ISSN 2229-5518

Physicochemical and Microbial properties of Water Samples around Abattoirs in Calabar

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Abstract

Water Samples obtained from three sources; Borehole, Stream and Drainage from Anantigha and Nkonib Abattoir were analyzed for physicochemical and microbial properties. The Physicochemical properties determined include; pH, turbidity, Dissolved Oxygen (DO) Electrical conductivity (EC), Total Saturated Solids (TSS), Total Dissolved Solids (TDS), Total Hardness and Biochemical Oxygen Demand (BOD). Heavy metals analyzed included Iron (Fe), Copper (Cu), Lead (Pb), quantity of nitrate and phosphate Ion in the samples. The results showed that pH was below tolerated limits of WHO. Turbidity in Anantigha drainage water and Nkonib drainage water were significantly ($p<0.05$) higher than other water sources in both locations. All values of dissolved oxygen were higher than WHO permissible levels. Electrical conductivity values obtained in this study showed that drainage water in both Anantigha & Nkonibs contained lower amounts of dissolved ions more than stream water & borehole were within WHO (1999) permissible levels. BOD values obtained except those in Anantigha borehole were below WHO (2011) permissible guidelines of 6mg/l. Total hardness in the water samples was less than 500mg/l &within permissible limits of WHO while the nitrate values were lower than WHO guidelines. Heavy metal values fluctuated within samples except Pb in which values in the three water sources exceeded WHO recommended levels. High bacterial population was obtained from drainage water in both locations but borehole water from both locations was free from bacterial load. The results showed that Nkonibs drainage water had more fungal load than that of Anantigha Abattoir. The bacteria isolates identified include, *Bacillus sp, Escherichia coli, Salmonella sp, Citrobacter sp* while the fungal isolates identified *were Mucor sp, Penicillium sp and Rhizopus sp.* This study recommends that water samples (boreholes and streams) around abattoirs, except that from drainage should be properly treated before consumption.

Key word: Borehole, physicochemical, water, abattoirs, bacterial

Introduction

An abattoir is a premise approved and registered by the government for the slaughtering and inspection of animals, processing, and effective preservation and storage of meat products for human consumption. Wastes generated from abattoirs are highly organic animals wastes and are usually contaminated by microorganisms living naturally or entering it from the surroundings such as those resulting from processing operations (Hassan *et al.*, 2014). Wastes generated from abattoirs sometimes are poorly disposed and area a major source of water pollution/contamination (Enoh *et al.*, 2012). These practices introduce enteric pathogens, excess nutrients and trace heavy metals into the soil which contaminates the ground water especially when discharged into water ways. Majority of inhabitants of Calabar have access to boreholes and streams as their major source of water supply. The use water form these sources for drinking and other domestic purposes, therefore, the determination of the portability of these supplies is of serious concern. Water samples obtained from the three sources: borehole, stream and drainage from Anantigha and Nkonib abattoir were analyzed for physiochemical and microbial properties. Water is an important substance of the earth; it is one of the most important elements of human survival and therefore is highly consumed by all living things. Water is important to all life, both living and non-living things and is also regarded as a universal solvent capable of dissolving all solutes (Taiwo *et al*., 2014). Water pollution according to (Daniels *et al.*, 2003) is said to occur when a chemical, physical and biological substance exceeds the capacity of a water body to breakdown these substances which can cause harm to the ecosystem. The provision of portable water to rural and urban areas is necessary to prevent health hazards therefore; access to safe drinking water is a prerequisite to reduction in the spread of water borne diseases (Gomez *et al.*, 2002).

Plate 1: Ongoing activities in Nkonib Abattoir

Plate 2: Unsanitary and unhygienic state of Anantigha Abattoir

Materials and methods

Clean, sterilized, wide-mouthed sample bottles with tight screw dust proof stoppers was first sterilized using warm water before use. 0.1ml of 18% sodium thiosulphate (a reducing agent) was put into each container before they were used; this was done to prevent oxidation of the effluent samples and continuation of bacterial activities during sample transit. Four (4) water samples each was collected from the boreholes, streams and drainage at Anantigha and Nkonibs abattoirs, respectively, to give a total of Twenty four (24) water samples. To obtain water samples, the sterilized containers were submerged into the water. Samples collected were then put in an Ice-cooler, for preservation and was transported to the laboratory immediately for processing within 6-12 hours post-collection.

