Distribution of Bacteria Load in Fish Tissues, Pond Water and Sediment in Oyo State, Nigeria

Ibrahim Adeshina, Samuel B. Umma, O. Adesanmi, Y.A. Adewale

1Department of Aquaculture and Fisheries, University of Ilorin, 2Department of Aquaculture and Fisheries, Federal University Wukari, 3Department of Agriculture, Kwara State College of Education, Ilorin, 4Department of Life and Environmental Science, Faculty of Science, Engineering and Built Environment, Deakin University, Australia.

Abstract

Consumption of fresh fish is increasing on daily basis in Nigeria; meanwhile Fish has been reported to capable of harbouring pathogenic bacteria. The load of pathogenic bacteria may results to diseases and cause biological and economical losses. The study investigated the total bacterial and enterobacteriacea count in water, pond sediment and seven fish organs from fish farms in the state. The state was zoned using Oyo State Agricultural Development Programme zonation. Farms in each zone were sub-grouped using stratified method. A total number of thirty-six (36) farms (5 Large, Medium and Small scales farms) were selected. Water, soil, and fish organs were collected aseptically and examined for bacteria load. The total viable count (TVC) and total enterobacteriacea (TEB) were expressed in mean (cfu/g) and Log10CFU/g. The mean data were compared using one way analysis of variance (ANOVA) and Duncan Multiple Range Test. The results show that water samples from Ogbomosho zone had highest TVC and TEB and 5.73±0.29 Log10cfu/ml and 5.25±0.31 Log10cfu/ml respectively. Evaluation of pond sediment shows that Ibadan/Ibarapa zone had highest TVC (5.89±0.26Log10cfu/g) and TEB (5.53±0.25Log10cfu/g). In liver, TVC was highest in Ogbomosho zone (5.85±0.21 Log10cfu/g) and TEB was highest in Saki zone (5.45±0.31 Log10cfu/g). TVC and TEB were highest in Ogbomosho zone in kidney (5.77±0.21 Log10cfu/g) and (5.57±0.28 Log10cfu/g), intestine (5.93±0.26 Log10cfu/g) and (5.62±0.34 Log10cfu/g) and skin (6.34±0.16 Log10cfu/g) and TEB (5.94±0.34 Log10cfu/g). Saki zone had highest TVC and TEB in flesh (5.57±0.22 Log10cfu/g) and (5.26±0.26 Log10cfu/g), gill TVC (6.08±0.16 Log10cfu/g) and TEB (5.81±0.18 Log10cfu/g) respectively. In spleen TVC was highest in Ogbomosho zone (5.78±0.21 Log10cfu/g) and TEB (5.37±0.18 Log10cfu/g) were highest in Ibadan/Ibarapa zone. Fish from most of agro-ecological zone of Oyo State are contaminated with enterobacteria higher than the recommended values opining consumer health risk.

Corresponding Author: Ibrahim Adeshina, padibra4all@yahoo.co.uk

1. INTRODUCTION

Aquaculture is becoming a business and occupying a priority list in the world, remedying the noticeable decrease in capture fisheries. The wide circulation of information on nutritional quality of fish has increased its consumption in addition to recommendation(s) from nutritionists and medical practitioners, which has created huge gap between its demand and supply (Adeshina and Umma, 2012). About 12.0 kg per capital of fish consumption has been considered adequate for normal and healthy growth (Ogbonnaya and Ibrahim 2009); however, developing nations have not met this recommendation. According to FAO, (1994), animal protein consumed throughout the world is made-up of about 60% from fish supply. It contains essential amino acids, low cholesterol and polyunsaturated fatty acid (Adedeji et al., 2011). Fish has become a delicacy in our society; however, it must be safe to remain in the market (WHO, 2007). Fish especially from aquaculture has also been reported to be capable of harbouring pathogenic bacteria and the level of its prevalence depends on many factors. Examples of such bacteria are Aeromonas, Listeria, Streptococcus and Pseudomonas species (Al-Harbi, 1994; Varvarigos, 1997; Bello et al., 2012). The load of bacteria may results to diseases outbreak and cause
biological and economical losses. Excess cost incurred when treating diseases influences market price of the products and zoonotic diseases further threatens public health (Abdelrazeq et al., 2014; Samaha et al., 2016). Spoilage begins immediately after fish die. Bacteria are dominant organisms in the fish tissue, rearing water and pond sediment. However it has been opined that microflora is one of the major causative agent or players of fish spoilage, which passes into unaffected portion of the fish (Adedeji et al., 2011; Ibrahim, 2016). Fish lives in water, some burrow in soil and receives majority of the bacteria into it gut and skin from water, sediment and feed (Sugita et al., 1988; Adedeji et al., 2011).

