



## **Bacteriological and Parasitological Assessment of Water use in Selected Abattoirs in Port Harcourt Metropolis, Rivers State, Nigeria**

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### **Authors' contributions**

This work was carried out in collaboration among all authors. Author ECN designed the study, performed the statistical analysis, wrote the protocol and wrote the first draft of the manuscript. Author IN managed the analyses of the study. Author IBO managed the literature searches. All authors read and approved the final manuscript.

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### **ABSTRACT**

In the abattoir, large amount of water is being used in processing operations; and this produces huge amount of wastewater which empty into the surrounding water bodies. The cross-sectional study followed the conventional microbiological techniques of macroscopy, microscopy, isolation, and identification to assess the bacteriological and parasitological examination of water sources in selected abattoirs in Port Harcourt Metropolis, Rivers State, Nigeria. The result of microbial population showed Total Coliform ranging from  $5 \times 10^1$ cfu/ml –  $2.80 \times 10^2$ cfu/ml and Faecal Coliform bacteria of  $2.80 \times 10^1$  cfu/ml - $1.85 \times 10^2$  cfu/ml. Total Heterotrophic bacteria ranged from  $7.8 \times 10^1$ cfu/ml to  $4.2 \times 10^2$ cfu/ml. The mean microbial counts;  $4.86 \times 10^1$  cfu/ml Faecal Coliform,  $9.65 \times 10^1$ cfu/ml Total Coliform and  $1.82 \times 10^2$ cfu/ml Heterotrophic Count. The isolates identified were *Klebsiella spp.*, *Shigella spp.*, *Salmonella typhimurium*, *E. coli*, *Proteus spp.*, *Salmonella paratyphi*, *Vibrio cholera*. Nkpor village abattoir recorded highest occurrence of bacteria isolate with a total of 50(22.03%) followed by Iwofe 48(21.15%). Water sample from ponds had a higher parasitic contamination while samples from the borehole were free from parasitic infestation. Water samples

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for parasitological assessment were filtered and examined for parasitic organism using standard methods. Four different parasites were identified in the study, they include *Ascaris lumbricoides* (32.5%), *Entamoeba histolytica* (22.5%), *Giardia lamblia* (17.5%) and the least *Taenia spp* (7.5%). Nkpor-village abattoir had the highest level of contamination with (30.0%) parasite occurrence, followed by Mgboshimini abattoir (15.0%). The use of unsafe water for meat processing by butchers, portends a serious public health risk to consumers who purchase the meat, from these abattoirs. Therefore, government should endeavour to make borehole water available to all the abattoirs in Port Harcourt.

**Keywords:** Bacteriological; parasitological; water source; abattoirs.

## 1. INTRODUCTION

Abattoir is a premise approved and registered by the controlling authority for hygienic slaughtering and inspection of animals, processing and effective preservation and storage of meat products for human consumption [1]. It is a place where animals such as cattle, goats, and so on are killed, dressed and distributed for consumption and other industrial purposes. The main abattoir activities include butchering, removal of the hide, intestine management, rendering, trimming, processing and cleaning activities. Abattoirs, are most commonly located very close to natural water bodies like rivers, streams and lakes for the ease of cleaning and discharging of the effluent. The volume of water which is available in portable forms is found in water from the ground, springs, rivers and lakes, the proportion of which is only about 3% [2]. In the abattoir, large amount of water is being used in processing operations; and this produces large amount of waste water which empty into the surrounding water bodies. Abattoirs are generally known all over the world to pollute the environment either directly or indirectly from their various processes [3]. In Nigeria, many slaughterhouses dispose of their waste directly into streams or rivers and use water from the same source to wash slaughtered meat. Such is the situation in most private and government abattoirs in south-western Nigeria [3]. 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 [4]. Sadly, most abattoirs in Port Harcourt are characterized by poor design, obsolete facilities and deteriorating environment (Personal observation). The challenge posed by poor abattoir waste management on public food safety and quality of life in Port Harcourt has become a source of concern in recent time. The importance of water in abattoir process cannot be

overemphasized and based on the importance of water to human, there is a great need to evaluate the quality of water use in various abattoir in Port Harcourt. Studies have shown bacteriological quality of abattoir effluents discharged into water bodies; and little or no documentation on the parasitological contamination of water use in abattoirs. This study, therefore, was conducted to assess the bacterial and parasite load of water use in selected abattoirs in Port Harcourt metropolis, Rivers State, Nigeria.

