MICROBIAL EVALUATION AND PHYSICOCHEMICAL ANALYSIS OF THE EFFECT OF BORI ABATTOIR EFFLUENT AND RUN-OFF WATER FROM SITES OF TYRE RAOSTED MEAT, ON ZAAMI STREAM WATER QUALITY

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Abstract

The effect of Bori Abattoir effluents and run-off water from sites of tyre roasted meat on Zaami stream water quality was evaluation for the microbiological and physicochemical qaulities. A tenfold serial dilution technique was adopted for microbiological analysis of samples, whereas standard Chemistry instruments such as AAS, pH meter and Turbidometer were used for assessment of trace metals, pH and turbidity. Result revealed the presence of Escherichia coli, Shigella, Klebsiella, Proteus, and Salmonella species, as the most encountered faecal coliform microbial pollutants. Result also indicated that acidity of the Zaami stream water were on the increase soon after effluent discharge, but decreased later in the day with pH-values from two random samples given as 3.0 & 6.0 and 3.0 & 7.0 during the mornings and evenings, pH3 being highest acidity, and pH7 being neutral. The presence of enterobacteria such as Escherichia coli became evidence of faecal pollutions of the water, traceable to Bori Abattoir effluent discharges. Result also revealed the presence of trace metals with the evidence of Lead (Pb), Iron (Fe), Chromium (Cr), and Zinc (Zn). Bori abattoir wastewater is discharged directly into the Zaami fresh water stream, without any form of treatment. With the evidence of high bacterial load, which includes faecal coliform pathogens, public health risk values for pH, turbidity and trace metals suggesting serious health hazard, posed by the direct abattoir effluent discharge into the water body, Zaami stream water is unsafe for domestic uses. It is my recommendation that regulatory bodies, public health sector of Government and other relevant agencies should be mobilized to take proactive measures such as orders, rules and guidelines for discharge of abattoir effluent to public environments for human safety.

Introduction

The killing of animals for community consumption is inevitable in most of the world and dated back to years immemorial. The origin of public abattoir had been traced down to the early Roman and French civilizations in the 15th and 16th centuries. Far back as 1890 in Italy, public slaughterhouses were among the facilities that were required to be provided in all communities of more than six thousand people living together as co-inhabitants (Bello and Oyedemi, 2009).

Abattoirs in the United Kingdom, perform vital roles in purchasing of cattle and sheep from farms, and in transforming them into carcass meat. By 2001, there were about 360 licensed red-meat abattoirs as compared with 90 by 1990 in UK. Whereas in Nigeria today, nearly every town and neighbourhood is provided with slaughterhouse or slaughter slab at the minimal (Robert, 2005).

Slaughtering animals on a large scale poses significant logistic problems, animal welfare problems, public health requirements and environmental problems. Animal welfare and animal rights groups frequently raise concerns about the methods of animal transportation, preparation, herding and killing within some slaughterhouses (Canencia et. al, 2016).

An abattoir is a slaughterhouse or a specialized facility approved and registered by regulatory authority for the inspection of animals, hygienic slaughtering, processing and effective presentation and storage of meat products for human consumption (Akindele et. al, 2015., Olaiya et. al, 2016).

Slaughterhouses supply meat which then becomes the responsibility of the packing department. Slaughterhouses that process meat not intended for human consumption are sometimes referred to as knackers' yards or Knackeries. Such animals include those horses not fit for work on farms and not also fit for human consumption. An abattoir or slaughterhouse on the other hand is a facility where animals are commercially killed or slaughtered for consumption as food (Canencia et. al, 2016).

In Nigeria, the abattoir industry is an important component of the livestock industry providing domestic meat supply to over 150 million people and employment opportunities for her teaming population. Unlike in developed countries where these facilities are adequately provided with facilities for treatment of abattoir effluents, the abattoir industries are less developed in most developing countries, like Nigeria and facilities for the treatment of abattoir effluents are lacking (Nafarnda et. al, 2012).

Abattoir waste water comprises majorly of waste generated from cleaning of roasted animal operations, animal blood, dissolved solids, oil and grease, to the cleaning of animal gut contents, and urine. The contamination of surface water from abattoir waste water constitute significant environmental and health hazards due to the elevated levels of biodegradable organic matter, sufficient alkalinity, and adequate phosphorous, nitrogen and micronutrient concentrations (Omole and Longe, 2008., Terrumun and Oliver, 2015).

