A Review of Salmonella sp. in Tilapia fish (Oreochromis niloticus) : Public Health Importance

by Hani Plumeriastuti

Sys Rev Pharm 2020;11(10):819-826
A multifaceted review journal in the field of pharmacy

A Review of *Salmonella sp.* in Tilapia fish (*Oreochromis niloticus*) : Public Health Importance

Azhar Muhammad Helmi[1], Akhmad Taufiq Mukti[2], Agoes Soegianto[3], Ketut Mahardika[4], Indah Mastuti[4], Mustofa Helmi Effendi[5]*, Hani Plumeriastuti[6]

[1]Postgraduate Student on Faculty of Fisheries and Marine, Universitas Airlangga, Indonesia
[2]Department of Fish Health Management & Aquaculture, Faculty of Fisheries and Marine, Universitas Airlangga, Indonesia
[3]Department of Biology, Faculty of Sciences and Technology, Universitas Airlangga, Indonesia
[4]Center for M[illegible]he Cultivation Research and Fisheries Extension, Buleleng, Bali, Indonesia
[5]Department of Veterinary Public Health, Faculty of Veterinary Medicine, Universitas Airlangga, Indonesia
[6]Department of Veterinary Pathology, Faculty of Veterinary Medicine, Universitas Airlangga, Jl. Mulyorejo, FKH UNAIR, Kampus C Universitas Airlangga, Surabaya 60115, Indonesia

***Corresponding author**: Mustofa Helmi Effendi
Email: mheffendi@yahoo.com

ABSTRACT
Tilapia fish or *Oreochromis niloticus* is a food security commodity from the fisheries sector and is traded internationally, but in Asian countries tilapia aquaculture is mostly maintained using traditional systems, besides that homemade feed is used to reduce production costs. Cultivation of tilapia with traditional systems and artificial feed that is integrated with other livestock has the potential to cause the danger of transmitting zoonotic pathogens from other livestock manure and feed residue. Salmonella sp. which is one of the zoonotic pathogens that can be transmitted from tilapia. The use of antibiotics in livestock and cultivation causes Salmonella sp. able to withstand some antibiotics. Salmonellosis in humans has become an important public health problem, incurring significant economic and medical costs worldwide. The incidence of salmonellosis due to fish consumption has become a concern of public health agencies in several countries, because increased consumption of fishery products, especially raw products, increases the risk. Pathogen exposure, especially in vulnerable groups, such as the elderly, has increased significantly. pregnant women and babies. The importance of this pathogen in fish can be assessed and evaluated, as records show that most Salmonella infections in humans are related to fish consumption.

Keywords: Tilaphia fish, Salmonella sp, Zoonotic pathogen, Public health

Correspondence:
Mustofa Helmi Effendi
Department of Veterinary Public Health, Faculty of Veterinary Medicine, Universitas Airlangga, Indonesia
Email: mheffendi@yahoo.com

INTRODUCTION
Integrated tilapia farming is a traditional practice by small-scale farmers in China as well as in other Asian countries. Fish are usually raised in ponds with livestock units, such as pigs, located on pond embankments, which allow drainage of livestock manure and excess feed into the pond as plankton and other fish feed [1, 2]. Although integrated agricultural systems are sustainable in many ways, they represent potential food safety hazards, for example transmission of zoonotic pathogens from faeces and accumulation of antimicrobials and others. residues originating from pig manure and feed [3, 4]. Tilapia is one of the easiest to cultivate and trade fishery food products internationally in the world, with an estimated 1.45 million tonnes produced in China in 2013 [5, 6.].
In the Asia-Pacific region, farmed fish are fed commercial or homemade feed [7]. Homemade feed is used to reduce costs and usually consists of chicken offal and by-products produced during poultry processing, kitchen waste, and other by-products from the food industry [7, 8]. Homemade diets can be a potential source of foodborne pathogens, particularly Salmonella bacteria [9, 10], which can then be transmitted to farmed fish [11] and to humans. Salmonellosis in humans has become an important public health problem, creating significant economic and medical costs worldwide. In the United States, nontyphoidal Salmonella caused approximately 1 million foodborne illnesses, 13,000 hospitalizations, and 242 deaths in 2011 [12]. In Taiwan, Salmonella is one of the most frequently isolated foodborne pathogenic bacteria [13]. Salmonella is usually transmitted to humans through consumption of contaminated food products. According to Bean et al. [14], approximately 7% of cases of human salmonellosis result from ingestion of contaminated food from fishery products, particularly ready-to-eat (RTE) products. In Hong Kong, detected Salmonella in smoked fish, salmon sushi, and salted fish products [15, 16, 17], which illustrates that Salmonella was continuously contaminated by these RTE products. In addition, human salmonellosis caused by contaminated fish products has been reported in European countries [18, 19], where processing is considered to be one of the important sources of contamination [20, 21]. Martinez-Urtaza and Liebana [21] and Morris et al. [22], who evaluated the incidence of Salmonella in seafood processing plants, surveillance of foodbour pathogens during processing is essential to a successful contamination control program. When monitoring Salmonella contamination, serotyping and molecular subtypes are often applied to trace the source of bacterial contamination [23, 24].
The incidence of salmonellosis due to fish consumption has become a concern of public health agencies in several countries, because the increased consumption of fish farming, especially raw products, which increases the risk of exposure to pathogens, especially in vulnerable groups, such as the elderly, increases significantly. pregnant women and infants [25, 26]. The importance of this pathogen in fish can be assessed and evaluated, as records show that fish is the source of transmission responsible for 7% of total foodborne outbreaks in Europe in 2016, with the majority of Salmonella infections in humans linked to

fish consumption caused by Salmonella Typhimurium. and Enteritidis serovars [27, 28, 29, 30].

Overview of Salmonella sp.

Salmonella spp. are Gram-negative rod-shaped bacteria that cause salmonellosis. In humans, these pathogenic bacteria cause enteric fever and acute gastroenteritis [31]. Symptoms include mild to severe gastroenteritis, with an incubation period of 6–72 hours [31]. Salmonellosis outbreaks due to fish consumption have been reported in several countries. For example, salmonellosis caused by eel consumption, which is linked to fish farming in Italy and has been reported in Germany [32]. Several reports have linked the presence of Salmonella spp. in various fishes and shell fishes [33, 34]. Various hazards associated with natural fish farming come from the environment or from human or animal activities. Fish can be a vehicle for transmission of Salmonella which can be pathogenic for humans and has a high potential to transmit its antibiotic resistance gene to other pathogens via plasmids [35]. The potential for antibacterial agents to cause the development of resistance in fish pathogens is of worldwide concern [36].

Salmonella grows optimally at 37 ºC, but these bacteria are able to grow in a temperature range of 5-47 ºC [37]. However, dietary Salmonella exhibits varying survival behavior depending on the type of food matrix and storage conditions [37]. Studies show that Salmonella can survive for more than 16 weeks in frozen processed chicken products and for more than 9 months in frozen beef without much change in quantity [37]. Studies on the viability of Salmonella in chilled and frozen fish and fishery products are very limited. One study reported that Salmonella Enteritidis survived but did not grow at 3 ºC, whereas bacteria thrived at 10 ºC in vacuum packed fish and poultry [38]. The amount of Salmonella in raw tuna was reduced by 1 to 2 logs after 12 days of storage at 5-7 ºC, whereas in frozen storage Salmonella became undetectable after 42 days of storage. In frozen shrimp, populations of S. Weltevreden and S. Senftenberg decreased but were not eliminated during 12 weeks of storage [39, 40].

