

## SPATIAL DISTRIBUTION OF BACTERIAL ISOLATES FROM DIFFERENT ABATTOIRS IN PORT HARCOURT, NIGERIA

### ABSTRACT

The constituents of wastes generated from abattoir activities create conducive environment for microbial proliferation, most of which are pathogenic. Infections caused by these microorganisms could result to zoonoses. This study was to determine the distribution of bacterial isolates and their biomass from different abattoirs in Port Harcourt. Samples like waste blood, table swab, service water, faecal matter, soil and wastewater from abattoirs in Iwofe, Rumuodomaya and Trans-Amadi were collected from October 2017 to November, 2018 and analysed using standard microbiological procedures. Results obtained revealed that the total heterotrophic bacterial count of blood samples ranged from  $8.33 \times 10^1$  to  $3.33 \times 10^2$  cfu/ml for Trans-Amadi and Iwofe abattoirs, table swabs ranged from  $6.74 \times 10^4$  to  $4.88 \times 10^6$  cfu/ml, water samples ranged from  $1.56 \times 10^4$  to  $2.07 \times 10^4$  cfu/ml; faecal matter had THB counts ranging from  $9.97 \times 10^7$  to  $1.06 \times 10^8$  cfu/g; and soil samples ranged from  $1.11 \times 10^{10}$  to  $1.17 \times 10^{10}$  g, while wastewater counts ranged from  $1.03 \times 10^8$  to  $1.08 \times 10^8$  cfu/ml. The predominant Bacterial isolates were of the genera *Micrococcus*, *Staphylococcus*, *Serratia*, *Pseudomonas*, *Proteus*, *Klebsiella*, *Escherichia* and *Chromobacterium*. *Serratia* sp only was isolated from Iwofe and Rumuodumaya abattoirs within April to October while *Chromobacterium* sp was isolated in Trans-Amadi and Rumuodumaya abattoirs within the months of May to October. Among the isolates, *Escherichia coli* and *Klebsiella* species occurred more compared to others in all the three locations. A higher percentage of microorganisms was recorded in the month of May compared to other months. It is presumed that abattoir wastes harbour many microorganisms of public health importance. The occurrence of these microbes, most of which are enteric pathogens, poses a public health challenge as infections by them could result in illnesses such as gastroenteritis, septicaemia and pneumonia especially in the absence of good hygiene around abattoirs. Proper sanitation in abattoirs as well as management of abattoir wastes is important in reducing the spread of these microorganisms.

Keywords: Abattoir, Microorganisms, Infections, Environmental Sanitation

### INTRODUCTION

Pollution of the environment has become a worldwide public health issue with the potential to affect human health [1]. Although abattoir operations provide meat for human consumption, a huge amount of wastes are generated as a result of the operations [2]. The untreated wastes including consumable parts of the slaughtered animals and wastewater used in washing the carcass from several abattoirs are disposed of into nearby rivers and streams without treatment [3]. This is as a result of lack of supervision and inappropriate management in these abattoirs, thus resulting in public health risks to the public [4]. This poor management further results in the degradation and contamination of soil, water and therefore result in pollution, global warming, epidemics and loss of biotic life [5]. Indiscriminate disposal of animal dung and other wastes products can produce leachates and greenhouse gases like methane, CO<sub>2</sub>, etc from decomposing organic wastes which may cause pollution of soils and the atmosphere [6].

In Nigeria, about 80% of abattoirs have been sources of zoonotic diseases which are yet to be controlled [7]. Abattoir wastes are known causes of parasitic organisms such as *Bacillus* spp., *Staphylococcus* spp., *Pseudomonas* spp., *Proteus* spp., *Klebsiella* spp. and *Escherichia coli* [8]. Outbreak of waterborne diseases as a result of abattoir-waste pollution of nearby streams has resulted in the spread of infectious diseases such as typhoid fever, diarrhoea and pneumonia [9]. The risks associated with this practice also includes the presence of antibiotic resistant microorganisms as well as resistance genes which makes treatment of infections resulting from these microorganisms difficult and in most cases, more expensive [10,11]. The situation is of public health importance because the occurrence of these microorganisms can be of

nuisance value. This study was thus aimed at determining the distribution of bacterial isolates in waste samples associated with abattoirs activities in Port Harcourt, Nigeria within the wet and dry seasons.