Series of decomposition processes of these wastes can introduce enteric pathogens, change in pH, heavy metal concentration and excess nutrients into the surrounding surface waters and also percolate into the underlying aquifers to contaminate any hand dug well in the neighbourhood which may serve the purpose of drinking water for butchers and others working in the abattoir, and including people in the neighbourhood (Olayiya et. al, 2016., EPA, 2016).

Water pollution occurs when pollutants are discharged directly or indirectly into water bodies without adequate treatment to remove harmful components. It is recommended by the World Health Organization that access to good drinking water or in accordance with other basic needs, in the quantity and quality required is the right of every individual, irrespective of developmental stage, social and economic conditions (WHO, 2004). Naturally, humans and other animals enjoyed good clean water from natural sources such as springs, fountains and streams, but by the 19th and 20th century industrial revolutions through human activities, pollution of air, water and soil gradually became damaging to the environment (Sadatipour et. al, 2004).

While some organic waste can be diluted in the river to a very low concentration and subsequently self-cleansed by natural biological processes, high strength waste may take a longer time to degrade. Certain of the waste may not biodegrade at all, depending on the ratio of chemical oxygen demand (COD) to the biological oxygen demand (BOD) (Mutamin et. al, 2013; Terrumun and Oliver, 2015).

And as a result of these pollutants the values of the pH and heavy metals become altered from the normal. These changes and other microbial pollutants pose serious health challenges to residents users of the water within the area. Pollution of the surface water bodies such as Streams and Rivers, resulting from anthropogenic activities, such as the abattoir effluent waste is of global concern. This is because potential health risk from waterborne pathogens can exist in water bodies contaminated by abattoir effluents (Sadatipour et. al, 2004).

Chemicals and bacteria from abattoir waste and effluents discharged into water columns can subsequently decant to sediments, and when the bottom stream is rigorously stirred the sediments release bacteria and chemical debris back into the water columns to pose untold dangers to human health (Nafarnda et. al, 2012). Other pathogens which may be present in animal carcasses or shed in animal wastes apart from bacteria have included rotaviruses, hepatitis E virus, Salmonella species, Escherichia coli 0157:H7,Yersinia enterocolitica, Giardia lamblia, Campylobacter species, Cryptosporidium parvum and ova of worms (Sobsey et. al, 2002).

The problems of sanitation and non treatment of abattoir wastewater effluents and the effect on neighbourhood water quality have been emphasized. A report presented that the quality of water of the wells situated within and around abattoirs, primarily used by butchers for dressing animal carcasses and as drinking source by butchers are greatly affected (Ukpong et. al, 2013).

Provision of abattoir is aimed at optimizing the recovery of edible portion from the meat processing cycle for human consumption (Akindele et. al, 2015). However, significant quantities of secondary waste materials not suitable for further human consumption are also generated, which have great pollution potentials if mishandled and, or disposed in and unhygienic manner (Olawumi et. al, 2017). Therefore, abattoirs must be adequately equipped with sanitary facilities to check the transmission rate of many animal related diseases, to avoid abattoir effluent waste contamination of water and soil(EPA, 2004., EPA, 2005).

Bori main abattoir which locates near Zaami stream water, is the largest servicing abattoir within the Bori metropolis. The site situate near Zaami stream, a major stream water which runs through the neighbourhood of Bori as water source supporting livelihood of most people within the area.

In Bori, abattoir effluent wastewater is discharged directly into the Zaami fresh water stream without any form of treatment. These activities will pose great health hazard to human residents around the area, and as a result analytical assessment of the effect of the abattoir effluent on the River becomes very necessary, and of public health concern.

Microbial evaluation and Physicochemical analysis of Zaami stream water quality following effluents and run-off water discharge from Bori abattoir and site of tyre roasted meat, into the Zaami stream will highlight on the negative impact and potential dangers which accompany the direct discharge of Bori abattoir effluents without any form of treatment, into the Zaami public stream water source. It will also serve as an appropriate directional gyro to regulatory bodies, public health sector of Government and other relevant agencies on the need to take proactive measures such as giving orders, rules and guidelines for discharge of Abattoir effluents to public environments for human safety purposes, especially in a middle class city like Bori community.

This study is aimed at microbial evaluation and physicochemical analysis of the effect of Bori Abattoir effluent and run-off water from sites of tyre roasted meat, on Zaami stream water quality. The objectives of which are to:

1. Determine the water quality changes following the abattoir effluents on Zaami stream water, using physicochemical parameters such as pH, turbidity and heavy metal contents, and to evaluate the microbiological quality.

