



Physico-chemical and Microbiological Qualities of Abattoir Wastewater in Egbu, Imo State, Nigeria

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Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

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ABSTRACT

Abattoir waste water is of a complex composition. When discharged without being treated, poses a threat to human health and the environment. This is the practice common in Nigeria, and is worrisome.

Objective: The aim of this study was to assess the physico-chemical and microbiological qualities of waste water from Egbu abattoir discharged into 'Otamiri' river in Owerri North local government area, Imo State, Nigeria.

Methods: The microbial quality of abattoir wastewater was studied. The duration of the study was three months, from June to September, 2019. Sample collection was done in the morning (8-10am) and in the evening (4-6pm). A total of thirty samples (30) were collected from two sampling points, at the place of generation of the wastewater (Effluent source) and at the point of discharge into the river (POE). Standard methods were employed to assess the microbiological and physiochemical quality of the effluent. The microorganisms isolated from the samples included *Escherichia coli*, *Salmonella*, *Staphylococcus*, *Aspergillus*, *Mucor*, *Listeria*, *Micrococcus* and *Candida* species. The Total Heterotrophic Count (THC) of effluent samples, at source and POE were 8.51log₁₀ cfu/ml and 6.15log₁₀cfu/ml respectively, Total Coliform Count (TCC) for same samples were 6.77log₁₀ cfu/ml

and $4.56\log_{10}$ cfu/ml respectively. The Total Fungal Count (TFC) of the effluent samples at source and at POE was $5.19\log_{10}$ cfu/ml and $4.18\log_{10}$ cfu/ml respectively. Results further revealed that the pH of the effluent at source was 6.58 while that at Point of Entry into the river was 7.30. The temperature of both samples was 25°C. The Total Dissolved Solid values of the effluent collected at source was higher, having a value of 1400mg/L against 1000mg/L at Point of Entry. Also the Biochemical Oxygen Demand (BOD) and Chemical Oxygen Demand (COD) values of the effluent at source were 5.10mg/L and 8.58mg/L respectively, while the BOD and COD of the water at the POE were 4.3mg/L and 7.9mg/L respectively.

Conclusion: Abattoir wastes are becoming a major environmental health challenge and being discharged into the Otamiri River indiscriminately is of public health concern. The potential public health implications associated with discharging untreated abattoir wastewater into the environment and thus, the need for adequate treatment to ensure decontamination as well as providing wastewater treatment facility is imperative.

Keywords: Effluent; physico-chemical; microbiological qualities; biochemical oxygen demand; chemical oxygen demand; heterotrophic count and decontamination.

1. INTRODUCTION

Abattoir wastewater is the water obtained after washing the remains of slaughtered animals and the slaughter house floor [1]. In developing countries like Nigeria, wastewater discharged from abattoirs is usually not treated before release into water bodies. Abattoir wastewater usually has a complex composition and is very harmful to the environment [1]. The animal blood is most often released untreated into the flowing stream while the consumable parts of the slaughtered animal are washed directly into the flowing water [2,3]. The release of this wastewater into water bodies is of public health concern because the water bodies into which these effluents are discharged serve various purposes to the residents in that area including being a source of potable water, domestic water and for irrigation of farm lands [1]. The water bodies also serve as tourist attraction centers and can also be used for swimming.

In Nigeria, the abattoir business is an important component of the livestock industry, as it provides domestic meat supply to over 150million people and employment opportunities for a good number of the population [4]. However, this industry is less developed and facilities for the treatment of abattoir effluents are lacking, unlike in advanced countries where these facilities are adequately provided [5]. Large amounts of solid waste and effluent such as rumen contents, blood and wastewater are generated from abattoirs and they pollute surface and ground water with pathogens and undesirable chemical compounds [6]. Such contamination of water bodies from abattoir wastes could constitute to

significant environmental and public health hazards [4,7,8]. Potential health risks from waterborne pathogens have been recorded in water contaminated with abattoir effluents such as the occurrence of diseases like diarrhoea, typhoid and cholera [9,10].

The organic load of abattoir wastewater could be very high; hence abattoir effluents usually increase levels of nitrogen, phosphorus and total solids in receiving water body considerably. Excess nutrients cause the water body to become choked with organic substances and organisms. When the concentration of organic matter exceeds the capacity of the microorganisms in water that break down and recycle the organic matter, it encourages rapid growth, or blooms of algae, leading to eutrophication[11]. The improper management of abattoir wastes and subsequent disposal either directly or indirectly into river bodies portends serious environmental and health hazards to both aquatic life and humans.

This study was carried out to determine the physico-chemical and microbiological characteristics of effluents generated from the abattoir as well as those of the surrounding water body these effluents are discharged into.

