Assessment of Physico-chemical and Microbiological qualities of Abattoir Wastewater in Sokoto, Nigeria.

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ABSTRACT: Wastewater samples were collected from three different points in Sokoto (Nigeria) abattoir and the physico-chemical and the microbiological qualities were determined. The pH of the wastewater was near neutral in the range of 7.22-7.47. The physico-chemical parameters were biochemical oxygen demand (BOD) (31.4mg/l), dissolved oxygen (DO) (85.0mg/l), and chemical oxygen demand (COD) (3.20mg/l). The microorganisms identified, mostly pathogenic, included *Escherichia coli*, *Salmonella typhi, Neisseria lactamica, Klebsiella pneumoniae, Serratia marcescens, Branhamella catarrhalis,* and *Shigella* sp, *Aspergillus clavatus, Aspergillus flavus, Aspergillus niger, Curvularia* sp, *Trichophyton rubrum, and Penicillium echinulatum.* 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 in the abattoir are discussed.
Keywords: Assessment, Physicochemical, Microbiological, Abattoir, Wastewater.

INTRODUCTION

An 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 (Alonge, 1991). According to Coker *et al*. (2001) abattoir wastewater is water used in the cleaning up of slaughtered animal carcasses, and the floor of slaughter hall, personnel and slaughter equipment. Wastewater is characterized by the presence of high concentration of whole blood of the slaughtered animals and suspended solid particles of semi-digested and undigested feeds within the stomach and intestine of slaughtered and dressed animals (Adeyemo *et al*., 2002).

In many developing countries, the bulk of domestic and industrial wastewater is discharged without any treatment or after primary treatment only. In fact, wastewater treatment receives the least attention, partly because enforcement of environmental standards is poor. In the year 2000, the United Nations established that 2.64 billion people had inadequate access to sanitation, but in Africa and Asia approximately half of the population had no access whatsoever to sanitation (http://en.wikipedia.org/wiki/ sewage_treatment). Waterborne diseases that are prevalent in developing countries, such as diarrhoea, typhoid, and cholera are caused primarily by poor hygiene practices and disposal of wastewater. Studies have shown that zoonotic diseases are yet to be eliminated or fully controlled in over 80% of the public abattoirs in Nigeria (Olugasa *et al*., 2000). Thus, they are a serious environmental health risks to the public. Some of these infectious diseases are tuberculosis, brucellosis and helminthoses (Coker *et al*., 2001).

Abattoir operations, including slaughter, boning, and processing produced a wastewater highly charged in soluble and insoluble inorganic matter. This equates to high loading biological oxygen demand (BOD) due to blood content and high loadings of total suspended solids (TSS) due to particulates accumulated from the slaughter process. The whole blood is a rich protein medium for bacterial growth, it is expected that intestinal bacterial flora of slaughtered animals and other pathological lesions on slaughtered animal tissues would suspend in the wastewater and possibly multiply in the stream environment (Coulibaly *et al*., 2003).

The Sokoto abattoir is located on a high elevation and the wastewater from the abattoir drains into the Rima River that is strategically located on a low elevation. The objectives of this research were to assess the physico-chemical as well as the microbiological qualities of the abattoir

wastewater before being discharged into the surrounding environment.

MATERIALS AND METHODS

Sample Collection

Wastewater was collected in sterile two litre capacity sample bottles and transported in an icebox to the laboratory. The wastewater was collected from three points in the abattoir: wastewater at exit point (Point A; PA), wastewater at midpoint (Point B; PB), and wastewater at discharge point (Point C; PC). Samples were collected in the month of April at 10 days interval. A total of three samples were collected from each point at different times. The media used in this study were Nutrient agar (Lab M, International Diagnostic Group (IDG) Plc), Nutrient broth (Lab M, IDG), MacConkey agar (Antec), and Sabouraud dextrose agar (Fluka). All the media were prepared and sterilized according to manufacturers' instructions.

Physico-chemical Analysis

The physico-chemical qualities of abattoir wastewater were determined using the methods of Udo and Ogunwale (1986) and that of Ezeronye and Okerentugba (1999). The parameters determined were pH (pH meter 3015, Jenway, U. K.), electrical conductivity (Conductivity meter 3392, Windaus Labortechnik, Germaany), Carbonate and Bicarbonate, Chloride, Dissolved Oxygen, Biochemical Oxygen demand, Chemical oxygen demand (Titration method). Sodium and potassium were determined using flame photometer (400, Corning Ltd, Halstead Essex, U. K.) while phosphorus was determined using spectrophotometer (6100, Jenway, U.K.). Calcium and magnesium were determined by ethylene diaminetetraacetic acid (EDTA) titration method.