Experimental design

A 2x3 factorial in a Completely Randomized Design was used for the physicochemical parameters, while a 2x3x2 factorial was used for the Bacterial and fungal parameters. The factor 1 is the different locations (Anantigha and Nkonibs) and the factor 2 are the sources of water which are the boreholes, streams and drainages.

Physicochemical assessment of water samples

The physicochemical properties that was analyzed includes the temperature, pH, turbidity, Dissolved Oxygen(DO), EC, Total Saturated Solids (TSS), Total Dissolved Solids (TDS), total Hardness and Biochemical Oxygen Demand(BOD) coefficients. The Heavy metal contents that were analyzed include Iron (Fe), copper (Cu), lead (Pb), the quantity of nitrate and phosphate ion in the samples.

pH was determined using a digital pH meter while Milton Roy(USA) spectronic 20D meter was used to determine the turbidity of the samples. A mercury in-glass thermometer was used to determine the temperature. Total hardness was determined by spectrophotometric procedure which involved addition of 1ml of the samples which was placed in a reaction cell of 1ml of total hardness reagent (H-1K) added with a pipette. Three minutes reaction time was allowed before the values were read out at a wavelength of 450m. BOD coefficients of the samples were determined using the Winkler's Titration Method as recommended by APHA (1998). For the determination of TSS, a filter paper was weighed using a digital balance and the initial reading noted. 100ml 0f the samples was then filtered through the filter and oven-dried. The filter paper was then weighed again and the final weight recorded. The TSS was determined by the difference between the initial and final weight of the filter paper. Electrical conductivity of the sample was measured using the 1-lach sension 5 conductivity meter and values were read directly from the instrument. Heavy metals Copper (Cu), Lead (Pb), Iron (Fe), were analyzed using the Atomic Absorption spectrophotometric (AAS) methods.

Bacteriological assessment of water

About 100mls of the water sample was filtered through a filter that retains bacteria. The filtrate was then transferred to Petri dishes containing MacConkey agar and incubated at 37^{o}c for 48hours as described by APHA (1998). The numbers of coliform colonies formed were counted using a microscope and the values are expressed as CFU/ml.

Statistical analysis

Data collected was subjected to a two-way analysis of variance (ANOVA). While significant means was separated using least significant difference (LSD) test at 5% and 1% probability level.

Results and Discussion

The temperature fluctuations in the three water samples (drainage, borehole and stream) in each location (Nkonibs and Anantigha) is presented in Table 1 below. The results showed that borehole water in Nkonibs had temperature that was significantly ($p<0.05$) higher than the other water sources in both Nkonibs and Anantigha. The temperature of water source does not have direct health implication (Willis, 1989). Similarly, pH in Anantigha drainage water, Anantigha stream water and Nkonibs streams water were not significantly ($p<0.05$) different but were significantly different from those in Anantigha borehole water, Nkonibs drainage water and Nkonibs borehole water. The observed pH was below the tolerated limits of WHO as Extreme pH in water is unhealthy for consumption especially when the acidity is high. Low pH in water tends to be corrosive to some metals, asbestos, pipelines, etc., while that of a high pH effect is also detrimental (UNICEF, 2008). According to WHO, health effects are most pronounced in pH extremes. Drinking water with an elevated pH above 11 can cause skin, eye and mucous membrane irritation. On the opposite end of the scale, pH values below 4 also cause irritation due to the corrosive effects of low pH levels. WHO warns that extreme pH levels can worsen existing skin conditions (WHO, 2009). WHO standard pH for portable water lies between 6.5 and 8.5.

Also, turbidity in Anantigha drainage and Nkonibs drainage water were significantly ($p<0.05$) higher than those in Anantigha borehole water, Anantigha stream water, Nkonibs borehole water and Nkonibs borehole water. The result also showed that dissolve oxygen

(DO) in Nkonibs drainage water was the highest and was significantly ($p < 0.05$) different from Nkonibs borehole and stream water as well as Anantigha borehole and stream water but was not significantly ($p>0.05$) different from Anantigha drainage water. All the values of dissolved oxygen (DO) obtained in this study were higher than the WHO (2011) permissible levels of 5 mg/l. This result indicates that DO concentrations can support diversified biota including fish (Jha *et al.*, 2008).