Consumption of fresh fish especially African Catfish (Clarias gariepinus) is increasing on daily basis based on information above with the increasing number of restaurants and relaxation centres in Nigeria. However, information on the bacterial load of African catfish in Oyo State is famine hence the need for this study. The study investigate the total bacterial and enterobactereacea count in water, pond sediment, fish flesh, liver, kidney, intestine and gill from fish farms across large, medium, and small scale farms in the zone.

1.1 Hypothesis
H0 = Occurrence of bacteria is not significantly different in fish organs and agroecological zones.

2. MATERIAL AND METHODS
The study was carried out in Oyo State, Nigeria, located on Latitude N8°0’0” and Longitude E4°0’0” (OYSG, 2015). The grouping of Oyo state into agroecological segment by Oyo State Agricultural Development Programme (OYADEP) (i.e Ibadan/Ibarapa, Oyo, Saki and Ogbomoso zones) was adopted (Adeola, et al., 2012). Farms in each zones were sub-grouped into Large, Medium and Small scales using stratified methods (Ogutade, et al., 2005; Fagbenro, 2005; Fagbenro and Adebayo, 2007; Ayinla, 2007). A total number of thirty-six (36) farms (3 Large, Medium and Small scales farms) were selected. Water (in-plastic bottles), soil, and fish (in sterile polythene) samples were collected and examined for bacteria load. Five organs (liver, kidney, gill, intestine, flesh/muscle and spleen) were aseptically collected and weighed into sterile universal bottles while skin samples were collected using skin swab. The Samples were inserted into sterile water and allowed to release the available bacterial for a period of 2-3 hours. One ml was taken from each sample bottles and diluted in ten folds and subsequently serially diluted with dilution factor $10^{-4}$. Two ml were taken from each sample and dispensed into two petri dishes (1ml to each). The first dish received plate count agar (PCA) for Total Bacteria Count (LAB M, LAB149) while the second petri dish received MacConkey agar (LAB M, LAB002) for total coliform count using the pure plate count method. The media were prepared according to manufacturers’ instruction. Each dilution was overlaid with PCA and MacConkey respectively that has been cooled to 50°C. The dishes were then gently swirled to mix the broth with the liquid agar (Nester et al., 2004). The mixtures were allowed to harden and incubated (Newlife Laboratory Incubator NL-9052-1) for 24 hours at 37°C to allow a distinguish colonies to form. The formed colonies were counted using Wincom Colony Counter (16W,220V±10%, 50Hz). The experiments were replicated three times. The total viable count and total enterobacteriacea were expressed in Log$_{10}$CFU/g (APHA, 1995; Bello et al., 2012; Hitchins et al., 1995). The mean data were compared using one way analysis of variance (ANOVA) and Duncan Multiple Range Test IBM Statistical Package for Social Science (SPSS) version 20.

3. RESULTS
Figure 1 shows that water samples from Ogbomosho zone had highest TVC $5.73\pm0.29 \log_{10}$cfu/ml while Saki zone had the least TVC $5.49\pm0.24 \log_{10}$cfu/ml. TEB was highest in Oyo zone ($5.27\pm0.19 \log_{10}$cfu/ml) while Saki zone had the least ($5.15\pm0.33 \log_{10}$cfu/ml).
Figure 1: Showing TVC and TEB in pond water by agroecological zones
Note: Values as presented as mean±standard deviation of triplicates,
Bar showing different alphabets (lower case) are TVC, statistically different P < 0.05
Bar showing different alphabets (upper case) are TEB, statistically different P < 0.05
Figure 2 show that pond sediment from fish farm in Ibadan/Ibarapa zone had highest mean TVC (5.89±0.26 Log_{10} cfu/g) and TEB (5.53±0.25 Log_{10} cfu/g) while the least TVC (5.65±0.44 Log_{10} cfu/g) and TEB (5.25±0.49 Log_{10} cfu/g) were recorded in Ogbomosho zone.

