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Research Article

Microbiological and Physiochemical Assessment of Abattoir Effluents and Receiving Water Bodies in Port Harcourt

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ABSTRACT

Wastes generated from abattoirs are an increasing source of pollution of water bodies. Physiochemical and microbial characteristics of effluents generated from abattoirs and the receiving water bodies in Port Harcourt were analyzed. The results showed no significant differences ($p > 0.05$) in physiochemical properties of the morning and evening samples of the effluents. Heterotrophic bacteria counts ranged from 4.6 – 5.6 x 10^6 cfu/ml and 3.5 – 4.1 x 10^6 cfu/ml for effluents and receiving water bodies respectively. Coliform count ranged from 2.6 – 3.7 x 10^6 cfu/ml, while fungal counts ranged from 0.9 – 1.9x 10^5 cfu/ml, which all exceed the WHO standards of water for domestic use. Significant differences ($P < 0.05$) were observed between the heterotrophic bacteria count, coliform count and fungal counts observed in the effluent and receiving water body samples. The results show heavy contamination of the water samples and occurrence of potentially pathogenic organisms such as *Escherichia coli, Salmonella* spp, *Shigella* spp, and *Aspergillus* spp. It is therefore imperative that abattoir operators treat the effluents before they are introduced into the surrounding water bodies.

Keyword: Pollution, Effluent, Abattoir, Physiochemical, Microorganisms.

INTRODUCTION

Environmental pollution is a worldwide problem and its potential to influence the health of human populations is great [1]. About a quarter of the diseases facing mankind today occur due to prolonged exposure to environmental pollution [2]. Abattoir activities are aimed at optimizing the recovery of edible portions of the meat processing cycle for human consumption. However, significant quantities of secondary waste materials are also generated during this process [3]. Abattoirs are sources of pollution, since human activities such as animal production and meat processing have been reported to impact negatively on soil and natural water composition leading to pollution of the soil, natural water resources and the entire environment [4]. Abattoirs in Nigeria have been known to dispose their wastes into surface water bodies without any prior treatment of the effluent. This leads to pollution of the water bodies and the environment directly or indirectly [5]. Abattoir wastes have been found to contain blood, grease, inorganic and organic solids, salts and chemicals added during the operation [5]. According to Cadmus *et al.* [6], Abattoirs have also been known to transmit parasites helminthes and pathogens such as *Escherichia*

coli and *Brucella*, which causes the zoonotic diseases, Brucellosis [6]. Water-borne diseases have been the leading cause of death in developing countries. Improper disposal of abattoir effluent could lead to transmission of pathogens to human which may cause an outbreak of water borne diseases such as diarrhoea, pneumonia, typhoid fever, asthma etc [7]. This study was carried out to determine the physiochemical and microbiological characteristics of effluents generated from Abattoirs and the surrounding water bodies these effluents are discharged into.

METHODOLOGY

Sample Collection

Abattoir effluents and surrounding water body samples were collected in the morning and evening periods into sterile containers around abattoirs from Rumuokoro, Ogbogoro and Nkpo areas in the Port Harcourt metropolis and transported to the laboratory for analyses.

Physiochemical Analysis

Turbidity, hardness, Nitrate, Sulphate, Phosphate, Chloride and Magnesium ion concentrations were among the parameters determined according to the standard methods of APHA [8]. Hydrogen ion concentrations (pH) and Temperature were carried out using an automatic digital pH and Temperature meter (model Mettle Delta- 340) made in England. Total organic carbon (TOC), Biochemical Oxygen Demand (BOD) and Dissolved Oxygen (DO) were determined according to the procedures of Agwa et al. [9].

Microbiological Analysis

Serial dilution was appropriately carried out on all the samples, using the stock as 10^{-1} and 0.1ml each of the selected dilution (10^{-4}) was plated using the pour plate method. Enumeration of total bacteria count was done using nutrient agar (NA). Coliform counts were done using eosin methylene blue agar (EMBA). Fungi counts were done on Sabouraud dextrose agar (SDA). All cultures were incubated at 37^{O}C for 24hours, except cultures for fungal counts which were incubated at 25^{O}C for 72hours.