## 2. MATERIALS AND METHODS

### 2.1 Study Area

This study was conducted at different abattoirs within Port Harcourt metropolis. These abattoirs include Trans-Amadi, Rumuodumaya, Iwofe, Ogbunabali, Mgboshimini, Diobu, Nkpor village and Choba Slaughters. Port Harcourt is a coastal city located in the Niger Delta region of Nigeria within latitudes 6°58' – 7°60'E and longitudes 4°40' – 4°55'N. Specifically, Trans-Amadi is situated at 4°49'14.32"N latitude and 7°3'18.8"E longitude, Rumuodumaya at latitude 4°52'49.66"N and longitude 6°59'55.6"E, Iwofe at latitude 4°49'4"N and longitude 6°57'24"E, Ogbunabali at latitude 4°48'11.17"N and longitude 7°0'34.29"E, Nkpor village at latitude 4°46'48.68"N and longitude 6°57'51.53"E, Diobu within latitude 4°47'54.93"N and longitude 6°59'31.53"E, Choba at latitude 4°51'25.01"N and longitude 7°1'18.07"E and Mgboshimini at 4°48'25.98"N latitude and 6°58'11.66"E longitude. The monthly rainfall in Port Harcourt follows a sequence of increase from March to October before decreasing in the dry season months of November to February. The annual average rainfall amount is 200.45mm. These locations were chosen as a result of the water bodies around them, and the use of these water sources by rural traders and butchers, as a result of inadequate provision of borehole water.

## 2.2 Samples and Water Sample Collection

The study population comprises of eight different abattoirs situated at different locations in Port Harcourt, Rivers State, Nigeria. Borehole, stream, river and pond water bodies were used for the study. Samplings were collected as early as 6.00am when slaughtering, processing to the sales of the meat were carried out. A total of 40 water samples were collected from different abattoirs, borehole (n = 10), stream (n = 15), pond (n = 10), river (n = 5). Samples were collected in one liter containers already pre-sterilized and transported to laboratory in ice box for laboratory investigation following the conventional microbiological and parasitological methods of analysis as outlined on the Standard methods for the examination of water and wastewater by American Public Health Association, APHA [5]. Also, while sampling in the streams and rivers the collection bottle was lowered in water at a depth of about 15cm to 30cm. The bottle was held at the base and placed in the direction of the water flow. Two sites where pipe borne water were made available for use in the abattoir served as the control.

## 2.3 Bacteriological Analysis

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 for bacterial count; MacConkey agar for coliform count and Menterococcus agar for faecal streptococcus count were sterilized in an autoclave at 121°C for 15minutes (APHA, 1995). Samples were cultured on the prepared medium in duplicate and incubated aerobically at 37°C for 48 hours to obtain pure isolates of bacteria, after incubation, the colonies formed were counted using colony counter and expressed as Colony-forming units per millimeter (Cfu/ml) of the sample.

## 2.4 Parasitological Analysis

The preserved one liter sample was allowed to settle for 24 hours and the parasitological analysis was carried out according to Iyagi *et al* [6]. Water samples were filtered through a filter sieve of 0.5 mesh size. The residue was soaked and rinsed thoroughly in a beaker containing 20ml of 5% formal saline. The filtrate was poured into centrifuge tube and centrifuged at

4000 rpm for 6 minutes at room temperature and allowed to rest in test tube rack for 3 minutes. The supernatant was discarded leaving small amount of suspended sediment. A drop of suspended sediment was placed on a clean glass slide and iodine solution was added. It was then covered with cover slip and examined under a microscope using x10 and x40 objectives. Parasites were identified by the morphological structures of their cysts, ova or larvae [7].

## 2.5 Data Analysis

Data was analyzed with MS Excel and Statistical Package for Social Sciences (SPSS) software version 22. Descriptive statistics included frequency, percentage, mean, and standard deviation. While inferences were deduced and p values less than 0.05 were considered statistically significant using Chi Square.