Microbiological Analysis

The microbiological analysis was carried out immediately after sample collection. An aliquot (1ml) of the wastewater was transferred into 9ml of distilled water and diluted serially in ten folds up to 10^5 according to the method of Adesemoye *et al.* (2006). Then, zero point one-milliliter (0.1ml) aliquots of the serially diluted samples were plated in triplicate plates of Nutrient agar (NA), MacConkey agar (MCA), and Saboraud dextrose agar (SDA) for the enumeration of total aerobic bacteria, coliforms, and moulds respectively. The NA and MCA plates were incubated at 37^OC for 24hours while the SDA plates were incubated at ambient laboratory temperature for 24-72hours. After the incubation period, colonies, which developed on the plates, were counted, multiplied by 10 and by the dilution factors, and recorded as colony forming units per milliliter (cfu/ml) of the sample. The colonies were also subcultured repeatedly on fresh media to obtain pure isolates. The pure isolates were maintained on agar slants for further characterization and identification. Bacterial isolates were characterized using microscopy and biochemical tests. The biochemical tests employed included Gram's reaction, indole production, motility, urease, catalase, coagulase, spore formation, oxidase, citrate utilization, methyl red, voges proskaeur, hydrogen sulphide production and utilization of carbohydrates. The bacteria isolated were identified by comparing their characteristics with those of known taxa using the schemes of Barrow and Feltham (1993). Moulds were characterized based on macroscopic and microscopic examinations. The characteristics that were observed included colour of aerial and substrate mycelium, arrangement of hyphae, and conidial arrangement. The isolates were identified by comparing their characteristics with those of known taxa using the schemes of Robert and Ellen (1988).

RESULTS AND DISCUSSION

The physico-chemical qualities of the abattoir wastewater are presented in Table 1. The pH of the wastewater in all the three points where the wastewater was collected was near neutral (7.22-7.47) and this may play a part in determining both the qualitative and quantitative abundance of the microorganisms in the wastewater. The highest BOD was recorded at PB (31.40mg/l), highest DO (85.0mg/l) was recorded at PA while the highest COD was recorded at PC (3.20mg/l). There was no significant ($p<0.05$) difference between the values obtained from the various points. The high amounts of these parameters indicated a higher level of contamination of the wastewater. This may be attributable to the high concentration of whole blood of the slaughtered animals as well as well as the presence of high

concentration of soluble and insoluble inorganic matter in the wastewater. This is in line with the work of Adesemoye *et al*. (2006) in which he reported a higher BOD (35mg/l), COD (142mg/l) and TDS (630mg/l) in Agege (Lagos) abattoir.

The results of the total viable counts (TVC) of bacteria and fungi as well as coliforms in the abattoir wastewater are presented in Table 2. The wastewater samples collected at PC (that is at discharge point) had the highest counts of $7.3x10^7$cfu/ml while the lowest count of 4.9x107cfu/ml was recorded at PB (at midpoint). The bacterial counts at PA (at exit point) were $7.0x10^7$cfu/ml. The high count of these organisms in the wastewater is due to the fact that the wastewater has a high content of whole blood which served as a rich protein medium for microbial growth. Analysis of variance using the completely randomized design indicated that significant difference existed. Post-experimental analysis using the least significant difference test (LSD=23.01) showed that differences exist between counts from PB and PC, but not between PA and PB or PA and PC. Similar findings were reported by Asamudo *et al*. (2005), in which they reported a mean bacterial population of 3.32×10^7 cfu/ml and fungal population of 1.60×10^5 cfu/ml from wastewater collected from Agege (Agege, Nigeria) abattoir. Also, Ogbonna and Igbenijie (2006) reported a total bacterial population of 2.08×10^3cfu/ml and total fungal population of 8.0×10^2cfu/ml from wastewater collection sites in Port Harcourt City, Nigeria. The bacteria isolated from the abattoir wastewater were identified as *Escherichia coli, Salmonella typhi, Neisseria lactamica, Klebsiella pneumoniae, Serratia marcescens, Branhamella catarrhalis,* and *Shigella* sp. The morphological characteristics of fungal isolates are presented in Table 3. The isolates were identified as *Aspergillus clavatus, Aspergillus flavus, Aspergillus niger, Curvularia* sp*, Trichophyton rubrum, and Penicillium echinulatum.*