## METHODOLOGY

### Sampling Locations

Samples for this study were obtained from the Iwofe, Rumuodomaya and Trans-amadi abattoirs situated in Port Harcourt, Nigeria. The choice of these abattoirs is based on the large number of persons visiting the abattoirs on daily basis, thus making these locations a beehive of activities by the public. A map showing the sampling locations is presented in Figure 1.

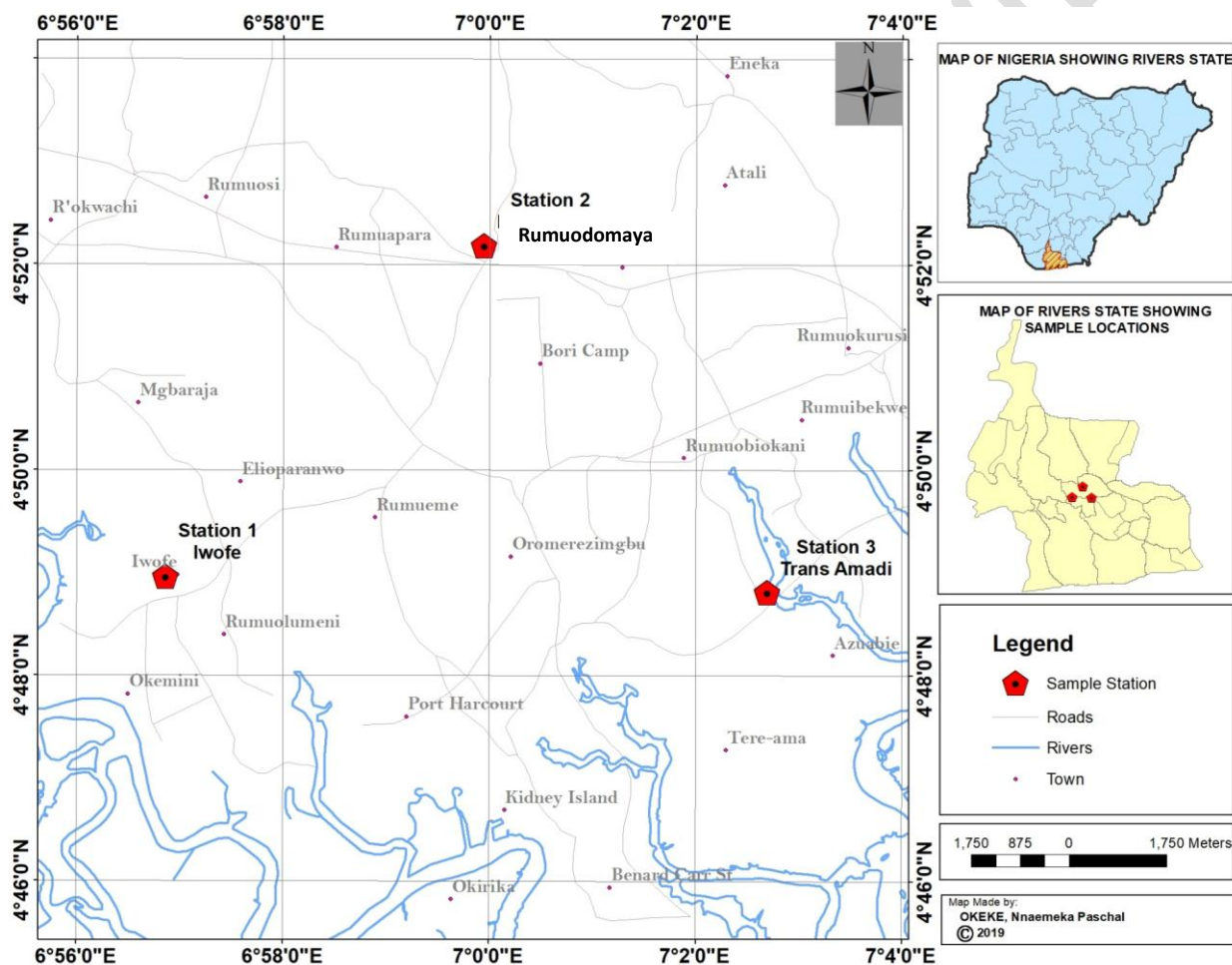


Figure 1: Map of Port Harcourt Metropolis showing the sampling stations

### Samples collection

Cow blood samples were collected using sterile 1 ml syringes; faecal matter samples were collected using a sterile spatula to scoop faecal matter recovered from stomach of the cow; wastewater samples were collected in sample bottles as the

carcasses were washed; the tap was allowed to run for 1 minute and then the service water samples were collected in sterile sample bottles; table swab samples were collected by swabbing the tables using a sterile swab sticks. All samples were kept in ice-packed coolers and immediately transported to the Microbiology laboratory for analyses. Samples were collected from October 2017 to November, 2018.

### Microbiological analyses

The samples were serially diluted by adding 1 ml or 1 g of each sample to 9 ml of normal saline solution and then a ten-fold serial dilution was carried out. Blood samples were diluted to  $10^{-2}$ , swabs to  $10^{-4}$ , service water to  $10^{-2}$ , faecal matter to  $10^{-5}$ , soil to  $10^{-5}$  and wastewater to  $10^{-5}$ . Subsequently, aliquots of the diluted samples were inoculated on prepared, solidified and surface-dried Nutrient agar plates. Plates that had been inoculated on, were incubated at  $37^{\circ}\text{C}$  for 24-48 hours. After 24-48 hours, discrete colonies seen were counted and expressed in colony forming units and thereafter sub cultured on fresh Nutrient agar. Biochemical tests such Gram's stain reaction, sugar fermentation, indole, Methyl Red & Vogues-Proskaurt (MRVP), oxidase, catalase, coagulase, motility and citrate were carried out to identify the isolates [12].

