International Letters of Natural Sciences Vol. 39 (2015) pp 73-79 *Online: 2015-05-12*
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doi:10.18052/www.scipress.com/ILNS.39.73

Microbiological Assessment of Abattoir Effluent on Water Quality of River Katsina-ala, Nigeria

Vershima Jose Addy*[1], Terkimbi Jonathan Kabough[2], Haruna K. Mohammed[3], Ibrahim Aliyu[4]

1Department of Biological Sciences, P.M.B. 2373, University of Agriculture, Makurdi, Nigeria

[2]Federal Capital Territory Administration Abuja, Nigeria.

[3]Department of Farming System Research, Lake Chad Research Institute, Maiduguri, Nigeria

[4]Department of Science Laboratory Technology, Nassarawa State Polytechnic, Lafia, Nigeria

*E-mail address: joseaddy1@gmail.com

Keywords: microbiological; abattoir; water quality; effluent; River Katsina-ala

ABSTRACT

Gram-negative bacteria isolated from the abattoir effluent on surface water of River Katsina-ala in rainy and dry seasons were *Escherichia coli; Klebsiella spp; Proteus vulgaris; Salmonella typhi* and Gram-positive bacterium isolated was *Streptococcus faecalis.* In rainy season, the lowest mean bacterial count was from *E.coli* (0.0067±0.031 CFU/ml) and highest mean bacterial count from *Salmonella typhi* (0.0262±0.0079 CFU/ml). In the dry season, lowest mean bacterial count was from *Proteus vulgaris* (0.0081± 0.0047 CFU/ml) and the highest from *Streptococcus faecalis* (0.0097± 0.05 CFU/ml). The presence of *Escherichia coli* indicates possible faecal contamination. The results revealed that bacterial load was within the accepted maximum limit by WHO (2004); nevertheless, the disease causing bacteria pose threat to human health when water from the river is consumed without treatment.

1. INTRODUCTION

Worldwide, water-borne diseases are among the leading cause of death of children under five years old and more people die from unsafe water annually than from all forms of violence, including war (WHO, 2004). Every year, around 1.8 million people die from diarrheal diseases, 88 percent of which are attributed to unsafe water supply or inadequate sanitation and hygiene (WHO, 2004b).

Improper disposal systems of wastes from abattoirs could lead to transmission of pathogens to humans and cause zoonotic diseases such as Coli Bacillosis, Salmonellosis, Brucellosis and Helminthes (Cadmus et al., 1999). Microorganisms commonly used as indicators of water quality include: Coliforms, faecal *Streptococci, Clostridium perfringens* and *Pseudomonas aeruginosa* (Bonde, 1977; Alonge 1991). The presence of faecal coliforms is considered as presumptive evidence of faecal pollution (Mara 1978). Seven pathogenic bacteria in Abattoir effluent were identified by Coker et al., (2001). These include *Staphylococcus sp., Streptococcus sp.*, in Southern Nigeria.

Nigeria's Federal Environmental Protection Agency (FEPA, 1991), outline national guidelines and standards for effluent, gaseous emission and hazardous waste management, these guidelines for effluent limitation have not been fully adhered to in the disposal of abattoir effluent in many areas in Nigeria including River Katsina-Ala, Benue state. Nigerians derive their water from surface water (springs/stream/rivers), hand dug wells, rain harvesting, pipe borne water, boreholes, and vendors (FGN, 2000). Due to lack of safe public water supply in Katsina-Ala Township, River Katsina-Ala has become a major source of water supply; and the effluent from Katsina-Ala abattoir may pollute the water of River Katsina-Ala.

2. MATERIALS AND METHODOLOGY

2.1. Sample Area

The study was conducted in Katsina-Ala town of Benue State of Nigeria which lies on latitude 7^{o} 10' 0' North and longitude 9 ^{o}17' 0' East (Google links, 2010). Katsina –Ala abattoir is situated at the bank of the river, about 1.4 km north of the bridgehead. The Samples were collected between November and March for dry season; April and October for rainy season.