Identification of Isolates

Distinct looking colonies were sub-cultured and the pure isolates were stored on nutrient agar slants at 4^{O}C for further confirmatory tests which included IMVIC test, carbohydrate utilization, and reaction on TSI, gelatin liquefaction, nitrate reduction, urease production and motility, The bacterial isolates were identified by comparing their characteristics with those of known taxa, as described [10]. Mounts of the pure isolated fungi were viewed microscopically and identified using cultural and morphological features according to the most documented keys in fungal identification [11].

Statistical Analysis

The data generated was subjected to the Student's T-test using Microsoft excel package 2007 version.

RESULTS AND DISCUSSION

Table 1.0 shows the physiochemical characteristics of the effluents at morning and evening periods from the different abattoirs sampled. pH ranged from 6.55 – 7.21, this was well within the FME limit of 6 – 9. Temperature ranged from 27 – 30^{o}C in all samples which was below the FME limit of 40^{o}C. The pH and temperature values observed are consistent with previous studies which reported effluent pH values between 6.5 to 8.5 and temperature values between 25 – 28^{o}C [5,6]. Conductivity was higher in the effluent samples at evening time (11380 – 13110µS/cm) when compared to conductivity at the morning time (107 – 562 µS/cm). The conductivity observed in the evening samples exceed the FME limit of 1000µS/cm, this is consistent with the findings of Koech *et al.,* [12], which reported that the increased electrical conductivity may due to the dissolution and washing off of salts used to preserve the hides slaughter animals leading to an increase of ions in effluent hence an increase of electrical conductivity. Turbidity ranged from 4.8 – 12.23 NTU, turbidity values are dependent on the amount and nature of the wastes generated from slaughtered animals as reported by Ogunseitan, [13]. Sulphate ion concentration was higher in the evening time (129.5 – 130.7mg/l) when compared to sulphate concentration at the morning time (0.69mg/l in all samples). Nitrate concentrations were within FME limit (20), except in the Rumuokoro morning sample (26.3). Phosphate concentrations were within the FME limit (5.0)

in all samples. Salinity ranged from 0.30 – 2560, which exceeded the FME limit (0.1). Chloride concentrations were within the FME limit (600), the evening samples had higher Chloride levels (101 – 136), while morning chloride levels were lower (24.0 – 38.0). Total hardness levels ranged from 670 - 1050 in the evening samples, these were higher than the FME limit (80) and hardness levels in the morning samples (20.0 – 52.05). Biochemical oxygen demand (BOD) ranged from 120 – 2500 mg/l. Chemical oxygen demand (COD) levels ranged from 436 – 5240mg/l. Dissolved oxygen levels were within FME limit (7.5) except in the morning sample of the Rumuokoro abattoir (240). Total organic carbon ranged from 0.0006 – 0.004. There was no statistical difference ($p > 0.05$) observed between the physiochemical characteristics of the effluent sample of the morning and evening times. This is consistent with previous studies by Koech *et al.,* [12].

Table 1: Physiochemical properties of effluent samples

Parameters	Rumuokoro		Ogbogoro		Npkor		FME limit
	M	E	M	E	M	E	
pH	6.96	7.21	6.55	7.13	6.55	7.17	6-9
Temperature (°C)	27	28.7	27	30	28	29.5	< 40
Conductivity (µS/cm)	562	13110	107	11380	357	12850	1000
Turbidity (NTU)	10.72	12.23	7.60	5.7	6.21	4.8	NA
Sulphate (mg/l)	0.69	130.7	0.69	129.5	0.69	130.7	500
Nitrate (mg/l)	26.3	14.2	1.94	0.12	5.38	3.09	20.0
Phosphate (mg/l)	1.57	1.25	0.3	0.10	1.30	1.18	5.0
Salinity (mg/l)	0.30	2560	0.24	154.0	0.26	202.2	0.1
Chloride (mg/l)	38.0	136.0	24.0	101.0	26.0	112.0	600
Hardness (mg/l)	52.05	1050	20.0	670	28.0	850.9	80
BOD (mg/l)	2000	2500	120	210.0	304	400	30
COD (mg/l)	5240	3470	436	331.0	740	492.0	NA
DO (mg/l)	240	0.12	3.28	0.92	5.28	2.40	7.5
TOC (mg/l)	0.004	0.003	0.0009	0.0006	0.002	0.0015	NA