### RESULTS

Table 1 shows the mean and standard deviation of blood, table swab, service water, faecal matter, soil and wastewater counts (cfu/ml) in the three locations within the period of study. The blood samples from Iwofe abattoir had a mean total heterotrophic bacteria (THB) count of  $3.33 \times 10^2$  cfu/ml, while the least counts were from Trans-Amadi abattoir with  $8.33 \times 10^1$  cfu/ml. There was no significant difference between the waste blood counts in the different locations at a 95% confidence interval. The mean microbial counts for table swab samples from Iwofe abattoir had high THB counts with  $6.74 \times 10^6$  cfu/ml and Trans-Amadi abattoir having the least with  $4.88 \times 10^6$  cfu/ml, statistically, there was no significant difference between the table swab counts in the three locations. Rumuodomaya abattoir recorded a high THB count with  $2.07 \times 10^4$  cfu/ml while Trans-Amadi recorded the least with  $1.56 \times 10^4$  cfu/ml among the service water samples. There was a significant difference between the THB counts across the locations. Rumuodomaya abattoir recorded high THB counts at  $1.06 \times 10^8$  cfu/g and Trans-Amadi had the least count of  $9.97 \times 10^7$  cfu/g from the faecal matter samples. There was a significant statistical difference in the counts between the three locations. A high mean bacterial count was recorded in soil samples for Iwofe abattoir with  $1.17 \times 10^{10}$  cfu/g while Trans-Amadi had the least count of  $1.11 \times 10^{10}$  cfu/g. There was no significant difference statistically between the mean counts obtained. Mean microbial counts for wastewater samples obtained showed that Rumuodomaya abattoir recorded the least THB count of  $1.03 \times 10^8$  cfu/ml while Iwofe abattoir had the highest count with  $1.08 \times 10^8$  cfu/ml. There was a significant difference statistically in the counts across the locations.