2.2. Pour Plate Method

Glass wares were washed, rinsed with water and sterilized in an autoclave machine. Serial (5-fold) dilution of each sample was done prior to inoculation. Media used were (Nutrient agar), (MacConkey agar) and Cystine Lactose Deficient Electrolyte (CLED) agar for identification of gram–negative (lactose fermenting bacteria) *Escherichia coli*, *Klebseilla spp*; and non- lactose fermenting bacteria *Salmonella typhimurium*, *Proteus vulgaris* and gram–positive bacterium-*Enterococcus faecalis*. A volume of 0.1 ml of sample from each station was cultured on the prepared medium and incubated aerobically at 36^{o}C for 24 hours. Identification of bacteria was based on Bergey's Manual of Determinative Bacteriology (Krieg and Holt, 1984). The colonies formed were counted using colony-counter. The average per dilution was determined and multiplied by the reciprocal of the dilution ratio and expressed as colony-forming units per milliliter (CFU/ml) of the sample (Amadi and Ayogu, 2005).

2.3. Statistical Tools

Data was analyzed by Statistical Package for Social Scientist (SPSS) software and Microsoft Excel 2003 version. The mean concentrations of relevant parameters were compared with Federal Ministry of Environment guidelines for interim uniform effluent limits for all categories of industries in Nigeria (FMEnv, 2001) and World Health Organization (2004).

3. RESULTS AND DISCUSSION

This study has shown the presence of total coliform and thermotolerant bacteria and Enterococci. Effluent discharge from the abattoir may have contributed to the increase in bacterial load of the surface water of river Katsina-ala. Surface run-off that conveys decomposed fauna and flora into the river may be a contributory factor.

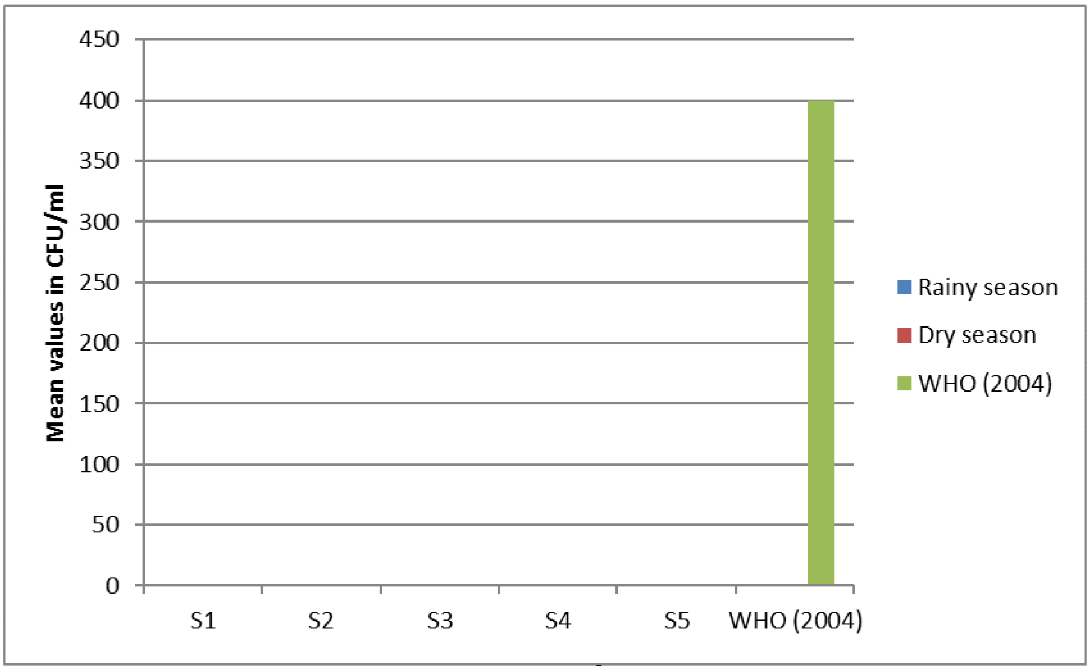
Results in Table 1 show the mean values of total heterotrophic bacterial population in both rainy season and dry season. The highest microbial count of 0.030×10^5 CFU/ml was recorded from *Salmonella typhi* in rainy season and the lowest mean microbial count of 0.0016×10^5 CFU/ml was recorded from *Klebsiella spp*. In dry season, the highest mean microbial count of 0.038×10^5 CFU/ml was recorded from *Proteus vulgaris* and the lowest mean microbial count of 0.021×10^5 CFU/ml was recorded from *Streptococcus faecalis*