## 3. RESULTS

Forty water samples were collected from the study area, the result of the bacteriological analysis is presented as Table 1. The isolates identified were *Klebsiella spp.*, *Shigella spp.*, *Salmonella typhymurium*, *E. coli*, *Proteus spp.*, *Salmonella paratyphi*, *Vibrio cholera*. Nkpor village abattoir recorded highest occurrence of bacteria isolate with a total of 50(22.03%) followed by Iwofe 48(21.15%), Choba 39(17.18%), Diobu 35(15.42%), Rumuodumaya 28(12.33%) and the least Mgboshimini 27(11.89%). Remarkably, *Klebsiella spp* was recovered highest in all the abattoirs followed by *Salmonella typhymurium*, *E.coli*, *Shigella spp.*, *Salmonella paratyphi*, *Proteus spp.*, and *Vibro cholera* (Table 2). Furthermore, Nkpor village (1.85 x 10<sup>2</sup>) has the highest Faecal Coliform count followed by Rumuodumaya (1.4 x 10<sup>2</sup> cfu/ml) while Mgboshimini, Iwofe, Diobu and Choba had 2.8 x 10<sup>1</sup>cfu/ml, 1.4 x 10<sup>1</sup> cfu/ml, 4 x 10<sup>1</sup> cfu/ml and 1.8 x 10<sup>1</sup> cfu/ml respectively. The least value recorded was Iwofe abattoir (1.4 x 10<sup>1</sup> cfu/ml) Faecal Coliform Bacteria. Rumuodumaya abattoir water source has the highest Total Coliform Bacteria count (2.8 x 10<sup>2</sup> cfu/ml) followed by Nkpor village abattoir water source in the study area. Iwofe, Diobu and Choba have values of 1.2 x 10<sup>2</sup> cfu/ml, 1.02 x 10<sup>2</sup> cfu/ml and 5 x 10<sup>1</sup> cfu/ml respectively of Total Coliform Bacteria count. From the study area, Choba abattoir had the least Total Coliform Bacteria. Total Heterotrophic Bacteria recorded

in Mgboshimini, Nkpor village, Iwofe, Rumuodumaya, Diobu and Choba abattoir water source were  $7.8 \times 10^1$  cfu/ml,  $4.45 \times 10^2$  cfu/ml,  $2.6 \times 10^2$  cfu/ml,  $4.2 \times 10^2$  cfu/ml,  $1.42 \times 10^2$  cfu/ml and  $1.06 \times 10^2$  cfu/ml respectively. Nkpor village abattoir water source, recorded highest occurrence of Total Heterotrophic Bacteria in the study area while the least occurrence recorded was Choba abattoir with a value of  $1.06 \times 10^2$  cfu/ml Total Heterotrophic Bacteria count (Table 2). Parasitological examination of the water samples collected from different sources of water in the abattoirs showed that water sample from ponds had a higher parasitic contamination followed by the water samples from the stream while the water samples collected from the borehole were free from parasitic infestation (Table 3). Four different parasites were identified in the study, they include *Ascaris lumbricoides* (32.5%), *Entamoeba histolytica* (22.5%), *Giardia lamblia* (17.5%) and the least *Taenia spp* (7.5%). Nkpor-village abattoir had the highest level of contamination with (30.0%) parasite occurrence, followed by Mgboshimini abattoir (15.0%), Iwofe abattoir (12.5%), Choba abattoir (10.0%), Rumuodumaya abattoir (7.5%), Diobu abattoir (5.0%). No parasite was recovered in Trans-Amadi and Ogbunabali abattoir which served as the control (Table 4).