Tables 2-4 show the percentage occurrence of the bacterial isolates within the sampling period (November 2017 – October, 2018) in the three abattoirs. The tables showed a higher occurrence of *E. coli* in the different locations. *Chromobacterium* sp was isolated between May to October in Trans-Amadi and Rumuodomaya abattoirs, whereas, it was not isolated from Iwofe abattoir. In Rumuodomaya and Iwofe abattoirs, *Serratia* sp was isolated in the months of May and October. Table 5 shows the total percentage occurrence of isolates in the months studied across the locations. Higher microbial counts were recorded in the month of October, 2017 with the highest count from Iwofe with 11.3% and the least from Trans-Amadi with 9.5%.

**Table 1: Microbial Counts Samples for Abattoir in the Three Locations**

Location	Blood (cfu/ml)	Table Swab(cfu/g)	Water (cfu/ml)	Faecal matter (cfu/g)	Soil (cfu/g)	Wastewater(cfu/ml)
Iwofe	3.33x10 <sup>2</sup> ±1.42	6.74x10 <sup>6</sup> ±0.12	1.85x10 <sup>4</sup> ±0.26	1.04x10 <sup>8</sup> ±0.05	1.17x10 <sup>10</sup> ±0.19	1.08x10 <sup>8</sup> ±0.42
Rumuodomaya	2.50x10 <sup>2</sup> ±1.11	5.48x10 <sup>6</sup> ±0.06	2.07x10 <sup>4</sup> ±0.21	1.06x10 <sup>8</sup> ±1.17	1.14x10 <sup>10</sup> ±0.27	1.03x10 <sup>8</sup> ±0.27
Trans-Amadi	8.33x10 <sup>1</sup> ±0.78	4.88x10 <sup>6</sup> ±0.06	1.56x10 <sup>4</sup> ±0.21	9.97 x10 <sup>7</sup> ±0.04	1.11x10 <sup>10</sup> ±0.21	1.07x10 <sup>8</sup> ±0.31
P value	0.13	0.22	0.003	0.00	0.69	0.00

P values >0.05 are not significantly different

**Table 2: Percentage Occurrence of Bacterial Isolates per Month in Iwofe Abattoir**

Isolates	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	August	Sept	Oct
<i>Escherichia coli</i>	20.2	16.4	18.1	16.8	16.1	18.2	21.1	16.5	17.8	14.5	15.1	14.3
<i>Klebsiella sp.</i>	17.0	22.4	17.2	18.8	11.3	17.4	16.5	11.3	14.0	17.6	18.1	19.0
<i>Proteus sp.</i>	18.1	15.5	16.4	9.9	13.7	17.4	7.3	4.3	14.7	7.6	6.6	7.7
<i>Salmonella sp.</i>	12.8	13.8	16.4	20.8	14.5	18.2	14.7	14.8	16.3	3.8	17.5	14.9
<i>Bacillus sp.</i>	9.6	12.1	11.2	14.9	16.1	6.6	11.0	17.4	13.2	9.2	6.0	8.9
<i>Serratia sp.</i>	0.0	0.0	0.0	0.0	0.0	4.1	10.1	13.0	9.3	9.2	8.4	6.5
<i>Pseudomonas sp.</i>	9.6	6.9	10.3	11.9	16.9	8.3	8.3	12.2	9.3	12.2	1.8	6.5
<i>Chromobacterium sp.</i>	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	19.1	17.5	15.5
<i>Micrococcus sp.</i>	3.2	1.7	5.2	3.0	4.8	5.8	2.8	4.3	1.6	5.3	3.6	2.4
<i>Staphylococcus sp.</i>	9.6	11.2	5.2	4.0	6.5	4.1	8.3	6.1	3.9	1.5	5.4	4.2
Total	100	100	100	100	100	100	100	100	100	100	100	100