Zoonoses in humans

Infection can occur if fishery food contaminated with salmonella is consumed raw or undercooked. Salmonellosis transmitted through food from fisheries is a major cause of human morbidity worldwide [40, 41]. Salmonella spp. cause various diseases such as enteric fever and gastroenteritis. The majority of the estimated 1.3 billion annual cases of salmonellosis result from consumption of contaminated food products especially pork, poultry, eggs and vegetables [41]. In comparison, fishery foods are less frequently associated with Salmonella infections although reports from Thailand, Malaysia and other Asian countries indicate that certain serovars, eg S. Weltevreden, may be primarily associated with aquatic environments and seafood [42]. Prevalence of Salmonella spp. may also be higher in seafood from Asia compared to seafood from other geographic regions [43, 44]. However, other studies argue that Salmonella spp. can last longer in tropical aquatic environments and should therefore be seen as part of the normal micro-flora of aquaculture products of the area [45]. Salmonella can be disseminated as a result of water currents, underground springs and rainwater runoff carrying contaminated material [46-49]. Like E. coli, Salmonella is continuously released into the environment from infected humans, livestock, domestic animals, and wildlife [50]. Pathogenic and potentially pathogenic bacteria associated with fish and shellfish include Mycobacteria, Streptococcus iniae, vibrio vulnificus, vibro spp, Aeromonads, Salmonella spp, Shigella and others [51, 52, 53]. Human infection by these fish pathogens is usually through contact with infected fish during handling, water or other elements of the fish's living environment [54]. The initial microflora on the surface of the fish is directly related to the aquatic environment whereas the flora in the digestive tract is related to the type of food and condition of the fish [55].

Salmonella sp. is a causative agent of pathological diseases in humans, cattle, poultry and other livestock and Salmonella infection is a major cause of concern for humans, animals and the food industry. Characterization of more than 2,500 Salmonella serovars, the pathogen infects nearly all vertebrates but the severity of infection varies from one serovar to another depending on the specificity of the host [56]. Some Salmonella serovars are limited to one or several hosts while others have a wide spectrum of hosts. An understanding of the mechanisms involving host preference by one serovar over another is essential. This is used to increase our knowledge about host adaptability and will be instrumental in designing better prevention models. Methods involving identification of genetic markers for host specificity will prove to play a role in determining virulence factors for other bacterial pathogens that cause systemic infection [54, 56].

The low standard of health in the coastal areas increases the eutrophication process, thus creating a broad conducive environment for the survival of microbes that eventually infect fish. Analysis of fish tissue slurry showed that the fish harvested from the landing beaches along the coast that had been contaminated by Enterobacteriaceae were; Salmonella, Shigella and E. coli [57, 58, 59]. In the Asia-Pacific region, farmed fish are fed commercial or homemade feed [60]. Homemade feed is used to reduce costs and usually consists of chicken offal and byproducts produced during poultry processing, kitchen waste, and other by-products from the food industry [60, 61]. Homemade diets can be a potential source of foodborne pathogens, particularly Salmonella bacteria [9, 62], which can then be transmitted to farmed fish [63, 64] and, in turn, to humans. Detailed information on salmonellosis due to consumption of tilapia in Malaysia is lacking, as most cases of food poisoning are not reported to the authorities. However, the Malaysian National Public Health Laboratory reports that the five most common nontyphoidal Salmonella serovars are Salmonella Enteritidis, Salmonella Weltevreden, Salmonella Corvallis, Salmonella Typhimurium, and Salmonella Tshiongwe [65]. In Malaysia, freshwater fish are kept using aquaculture ponds, ex-mining ponds, freshwater cages, cement tanks, canvas tanks, and freshwater cage culture systems. Most of the freshwater cultivated fish are maintained using the aquaculture system (59.5%) and ex-mining ponds (25%). Catfish (58.1%) and tilapia (41.3%) were reared in ground ponds and ex-mining [65].

Transmission of bacteria from tilapia (*Oreochromis sp.*)

Fish is considered to be one of the most nutritious and highly desirable food ingredients due to its high nutritional value and is rich in protein, vitamins and unsaturated fatty acids. Fish contains n-3 polyunsaturated fatty acids which is a very important aspect for health-conscious people especially in affluent countries where the death rate from cardiovascular disease is high. Fish contains more easily digestible protein than protein found from other sources. Fish are of great concern for export earnings because of their higher nutritional value, low cholesterol levels and presence of essential amino acids [64]. Bangladesh is the 5th in world aquaculture production, which accounted for half of the country's total fish production in 2015-2016 [65, 66]. This sector contributed 3.65% to GDP and 1.97% to foreign exchange earnings through exports [66]. It is the second largest export industry in Bangladesh and accounts for 2.5 percent of global shrimp production [66].

The main pathogens affecting cultivation include bacteria, fungi, viruses, and parasites [67-69]. Bacterial diseases have become a major concern for cultivation, especially with warm water temperatures [70]. Different bacterial species are reported to be pathogens against aquatic tilapia, including Aeromonas hydrophila, Edwardsiella tarda, Flavobacterium columnare, Francisella spp., Yersinia ruckeri, Staphylococcus epidermidis, Vibrio vulnificus, and Streptococcus agalactiae [71-79].

Fish was associated with 24% of foodborne disease outbreaks and 6% of all food poisoning, or foodborne illness [80]. Levels of pathogenic bacteria in tilapia are related to the environment and its handling before entering food markets and restaurants. The bacteria associated with tilapia fish can be transmitted by direct contact and cause foodborne illness. For example, handling of tilapia has been linked to an outbreak of Vibrio vulnificus in a Seattle supermarket [81]. Other foodborne pathogenic bacteria including Salmonella enterica, enteropathogenic Escherichia coli, Listeria monocytogenes, Yersinia enterocolitica, and Klebsiella pneumoniae were identified from fresh tilapia in the Kenyan freshwater fish chain [82]. Shigatoxigenic and enteropathogenic Escherichia coli was isolated from farmed tilapia (Oreochromis niloticus) in the northeast region of the state of Sao Paulo [83]. It was reported that the microbial quality of tilapia showed that all the tissues were contaminated by salmonella and fecal coli. Salmonella can spread as a result of water currents, underground springs and rain runoff carrying contaminated material [84, 85]. Human infection by these fish pathogens is usually through contact with infected fish while handling them over, water or other elements of the fish's living environment [86]. These pathogenic organisms have been isolated from freshwater fish such as Tilapia nilotica Linn [87]. Tilapia is an important aquaculture production for food supply. Because on a global scale, fish and fish products are the most important sources of protein and it is estimated that more than 30% of the fish consumed by humans comes from aquaculture [88, 89].

Safe consumption of fish and fishery products requires adequate sanitary conditions from harvest to consumption [90, 91]. Consumption of fish and shellfish can also cause illness due to infection or poisoning. Most of the foodborne diseases are caused by Salmonella spp., Staphylococcus spp. and Escherichia coli, usually associated with the consumption of fish infected with these bacterial species especially Salmonella and E. coli [92, 93]. Salmonella usually enters the human intestine with food, Salmonella spp. must overcome resistance to colonization mediated by the gut microbiota and the innate immune system. Salmonella by inducing inflammation and innate immune defense mechanisms. Many models have been developed to study Salmonella spp. interactions with the microbiota have helped to identify the factors needed to overcome colonization resistance and to mediate disease [10, 54, 93]. Salmonella infection in humans mainly includes typhoid fever and this infection, known as enteric fever, continues to be one of the most serious public health problems worldwide. The presence of higher levels of Salmonella in fish causes several symptoms in the human body such as diarrhea, nausea, vomiting and abdominal pain. Human salmonellosis caused by contaminated fish products has been reported in European countries [18, 19], where processing is considered to be one of the important sources of contamination [20, 21].