#### 4. DISCUSSION

Bacteriological examination of water is a powerful tool for identifying the presence of microorganisms that might constitute a health hazard. The outcome of the study obviously indicates bacteria contamination of water sources in the abattoirs studied, the results showed that they were grossly contaminated with bacteria which could be pathogenic to humans. The study revealed the presence of bacterial species; *Klebsiella spp*, *Salmomella typhymurium*, *E. coli*, *Shigella spp*, *Salmonella paratyphi*, *Proteus spp* and *Vibro cholera*. The isolation of enteric bacteria such as *E. coli* is an indication of fecal contamination of the water used. This could lead to faecal contamination of meat through water used in washing the meat and/ or hands or unhygienic handling of meat right from the slaughter slabs to the tables [8]. The high incidence of isolated pathogens at these abattoirs is not surprising considering the large number of people engaged in abattoir procedures and the unhygienic practices

observed in the study. According to prior studies, scholars opined that the abattoir water has several pathogenic bacteria and fungi species [9-11]. The presence of this high microbial load may be due to the poor nature of the environment and quality of water used in washing carcass of animal in some of the abattoirs and this has led to the closing of Eleme abattoir by the Rivers State Ministry of Health. Slaughtering is generally carried out on the floor and outside the abattoir by individual butchers, with little or no concern for hygiene, a practice that could be readily observed in slaughter sites located across major cities in Nigeria [12]. Sangodoyin and Agbawhe [13] investigated the possible interaction between abattoir effluent on surface and ground waters in Ibadan, Nigeria. The high total heterotrophic count is indicative of the presence of high organic and dissolved salts in the water. The primary sources of these bacteria in water are animal and human wastes. However, the presence of *Vibro cholera* in the study is worrisome because of its public health significance, having been associated with gastrointestinal infections: diarrhoea, dysentery, typhoid fever and other form of infection [14]. The parasitological investigation proved a clear indication of parasitic contamination of water sources in the abattoirs in this study. However, prevalence of contamination varied between ponds, stream and river water sources. Ponds served as reservoirs that collect run-off water from different routes, they therefore stand a greater risk of contamination. Nkpor village and Iwofe abattoir were highly contaminated by parasite, they recorded the highest number of pathogenic parasites. The presence of parasite species of human health importance identified could be attributed to anthropogenic activities around the abattoirs (personal observation) and the act of disposing of abattoirs waste directly into streams or rivers and use water from the same source to wash slaughtered meat. Nonetheless, water samples from boreholes (control) were found to be free from parasitic infestation, this is largely attributed to its make-up. Unlike other sources that are open to external contamination, boreholes operate a water system that is closed. The public health significance of these results is that the pathogenic parasites may pose serious hazard to human health.

Table 1. Bacteria isolates from water samples

Isolates	Control 1	Control 2	Nkpor-Village (%)	Iwofe	Mgboshimini	Rumuodumaya	Diobu	Choba	Total
<i>Shigella spp.</i>	0	0	8 (16.00)	6(12.5)	9(33.33)	0 (0)	0 (0)	13(33.33)	36 (15.86)
<i>Salmonella typhymurium</i>	0	0	7(14.00)	15(31.25)	2(7.41)	10(35.71)	0 (0)	14 (35.90)	48 (21.15)
<i>E.coli</i>	0	0	13 (26.00)	9(18.75)	12(44.41)	4(14.29)	3(8.57)	5(12.82)	46 (20.26)
<i>Klebsiella spp.</i>	0	0	10 (20.00)	7(14.58)	2(3.70)	14(50.00)	12(34.29)	7 (17.95)	52 (22.91)
<i>Proteus spp.</i>	0	0	8 (16.00)	0 (0)	0 (0)	0 (0)	8(22.86)	0 (0)	16 (7.05)
<i>Salmonella paratyphi</i>	0	0	0	11(22.92)	2(7.4)	0 (0)	10(28.57)	0 (0)	23 (10.13)
<i>Vibrio cholera</i>	0	0	4 (8.00)	0 (0)	0 (0)	0 (0)	2(5.71)	0 (0)	6 (2.6)
Total	0	0	50(22.03)	48(21.15)	27(11.89)	28(12.33)	35(15.42)	39(17.18)	227(100)
X <sup>2</sup>	0	0	63.000	63.000	63.000	45.000	63.000	54.000	
P-value	0	0	0.243	0.243	0.243	0.271	0.243	0.256	