**Table 3: Percentage Occurrence of Bacterial Isolates per Month in Rumuodomaya Abattoir**

Isolates	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	August	Sept	Oct
<i>Escherichia coli</i>	20.7	20.6	17.2	19.8	18.5	16.4	17.5	19.0	15.6	15.0	17.0	13.3
<i>Klebsiella</i> sp.	19.0	16.0	16.4	18.3	16.9	18.9	16.1	18.1	13.6	14.2	13.3	15.0
<i>Proteus</i> sp.	19.0	18.3	21.3	19.0	19.4	17.2	16.8	14.3	12.9	12.6	12.1	11.0
<i>Salmonella</i> sp.	9.9	7.6	10.7	12.7	6.5	7.4	7.3	4.8	10.9	11.0	7.3	9.8
<i>Bacillus</i> sp.	7.4	11.5	8.2	0.0	5.6	4.9	3.6	1.9	6.1	4.7	5.5	6.9
<i>Serratia</i> sp.	0.0	0.0	0.0	0.0	0.0	0.0	16.8	14.3	12.9	12.6	12.1	11.0
<i>Pseudomonas</i> sp.	17.4	14.5	13.1	15.9	18.5	18.0	11.7	18.1	11.6	15.0	13.9	15.0
<i>Chromobacterium</i> sp.	0.0	0.0	0.0	0.0	0.0	0.0	0.7	1.9	6.1	10.2	10.3	13.3
<i>Micrococcus</i> sp.	2.5	7.6	6.6	9.5	8.1	10.7	6.6	2.9	4.8	3.9	6.1	3.5
<i>Staphylococcus</i> sp.	4.1	3.8	6.6	4.8	6.5	6.6	2.9	4.8	5.4	0.8	2.4	1.2
Total	100	100	100	100	100	100	100	100	100	100	100	100

**Table 4: Percentage Occurrence of the Isolates per Month in Trans-Amadi Abattoir**

Isolates	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	August	Sept	Oct
<i>Escherichia coli</i>	18.5	18.9	18.4	18.2	17.1	16.8	17.6	15.5	17.5	16.3	17.0	16.3
<i>Klebsiella</i> sp.	16.7	17.6	13.8	15.5	14.2	14.2	18.6	14.2	13.8	14.4	17.4	13.5
<i>Proteus</i> sp.	17.1	14.9	17.1	14.1	14.2	15.1	17.1	17.8	16.6	18.7	14.7	14.7
<i>Salmonella</i> sp.	12.0	13.5	18.0	17.3	17.5	15.1	8.6	7.3	11.5	11.5	11.6	12.7
<i>Bacillus</i> sp.	10.6	9.5	9.2	10.0	11.4	12.5	13.8	15.5	12.9	12.4	9.4	7.6
<i>Serratia</i> sp.	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.6
<i>Pseudomonas</i> sp.	15.3	14.0	14.7	16.8	14.2	16.4	10.5	11.9	11.1	14.4	13.8	14.3
<i>Chromobacterium</i> sp.	0.0	0.0	0.0	0.0	0.0	0.0	3.3	4.6	8.3	8.1	9.4	9.6
<i>Micrococcus</i> sp.	0.9	1.4	0.5	3.2	1.9	3.4	1.4	3.2	2.8	1.9	0.9	3.2
<i>Staphylococcus</i> sp.	8.8	10.4	8.3	5.0	9.5	6.5	9.0	10.0	5.5	2.4	5.8	6.4
Total	100	100	100	100	100	100	100	100	100	100	100	100