ANTIBIOTIC RESISTANCE

Self-limiting gastroenteritis is the main clinical picture developed by Salmonella, which in severe cases may require fluid and electrolyte replacement. The use of antibiotics is reserved for patients with serious illness or a high risk of invasive disease [94]. The antibiotic therapy scheme for typhoid fever includes third generation cephalosporin antibiotics, quinolones and macrolides. However, recently it has developed between typhoid Salmonellas and non-typhoid strains with a high degree of resistance to quinolones and cephalosporins [95]. The emergence of several drugs resistant to Salmonella (MDR) is currently of worldwide concern, and the occurrence of Salmonella MDR in food is a risk condition, indicating an increase in the severity of foodborne disease, leading to increased hospitalization rates and the likelihood of death [96]. In contrast, the epidemiology of antimicrobial resistance of Salmonella spp. It is complex and can be influenced by factors such as: consumption of antibiotics, human travel, transmission between patients in hospitals, import and trade in food of animal origin or not, trade in live animals within the country or between countries and exposure through animals or the environment human [97].

The use of antibiotics for therapeutics and growth promoters in feed animals has shown that the main factor for the emergence of resistant isolates [98], has been reported from livestock [99-103], poultry [104-108], pets [109-112]), fish [113-116], and from animal products. [117-120]. Several studies have reported that pet food, meat, milk and fishery products contaminated by a multi-resistant S. aureus strain which has been one of the common causes of severe nosocomial infection for a long time [121]. In contrast, a large number of studies have reported increased incidence of resistance among Salmonella spp. isolated from poultry, beef and fishery products [122].

Antibiotics are used for medicinal purposes and as growth promoters in livestock and aquaculture leading to the development of resistance [123]. Acquired resistance to tetracyclines and chloramphenicol has been associated with extensive use of antibiotics in aquaculture in several Asian countries [124]. Sapkota et al. [125] reported that of the top 13 aquaculture producing countries, 92% used oxytetracycline and 46% used chloramphenicol.

It was reported that antibiotic resistance in Gram-negative bacteria from pond culture was higher in ponds undergoing antimicrobial therapy or with a recent history of treatment than in ponds without antimicrobial treatment recently [126, 127]. In a previous study, it was reported that all S. enteritidis strains isolated from tilapia sold in a wet market in Selangor, Malaysia were susceptible to rifampin. The emergence of Salmonella serovars with high MAR index indicates that these serovars originate from environments where antimicrobials are often used as therapy or as growth promoters in animal feed [128, 129]. Some drug-resistant Salmonella isolates have been suggested to be more virulent than non-multiple drug-resistant Salmonella isolates [130]. Salmonella resistance to one or more antibiotics has been reported by many investigators [131]. Horizontal transfer of resistance genes in plasmids has been shown between bacteria in fish pond water [131] and in marine sediments [132]. Plasmids in Salmonella spp. has been reported to transfer antibiotic resistance and virulence properties [35].

CONCLUSION

The presence of higher levels of Salmonella sp in tilapia fish causes several symptoms in the human health such as diarrhea, nausea, vomiting and abdominal pain. Salmonella sp in tilapia obtained from the decay of animal waste and feed residue during the traditional cultivation process. Salmonella sp is often resistant to several antibiotics which allow it to be transferred to the surrounding environment, which is because in the process of tilapia pond cultivation it is mixed with disposal from livestock waste where there is a lot of antibiotic residue and while cultivation is still using antibiotics. This is what needs to be a public health concern about antibiotic resistance from isolates obtained in tilapia fish.

REFERENCES

1. Little DC, Edwards P. Alternative strategies for livestockefish integration with emphasis on Asia. *Ambio* , 1999;28: 118-124.
2. Petersen A, Andersen JS, Kaewmak T, Somsiri T, Dalsgaard A. Impact of integrated fish farming on antimicrobial resistance in a pond environment. *Appl. Environ. Microbiol*. 2002; 68: 6036-6042.
3. Dhawan A, Kaur S. Effect of pig dung on water quality and polyculture of carp species during winter and summer. *Aquac. Int*. 2002;10: 297
4. Shah SQ, Colquhoun DJ, Nikuli HL, Sorum H. Prevalence of antibiotic resistance genes in the bacterial flora of integrated fish farming environments of Pakistan and Tanzania. *Environ. Sci. Technol*. 2012;46: 8672-8679.
5. FAO. The State of World Fisheries and Aquaculture, 2014; Rome.
6. Zhang WB, Murray FJ, Liu LP, Little DC. A comparative analysis of four internationally traded farmed seafood commodities in China: domestic and international markets as key drivers. *Rev. Aquac*. 2015;0: 1-22.
7. Food and Agriculture Organization of the United Nations. Report of the FAO Workshop on the On-Farm Feeding and Feed Management in Aquaculture, 2010; p. 4–5: FAO Fisheries and aquaculture report no. 949. Food and Agriculture Organization of the United Nations, Rome.
8. Food and Agriculture Organization of the United Nations. Report of the Expert Workshop on the Application of Biosecurity Measures To Control Salmonella Contamination in Sustainable Aquaculture, 2010; p. 9–26: FAO Fisheries and aquaculture report no. 937. Food and Agriculture Organization of the United Nations, Rome.
9. Burr WE. and Helmboldt CF. Salmonella species contaminants in three animal by-products. *Avian Dis.* 1962; 6:441–443.
10. Lunestad BT, Nesse L. Lassen J, Svihus B, Nesbakken T, Fossum K, Rosnes JT. Salmonella in fish feed; occurrence and implications for fish and human health in Norway. *Aquaculture* 2007; 265:1–8.
11. Junior PG, Assunc¸a˜o AW, Baldin JC, Amaral LA. Microbiological quality of whole and filleted shelf-tilapia. *Aquaculture* 2014; 433:196–200.
12. Scallan E, Hoekstra RM, Angulo FJ, Tauxe RV, Widdowson MA, et al. Foodborne illness acquired in the United States—major pathogens. *Emerg. Infect..Dis*. 2011;17:7–15.
13. Su HP, Chiu SI, Tsai JL, Lee CL, Pan TM. Bacterial food-borne illness outbreaks in northern Taiwan, 1995– 2001. *J. Infect. Chemother*. 2005; 11:146–151.
14. Bean NH, Goulding JS, Lao C, Angulo FJ. Surveillance for foodborne-disease outbreaks—United States, 1988– 1992. *MMWR CDC Surveill. Summ*. 1996; 45:1–66.
15. Cabedo L, Picart i Barrot L, Teixido i Canelles A. Prevalence of Listeria monocytogenes and Salmonella in ready-to-eat food in Catalonia, Spain. *J. Food Prot*. 2008; 71:855–859.
16. Heinitz ML, Johnson JM. The incidence of Listeria spp, Salmonella spp, and Clostridium botulinum in smoked fish and shellfish. *J. Food Prot*. 1998; 61:318–323.
17. Heinitz ML, Ruble RD, Wagner DE, Tatini SR. Incidence of Salmonella in fish and seafood. *J. Food Prot*. 2000; 63:579– 592.
18. Fell G, Hamouda O, Lindner R, Rehmet S, Liesegang A, Prager R, Gericke B, Petersen L. An outbreak of Salmonella Blockley infections following smoked eel consumption in Germany. *Epidemiol. Infect*. 2000; 125:9–12.
19. Guerin PJ, De Jong B, Heir E, Hasseltvedt V, Kapperud G, Styrmo K, et al. Outbreak of Salmonella Livingstone infection in Norway and Sweden due to contaminated processed fish products. *Epidemiol. Infect*. 2004; 132:889–895.
20. Klaeboe H, Rosef O, Saebo M. Longitudinal studies on Listeria monocytogenes and other Listeria species in two salmon processing plants. *Int. J. Environ. Health Res.* 2005; 15:71–77.
21. Martinez-Urtaza J, Liebana E. Use of pulsed-field gel electrophoresis to characterize the genetic diversity and clonal persistence of Salmonella Senftenberg in mussel processing facilities. *Int. J. Food Microbiol*. 2005; 105:153–163.
22. Morris GK, Martin WT, Shelton WH, Wells JG, Brachman PS. Salmonellae in fish meal plants: relative amounts of contamination at various stages of processing and a method of control. *Appl. Microbiol*. 1970; 19:401–408.
23. Kilic A, Bedir O, Kocak N, Levent B, Eyigun CP, Tekbas OF, at al. Analysis of an outbreak of Salmonella Enteritidis by repetitive-sequence-based PCR and pulsed-field gel electrophoresis. *Intern. Med. (Tokyo)* 2010; 49:31–36.
24. Weigel RM, Qiao B, Teferedegne B, Suh DK, Barber DA, Isaacson RE, at al. Comparison of pulsed field gel electrophoresis and repetitive sequence polymerase chain reaction as genotyping methods for detection of genetic diversity and inferring transmission of Salmonella. *Vet. Microbiol*. 2004; 100:205–217.
25. Zhang J, et al. Prevalence of antimicrobial resistance of nontyphoidal *Salmonella* serovars in retail aquaculture products. *International Journal of Food Microbiology*, 2015;210:47-52.
26. Paudyal NV. et al. Prevalence of foodborne pathogens in food from selected African countries–A meta-analysis. *International Journal of Food Microbiology*, 2017;249:35-43.