2. MATERIALS AND METHODS

2.1 Sample Collection

The samples were collected with sterile flasks at different points of discharge from the slaughter house and the Point of Entry (POE) of the effluent into 'Otamiri' River. The samples were

immediately taken to the laboratory for analysis using standard procedures for examination of water and wastewater [26].

2.2 Measurement of Physico-chemical Parameters

The temperatures and pH of the samples were measured using a mercury thermometer and a Hanna pH meter PHS 25-H198107 model respectively. Determination of Total Dissolved Solids (TDS), Biochemical Oxygen Demand (BOD) and Chemical Oxygen Demand (COD) were carried out using the methods described by [26].

2.3 Culture Media Preparation

Culture media used which included Nutrient Agar (NA), Potato dextrose Agar (PDA), MacConkey Agar (MA) and Salmonella-Shigella Agar (SSA) were all prepared according to the manufacturer's specification. Ten-fold serial dilutions of the effluents were carried out and 0.1 ml each of the diluted samples was aseptically introduced into appropriate agar plates followed by the addition of sterile prepared media using the pour plate technique. The plates were incubated at 37°C for 24 hours for bacteria and 72 hours for fungi. Biochemical tests were carried out on pure bacterial isolates using standard methods as described by [12] and [13]. Macroscopic and microscopic examinations including staining for morphological characteristics were carried out on bacterial and fungal isolates for identification based on the characteristics observed.

3. RESULTS

3.1 Microbiological Assessment of the Samples

The results of the total bacterial counts (TBC), total coliform count (TCC), total fungal count (TFC) and total Salmonella count (TSC) of the samples are presented in Fig. 1. The microbial counts of the effluent samples obtained at source were higher than that of point of entry (POE) into the river. Bacterial and fungal species recovered from the abattoir wastewater are presented in Table 1. The microorganisms isolated from the abattoir wastewater samples included: *Escherichia coli*, *Bacillus* sp, *Salmonella* sp, *Micrococcus* sp, *Staphylococcus* sp, *Aspergillus* sp, *Candida* sp and *Mucor* sp. However, there was similarity in the microbial distribution in the samples as both the effluent (E) and point of entry (POE) samples had *Staphylococcus* species, *Salmonella* species and *Escherichia coli* isolated from them.

3.2 Physico-chemical Analysis of the Samples

The physico-chemical results of the samples are shown in Table 2, representing the mean of values obtained. The results were within the Federal Environmental Protection Agency (FEPA) permissible level. The BOD, COD and TDS values for effluent sample (E) were higher than that of the POE into the river. The temperature value was 25°C for both samples. The pH values for the samples were slightly acidic and basic with values, 6.58 and 7.30 for effluent and point of entry, respectively.

Table 1. Bacterial and Fungal isolates from effluent samples

Sample Code	Bacterial Isolates	Fungal Isolates
E ^a	<i>Listeria</i> sp, <i>Staphylococcus</i> sp, <i>Salmonella</i> sp, <i>E.coli</i> ,	<i>Candida</i> sp
POE ^a	<i>Staphylococcus</i> sp, <i>Micrococcus</i> sp, <i>Salmonella</i> sp, <i>E.coli</i> ,	<i>Mucor</i> sp, <i>Aspergillus</i> sp

E – Effluent sample; POE= Point of Entry sample

^aSame alphabet shows there is similarity in microbial distribution between the locations

Table 2. Physico-chemical attributes of the Abattoir Wastewater samples

Parameters	E	POE	FEPA Standard Limit
Temperature (°C)	25.0	25.0	<40
BOD (mg/l)	5.10	4.30	50
COD (mg/l)	8.58	7.90	80
TDS (mg/l)	1400	1000	2000
pH	6.58	7.30	6-9

Keys: E= Effluent sample from source; POE= Point of Entry sample

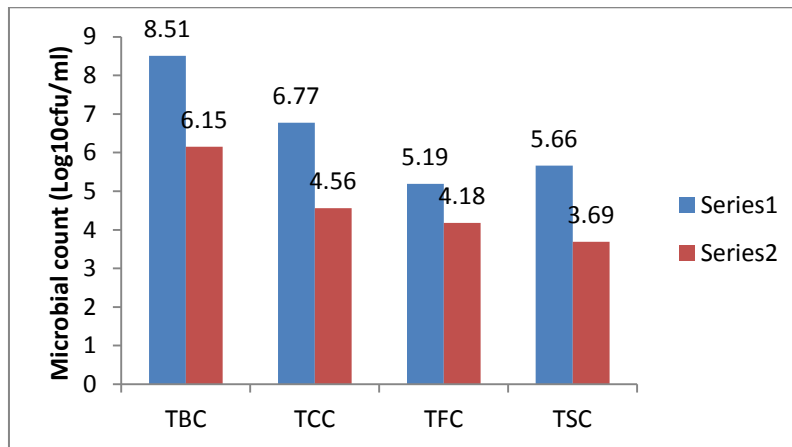


Fig. 1. Total Microbial Count (\log_{10} CFU/ml) of the Abattoir waste water Samples