The result for electrical conductivity (EC) for water samples in the two location showed that EC in Nkonibs drainage water had the highest EC value (811.767 µS/cm) which was significantly different from EC content in Anantigha drainage (656.03 µS/cm), borehole (78.96 µS/cm) and stream (148.23 µS/cm), Nkonibs borehole (83.77 µS/cm) and stream water (151.83 µS/cm). Conductivity values obtained in this study showed that the drainage water in both Anantigha and Nkonibs contained appreciable amount of dissolved ions more than stream water and borehole water. This high EC values observed in Drainage water in both locations may be as a result of the chemicals present in ionic form in the effluent discharged into the surface water from the abattoir. The EC of all water sources within Anantigha and Nkonibs fall within the WHO (1999) recommended limit of 500-1500µS/cm.

The total suspended solid (TSS) was the highest in Nkonibs drainage (47.93 mg/l) water and was significantly ($p>0.05$) higher than TSS in Anantigha drainage water (37.46 mg/l), borehole water (0.88 mg/l) and stream water (5.78 mg/l) including Nkonibs borehole water (1.43 mg/l) and stream water (8.4 mg/l). The totals dissolved solids (TDS) result obtained in this study showed that Nkonibs drainage water (390.63 mg/l) was significantly ($p< 0.05$) higher in TDS content than Nkonibs borehole water (109.6 mg/l), and stream water (264.43 mg/l) including Anantigha drainage water (270.0 mg/l), borehole water (20.97 mg/l) and stream water (139.3 mg/l). TDS values obtained for this study were generally below the 1000 mg/L upper limit set by WHO above which water become significantly and increasingly unpalatable.

The biochemical oxygen demand (BOD) in the study area fluctuated greatly. The highest value obtained from that result was 6.93 mg/l in Anantigha borehole and the value obtained was significantly ($p<0.05$) higher than BOD in Anantigha drainage (3.62 mg/l) and stream water (4.48 mg/l) including those in Nkonibs drainage water (4.74 mg/l), borehole water (3.82 mg/l) and stream water (3.82 mg/l). The result obtained in this study is similar to that of (Eni *et al.*, 2014) who had a value of 2.80-4.80mg/L for BOD in Obot Okoho stream Nassarawa village Calabar. All the BOD values obtained in this study except those in Anantigha borehole are below the WHO (2011) permissible guideline of 6mg/l. Total hardness is defined by the quantity of calcium and magnesium found in water and was generally low in the three water sources in Anantigha and Nkonibs. The highest value obtained was 68.17 mg/l in Nkonibs drainage water and this value was significantly ($p<0.05$) higher than the total hardness in Anantigha drainage water (58.3 mg/l), borehole water (16.73 mg/l) and stream water (4.48 mg/l) including those in Nkonibs borehole water (20.67 mg/l) and stream water (39.03 mg/l). From the result of the study as shown in Table 1, the total hardness (the sum of calcium and magnesium hardness) of water samples was less than 500 mg/L and within the permissible limit of WHO suggesting that this water is fit for domestic use. The presence of nitrate can be attributed to the feed and faeces of the cow. The nitrate content is also shown in Table 1. The highest value obtained from the result was 28.1 mg/l in Nkonibs drainage water and this value was significantly ($p<0.05$) higher than nitrate content in Anantigha drainage water (18.20 mg/l), borehole water (4.56 mg/l) and stream water (10.67 mg/l) and Nkonibs borehole water (5.41 mg/l) and stream water (14.07 mg/l). All the nitrate values obtained in the study are lower than the WHO (2011) recommended guideline value of 50mg/l.

The phosphate content showed that drainage water in Nkonibs had the highest value of 9.38 mg/l and this value was not significantly ($p<0.05$) higher than phosphate content in Anatigha drainage water but was significantly higher than phosphate content in Anantigha borehole water (6.0 mg/l) and stream water (7.11 mg/l) and Nkonibs borehole water (6.23 mg/l) and stream water (7.43 mg/l). It is established that high phosphate concentration has no health implication (WHO, 2011) except for its role in causing eutrophication of water bodies.