27. Santiago JDA. S. Bactérias patogênicas relacionadas à ingestão de pescados-revisão. *Arquivos de Ciências do Maret*, 2013;46:2.
28. EFSA. European Food Safety AutorityGuidelines for reporting data on zoonoses, antimicrobial resistance and foodborne outbreaks using the EFSA data models for the data collection framework (DCF) to be used in 2017 for 2016 data. 2016; ISSN 2397-8325.
29. Bae D. Characterization of extended-spectrum β-lactamase (ESBL) producing non-typhoidal *Salmonella* (NTS) from imported food products. *International Journal of Food Microbiology*. 2015; 214:12-17.
30. CDC. Center Diseases Control. Multistare Outbreak of *Salmonella* Parathyphi B variant L and tartrate and *Salmonella* Weltevreden infections linked to frozen raw tuna. 2015.
31. Hohmann EL. Nontyphoidal salmonellosis. *Clin. Infect. Dis.* 2001;32:263–269.
32. Fell G, Hamouda O, Lindner R, Rehmet S, Liesegang A, Prager R, et al. An outbreak of Salmonella Blockley infections following smoked eel consumption in Germany. *Epidemiology and Infection* 2000;125: (1), 9–12.
33. Brands DA, Inman AE, Gerba CP, Mare J, Billington SJ, Saif LA. Prevalence of Salmonella spp. in oysters in the United States. *Applied and Environmental Microbiology* 2005;71: 893–897.
34. Duran GM, Marshall DL. Ready to eat shrimp as an international vehicle of antibiotic-resistant bacteria. *Journal of Food Protection* 2005;.68 (11): 2395–2401.
35. Hradecka H, Karasova D, Rychlik I. Characterization of Salmonella enterica serovar Typhimurium conjugative plasmids transferring resistance to antibiotics and their interaction with the virulence plasmid. *Journal of Antimicrobial Chemotherapy* 2008;62 (5): 938–941.
36. Schnick RA. International harmonization of antimicrobial sensitivity determination for aquaculture drugs. *Aquaculture* 2001;196: 277–288.
37. Nychas GJE, Tassou CC. Growth/survival of *Salmonella* enteritidis on fresh poultry and fish stored under vacuum or modified atmosphere. *Letters in Applied Microbiology*, 1996;23(2): 115–119.
38. Liu C, Mou J, Su YC. Behavior of *Salmonella* and *Listeria monocytogenes* in raw yellowfin tuna during cold storage. *Foods (Basel, Switzerland)*, 2016;*5*(1): 16
39. Noda H, Chisuwa M, Kaneko M, Onoue Y, Takatori K, Hara-Kudo Y. Survival of *Salmonella* Weltevreden and *S.* Senftenberg in black tiger shrimp under frozen storage. *Shokuhin Eiseigaku Zasshi. Journal of the Food Hygienic Society of Japan*, 2009;*50*(2): 85–88.
40. Hassan R, Tecle S, Adcock B, Kellis M, Weiss J, Saupe A, et al. Multistate outbreak of *Salmonella* Paratyphi B variant L(+) tartrate(+) and *Salmonella* Weltevreden infections linked to imported frozen raw tuna: USA, March–July 2015. *Epidemiology & Infection*, 2018;*146*(11): 1461–1467.
41. Gong J, Zhang J, Xu M, Zhu C, Yu Y, Liu X, et al. Prevalence and fimbrial genotype distribution of poultry Salmonella isolates in China (2006 to 2012). *Appl. Environ. Microbiol.* 2014;80: 687-693.
42. Deekshit VK, Ballamoole KK, PraveenRai M, Karunasagar I, Karunasagar I. Draft genome sequence of multidrug resistant Salmonella enterica serovar Weltevreden isolated from seafood. *J. Genom.* 2015;3: 57-58.
43. Yan H, Li L, Alam MJ, Shinoda S, Miyoshi S, Shi L. Prevalence and antimicrobial resistance of Salmonella in retail foods in northern China. *Int. J. Food Microbiol.* 2010;143: 230-234.
44. Koonse B, Burkhardt W, Chirtel S, Hoskin GP. Salmonella and the sanitary quality of aquacultured shrimp. *J. Food Prot.* 2005;68: 2527-2532.
45. FAO. Report of the FAO expert workshop on the application of biosecurity measures to control Salmonella contamination in sustainable aquaculture. In: FAO Fisheries and Aquaculture Report No. 937. FAO, Mangalore, India. 2010.
46. Fortes TP. et al. Ilhas de patogenicidade de *Salmonella* enterica: uma revisão. *Revista do Instituto Adolfo Lutz*, 2012;71:219227.
47. Wotzka SY. et al. *Salmonella* Typhimurium Diarrhea Reveals Basic Principles of Enteropathogen Infection and DiseasePromoted DNA Exchange. *Cell Host & Microbe* 2017;21(12):443-454,
48. Chao W, Ding R, Chen R, Survival of pathogenic bacteria in environmental microcosms, *Chinese J. Microbial Immun.* 1987; Vol. 20: pp.339-348,
49. Abdel-Monem MH, Dowidar AA, Recoveries of Salmonella from soil in Eastern region of Saudi Arabia Kingdon, J. *Egypt. Public Health Assoc*. 1990; vol, 65: pp.61- 75,
50. Baudart J, Lemarchand K, Brisabois A, Lebaron P, Diversity of Salmonella strains isolated from the acquatic environment as determined by serotyping and amplification of ribosomal DNA spacer regions. *Appl. Environ. Microbiol*. 2000;66(4):1544 –1552,
51. Lipp EK, Rose JB. The role of sea food in foodborne diseases in the United States of America, *Rev. Sci. Tech*. OIE, 1997;16:620640,
52. Zlotkin A, Eldar A, Ghifino C, Bercovier H, Identification of Lactococcus garvieae by PCR, *J. Clin. Microbiol*, 1989;36: 983985,
53. Bhaftopadhyay P, Fish – catching and handling, In: Robinson R.K. (ed.): Encyclopedia of Food Microbiology, Academic Press, London, 2000; vol.2, pp. 1547,
54. Acha PN, Szyfres B, Zoonoses and communicable diseases common to man and animals, Bacterioses and mycoses. 3rd ed. Scientific and Technical Publication, vol.1, No. 580, Pan American Health Organization, Regional Office of the WHO, Washington, USA, ISBN 92 75 31580 9. 2003; pp..384,
55. Liston J. Microbiology in fishery science, In Connell, JJ. (ed). Advances in Fish Science andTechnology; Jubilee Conference of Torry Research Oxford: Fishing News Books Ltd, Farnham, UK, 1980.
56. Singh, V. Salmonella Serovars And Their Host Specificity. *J Vet Sci Anim Husb*, 2013; 1(3): 301.
57. Abila RO, Jansen EG. From Local to Global markets: The fish exporting and fishing meal industries of Lake Victoria– Structure, Strategies and Socio-economic Impacts in Kenya, IUCN Eastern Africa programme. Socioeconomics of Lake Victoria fisheries: Report No.2, The World Conservation Union, Nairobi, 1997.