**Table 5: Total Percentage occurrence of isolates within the months**

Location/Month	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Total
Iwofe	6.3	7.8	7.8	6.8	8.3	8.1	7.3	7.7	8.7	8.8	11.1	11.3	100
Rumuodomaya	7.6	8.2	7.6	7.9	7.8	7.6	8.6	6.6	9.2	7.9	10.3	10.8	100
Trans-Amadi	8.2	8.4	8.2	8.3	8.0	8.8	7.9	8.3	8.2	7.9	8.5	9.5	100

## DISCUSSION

The predominant bacteria isolated in this study were of the genera *Micrococcus*, *Staphylococcus*, *Serratia*, *Pseudomonas*, *Proteus*, *Klebsiella*, *Escherichia* and *Chromobacterium*. Similar studies have recorded the presence of these microorganisms from abattoirs in Nigeria and other countries [13-17]. The presence of *Escherichia coli*, *Salmonella* sp., *Klebsiella* sp., *Proteus* sp. and *Serratia* sp. in the soil and wastewater could be as result of faecal contamination and the run-off of wastes into the reservoirs [13, 18]]. The presence of *Pseudomonas* sp. in these ecologies may be the result of hydrocarbon production during burning of firewood, as this organism has been linked with hydrocarbon oxidation [19]. These bacteria from abattoir wastes may be discharged into water columns and can subsequently be absorbed to sediments, and when the bottom stream is disturbed, the sediment releases the bacteria back into the water columns presenting long term health hazards [20,21].The accumulation of the faecal materials act as a collection basin for pathogenic microorganisms which may spread between animals and man leading to zoonoses [22]. These zoonotic pathogens can exceed millions to billions per gram of faeces, and may infect humans through various routes such as contaminated air, contact with livestock animals or their waste products, swimming in water impacted by animal faeces, exposure to potential vectors (such as flies, mosquitoes, water fowl, and rodents), or consumption of food or water contaminated by animal wastes [23,24].

In consonance with this study, isolation of microorganisms from cow waste blood was also reported by Adesoji *et al.*, who isolated bacteria from abattoir wastes in Katsina State, Nigeria [25]. In their study, *E. coli*, *Salmonella* sp. and *Pseudomonas* sp. were isolated from cow waste blood. Isolation of enteric bacteria from the water samples may be linked with the poor construction of the water sources which makes it prone to faecal contamination as well as irregular washing of the water tanks and the non-use of water purifiers. The consequences of anthropogenic pollution during abattoir operations can lead to the transmission of diseases by water borne pathogens, eutrophication of water bodies, accumulation of toxic or recalcitrant chemicals in the soil, destabilization of ecological balance and negative effects on human health [20,26].

The isolation of *Serratia* sp. and *Chromobacterium* sp during the months of May–October (wet season), may be linked with the weather conditions that may have favoured their proliferation in these environments. *Chromobacterium* sp. is often found in aquatic environments and very sensitive to temperature. Its purple colour owes to the antioxidant pigment it produces, called violacein [27]. Infections caused by these microorganisms in humans are rare; however, some species have been reported to cause urinary tract infection, hemophagocytic syndrome, respiratory distress syndrome, fulminant sepsis, pneumonia, gastrointestinal infection, localized cutaneous lesions, localized or metastatic abscesses, osteomyelitis, meningitis, peritonitis, brain abscess and endocarditis [28]. *Serratia* sp. are opportunistic pathogens that have been implicated as causative agents of nosocomial infections including empyema, septicaemia, osteomyelitis and meningitis [29]. Its characteristic red to pink colour (depending on colony's age) stems from its production of a pigment called prodigiosin [30].