Table 1: Seasonal Variations in Bacterial Count (10^5 CFU/ml) in River Katsina-Ala, Nigeria

Bacteria (CFU/ml)	Site 1	Site 2	Site 3	Site 4	Site 5	Total	Mean	WHO(2004)/ FMEnv (2001)
Escherichia coli								400
Rainy season	0.0014	0.0062	0.0064	0.0027	0.0022	0.02	0.0038±0.002	
Dry season	0.009	0.0016	0.0039	0.0016	0.003	0.02	0.0038±0.003	
Klebsiella spp								400
Rainy season	0.006	0.0013	0.0058	0.0024	0.0022	0.08	0.0016±0.002	
Dry season	0	0	0.0034	0.0023	0.0020	0.01	0.0015±0.0015	
Proteus vulgaris								400
Rainy season	0.0008	0.0009	0.0212	0.0201	0.0102	0.05	0.011±0.0013	
Dry season	0	0	0.0120	0.0042	0.0026	0.02	0.038±0.0049	
Salmonella typhi								400

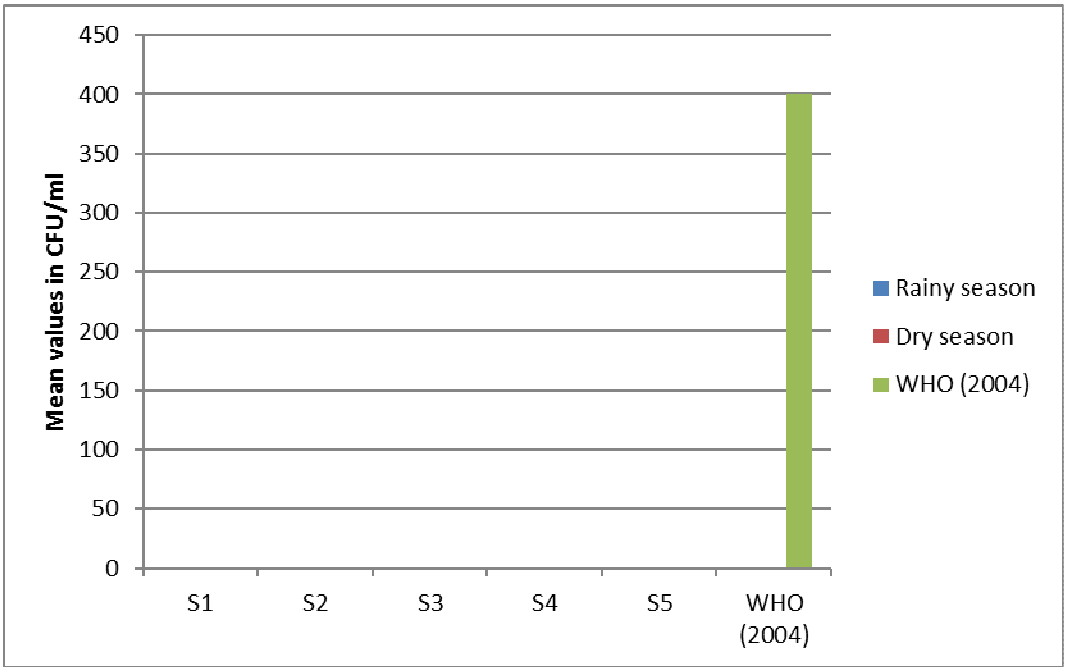
Rainy season	0.0033	0.0035	0.0348	0.038	0.010	0.15	0.030±0.013	
Dry season	0	0	0.025	0.024	0.022	0.07	0.014±0.0130	
Streptococcus faecalis								400
Rainy season	0	0	0.0176	0.0038	0.0032	0.02	0.0049±0.0073	
Dry season	0	0	0.0013	0.0010	0.008	0.01	0.0021±0.0033	

KEY: dilution factor = 10^5 (CFU/ml)