58. Kayambo S, Sven EJ. Lake Victoria. Experience and lessons learnt. A case Study for Preliminary Risk Assessment Report. 2006; pp. 431 – 446,
59. Onyango D, Wandili S, Kakai R, Waindi EN, Isolation of Salmonella and Shigella from fish harvested along winam Gulf of Lake Victoria, Kenya, *J. infect. Dis. In Developing Countries,* 2008;2: 106111,
60. Food and Agriculture Organization of the United Nations. Report of the FAO Workshop on the On-Farm Feeding and Feed Management in Aquaculture, p. 4–5. FAO Fisheries and aquaculture report no. 949. Food and Agriculture Organization of the United Nations, Rome. 2010.
61. Food and Agriculture Organization of the United Nations. Report of the Expert Workshop on the Application of Biosecurity Measures to Control Salmonella Contamination in Sustainable Aquaculture, p. 9–26. FAO Fisheries and aquaculture report no. 937. Food and Agriculture Organization of the United Nations, Rome. 2010.
62. Lunestad BT, Nesse L, Lassen J, Svihus B, Nesbakken T, Fossum K, Rosnes JT. Salmonella in fish feed; occurrence and implications for fish and human health in Norway. *Aquaculture* 2007; 265:1–8.
63. Junior PG, Assunc¸a˜o AW, Baldin JC, Amaral LA. Microbiological quality of whole and filleted shelf-tilapia. *Aquaculture* 2014; 433:196–200.
64. Torpdah M, Sorensen G, Lindstedt BA, Nielsen EM. Tandem repeat analysis for surveillance of human Salmonella Typhimurium infections. *Emerg. Infect. Dis.* 2007; 13:388–395.
65. Department of Fisheries Malaysia. Annual Fishery Statistic 2011. Department of Fisheries Malaysia, Putrajaya, Malaysia. 2011.
66. Department of Fisheries. National fish week, Ministry of Fisheries and Livestock, Government of the people's Republic of Bangladesh. 2016;19: 13-132.
67. Ramaiah N. A review on fungal diseases of algae, marine fishes, shrimps and corals. *Indian Journal of Marine Sciences.* 2006;35: 380-387.
68. Guo FC, Woo PT. Selected parasitosis in cultured and wild fish. *Veterinary Parasitology*. 2009;163: 207-216.
69. Vega-Heredia S, Mendoza-Cano F, Sanchez-Paz A. Theinfectious hypodermal and haematopoietic necrosis virus: a brief review of what we do and do not know. *Transboundary and Emerging Diseases*. 2012;59: 95-105.
70. Reddy TV, Ravindranath K, Sreeraman PK, et al. Aeromonas salmonicida associated with mass mortality of Cyprinus carpio and Oreochromis mossambicus in a freshwater reservoir in Andhra Pradesh, India. *Journal of Aquaculture in the Tropics.* 1994; 9: 259-268.
71. Huang S, Chen W, Shei M, et al. Studies on epizootiology and pathogenicity of Staphylococcus epidermidis in Tilapia Oreochromis spp. cultured in Taiwan. *Zoological Studies*. 1999; 38:178-188.
72. Chen CY, Wooster GA, Bowser PR. Comparative blood chemistry and histopathology of tilapia infected with Vibrio vulnificus or Streptococcus iniae or exposed to carbon tetrachloride, gentamicin, or copper sulfate. *Aquaculture.* 2004; 239: 421-443.
73. Jime´ nez AP, Iregui CA, Figueroa J. In vitro/in vivo characterization and evaluation of Aeromonas hydrophila lipopolysacharides (LPS). *Acta Biologica Colombiana*. 2008; 13: 147-162.
74. Eissa AE, Moustafa M, Abdelaziz M, et al. Yersinia ruckeri infection in cultured Nile tilapia, Oreochromis niloticus, at a semi-intensive fish farm in lower Egypt. *African Journal of Aquatic Science.* 2008; 33: 283-286.
75. Jeffery KR, Stone D, Feist SW, et al. An outbreak of disease caused by Francisella sp. in Nile tilapia Oreochromis niloticus at a recirculation fish farm in the UK. *Diseases of Aquatic Organisms.* 2010; 91:161-165.
76. Mohamed SG, Saleh WD. Flavobacterium columnare infection in cultured Oreochromis niloticus. *Assiut Veterinary Medical Journal*. 2010; 56: 15-30.
77. Ye X, Li J, Lu M, et al. Identification and molecular typing of Streptococcus agalactiae isolated from pond-cultured tilapia in China. *Fisheries Science*. 2011; 77: 623-632.
78. Iregui CA, Guari´n M, Tibata´ VM, et al. Novel brain lesions caused by Edwardsiella tarda in a red tilapia Oreochromis spp. *Journal of Veterinary Diagnostic Investigation*. 2012; 24: 446-449.
79. Zhang Z, Lan J, Li Y, et al. The pathogenic and antimicrobial characteristics of an emerging Streptococcus agalactiae serotype IX in Tilapia. *Microbial Pathogenesis*. 2018; 122: 39-45.
80. CDC. Surveillance for Foodborne Disease Outbreaks United States Annual Report. GA, USA. 2013.
81. Food poisoning bulletin (FPB). Vibrio Outbreak Associated with Tilapia from Seattle Supermarket. 2017.
82. Onjong HA, Ngayo MO, Mwaniki M, et al. Microbiological Safety of Fresh Tilapia Oreochromis niloticus from Kenyan Fresh Water Fish Value Chains. *Journal of Food Protection.* 2018; 81: 1973-1981.
83. Cardozo MV, Borges CA, Beraldo LG, et al. Shigatoxigenic and atypical enteropathogenic Escherichia coli in fish for human consumption. *Brazilian Journal of Microbiology*. 2018; 49: 936-941.
84. Thampuren N, Surendraraji A, Surendran P. Prevalence and characterization of typical and atypical Escherichia coli from fish sold at retail in Cochin, India *Journal Food Protection*, 2005; 68: 2208 – 2211.
85. Abdel–Monem MH. Dowidar AA. Recoveries of Salmonella from Soil in Eastern region of Saudi Arabic Kingdom, *Journal Egypt Public Health Association*. 1990;65: 61–75.
86. Acha PN, Szyfres BC. Zoonoses and communicable diseases common to man and animals. Bacterioses and mycoses. 3rd ed. Scientific and Technical Publication: 1: 580, Pan American Health Organization, Regional Office of the WHO, Washington, USA: ISBN 92 75 315809. 2003; pp 384.
87. D' Aoust J, Sewell A, Daley E, Greco P. Antibiotic resistance of agricultural and food borne, Salmonella isolates in Canada: 1986 – 1989. *Journal Food Protection*, 1992;55: 428 – 434.
88. Hastein T, Hjeltnes B, Lillehaug A, Utne Skare J, Berntssen M, Lundebye K. Food safety hazards that occur during the production stage: challenges for fish farming and the fishing industry Review Science. Technology, 2006;25: 607–625.