BOD-Biochemical oxygen demand. COD- Chemical oxygen demand
DO- Dissolved oxygen. TOC- Total organic carbon

The microbial characteristics of the effluents and receiving water bodies in the morning and evening periods are presented in Table 2.0. Heterotrophic counts of the effluents in the morning ranged from 5.4 – 5.6 x 10^6 cfu/ml, while heterotrophic counts of the evening samples of the effluents ranged from 4.6 – 4.8 x 10^6 cuf/ml. Heterotrophic count of the receiving water bodies in the morning ranged from 4.1 – 4.2 x 10^6 cfu/ml, while evening heterotrophic counts ranged from 3.5 – 3.9 x 10^6 cfu/ml. Coliform counts of the effluents in the morning ranged from 3.9 – 4.2 x 10^6 cfu/ml, while coliform counts in the evening ranged from 3.0 – 3.2 x 10^6 cfu/ml. coliform counts of the receiving water body in the morning ranged from 3.4 – 3.7 x 10^6 cfu/ml and 2.6 – 2.9 x 10^6 cfu/ml in the evening. Fungal counts of the effluents ranged from 1.1 – 1.9 x 10^5, while fungal counts in the receiving water bodies ranged from 0.9 – 1.8 x 10^5 cfu/ml. There was a significant difference ($p < 0.05$) between the heterotrophic bacteria count, coliform count and fungal counts observed in the effluent and receiving water body samples. The microbial population (bacteria and fungi) observed is similar to the findings of Ogunseitan, [13] which reported similarly high heterotophic bacteria, colifom and fungal counts in effluents and receiving water bodies sampled. The differences in the microbial population of the effluents and receiving water body may be due to the dilution effects of the receiving water bodies (Koech *et al.,*[12]. However the microbial characteristics of the receiving water body far exceed the WHO recommended limits of water safe for domestic use. This is due to the volume of untreated wastes and effluents disposed directly to the water bodies [5]. These wastes and effluents harbor potentially pathogenic microbial flora and can lead to serious illnesses when they are ingested [13, 14].

Table 2.0: Microbial counts of Effluent and Receiving water bodies

Location	Time of Sampling	THC (10^6 cfu/ml)		TCC (10^6 cfu/ml)		Fungal count (10^5 cfu/ml)	
		Effluent	Receiving water body	Effluent	Receiving water body	Effluent	Receiving water body
Rumuokoro	Morning	5.6	4.2	4.1	3.7	1.9	1.8
	Evening	4.8	3.9	3.2	2.9	1.7	1.5
Ogbogoro	Morning	5.4	4.2	3.9	3.4	1.3	1.2
	Evening	4.6	3.5	2.9	2.6	1.1	0.9
Nkpor	Morning	5.4	4.1	4.2	3.6	1.5	1.4
	Evening	4.7	3.7	3.0	2.8	1.2	0.9

THC- Total heterotrophic count. TCC- Total coliform count

Bacteria isolated and frequency of occurrence include; *Escherichia coli* (19.6%), *Bacillus* spp (15.7%), *Staphylococcus* spp (11.8%), *Proteus* spp (9.8%), *Enterobacter* spp (7.8%), *Klebsiella* spp (7.8%), *Serratia* spp (5.9%), *Micrococcus* spp (5.9%), *Pseudomonas* spp (5.9%), *Salmonella* spp (5.9%) and *Shigella* spp (3.9%) as shown in Fig 1.0. Frequency of fungi isolated include; *Aspergillus niger* (25%), *Fusarium* spp (21.9%), *Aspergillus flavus* (15.6%), *Penicillium* spp (15.6%), *Mucor* sp (9.4%), *Rhizopus* spp (6.3%) and *Saccharomyces* spp (6.3%). As shown in Fig 2.0. These organisms have been reported in previous studies on water bodies receiving effluents from abattoirs [5, 14]. The occurrences of these microorganisms are an indication of high contamination levels of the receiving water bodies. These organisms could cause illnesses such as diarrhea, aspergillosis and other health complications [15].