Table 2. Bacteriological examination of water samples from the abattoirs

Location	Faecal Coliform (Cfu/ml)	Total Coliform (Cfu/ml)	Total Heterotrophic (Cfu/ml)
Control 1	0.0	0.0	0.0
Control 2	0.0	2.0	2.0
Mgboshimini	2.8 x 10 <sup>1</sup>	5 x 10 <sup>1</sup>	7.8 x 10 <sup>1</sup>
Nkpor village	1.85 x 10 <sup>2</sup>	2.6 x 10 <sup>2</sup>	4.45 x 10 <sup>2</sup>
Iwofe	1.4 x 10 <sup>1</sup>	1.2 x 10 <sup>2</sup>	2.6 x 10 <sup>2</sup>
Rumuodumaya	1.4 x 10 <sup>2</sup>	2.8 x 10 <sup>2</sup>	4.20 x 10 <sup>2</sup>
Diobu	4 x 10 <sup>1</sup>	1.02 x 10 <sup>2</sup>	1.42 x 10 <sup>2</sup>
Choba	1.8 x 10 <sup>1</sup>	5 x 10 <sup>1</sup>	1.06 x 10 <sup>2</sup>
Total	3.89 x 10 <sup>2</sup>	7.72x 10 <sup>2</sup>	1.45 x 10 <sup>3</sup>
Mean	4.86x10 <sup>1</sup>	9.65 x 10 <sup>1</sup>	1.82 x 10 <sup>2</sup>

**Table 3. Overall parasite species identified from the water samples use in some abattoirs in the study area**

Water source N=40	Stream	Pond	River	Borehole	Total
<i>A. lumbricoides</i>	4	7	2	0	13(32.5)
<i>G. lamblia</i>	2	3	2	0	7(17.5)
<i>E. histolytica</i>	5	4	0	0	9(22.5)
<i>Taenia spp.</i>	0	3	0	0	3(7.5)
Total	11(27.5)	17(42.5)	4(10.0)	0	32(80.0)

*Trans-amadi –borehole; Ogbunabali- bore hole; Nkpor-village- pond; Iwofe -pond, Mgboshimini – stream; Rumuodumaya – stream; Diobu – stream; Choba - river*

**Table 4. Distribution of parasites found in the water samples from the abattoirs based on location**

Abattoirs N=40	<i>A. lumbricoides</i> (%)	<i>G. lamblia</i> (%)	<i>E.histolytica</i> (%)	<i>Taenia spp</i> (%)	Total (%)
Trans-amadi	-	-	-	-	-
Ogbunabali	-	-	-	-	-
Nkpor-village	5(12.5)	3(7.5)	3(7.5)	1(2.5)	12(30.0)
Iwofe	2(5.0)	0	1(2.5)	2(5.0)	5(12.5)
Mgboshimini	2(5.0)	2(5.0)	2(5.0)	-	6(15.0)
Rumuodumaya	-	-	3(7.5)	-	3(7.5)
Diobu	2(5.0)	-	-	-	2(5.0)
Choba	2(5.0)	2(5.0)	-	-	4(10.0)
Total (%)	13(32.5)	7(17.5)	9(22.5)	3(7.5)	32(80.0)

*Trans-amadi –borehole; Ogbunabali- bore hole; Nkpor-village- pond; Iwofe -pond, Mgboshimini – stream; Rumuodumaya – stream; Diobu – stream; Choba - river*

## 5. CONCLUSION

Seven bacteria isolates and four parasites were identified from the samples. The isolation of enteric bacteria such as *E.coli* is an indication of fecal contamination of the water used and the presence of *Vibrio cholera* in the study is worrisome because of its public health significance, having been associated with gastrointestinal infections. The use of contaminated water for meat processing portends a serious public health risk to consumers. Therefore, there is an urgent need to discourage the use of this water to safe guard the health of the populace. Government should endeavor to make borehole water available to all the abattoirs in Port Harcourt.

## CONSENT

All authors have declared that written informed consent was obtained from the patients for publication of this case report and accompanying images.

## ETHICAL APPROVAL

Ethical approval was gotten from the ethical committee of the University of Port Harcourt,

Choba before the commencement of this research. All authors hereby declare that all experiments have been examined and approved by the appropriate ethics committee and have therefore been performed in accordance with the ethical standards laid down in the 1964 Declaration of Helsinki.

## COMPETING INTERESTS

Authors have declared that no competing interests exist.

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