Keys: TBC= Total Bacterial Count; TCC= Total Coliform count; TFC= Total fungal count; TSC = Total salmonella Count; Series1 = Effluent sample; Series2 = Point of entry sample

4. DISCUSSION

The isolation of *Escherichia coli*, *Bacillus* sp, *Salmonella* sp, *Micrococcus* sp, *Staphylococcus* sp, *Aspergillus* sp, *Candida* sp and *Mucor* sp (Table1) corroborates the results of [1,14,15], who also isolated similar organisms. The similarity index done using Sorenson's coefficient showed high degree of similarity in the microbial distribution of the wastewater samples. This also agrees with the report of [1]. Similar pathogenic microorganisms had been isolated from abattoir wastewater in different parts of Nigeria by [16,17]. According to [18] and [19], any water body with such a level of contamination will be neither good for domestic use nor should be discharged directly into the environment without treatment. The wastewater from the abattoir is washed into open drainage and these wastes may introduce enteric pathogens into the nearby river and thus serve as a vehicle for gastrointestinal infections. The occurrence of these microorganisms is an indication of possible contamination of the receiving water bodies. These organisms could cause illnesses such as diarrhoea, aspergillosis and other health complications [15,20,21].

Furthermore, the effluent sample obtained from source of discharge had higher counts of 8.51 \log_{10} cfu/ml, 6.77 \log_{10} cfu/ml, 5.19 \log_{10} cfu/ml, and 5.66 \log_{10} cfu/ml for TBC, TCC, TFC and TSC respectively. The high count of these organisms in these effluents may possibly be due to their high content of whole blood which served as a rich protein medium for microbial growth [20,22].

The physic-chemical analysis showed that the effluent sample had a higher BOD, COD, and TDS values than the POE sample. The higher values of these parameters for effluent samples from source are in agreement with the report of [16,23]. This could be attributed to the fact that the effluent usually contains fat, blood, bones, and other substances which are rich in nutrients and also support microbial growth [24].

The temperature of the samples were 25°C and these were within the acceptable limit of <40°C reported by [26] and also regarded as the normal temperature range for effluent discharge. This temperature also is suitable for growth of most of the microorganisms isolated. Temperature is one of the most important environmental features in waste water. It controls behavioural characteristics of organisms and solubility of gases and salts in water [25]. The pH of the samples, as recorded pH 6.0 – 9.0, were also within the limit for effluent meant for discharge and were also in tandem with the results obtained by [1], however [26] obtained pH of 5.7-6.7 for abattoir wastewater. This pH range is within the requirement for bacterial growth [26].

The BOD of both samples at source (E) and point of entry (POE) into river were 5.10mg/l and 4.3mg/l respectively and were within the FEPA permissible level [29]. The COD values were also within FEPA permissible level of <80mg/l. The low level of COD and BOD may be an indication that oxidation of organic matter is taking time due to high microbial contamination [27,28]. The low level of COD and BOD obtained in this study are not in agreement with other works done by [1 and 24], having reported high COD and BOD

levels. The TDS of the samples were within the permissible level of FEPA as recorded. The low BOD and COD levels reported in this study may be as a result of interferences in the analysis. According to the American Public Health Association and Others (1995), residual chlorine from detergents used while washing off after slaughtering the animals could have interfered with the analysis. Other factors that can affect the results include: caustic alkalinity or acidity, presence of toxic or trace elements such as copper, lead, mercury and cyanide (APHA, 1995). In a report by [1], the receiving water body, 'Otamiri' river also serve as a dumping site of effluents from paint industries, sawmills, cassava processing plants, oil mills, car wash services and motor servicing workshops. The report from this study however shows the water from the point of discharge of the effluent as moderately clean. Since the river flows, it is natural that the effluent gets diluted down the course of the river, hence the microbial load, BOD, COD and TDS were expected to be higher at the point of entry than other points upstream[1].

5. CONCLUSION

This study has revealed that abattoir activities and management have direct and indirect negative effects on the environment and public health, as regards the presence of pathogenic microorganisms in the wastewater samples analyzed. The results also showed that discharges from the abattoir may pose serious health issues if discharged directly into the river, making the river water unfit for domestic usage. The microbial properties of the abattoir effluent as recorded make it very important for abattoir owners to treat their effluents properly before they are introduced into the surrounding water bodies. It is also important that water obtained from the nearby river is treated before they are used for domestic purposes to prevent occurrence of zoonotic diseases. Government agencies and other stakeholders should develop methods for monitoring the treatment of abattoir waste for reasons of environmental conservation and public health. The physico-chemical attributes, BOD, COD and TDS did not however show that there was serious pollution at the site of discharge.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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