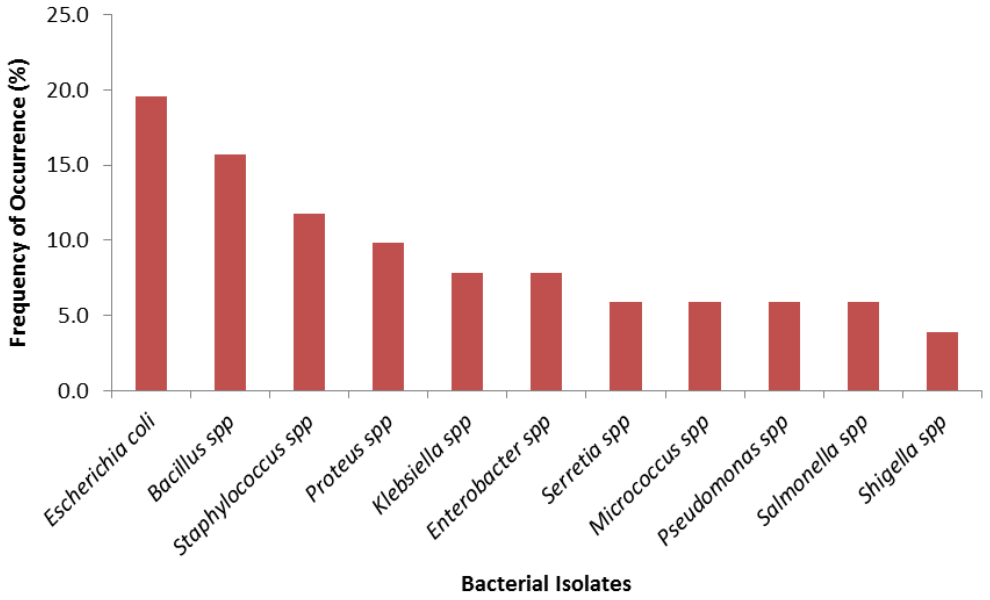

Fig. 1: Occurrence of Bacterial Isolates

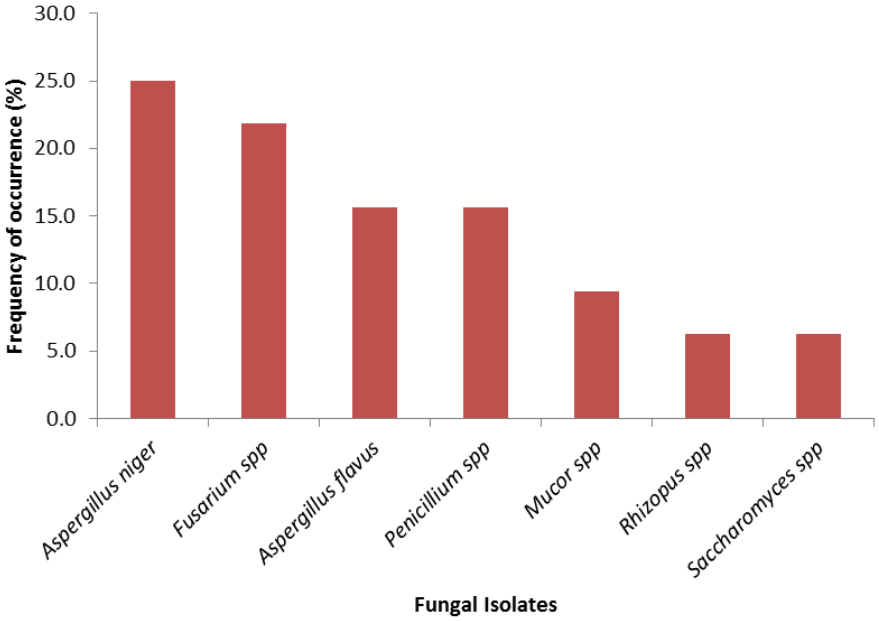

Fig.2: Occurrence Fungal Isolates

CONCLUSION AND RECOMMENDATION

This study has shown that these effluents contain high concentrations of potentially harmful substances. The effluents generated from the abattoir causes contamination when introduced to the surrounding water bodies, making them unsuitable for domestic use. The microbial and physiochemical properties of these abattoir effluents, makes it imperative for abattoir owners to treat these effluents properly before they are introduced into the surrounding water bodies. It is also important for to treat water gotten from surrounding rivers in residential areas before they are used for domestic purposes to prevent occurrence of zoonotic diseases.

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