The heavy metals contents (Fe, Cu and Pb) in the three water samples (drainage, borehole and stream) in each location (Nkonibs and Anantigha) is also presented in Table 1 below. The results showed that drainage water in Nkonibs had highest Fe content that was significantly ($p<0.05$) higher than Fe content in Anantigha drainage water (1.73 mg/l) and stream water (0.64 mg/l) and Nkonibs borehole water (0.72 mg/l) and stream water (1.70 mg/l).The Cu content in stream water in both Nkonibs and Anantigha was the highest and was significantly ($p<0.05$) higher than Cu content in Anantigha drainage water (0.0633 mg/l) and borehole water (0.033 mg/l) and Nkonibs drainge water (0.006 mg/l) and borehole water (0.033 mg/).The Pb content was the highest in Nkonibs drainage water and was significantly higher than those in Anantigha drainage water (0.42 mg/l), borehole water (0.027 mg/l) and stream water (0.07 mg/l) including those in Nkonibs borehole water (0.033 mg/l) and stream water (0.15 mg/l). All the values of Pb in the three water sources within each location exceeded the WHO (2011) recommended levels of 0.01mg/l.

The result as presented on Table 4 showed that high bacterial population was obtained from drainage at Anantigha and Nkonibs, followed by the bacterial load at the stream in Nkonibs. No bacterial load was observed at both borehole water source. Table 5 compared the result of the bacterial from the drainage, borehole, and stream at different dilution factor, as it was observed that the drainage water at 10^{-2} had the highest bacteria counts while the streams at 10^{-3} had the lowest bacterial count. However, among the locations the Anantigha and Nkonibs at a dilution factor of 10^{-2} had the highest bacteria count, followed by 10^{-3}. The bacteria count in the water samples in Anantigha were observed to be more than the bacterial count in Nkonibs. While the drainage had more bacterial counts than the streams, the boreholes were observed to be free of bacterial load.

The results as presented in table 4, indicates that the fungi count obtainedin the drainage water at Nkonibs had significantly high fungi counts than the drainage water at Anantigha, while the streams at both locations had low fungi counts. The fungi count at the dilution factor 10^{-3} in the drainage water had high fungi counts than the dilution factor 10^{-2}, this was followed by the stream at 10^{-2} dilution factor. The borehole water sample had the lowest fungi count. The fungal count at Nkonibs (10^{-2}) had the highest counts followed by the counts obtained at 10^{-2} in Anantigha water source. This result implies that Nkonibs water source had more water fungi load than the Anantigha abattoir. It was also observed that the drainage had more fungi load than streams while the borehole had the lowest fungi count.

The presence of bacterial and fungal load in Anantigha and Nkonibs stream and drainage indicated that the water was faecally polluted, this was seen through the presence of *E-coli, Salmonella, Citrobacter, Bacillus, Mucor, Penicillum and Rhizopus Sp.*

TABLE 1

Physicochemical properties of water sources within Anantigha and Nkonibs

	Anantigha			Nkonibs			
Parameter	Drainage	Borehole	Stream	Drainage	Borehole	Stream	LSD (0.05)
Temp ^{0}C	$28.4^c \pm 0.36$	$29.73^b \pm 1.04$	$28.06^c \pm 0.31$	$28.2^c \pm 0.36$	$30.97^a \pm 0.12$	$28.2^c \pm 0.057$	0.20
Ph	$6.16^b \pm 0.29$	$5.12^d \pm 0.10$	$6.57^a \pm 0.21$	$5.82^c \pm 0.47$	$4.53^c \pm 0.057$	$6.16^b \pm 0.057$	0.12
Turbidity(NTU)	$43.0^a \pm 2.46$	$1.84^c \pm 0.038$	$16.5^b \pm 0.43$	$43.33^a \pm 2.72$	$2.18^c \pm 0.59$	$16.37^b \pm 0.35$	2.54
DO (mg/l)	$38.23^b \pm 0.87$	$6.87^F \pm 0.75$	$13.8^d \pm 0.36$	$40.17^a \pm 0.85$	$8.83^e \pm 0.40$	$18.17^c \pm 1.02$	1.48
EC (µS/cm)	$656.03^b \pm 46.68$	$78.967^d \pm 0.81$	$148.23^c \pm 1.25$	$811.767^a \pm 8.79$	$83.77^d \pm 3.75$	$151.83^c \pm 4.47$	37.41
TSS (mg/l)	$37.46^a \pm 1.42$	$0.88^d \pm 0.32$	$5.78^c \pm 0.30$	$47.93^a \pm 1.06$	$1.43^d \pm 0.21$	$8.4^b \pm 0.26$	1.39
TDS (mg/l)	$270^b \pm 35.61$	$20.97^e \pm 0.50$	$139.3^c \pm 5.45$	$390.63^a \pm 1.06$	$109.6^d \pm 7.07$	$264.43^b \pm 0.55$	27.66
BOD(mg/l)	$3.62^b \pm 0.17$	$6.93^a \pm 0.11$	$4.48^b \pm 0.43$	$4.74^b \pm 0.12$	$3.82^b \pm 0.015$	$3.82^b \pm 0.015$	0.42
Total harness (mg/l)	$58.3^b \pm 0.56$	$16.73^f \pm 0.50$	$33.33^d \pm 0.84$	$68.17^a \pm 0.35$	$20.67^e \pm 0.41$	$39.03^c \pm 0.25$	0.67
Nitrate (mg/l)	$18.20^b \pm 0.61$	$4.56^f \pm 0.42$	$10.67^d \pm 0.40$	$28.1^a \pm 0.43$	$5.41^e \pm 0.45$	$14.07^c \pm 0.75$	0.88
PO_4^3(mg/l)	$8.97^a \pm 0.32$	$6.0^b \pm 0.71$	$7.11^b \pm 0.30$	$9.38^a \pm 0.40$	$6.23^b \pm 0.51$	$7.43^b \pm 0.42$	0.89
Fe	$1.73^b \pm 0.095$	$0.64^c \pm 0.12$	$1.37^c \pm 0.15$	$2.73^a \pm 0.095$	$0.72^c \pm 0.026$	$1.70^b \pm 0.265$	0.18
Cu	0.0633±0.011	0.033±0.015	0.15±0.021	0.060±0.01	0.033±0.015	0.15±0.021	NS
Pb	$0.42^b \pm 0.029$	$0.027^c \pm 0.021$	$0.070^c \pm 0.027$	$0.5^a \pm 0.05$	$0.033^c \pm 0.015$	$0.15^c \pm 0.21$	0.051