## CONCLUSION

Abattoir wastes have adverse impacts on aquatic and soil environment and this may trigger algal blooms (eutrophication), depletion of dissolved oxygen, destruction of habitat and fish kills, thereby reducing the population of fishes and other

aquatic organisms. Sometimes may result in the transmission of diseases by water borne pathogens, accumulation of toxic or recalcitrant chemicals in the soil, which may have negative effects on human health. The occurrence of these microorganisms of the genera *Micrococcus*, *Staphylococcus*, *Serratia*, *Pseudomonas*, *Proteus*, *Klebsiella*, *Escherichia* and *Chromobacterium* could pose severe threat to consumers of beef if appropriate sanitation is not employed in abattoirs. Occasional consumption of the service water by the slaughter men predisposes them to illnesses caused by these bacteria and in cases where the organisms are multidrug resistant strains, treatment resulting from their infection becomes difficult. Therefore, adequate sanitation and management of abattoir wastes are valid means of preventing or reducing the spread of these microorganisms.

## CONSENT AND ETHICAL APPROVAL

It is not applicable.

interests exist.

## References

1. Fereidoun H, Nourddin MS, Rreza NA, Mohsen A, Ahmad R, Pouria H. The effect of long-term exposure to particulate pollution on the lung function of Teheranian and Zanjanian students. *Pakistan Journal of Physiology*, 2007; (2): 1-5.
2. RMMA (Red Meat Abattoir Association). *Waste Management in Red Meat Abattoir*, Pretoria, South Africa. 2010; 40.
3. Adelegan JA . Environmental policy and Slaughter house waste in Nigeria. IN: Reed, B. (ed). *Sustainable environmental sanitation and water services: Proceedings of the 28<sup>th</sup> WEDC International Conference*, Kolkata (Calcutta), India, 18-22 November 2002, p 4.
4. Sangodoyin AY, Agbawhe OM. Environmental Study on surface and ground water pollutant from abattoir effluents. *Bioresource Technology*, 1992; 41(3), 193-200.
5. Adedipe NO. The challenge of urban solid waste management in Africa, IN: Baijnath. H and Singh (Eds) *Rebirth of science in Africa* (Hatfield, South Africa: Umदाus Press), 2002; Pp. 175-192.
6. Akindede ST, Abimbola WA, Oluwabiya BA, Jokotagba OA, Agbolade OM, Sam-Wobo SO. Microbiological Assessment Of Waste-Water And Soil In Ijebu-Igbo Abattoir, Southwest, Nigeria. *International Journal of Advancements in Research & Technology*, 2015; 4:10
7. Cadmus SI, Olugasa BO, Ogunipe GA. The prevalence and zoonotic importance of bovine tuberculosis in Ibadan. *Proceedings of 37<sup>th</sup> Annual Congress of the Nigerian Veterinary Medical Association*, 1999; pp 883-886.
8. Ogonna DN, Azuonwu TC. Plasmid profile and antibiotic resistance pattern of bacteria from abattoirs in Port Harcourt City, Nigeria. *International Journal of Pathogen Research*. 2019; 2(2):1-11.
9. Ire FS, Amos MO, Ossia-Ndidi LN. Microbiological and physiochemical assessment of abattoir effluents and receiving water bodies in Port Harcourt. *Journal of Pharmaceutical, Clinical and Biological Sciences*, 2017; 5(1), 34-39.
10. Igbiosa EO, Obuekwe IS. Evaluation of antibiotic resistant gene in abattoir environment. *Journal of Applied Sciences and Environmental Management*. 2014; 18(2):5-9.
11. Azuonwu TC and Ogonna DN. Resistance genes of microbes associated with abattoir wastes. *Journal of Advances in Medical and Pharmaceutical Sciences*, 2019; 21(2), 1-11.