89. Morales G, Blanco L, Arias M, Chaves C. Bacteriological evaluation of fresh tilapia coming from the Northern Region of Costa Rica. *Archive Latinoam Nutrition*. 2004;54: 433 – 437.
90. Elhadi N. Prevalence and antimicrobial resistance of *Salmonella* spp. in raw retail frozen imported freshwater fish to Eastern Province of Saudi Arabia. *Asian Pacific Journal of Tropical Biomedicine*, 2014;4:234-238
91. Alghabban AJM. Fish Farms as a source for parasites transport: Parasitological and developmental studies of *Prohemistomum vivax* with the ameliorating role of *Moringa oleifera* in the treatment, *J American Sci.* 2014;10: 6-14.
92. Yagoub SO. Isolation of Enterobacteriaceae and *Pseudomonas spp.* from raw fish sold in fish market in Khartoum state, *African J Bacterio Res.* 2009;1: 085-088.
93. Ahmer, B.M.M. and Gunn, J.S. Interaction of Salmonella spp. with the intestinal microbiota. *Frontier in Microbiology*, 2011; 2: 101
94. WHO, World Health Organization? Antimicrobial resistance: global report on surveillance. 2014, Publications of the World Health Organization are available on the WHO website (www. who.int) or can be purchased from WHO Press, World Health Organization, 20 Avenue Appia, 1211 Geneva 27, Switzerland.
95. Cosby DE. *Salmonella* and antimicrobial resistance in broilers: A review. J. *Appl. Poult. Res.* 2015; 24:408–426.
96. Crump JA, Heyderman RS. A Perspective on Invasive *Salmonella* Disease in Africa. *Clinical Infectious Diseases*. 2015;61(S4): S235-40,
97. ECDC (European Centre for Disease Prevention and Control), EFSA (European Food Safety Authority), and EMA (European Medicines Agency), ECDC/EFSA/EMA second joint report on the integrated analysis of the consumption of antimicrobial agents and occurrence of antimicrobial resistance in bacteria from humans and food-producing animals – Joint Interagency Antimicrobial Consumption and Resistance Analysis (JIACRA) Report. *EFSA Journal* 2017;15(7):4872
98. Barber DA, Miller GY, McNamara PE. Models of antimicrobial resistance and food-borne illness: examining assumptions and practical application. *J. Food Protect.* 2003;66: 700–709.
99. Effendi, M.H., Oktavianto, A and Hastutiek, P. Tetracycline Resistance Gene in Streptococcus Agalactiae Isolated from Bovine Subclinical Mastitis in Surabaya, Indonesia. *Philipp. Journal of Veterinary Medicine*. 2018; 55 (SI): 115-120.
100. Effendi M.H, Harijani N, Budiarto, Triningtya N.P, Tyasningsih W. and Plumeriastuti H. Prevalence of Pathogenic *Escherichia Coli* Isolated from Subclinical Mastitis in East Java Province, Indonesia. *Indian Vet. J.* 2019; 96 (03): 22 – 25.
101. Tyasningsih, W., Effendi, M. H., Budiarto, B., Syahputra, I. R. Antibiotic Resistance to Staphylococcus aureus and Methicillin Resistant Staphylococcus aureus (MRSA) Isolated from Dairy Farms in Surabaya, Indonesia. *Indian Vet. J*, 2019; *96*(11), 27-31.
102. Putra, A.R. Effendi, M.H. Koesdarto, S. Suwarno, S. Tyasningsih, W. and Estoepangestie, A.T. Detection of the extended spectrum β-lactamase produced by Escherichia coli from dairy cows by using the Vitek-2 method in Tulungagung regency, Indonesia. *Iraqi Journal of Veterinary Sciences*, 2020; 34 (1): 203-207.
103. Putra ARS, Effendi MH, Koesdarto S, and Tyasningsih W. Molecular Identification of Extended Spectrum Beta-Lactamase (ESBL) Producing *Escherichia coli* Isolated from Dairy Cows in East Java Province, Indonesia. *Indian Vet. J.* 2019; 96 (10): 26 – 30.
104. Wibisono FJ, Sumiarto B, Untari T, Effendi MH, Permatasari DA, Witaningrum AM. The Presence of Extended Spectrum Beta-Lactamase (ESBL) Producing *Escherichia coli* On Layer Chicken Farms In Blitar Area, Indonesia. *Biodiversitas.* 2020; 21 (6): 2667-2671.
105. Rahmahani J, Salamah, Mufasirin, Tyasningsih W, and Effendi MH. Antimicrobial Resistance Profile of *Escherichia coli* From Cloacal Swab of Domestic Chicken in Surabaya Traditional Market. *Biochem. Cell. Arch.* 2020; 20 (1): 2993-2997.
106. Wibisono, F.J., Sumiarto, B., Untari, T., Effendi, M.H., Permatasari, D.A., Witaningrum, A.M. CTX Gene of Extended Spectrum Beta-Lactamase (ESBL) Producing Escherichia coli on Broilers in Blitar, Indonesia. *Sys Rev Pharm 2020;11(7): 396-403.*
107. Permatasari, D.A., Witaningrum, A.M., Wibisono, F.J., Effendi, M.H. Detection and prevalence of multidrug-resistant *Klebsiella pneumoniae* strains isolated from poultry farms in Blitar, Indonesia. *Biodiversitas,* 2020; 21 (10): 4642-4647.
108. Wibisono, F.J., Sumiarto, B., Untari, T., Effendi, M.H., Permatasari, D.A., Witaningrum, A.M. Short Communication: Pattern of antibiotic resistance on extended-spectrum beta-lactamases genes producing *Escherichia coli* on laying hens in Blitar, Indonesia. *Biodiversitas*, 2020; 21 (10): 4631- 4635.
109. Rahmaniar, R. P., Yunita, M. N., Effendi, M. H., Yanestria, S. M. Encoding Gene for Methicillin Resistant Staphylococcus aureus (MRSA) Isolated from Nasal Swab of Dogs. *Indian Vet. J*, 2020; *97*(02), 37-40.
110. Kristianingtyas L, Effendi, MH, Tyasningsih W, Kurniawan F. Genetic Identification of blactx-M Gene and blatem Gene on Extended Spectrum Beta Lactamase (ESBL) Producing *Escherichia Coli* from Dogs. *Indian Vet. J.* 2020; 97 (01): 17 – 21.
111. Decline, V., Effendi, M. H., Rahmaniar, R. P., Yanestria, S. M., Harijani, N. Profile of antibiotic-resistant and presence of methicillin-resistant Staphylococcus aureus from nasal swab of dogs from several animal clinics in Surabaya, Indonesia. *Intl J One Health*, 2020; *6*(1), 90-94.
112. Yunita, M. N., Effendi, M. H., Rahmaniar, R. P., Arifah, S., Yanestria, S. M. Identification of Spa Gene for Strain Typing of Methicillin Resistant Staphylococcus aureus (MRSA) Isolated From Nasal Swab Of Dogs. *Biochem. Cell. Arch.* 2020; 20 (1), 2999-3004.
113. Helmi, AM, Mukti, AT, Soegianto, A and Effendi, MH. A Review of Vibriosis in Fisheries: Public Health Importance. *Sys Rev Pharm, 2020;11(8):51-58.*
114. Helmi, AM., Mukti, AT., Soegianto, A., Mahardika, K., Mastuti, I., Effendi, MH., Plumeriastuti, H. A Review of Bacterial Zoonoses and Antimicrobial Resistant (AMR) on Grouper fish *(Epinepholus sp.). Sys Rev Pharm 2020;11(9):79-88.*
115. Effendi MH, Bintari IG, Aksono EB, Hermawan IP. Detection of *bla*TEM Gene of Klebsiella pneumoniae Isolated from Swab of Food Producing Animals in