Figure 2: Showing TVC and TEB in pond sediment by agroecological zones
Note: Values as presented as mean±standard deviation of triplicates,
Bar with same patter showing different alphabets (lower case) are TVC, statistically different P < 0.05
Bar with same patter showing different alphabets (upper case) are TEB, statistically different P < 0.05
Figure 3a shows Saki zone has highest TVC (6.08±0.16 Log_{10} cfu/g) and TEB (5.81±0.18 Log_{10} cfu/g) while Ibadan/Ibarapa zone had the least TVC (5.88±0.11 Log_{10} cfu/g) and TEB (5.49±0.18 Log_{10} cfu/g) in gill. However, examination of liver shows that TVC was highest in Ogbomosho zone (5.85±0.21 Log_{10} cfu/g), TEB was highest in Saki zone (5.45±0.31 Log_{10} cfu/g) while the least TVC
(5.66±0.17 Log_{10}cfu/g) and TEB (5.29±0.17 Log_{10}cfu/g) as showed in figure 3b. Figure 3c shows that Ogbomosho zone had highest TVC (5.77±0.21 Log_{10}cfu/g) and TEB (5.57±0.28 Log_{10}cfu/g) while Ibadan/Ibarapa zone had least TVC (5.61±0.21 Log_{10}cfu/g) and TEB (5.26±0.24 Log_{10}cfu/g) in Kidney. Figure 3d shows that TVC (5.93±0.26 Log_{10}cfu/g) and TEB (5.62±0.34 Log_{10}cfu/g) were highest in Ogbomosho zone while the least TVC (5.71±0.18 Log_{10}cfu/g) and TEB (5.29±0.23 Log_{10}cfu/g) were in Ibadan/Ibarapa zone in intestines. Figure 3e shows that TVC (6.34±0.16 Log_{10}cfu/g) and TEB (5.94±0.34 Log_{10}cfu/g) were highest in Ogbomosho zone while the least TVC (6.10±0.13 Log_{10}cfu/g) and TEB (5.72±0.18 Log_{10}cfu/g) were in Ibadan/Ibarapa zone in skin. Figure 3f shows that TVC (5.57±0.22 Log_{10}cfu/g) and TEB (5.26±0.26 Log_{10}cfu/g) were highest in Saki zone while the least TVC (5.54±0.25 Log_{10}cfu/g) and TEB (5.09±0.33 Log_{10}cfu/g) were in Ogbomosho zone in flesh. Figure 3g shows that TVC (5.78±0.21 Log_{10}cfu/g) and TEB (5.37±0.18 Log_{10}cfu/g) were highest in Ogbomosho and Ibadan/Ibarapa zones respectively while the least TVC (5.66±0.16 Log_{10}cfu/g) and TEB (5.34±0.44 Log_{10}cfu/g) were in Saki and Ogbomosho zones respectively in spleen.

Figure 3a: Showing TVC and TEB in gill by agroecological zones
Note: Values as presented as mean±standard deviation of triplicates, Bar with same patter showing different alphabets (lower case) are TVC, statistically different P < 0.05
Bar with same patter showing different alphabets (upper case) are TEB, statistically different P < 0.05
Figure 3b: Showing TVC and TEB in liver by agroecological zones
Note: Values as presented as mean±standard deviation of triplicates,
Bar with same pattern showing different alphabets (lower case) are TVC, statistically different P < 0.05
Bar with same pattern showing different alphabets (upper case) are TEB, statistically different P < 0.05