Most of the fungal isolates are dermatophytes as well as common spoilage organisms associated with the beef industry. The bacterial isolates are mostly inhabitants of the small intestines and are known to persist in water environment (Coker *et al*., 2001). Similar pathogenic microorganisms were isolated from abattoir wastewater in different parts of the country. For example, Coker *et al*. (2001) isolated *Salmonella* sp, and *Escherichia coli* among many microorganisms from Bodija abattoir wastewater in Ibadan, Nigeria. Similarly, Adesemoye *et al*. (2006) reported the presence of *Aspergillus niger*, *Mucor* sp, and *Penicillium* sp from wastewater in two different abattoirs in Lagos State, Nigeria. Isimite and Atuanya (2006) reported the presence of *Klebsiella* sp, *Serratia* sp, *Aspergillus* sp, among many microorganisms in raw textile effluents. According to International standards, any water contaminated to this level is neither good for domestic use nor is it supposed to be discharged directly into the environment without treatment (WHO, 1996). The wastewater from the abattoir is washed into open drainages untreated and the leachates from the series of decomposition of these wastes can introduce enteric pathogens into the Rima River and thus serve as a vehicle for gastrointestinal infections. Also it may introduce excess nutrients into surface water and percolates into the underlying aquifers to contaminate hand-dug wells. The high levels of organic matter in the wastewater encourage rapid proliferation of O_2 consuming microorganisms to deplete the water of its dissolved oxygen leading to septic condition or anoxia which is lethal to aquatic fauna (Abiola, 1995).

CONCLUSION

The abattoir wastewater analyzed had high counts and various species of fungi (17.5×10^4cfu/ml), bacteria (9.6×10^7cfu/ml) and coliforms (2.8×10^5cfu/ml). It also had some physicochemical properties in amounts that indicate that the wastewater was highly polluted. Therefore, it is highly recommended that since many of the pathogens isolated have the potential for surviving in the environment and thus affecting animal and human health eventually, there is the need for the establishment of wastewater treatment facility in the abattoir. The high level of contamination of the abattoir wastewater as revealed in this study highlights the dangers associated with discharging untreated abattoir wastewater into the environment, thus the need for adequate treatment to ensure decontamination.

Table 1: Physico-chemical qualities of Sokoto abattoir wastewater

Parameter	PA	PB	PC	Mean	Range
Colour	Oxblood	Oxblood	Oxblood	-	-
Appearance	Turbid	Turbid	Turbid	-	-
Ph	7.22	7.47	7.24	7.31	7.22-7.47
Electrical conductivity (µs/cm)	1342	4448	5.97	1931.99	5.97-4448
Sodium (mg/l)	13.20	58.00	70.00	47.07	13.20-70.00
Potassium (mg/l)	3.30	80.00	89.00	57.43	3.30-89.00
Calcium (mg/l)	0.60	1.10	0.60	0.77	0.60-1.10
Magnesium (mg/l)	1.50	1.20	1.25	1.32	1.20-1.50
Phosphorus (mg/l)	0.155	0.21	0.41	0.26	0.155-0.41
Carbonate (mg/l)	0.00	0.00	0.00	0.00	0.00
Bicarbonate (mg/l)	0.00	0.40	0.55	0.32	0.00-0.55
Chloride (mg/l)	0.35	0.08	1.20	0.54	0.08-1.20
Nitrate (mg/l)	16.00	56.00	0.88	24.29	0.88-56.00
DO (mg/l)	85.20	66.80	68.70	73.57	66.80-85.20
BOD (mg/l)	22.40	31.40	24.50	26.10	22.40-31.40
COD (mg/l)	2.10	0.60	3.20	1.97	0.60-3.20

PA: Wastewater at exit point; PB: Wastewater at midpoint; PC: Wastewater at discharge point; mg/l: milligramme per litre,

DO: Dissolved oxygen, BOD: Biochemical oxygen demand, COD: Chemical oxygen demand.

Table 2: Total viable counts* of bacteria and fungi in Sokoto abattoir wastewater

Points of collection of wastewater	Bacteria ($x10^7$ cfu/ml)	Fungi ($x10^4$ cfu/ml)	Coliforms ($x10^5$ cfu/ml)
PA	7.0	13.9	2.0
PB	4.9	14.0	1.3
PC	7.3	7.2	2.2
Mean	6.4	11.7	1.83
Range	4.9-7.3	7.2-14.0	1.3-2.2

*Counts represents mean of triplicate samples; cfu/ml: colony forming unit per milliliter: PA: Point where the wastewater leaves the slaughter hall; PB: midway through the drainage; PC: Point where the wastewater drained to the surrounding soil.

Table 3: Morphological characteristics of fungal isolates from Sokoto abbatoir wastewater

Isolate code	Macroscopy	Microscopy	Organism
AW 1	Brown and cottony-like	Long, erect conidiophores. Round-shaped conidia	*Penicillium* sp
AW 2	Bluish-green and velvety	Conidiophores ellipsoid, smooth	*Aspergillus clavatus*
AW 3	Green and powdery-like	Long, erect and non septate conidiophores	*Aspergillus flavus*
AW 4	Black and powdery-like	Smooth walled and non septate conidiophores	*Aspergillus niger*
AW 5	Greyish, velvety and powdery	Erect and septate, Conidia 4 walled and curved conidiophores	*Curvularia* sp
AW 6	Light red	Long, erect and septate conidiophores	*Trichophyton rubrum*
AW 7	Light green and powdery-like	Greenish and rough walled conidia	*Penicillium echinulatum*

AW: Code for fungal isolates from abattoir wastewater

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