contact with infected fish. Infections receive little attention in developing countries, including Ethiopia, and routine endemic exposure to waterborne pathogens may result in unusually frequent occurrences. Zoonotic bacteria of fish are among the most common occupational hazards for fishermen, veterinarians, and other fish handlers globally. Their

zoonotic importance is predominantly opportunistic, which affects aged or immunocompromised people through the invading of puncture wounds during the handling of contaminated fish. In Ethiopia, these infections are considered among the most neglected fish diseases as a result of a lack of studies on their zoonotic importance. Good communication is important between stakeholders to have awareness of their public health importance.

Recommendations

Therefore, based on the above conclusions the following recommendations are suggested.

- Using personal protective equipment and good hygiene during fish handling and after handling, respectively, is so important.
- Immunecompromized people should take care of themselves while they have exposure to aquatic environments containing fish.
- Professional collaboration should be applied between veterinarians, medical professionals and environmental experts as per one health approach.
- Developing countries, including Ethiopia, should give appropriate emphasis on the safety parallel with the growing fish industry.
- Further studies on the detection, specific mechanism of transmission and molecular basis of their zoonotic patterns should be conducted in the aquatic environment of Ethiopia.
- People with frequent exposure to fish and health professionals should have an awareness of the diseases and their control measures.

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Conflicts of Interest

The authors declare that there is no conflict of interest regarding the publication of this paper.

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