2. Determine total aerobic heterotrophic bacterial count, as to assess coliform bacterial load of the water, as a way to ascertain if the water is likely to contribute to public health hazard in the Bori city.
3. Isolate and identify bacterial contaminants, as to know if there are likely pathogens, the inevitable and viable sources of infection, and more so if connected to the public incidence of enterobacterial infections, such as typhoid in Bori metropolis.
4. Serve as blue print to compare quality status of the stream water with recommended international regulatory standard for public use, which will serve as reference point to public health and butchers to maintain good sanitary standard.

Materials and Method

Sample collection:

Water samples were collected at Zaami fresh water stream, at point of entry of effluent discharge from Bori abattoir in a sterile 250ml bottle and analysed for microbiological quality, pH value, and heavy metal contents. The water samples were collected for eight days by mornings and by evenings. The morning samples were collected soon after wash-ups, whereas the evening samples were collected long after wash-ups, about the settling time when the effluent water has settled down, diluted and the water in less use.

Method of Analysis:

The ten fold serial dilution technique of the water sample from abattoir effluent was adopted for microbiological analysis. From each diluent, exactly 0.1ml volumes were inoculated unto fresh plates of Nutrient and MacConkey media. A standard pH metre was used for the estimation of the pH values and the values for turbidity estimated with a standard turbidity metre. Atomic Absorption Spectrophotometer (AAS) was used to estimate the values of trace metals in the samples.

pH Determination:

The pH was measured in situ with the use of a portable pH metre. The probe of the metre was dipped into the sample and values obtained as displayed on the metre screen.

Turbidity Determination:

A turbidity metre within the range of 0-800NTU was used. Total hardness levels of effluent samples were determined by titration with standard EDTA titrant and Erichrome black indicator.

Trace Heavy Metal Determination:

Heavy metal contents of the water samples from effluent discharge were obtained with the use of Atomic Absorption Spectrophotometer (AAS). By this method, 500ml of the water sample was filtered through the Whatman No.1 filter paper into a 600ml beaker, and evaporated to dryness at 105^{o}c in an oven. The residue dissolved in 10ml of HNO3 and placed over a steam bath for 30minutes, later filtered through Whatman No.1 paper into 25ml flask. The solution obtained was made up to mark and allowed to thaw at an ambient temperature and sieved through 0.5mm sieve. 2g sample was digested in a mixture of HClO4, HNO3 and H2SO4 in the ratio of 1:3:1 in a water bath. 10ml volume of deionised water was added to the digest and decanted into a 50ml standard flask, made up to mark with more deionised water and the absorbance read with AAS.

Microbiological Quality Determination:

By the ten fold serial dilution technique of water samples from Zaami stream for microbiological analysis, 1ml of each water sample was drawn into the first of four different sterile test tubes containing 9ml of deionised water from which serial dilutions in order of 10^{-1}, 10^{-2}, 10^{-3} and 10^{-4} were conducted. Inoculations of fresh plates of MacConkey and Nutrient media were made with 0.1ml aliquot from each dilute, and incubated at 35^{0}c for 24 hours. Biochemical identifications of isolates were conducted on pure cultures obtained by serial subcultures.

Total aerobic heterotrophic count were enumerated from the various plates of Nutrient medium, whereas the total faecal coliform pathogen count were enumerated from the visible colonies on MacConkey agar showing lactose fermentation with evidence of pale colour as cultural characteristic.

Result and Discussion

Tables 1, 2, 3 & 4 summarise results for the physicochemical and bacteriological analysis of the abattoir effluents from Zaami stream water. Results of the experiment showed evidence of bacterial load, including faecal coliform pathogens. The values for pH, turbidity and trace metals suggested serious health hazard.

Table 1: Total aerobic Heterotrophic and faecal coliform pathogen counts on primary culture media.

Total	Aerobic	Heterotrophic	Count
Media	**Dil.factor**	**Colony**	**CFU/ml**
Nutrient agar	10^{-1}	TNTC	TNTC
Nutrient agar	10^{-2}	300	$3.0x10^{-6}$
Nutrient agar	10^{-3}	150	$1.5x10^{-6}$
Nutrient agar	10^{-4}	56	$5.6x10^{-6}$
FAECAL	COLIFORM	PATHOGENS	
Media	**Dil.factor**	**Colony**	**CFU/ml**
MacConkey	10^{-1}	50	$5.0x10^{-3}$
MacConkey	10^{-2}	15	$1.5x10^{-4}$
MacConkey	10^{-3}	10	$1.0x10^{-5}$
MacConkey	10^{-4}	03	$3.0x10^{-5}$

Key:
CFU/ml......................Colony forming unit/mill
Dil. Factor.................Dilution factor
TNTC........................Too numerous to count

Table 2: Result of biochemical tests, Grams reaction, Morphology for the probable bacterial Isolates.