East Java. *Tropical Animal Science Journal*. 2018;41(3):174-178.
116. Yanestria, S.M., Rahmaniar, R.P., Wibisono, F.J., Effendi, M.H. Detection of *inv*A gene of *Salmonella* from milkfish (*Chanos chanos*) at Sidoarjo wet fish market, Indonesia, using polymerase chain reaction technique, *Veterinary World*, 2019; 12(1): 170-175.
117. Effendi, MH, Harijani N, Yanestria SM, Hastutiek P. 2018. Identification of shiga toxin-producing Escherichia coli in raw milk samples from dairy cows in Surabaya, Indonesia. *Philippine J Vet Med.*55(SI):109-114.
118. Harijani, N., Wandari, A., Effendi, M.H. and Tyasningsih. W. Molecular Detection of Encoding Enterotoxin C Gene and Profile of Antibiotic Resistant on *Staphylococcus Aureus* Isolated from Several Dairy Farms in East Java, Indonesia. *Biochem. Cell. Arch.* 2020; 20 (1): 3081-3085.
119. Ramandinianto, S.C., Khairullah, A.R., Effendi, M.H., Tyasningsih, W. and Rahmahani, J. Detection of Enterotoxin type B gene on Methicillin Resistant *Staphylococcus aureus* (MRSA) isolated from raw milk in East Java, Indonesia. *Sys Rev Pharm, 2020;11(7):290-298.*
120. Ramandinianto, S.C., Khairullah, A.R., Effendi, M.H. *Mec*A gene and methicillin-resistant *Staphylococcus aureus* (MRSA) isolated from dairy farms in East Java, Indonesia. *Biodiversitas,* 2020; 21(8): 3562-3568.
121. Cailhol J, Lailler R, Bouvet P, La Vieille S, Gauchard F, Sanders P, Brisabois, A. Trends in antimicrobial resistance phenotypes in non-typhoid Salmonellae from human and poultry origins in France. Epidemiol. Infect. 2006;134, 171–178.
122. Serrano PH. Responsible use of antibiotics in aquaculture. FAO Fisheries Technical Paper. 2005; No. 469. FAO, Rome
123. Mohamed S, Nagaraj G, Chua FHC, Wang YG. The use of chemicals in aquaculture in Malaysia and Singapore. In: Arthur, J.R, Lavilla-Pitogo, C.R, Subasinghe, R.P. (Eds.), Use of Chemicals in Aquaculture in Asia: Proceedings of the Meeting on the Use of Chemicals in Aquaculture in Asia. Aquaculture Department, Southeast Asian Fisheries Development Center.2000.
124. Sapkota A, Sapkota AR, Kucharski M, Burke J, McKenzie S, Walker P, Lawrence R. Aquaculture practices and potential human health risks: current knowledge and future priorities. *Environment International* 2008;34 (8): 1215–1226.
125. Doublet B, Weill FX, Fabre L, Chaslus-Dancla E, Cloeckaert A. Variant Salmonella genomic island 1 antibiotic resistance gene cluster containing a novel 3'-Naminoglycoside acetyltransferase gene cassette, aac(3)-Id, in Salmonella enterica serovar Newport. *Antimicrobial Agents and Chemotherapy* 2004;48 (10): 3806–3812.
126. McPhearson RM, DePaolo A, Zywno SR, Motes ML, Guarino AM. Antibiotic resistance in Gram-negative bacteria from cultured catfish and aquaculture ponds. *Aquaculture* 1991;99: 203–211.
127. Radu S, Sahilah AM, Rusul G, Samuel L, Zuraini MI, Nasreldin EH. Comparison of arbitrarily primed PCR, antibiotic resistance and plasmid profiling for differentiating Salmonella Enteritidis isolated from fish. *Asian Fisheries Science* 2000;13: 13–20.
128. Singh S, Yadav AS, Singh SM, Bharti P. Prevalence of Salmonella in chicken eggs collected from poultry farms and marketing channels and their antimicrobial resistance. *Food Research International* 2010;43 (8): 2027–2030.
129. Foley SL, Lynne AM. Food animal-associated Salmonella challenges: pathogenicity and antimicrobial resistance. *Journal of Animal Science* 2008;86: E173–E187.
130. Pan ZM, Geng SZ, Zhou YQ, Liu ZY, Fang Q, Liu BB, Jiao XA. Prevalence and antimicrobial resistance in Salmonella spp. isolated from domestic animals in Eastern China. *Journal of Animal and Veterinary Advances* 2010;9 (17): 2290–2294.
131. Aoki T. Resistance plasmids and the risk of transfer. In: Bernoth, E.-M, Ellis, A.E, Midtyling, P.J, Olivier, G, Smith, P. (Eds.), Furunculosis: multidisciplinary fish disease research. Academic Press, San Diego, 1997; pp. 433–440.
132. Stewart GJ, Sinigalliano C.D. Detection of horizontal gene transfer by natural transformation in native and introduced species of bacteria in marine and syntetic sediments. *Applied and Environmental Microbiology* 1990;56 (6): 1818–1824.