Mean with the same case letters along the horizontal arrays indicate the significant difference at 5% probability level.

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TABLE 2
Physicochemical properties of water samples among different water sources

Parameter	Drainage	Borehole	Stream	LSD (0.05)
Temp ^{0}C	28.30^b±0.34	30.35^a±0.94	28.25^b±0.28	0.77
pH	5.99^a±0.39	4.87^b±0.37	6.37^a±0.26	0.47
Turbidity	43.17^a±2.32	2.01^c±0.42	16.43^b±0.36	1.55
DO (mg/l)	39.20^a±1.31	7.85^c±1.2	15.98^b±2.49	2.36
EC (µS/cm)	733.90^a±90.43	81.36±3.58	150.0^b±3.54	69.8
TSS (mg/l)	42.7^a±5.84	1.16^c±0.38	7.01^b±0.38	4.65
TDS (mg/l)	330.32^a±69.8	65.28^c±48.75	201.86^b±68.62	84.3
BOD(mg/l)	4.18^b±0.63	6.96^a±0.15	4.15^b±0.45	0.61
Total hardness (mg/l)	63.23^a±5.42	18.7^c±2.19	36.18^b±3.17	5.12
Nitrate (mg/l)	23.15^a±5.44	4.99^c±0.61	12.36^b±1.94	4.48
$PO_4{}^3$(mg/l)	9.17^a±0.39	6.11^c±0.57	7.52^b±0.37	0.59
Fe (mg/l)	2.22^a±0.55	0.67^c±0.089	1.53^b±0.26	0.46
Cu (mg/l)	0.062^b±0.0098	0.033^c±0.014	0.16^a±0.018	0.019
Pb(mg/l)	0.46^c±0.058	0.030^c±0.017	0.11^b±0.052	0.059

Mean with the same case letters along the horizontal arrays indicate the significant difference at 5% probability level.

TABLE 3
Physicochemical properties of water samples within locations

Parameter	Anatigha	Nkonibs	LSD (0.05)
Temp ^{0}C	28.73^b±0.95	29.20^a±1.34	0.20
pH	5.98±0.62	5.51±0.78	NS
Turbidity	20.44±18.11	20.62±18.6	NS
DO (mg/l)	19.64^b±14.27	22.38±13.95	0.21
EC (µS/cm)	294.411^b±273.87	349.12±348.27	14.6
TSS (mg/l)	14.71^b±17.21	19.25±21.72	1.24
TDS (mg/l)	143.42^b±109.37	254.89±121.16	10.4
BOD(mg/l)	5.0±1.50	5.19±1.42	NS
Total harness (mg/l)	36.12^b±18.13	42.62±20.74	3.64
Nitrate (mg/l)	11.14^b±5.93	15.86±9.93	2.80
PO_4^3(mg/l)	7.36±1.36	7.68±1.43	NS
Fe (mg/l)	1.24±0.49	1.71±0.88	NS
Cu (mg/l)	0.084±0.057	0.083±0.057	NS
Pb(mg/l)	0.17±0.186	0.23±0.211	NS

Mean with the same case letters along the horizontal arrays indicate the significant difference at 5% probability level.