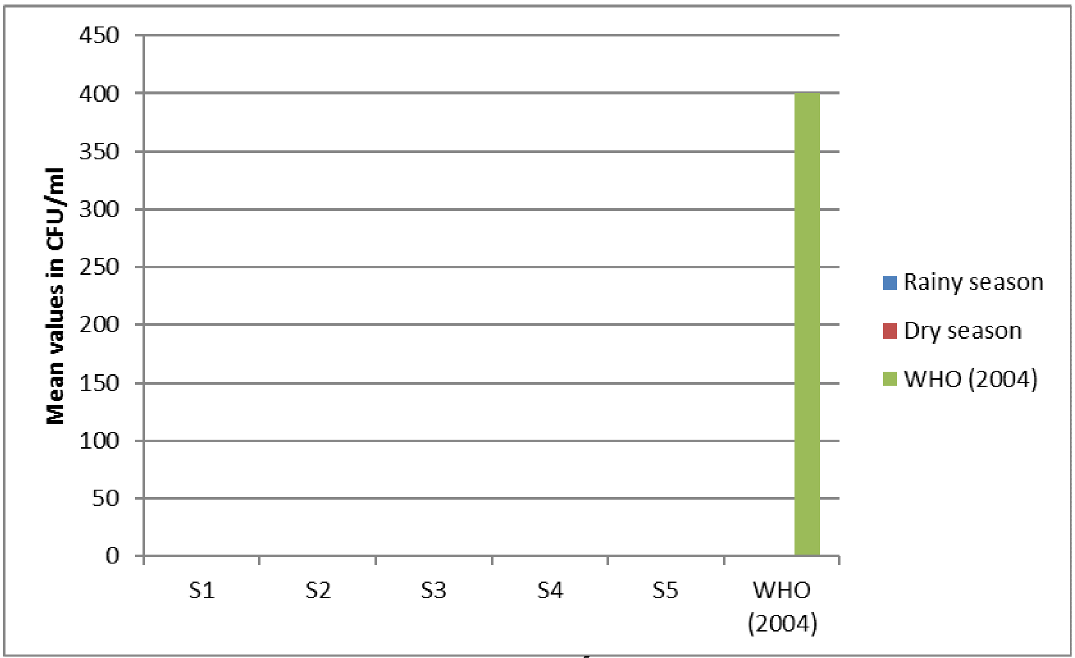
Dilution factor 10^5 (CFU/ml

Figure 1: Seasonal variations in *Escherichia coli*



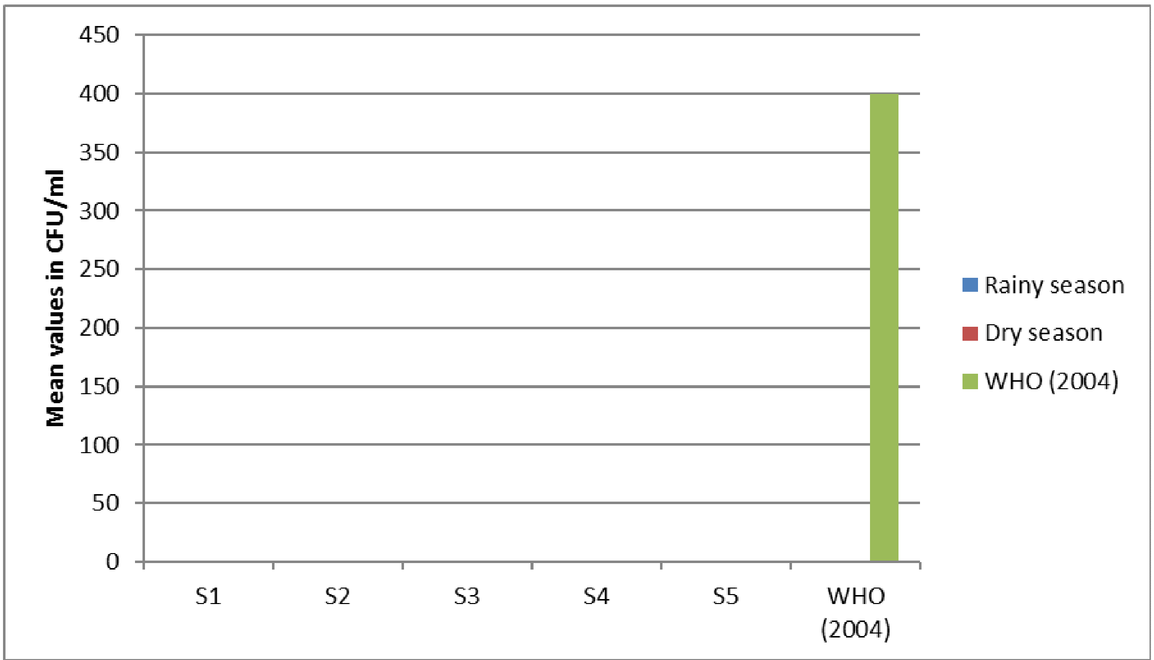
Dilution factor 10^5 (CFU/ml)