Sample/ Media	Grams	Shape	Oxida	Cata	Coagu	Idole	Bacterial Isolates

Mac	-	Bacilli	-	+	-	-	Klebsiella spp
Mac	-	Bacilli	-	+	-	-	E. coli
Mac	-	Bacilli	-	-	-	-	Proteus spp
Mac	-	Bacilli	+	+	-	-	Pseudomonas spp
Mac	-	Bacilli	-	+	+	-	Proteus spp
NA	+	Bacilli	-	-	-	-	Bacillus spp
NA	-	Bacilli	-	-	-	-	Salmonella spp
NA	-	Bacilli	-	+	-	-	E. coli
NA	-	Bacilli	-	-	-	-	Shigella spp
NA	+	Cocci	-	+	+	-	Staph aureus

Key:
Cocci--Round shapes
Bacilli--Rod shapes
(+)..Positive or Reactive
(-)..Negative or No reaction
Oxida...Oxidase
Cata..Catalase
Coagu..Coagulase
Spp--Species
Staph aureus---------------------------Staphylococcus aureus
E. coli...Escherichia coli.

Table 3: **Physicochemical analysis of Zaami water from random sampling in the mornings and evenings.**

Parameter	Morning	Evening	Morning	Evening
pH	3.0	6.0	3.0	7.0
Turbidity	High	Low	High	Low
Trace metal	Pb, Fe, Cr & Zn	Pb, Cr & Zn	Pb, Fe, Cr & Zn	Pb & Zn

Key: pH…………………Hydrogen ion concentration
Pb……………………………………………………………Lead
Fe……………………………………………………………Iron
Cr……………………………………………………Chromium
Zn……………………………………………………………Zinc

Table 4: Trace metals in the Abattoir effluents and their values at mornings and evenings from random sampling

Days	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**
Time	**Fe**	**Pb**	**Cr**	**Zn**	**Fe**	**Pb**	**Cr**	**Zn**
Morning	31.2	4.3	0.2	3.2	35.4	2.9	0.1	3.5

Evening	12.3	1.3	-	2.7	32.3	0.9	-	2.9
Normal	20.0	2.0	1.3	50	20.0	2.0	1.3	50

Key: (-)…………………..…………………Not present or absent
Morning (M)……………………..Soon after slaughter wash-up
Evening (E)……………………..On settling, long after wash-up

Table 5: WHO Recommended Maximum value for Trace Heavy Metals in Food Plants (Ruqia et al.,2015).

Metal	Description of food	Maximum permitted concentration (mg/kg)
Pb	All food plant	2.0
Cr	All food plant	1.30
Fe	All food Plant	20.0
Cu	All food Plant	10.0
Zn	All food Plant	50.0

Table 1 summarizes the total aerobic Heterotrophic and faecal coliform pathogen counts. Total heterotrophic bacterial count were enumerated by counting all the significant bacterial colonies found upon each Nutrient agar plate, whereas the total faecal coliform pathogen counts were enumerated by counting only to the pale coloured non-lactose fermenting bacterial colonies upon the MacConkey agar plates. Table 2 shows result of commonly encountered bacterial isolates during the analysis among the faecal coliforms were, *Escherichia coli*, Salmonella, Shigella, Proteus and Klebsiella species. Other isolates were *Staphylococcus aureus* and Bacillus species. Tables 3 shows results for the physicochemical analysis, with values for pH being 3 at discharge point at mornings soon after discharge into the water body, but pH6 and 7 respectively during the evening hours, long after the effluent discharge at discharge point. Table 3 also shows turbidity rate as being low at evenings, but high at mornings. Evidence of trace metals were seen and also recorded in table 3 as; Zinc, Iron, Lead and Chromium. Table 4 summarizes the values for the trace metals identified, whereas table 5 is a pointer to the World Health Organization,(WHO) standard values for trace metal in food plants required for safety.

Conclusion and Recommendation

The problems of sanitation and non treatment of the abattoir wastewater effluents and the effect on our neighborhood water quality have been emphasized. Bori abattoir effluent wastewater is discharged directly into the Zaami fresh water stream, without any form of treatment. With the evidence of high bacterial load, which includes faecal coliform pathogens, public health risk values for pH, turbidity and trace metals suggesting serious health hazard, posed by the direct effluent discharge into the Zaami stream water, it is my recommendation that regulatory bodies, public health sector of Government and other relevant agencies should be mobilized to take proactive measures such as orders, rules and guidelines for discharge of Abattoir effluents to public environments for human safety.

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