A Review of Salmonella sp. in Tilapia fish (Oreochromis niloticus) : Public Health Importance

ORIGINALITY REPORT

19%	14%	12%	0%
SIMILARITY INDEX	INTERNET SOURCES	PUBLICATIONS	STUDENT PAPERS

PRIMARY SOURCES

1	link.springer.com Internet Source	2%
2	www.allsubjectjournal.com Internet Source	1%
3	www.mdpi.com Internet Source	1%
4	www.ncbi.nlm.nih.gov Internet Source	1%
5	Jaroni, Divya, Sadhana Ravishankar, and Vijay Juneja. "Microbiology of Ready-to-Eat Foods", Ready-to-Eat Foods Microbial Concerns and Control Measures, 2010. Publication	1%
6	www.rjlbpcs.com Internet Source	1%
7	Azin Shirani, Somayeh Reiisi, Leila Shabani. "Pyrogallol enhances the sensitivity of ovarian cancer cell (A2780) to cisplatin and induced	1%

miR-15a upregulation", Research Square Platform LLC, 2023
Publication

8	G.O. Abakpa, V.J. Umoh, J.B. Ameh, S.E. Yakubu, J.K.P. Kwaga, S. Kamaruzaman. "Diversity and antimicrobial resistance of Salmonella enterica isolated from fresh produce and environmental samples", Environmental Nanotechnology, Monitoring & Management, 2015 Publication	1 %
9	www.saulibrary.edu.bd Internet Source	1 %
10	www.suaire.sua.ac.tz Internet Source	1 %
11	journal.fapetunipa.ac.id Internet Source	<1 %
12	pubmed.ncbi.nlm.nih.gov Internet Source	<1 %
13	Sohana Al Sanjee, Md. Ekramul Karim. "Microbiological Quality Assessment of Frozen Fish and Fish Processing Materials from Bangladesh", International Journal of Food Science, 2016 Publication	<1 %
14	www.agriculturejournals.cz Internet Source	<1 %

15	"Nanoscience in Food and Agriculture 1", Springer Science and Business Media LLC, 2016 Publication	<1%
16	G. Amagliani, G. Brandi, G.F. Schiavano. "Incidence and role of Salmonella in seafood safety", Food Research International, 2012 Publication	<1%
17	jbiomedsci.biomedcentral.com Internet Source	<1%
18	Rosalie A. Schnick. "International harmonization of antimicrobial sensitivity determination for aquaculture drugs", Aquaculture, 2001 Publication	<1%
19	nexusacademicpublishers.com Internet Source	<1%
20	Adzitey, F.. "Prevalence and antibiotic resistance of Salmonella serovars in ducks, duck rearing and processing environments in Penang, Malaysia", Food Research International, 201203 Publication	<1%
21	Dieter A. Stürchler. "References", American Society for Microbiology, 2014 Publication	<1%

22	Ishmael Festus Jaja, James Oguttu, Chinwe-Juliana Iwu Jaja, Ezekiel Green. "Prevalence and distribution of antimicrobial resistance determinants of Escherichia coli isolates obtained from meat in South Africa", PLOS ONE, 2020 Publication	<1 %
23	Jie Yang, Zijing Ju, Yi Yang, Xiaonan Zhao, Zhiyu Jiang, Shuhong Sun. "Serotype, antimicrobial susceptibility and genotype profiles of Salmonella isolated from duck farms and a slaughterhouse in Shandong province, China", BMC Microbiology, 2019 Publication	<1 %
24	Kang Li, Liping Liu, Jia Zhan, Marie-Louise Scippo, Kristian Hvidtfeldt, Yuan Liu, Anders Dalsgaard. "Sources and fate of antimicrobials in integrated fish-pig and non-integrated tilapia farms", Science of The Total Environment, 2017 Publication	<1 %
25	drum.lib.umd.edu Internet Source	<1 %
26	fosrec.upm.edu.my Internet Source	<1 %
27	journals.uob.edu.ly Internet Source	<1 %

28	www.entomoljournal.com Internet Source	<1 %
29	Robert E. Levin. " The Use of Molecular Methods for Detecting and Discriminating Associated with Foods — A Review ", Food Biotechnology, 2009 Publication	<1 %
30	T Budiati, W Suryaningsih, S. Umaroh, B. Poerwanto, A Bakri, E Kurniawati. "Antimicrobial activity of essential oil from Indonesian medicinal plants against food-borne pathogens", IOP Conference Series: Earth and Environmental Science, 2018 Publication	<1 %
31	The Prokaryotes, 2014. Publication	<1 %
32	Upadhyay, A., D.P. Karumathil, I. Upadhyaya, V. Bhattaram, and K. Venkitanarayanan. "Controlling Bacterial Antibiotic Resistance Using Plant-Derived Antimicrobials", Antibiotic Resistance, 2016. Publication	<1 %
33	eber.uek.krakow.pl Internet Source	<1 %
34	ijvr.shirazu.ac.ir Internet Source	<1 %

35	infolib.hua.edu.vn Internet Source	<1%
36	ir-library.ku.ac.ke Internet Source	<1%
37	mro.massey.ac.nz Internet Source	<1%
38	refubium.fu-berlin.de Internet Source	<1%
39	researchbank.rmit.edu.au Internet Source	<1%
40	scholarworks.uark.edu Internet Source	<1%
41	scirp.org Internet Source	<1%
42	www.efsa.europa.eu Internet Source	<1%
43	Akter, S, Z Ferdowshi, MN Islam, MAM Prodhan, and MYE Chowdhury. "Determination of Salmonella in egg shell and egg content in some selected areas of Bangladesh", International Journal of Natural Sciences, 2016. Publication	<1%
44	Aty Widyawaruyanti, Muhammad Asrory, Wiwied Ekasari, Dwi Setiawan, Achmad	<1%

Radjaram, Lidya Tumewu, Achmad Fuad Hafid. "In vivo Antimalarial Activity of Andrographis Paniculata Tablets", Procedia Chemistry, 2014

Publication

45 C. Piñeiro, M. Piñeiro, J. Morales, R. Carpintero et al. "Pig acute-phase protein levels after stress induced by changes in the pattern of food administration", animal, 2007 <1%

Publication

46 Le, T.X.. "Antibiotic resistance in bacteria from shrimp farming in mangrove areas", Science of the Total Environment, The, 20051015 <1%

Publication

47 Mahmoud Elhariri, Rehab Elhelw, Salah Selim, Mai Ibrahim, Dalia Hamza, Eman Hamza. " Virulence and Antibiotic Resistance Patterns of Extended-Spectrum Beta-Lactamase-Producing serovar Heidelberg Isolated from Broiler Chickens and Poultry Workers: A Potential Hazard ", Foodborne Pathogens and Disease, 2020 <1%

Publication

48 Zoonoses - Infections Affecting Humans and Animals, 2015. <1%

Publication

49 Keelara, Shivaramu, Siddhartha Thakur, and Jitendra Patel. "Biofilm Formation by <1%

Environmental Isolates of Salmonella and Their Sensitivity to Natural Antimicrobials", Foodborne Pathogens and Disease, 2016.

Publication

Exclude quotes	Off	Exclude matches	Off
Exclude bibliography	On		

A Review of Salmonella sp. in Tilapia fish (Oreochromis niloticus) : Public Health Importance

GRADEMARK REPORT

FINAL GRADE

/0

GENERAL COMMENTS

Instructor

PAGE 1

PAGE 2

PAGE 3

PAGE 4

PAGE 5

PAGE 6

PAGE 7

PAGE 8