Figure 2: Seasonal variations in *Klebseilla* spp



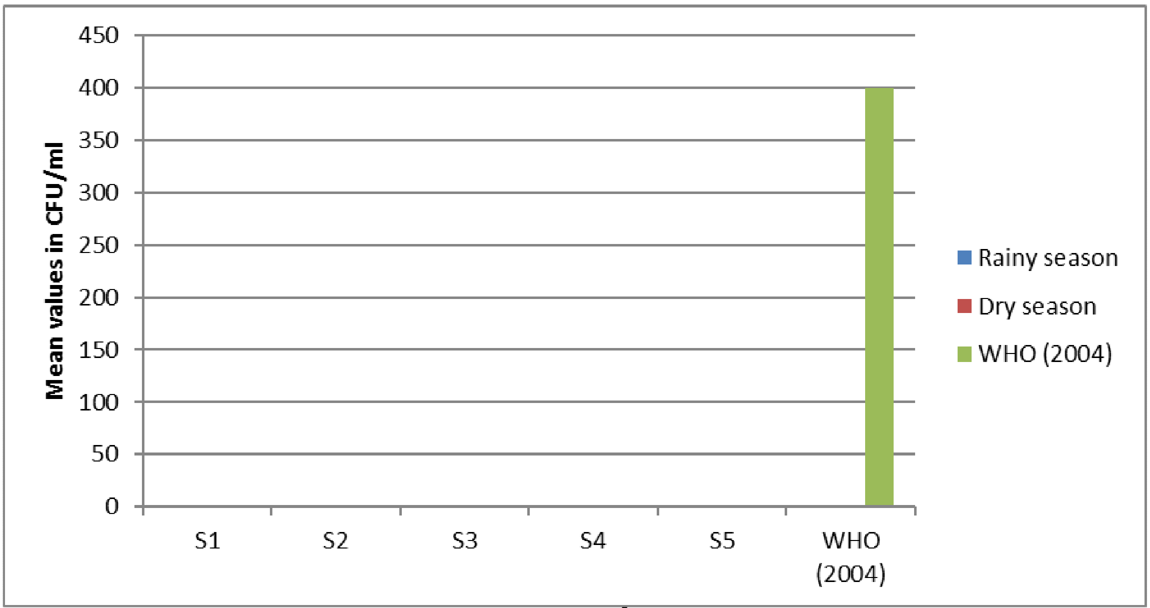
Dilution factor 10^5 (CFU/ml)

Figure 3: Seasonal variations in *Proteus vulgaris*



Dilution factor 10^5 (CFU/ml)

Figure 4: Seasonal variations in *Salmonella typhi*



Dilution factor 10^5 (CFU/ml)

Figure 5: Seasonal variations in *Streptococcus faecalis*

Escherichia coli mean count at the five sample sites for both seasons is within the standard set by FMEnv (2001) of 400 coliforms daily average CFU/ml. The coliform group is made up of well-defined biochemical and growth characteristics that are used to identify bacteria that are more or less related to fecal contamination; and *Escherichia coli* is specifically of faecal origin (Fujioka *et al.,* 1999). United States Environmental Protection Agency (USEPA) recommended that the presence of *Escherichia coli* in the river serves as bacteria indicator of freshwater contamination (Hicks, 2000). *Escherichia coli* count at the upstream sites was low and high at the downstream sites in both seasons. Most strains *E. coli* are harmless, but some can cause serious diarrhea. Enterotoxigenic *Escherichia coli* (EHEC) and Enteropathogenic *Escherichia coli* (EPEC) are the main causes of childhood diarrhea (UNICEF, 2008).