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TABLE 4
Total heterotrophic Bacterial and fungal within location and sources of water samples

Parameter	Anantigha			Nkonibs			LSD (0.05)
	Drainage	Borehole	Stream	Drainage	Borehole	Stream	
Bacterial count (cfu)	2.22×10^{4a}	NA	9.45×10^{3c}	2.27×10^{4a}	ND	9.52×10^{3b}	3.28
Fungal count (cfu)	7.93×10^{3b}	NA	3.59×10^{3d}	9.9×10^{3a}	0.32×10^{3e}	4.4×10^{3c}	2.14

Mean with the same case letters along the horizontal arrays indicate the significant difference at 5% probability level.

TABLE 5
Total heterotrophic Bacterial and fungal within sources of water samples and dilution factor

Parameter	Drainage		Borehole		Stream		LSD (0.05)
	10^{-2}	10^{-3}	10^{-2}	10^{-3}	10^{-2}	10^{-3}	
Bacterial count (cfu)	$2.56^{a}\times10^{4}$	$1.93^{b}\times10^{4}$	ND	ND	$1.05^{C}\times10^{4}$	$4.78^{d}\times10^{3}$	2.80
Fungal count (cfu)	$1.15^{b}\times10^{4}$	$6.37^{a}\times10^{4}$	$0.32^{e}\times10^{3}$	ND	$3.9^{c}\times10^{3}$	$2.72^{d}\times10^{3}$	1.84

Mean with the same case letters along the horizontal arrays indicate the significant difference at 5% probability level.

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TABLE 6

Total heterotrophic Bacterial and fungal within location and dilution factor

Parameter	Anatigha		Nkonibs		LSD (0.05)
	10^{-2}	10^{-3}	10^{-2}	10^{-3}	
Bacterial count (cfu/ml)	$1.22^{a}\times10^{4}$	$8.94^{b}\times10^{3}$	$1.19^{a}\times10^{4}$	$7.13^{c}\times10^{3}$	4.0
Fungal count (cfu/ml)	$4.78^{b}\times10^{3}$	$2.90^{c}\times10^{3}$	$5.68^{a}\times10^{3}$	$3.16^{c}\times10^{3}$	2.76

Means with the same case letter along the horizontal arrays indicate the significant difference at 5% level.

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TABLE 7
Total heterotrophic Bacterial and fungal within location

Parameter	Anatigha	Nkonibs	LSD (0.05)
Bacterial count (cfu/ml)	1.06×10^{4a}	9.52×10^{3b}	4.02
Fungal count (cfu/ml)	3.84×10^{3b}	4.42×10^{3a}	3.24

Means with the same case letter along the horizontal arrays indicate the significant difference at 5% level.

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TABLE 8
Total heterotrophic Bacterial and fungal within sources of water samples

Parameter	Drainage	Borehole	Stream	LSD (0.05)
Bacterial count (cfu/ml)	$2.24^{a}\times10^{4}$	NA	$7.64^{b}\times10^{3}$	8.90
Fungal count (cfu/ml)	$8.92^{a}\times10^{3}$	$0.16^{c}\times10^{3}$	$3.31^{b}\times10^{3}$	2.84

Mean with the same case letter along the horizontal arrays indicate no significant difference at 5% probability level.

Conclusion

From the physicochemical and microbial analysis of water samples around abattoirs in Calabar the results indicated some levels of contamination of heavy metals in the stream and drainage sample with less contamination in borehole water in both locations. The bacterial load was significantly present in stream and drainage sample but not present in borehole water samples. This point to the conclusion that abattoir activities contribute to the contamination of water samples around abattoirs. Therefore, the inhabitant of Calabar especially those who live close to abattoirs and make use of boreholes and streams as their water supply should properly boil water or use any other good treatment methods before drinking.

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