Figure 3c: Showing TVC and TEB in kidney by agroecological zones
Note: Values as presented as mean±standard deviation of triplicates,
Bar with same pattern showing different alphabets (lower case) are TVC, statistically different P < 0.05
Bar with same pattern showing different alphabets (upper case) are TEB, statistically different P < 0.05
Figure 3d: Showing TVC and TEB in intestine by agroecological zones
Note: Values as presented as mean±standard deviation of triplicates,
Bar with same pattern showing different alphabets (lower case) are TVC, statistically different P < 0.05
Bar with same pattern showing different alphabets (upper case) are TEB, statistically different P < 0.05

Figure 3e: Showing TVC and TEB in skin by agroecological zones
Note: Values as presented as mean±standard deviation of triplicates,
Bar with same pattern showing different alphabets (lower case) are TVC, statistically different P < 0.05
Bar with same pattern showing different alphabets (upper case) are TEB, statistically different P < 0.05
4. DISCUSSION

International Commission on the Microbiological Specification of Foods (ICMSF) in 1982 recommended that acceptable level of bacterial load in food should be between $10^2 - 10^7$ per gram or cm$^2$ equivalent to about $5.70 \log_{10} \text{cfu/cm}^2$ for skin while FAO, (1979) recommended $10^5$ per gram for other part of fish as acceptable level. However, results from this study were higher than the recommended values in most of the samples. In gills, TVC were higher in all zones ranges from $5.88 \pm 0.11 \log_{10} \text{cfu/g}$ in Ibadan/Ibarapa zone to $128.04 \pm 51.57 \log_{10} \text{cfu/g}$ in Ogbomosho zone while TEB in other zones were
higher than recommended level except in Ibadan/Ibarapa zone with 5.49±0.18 Log_{10}cfu/g. In Liver and Kidney, Ibadan/Ibarapa zone had TVC within the acceptable level but TEB were within recommended values in all zone. This result is similar to that of Zmyslowska, et al., (2000b). In intestines, TVC were higher than acceptable level in all the zones but TEB were within recommended ranges. In skin, both TVC and TEB were higher than the recommended values but both TVC and TEB were lower than the recommended level in the flesh, while Ibadan/Ibarapa and Saki zones had TVC at acceptable values in spleen. The results is in agreement with the work of Adedeji, et al., (2011). The results further revealed that the higher levels of TVC and TEB in most of the samples signify possible threat in the study area. Low level of TVC and TEB in flesh signifies a little relief as the flesh is the major part consumed in Nigeria, however, higher values recorded in skin negates the green light from the flesh as it consumed directly together with flesh. The higher microbial load in fish may be as a result of its heavy presence in water and sediment that host fish. This further suggest that fish may source the bacteria from the environment but the higher load in fish tissues than the water and sediment reveals better living condition of the bacteria in the tissue of fish than the surrounding thereby reproduce, multiply, and colonize the fish tissues than the environment which corroborate with the works of Zaleski, (1985), Zmyslowska, et al.,(2000a) and Adedeji, et al., (2011) and Bello, et al., (2013). As a result of urbanization and land use dimension in Nigeria, human waste, run-off, and dropping of both raring and wild animals have easy access to the ponds and thereby serve as source of bacteria to the culture system. The results shows that there is significant different in the distribution of bacteria among the fish tissues. F-tabulated is 5.68 while F-calculated is 22.011 hence, the null hypothesis is rejected. This result suggests that the organ position, exposure to environment and its medium composition may be responsible. In the case of skin, it higher space cover and being the fish location to have contact with water and environment, the bacteria load tends to be high. The other organs follow the same trend.

5. Conclusion and recommendation

In this present study, fish from most of agro-ecological zone of Oyo State are contaminated with enterobacteriaceae higher than recommended opining consumer health risk therefore, effort should be put in place to prevent culture system contamination throughout the value production chain and prevent bacteria carrying vector from accessing the culture system, proper hygiene cooking should be encouraged.

6. REFERENCES


Food and Agriculture Organization (FAO), 1979. Manuals of food quality control. FAO. Food and Nutrition paper 1/4/4