Salmonella typhi mean counts at the five sites in rainy season were within the maximum limit of 400 CFU/ml by WHO (2004) with the highest mean value of 3.8×10^2 CFU/ml at site 4. It is interesting that no *Salmonella typhi* counts were recorded at site 1 and 2 in dry season before the abattoir site. *Salmonella typhi* mean values of 2.5×10^2 CFU/ml, 2.4×10^2 CFU/ml and 2.2×10^2 CFU/ml in site 3, site 4 and site 5 respectively in the dry season could be from the abattoir effluent. *Salmonella typhi* is an exclusively human pathogen and a leading cause of enteric fever worldwide. The *Salmonella* infection may spread from the intestines to the blood stream and then to other body sites and can cause death (Sarwar, 2015).

Klebsiella spp. can lead to wide range of disease states, notably pneumonia, urinary tract infection, septicemia, spondylitis, and soft tissue infection. *Klebsiella pneumoniae* and *Klebsiella oxytoca* are the two members of this genus responsible for most human infections. They are opportunistic pathogens found in the environment and in mammalian mucosal surfaces (Ashok and Amitabh 2010). *Klebsiella spp* mean counts in both seasons were within the maximum limit of 400 CFU/ml by WHO (2004) with the highest of 0.0058 CFU/ml at site 3 and 0.0034 CFU/ml at site 3 in rainy and dry seasons respectively.

There were no bacteria mean counts in dry season at sites 1 and 2 before the abattoir site (site 3), notable presence of bacteria recorded in both seasons after the discharge of abattoir effluent. Effluent discharge from the abattoir may have contributed to the increase in bacterial load of the river. Surface run-off that conveys decomposed fauna and flora into the river may be a contributory factor.

Faecal streptococci and enterococci are also indicators of faecal pollution (APHA, 1999). The presence of *Streptococcus faecalis* at the two upstream sites was not feasible during the period of study. It further suggests that *Streptococcus faecalis* originated from the abattoir and flew into the river; thus upsetting the bacterial load of the river. Epidemiological studies have shown that there is a linear correlation between microbial water quality and gastro-intestinal illnesses (Baron et al., 1982; Cabelli et al., 1982). This is confirmed by World Bank (2003) damages caused by increased illness or mortality due to ingestion or skin contact with contaminated water; give rise to direct health care costs and indirect opportunity costs. Furthermore, Oyedemi (2004) reports from medical experts to have associated some diseases with abattoir activities which include pneumonia, diarrhea, typhoid fever, asthma, wool sorter diseases, respiratory and chest diseases. The presence of *Salmonella typhi, Escherichia coli, Klebsiella pneumonia, Proteus vulgaris* and *Streptococcus faecalis* in the river clearly show microbial pollution of the river. These bacteria have the potentials of causing infections in humans when consumed without proper disinfection of water from river Katsina-ala. Contaminated water of the river from the effluent in the abattoir was used for washing beef. During rainy season, the high amount of *Salmonella tyhpi*, which is the causative agent of typhoid fever, indicates that consumption of water from the river without treatment may increase susceptibility to typhoid fever. The low bacterial count at the upstream sites when compared to the other sites may be due to reduced human activities, sedimentation and depuration (Ezeronye and Ubalua, 2005).

5. CONCLUSION

Bacterial contamination of the river from abattoir effluent poses health threats. The potential health consequences of microbial contamination are such that its control must always be of paramount importance and must never be compromised. The isolated bacteria cause diseases ranging from diarrhea to typhoid fever. The effluent discharge should be monitored and regulated to reduce the increase of contaminants into the river. Majority of the people do not have access to portable water and do collect water from the river. People that collect water or purchase water from water vendors downstream of the abattoir are at higher risk from contamination than people that collect water or purchase water upstream of the abattoir. Provision of retention ponds downstream of abattoirs for pre-treatment of abattoir waste before discharge into water bodies; monitoring of abattoir activities to enhance compliance with sanitary and hygienic requirements must never be compromised and adequate provision of portable water for the populace to avoid total dependence on untreated river water for meeting varying needs of the communities.

Acknowledgement
The authors acknowledge the assistance received from Water Works Laboratory of Benue State, Nigeria

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(Received 03 May 2015; accepted 11 May 2015)

Volume 39
10.18052/www.scipress.com/ILNS.39

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