12. Cheesbrough M. District laboratory practice in tropical countries. Part 2. Cambridge University Press, 2006; 143-157.
13. Ezeronye OU, Ubalua AO. Studies in the effect of abattoir and industrial effluents on the heavy metals and microbial quality of Aba River in Nigeria. *African Journal of Biotechnology*, 2005; 4(3), 266-272.
14. Adesemoye, AO, Opere BO, Makinde SCO. Microbial content of abattoir wastewater and its contaminated soil in Lagos, Nigeria, *African Journal of Biotechnology*. 2006; 5(20), 1963-1968.
15. Teo KC, Teoh SM. Preliminary biological screening of microbes isolated from cow dung in Kampar. *African Journal of Biotechnology*, 2011; 10(9), 1640-1645.
16. Adekanmbi AO, Falodun OI Heavy metals and antibiotics susceptibility profiles of *Staphylococcus aureus* isolated from several points receiving daily input from the Bodija abattoir in Ibadan, Oyo State, Nigeria. *Advances in Microbiology*, 2015; 5, 871-880.
17. Onuoha CS Distribution and antibiogram of bacterial species in effluents from abattoirs in Nigeria. *Journal of Environmental and Occupational Science*, 2018; 7(1), 1-8.
18. Nandita D, Badaru OA, Adekeye BT. Microbiological Assessment of Agege Abattoir Situated In Lagos State, Nigeria. *IOSR Journal of Environmental Science, Toxicology and Food Technology*, 2015; 9(9), 86-93.
19. Faria D, Bharath L. Marine and estuarine methylotrophs: their abundance activity and identity. *Current Science*, 2006; 90(7), 984-989.
20. Nafarnda WD, Ajaylu JC, Kawe MS, Omeiza GK, Sani NA, Tenuche OZ, Dantong DD, Tags SZ. Bacteriological quality of abattoir effluents discharged into water bodies in Abuja, Nigeria. *Veterinary Science*. 2012; 515689.
21. Ogbonna DN. Distribution of Microorganisms in Water, Soils and Sediment from Abattoir Wastes in Southern Nigeria. *Int.J.Curr.Microbiol.App.Sci*, 2014; 3(9) 1183-1200.
22. Adeyemo OK, Ayodeji IO, Aiki-raji CO. The water quality and sanitary conditions in a major abattoir (Bodija) in Ibadan, Nigeria, *Afr. J. Biomedical Res.* 2002; 5: 51-55.
23. Armand-Lefevre L, Ruimy R, Andremont A. Clonal comparison of *Staphylococcus aureus* isolates from healthy pig farmers, human controls, and pigs. *Emerging Infectious Diseases*. 2005; 11(5): 711-714.
24. Schlech WF, Lavigne PM, Bortolussi RA. Epidemic listeriosis-evidence for transmission by food. *The New England Journal of Medicine*, 2005; 308: 203-206.
25. Adesoji AT, Abubakar F, Ipinlaye JS. Occurrence of Antibiotic Resistant Bacteria in Faeces from Abattoir Waste, Processing Water and Products from Dutsin-Ma, Katsina State, Nigeria. *Journal of Bacteriology and Mycology*, 2016; 3(1), 1022.
26. Amisu KO, Coker AO, Isokphehi RD. *Arcobacter butzleri* strains from poultry abattoir effluent in Nigeria. *East Afr. Med. J.* 2003; 80: 218-221.
27. Byamukama D, Farnleither AH, Kansime F, Manafi M, Burtsher M, Mach RL. Contrasting occurrence of *Chromobacterium violaceum* in tropical drinking water springs of Uganda. *Journal of Water Health*, 2005; 3, 229e38.
28. Yang C, Li Y. *Chromobacterium violaceum* infection: A clinical review of an important but neglected infection. *Journal of Chinese Medical Association*, 2011; 74, 435-461.



29. Khanna A, Khanna M, Aggarwal A. *Serratia marcescens*- a rare opportunistic nosocomial pathogen and measures to limit its spread in hospitalized patients. *Journal of Clinical and Diagnostic Research*, 2013; 7(2), 243-246.
30. Rajpit, A., Shah, U., Chauhan, B. and Shah, P. (2009). *Serratia*: An emerging pathogen in hospital environment. *Gujarat Medical Journal*, 64(2), 70-7.

UNDER PEER REVIEW