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Research Article

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Physicochemical Characteristics of Effluents of Some Selected Abattoirs in Etsako West Local Government Area, Edo State, Nigeria

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Abstract: The physiochemical characteristics of abattoir effluents of some selected abattoirs in Etsako West Local Government, Edo State, Nigeria, were investigated. The study involved the collection of water samples at the three different locations from the river where the abattoir wastewaters are discharged. The physical and chemical analyses of the wastewater samples were conducted using the standard method for examination of water and wastewater. Results of the laboratory tests were analysed. The results obtained were compared with the World Health Organisation (WHO). The results obtained were pH 6.20 at 27.1°C, Biochemical Oxygen Demand (BOD) 14.8 (mg/L), Chemical Oxygen Demand (COD) 37.3 (mg/l), Total Suspended Solids (TSS) 200 (mg/l), Total Dissolved Solids (TDS) 300 (mg/l), conductivity 62.2 (µS/cm), Dissolved Oxygen (DO) 4.6 (mg/L), and turbidity 68 (cm) using a Secchi disc. Colour; 20 (Hz), total solids (TS); 500 (mg/L), total hardness; 168 (mg/L), magnesium; 52.12 (mg/L). Analyses of the results showed that the samples were polluted. Hence, appropriate measures are thereby suggested as a means to control or reduce the pollution of the river receiving the discharge in order to enhance the quality of human and aquatic life.

Keywords: Abattoir effluents, Physiochemical characteristics, River, BOD, COD, TSS, Etsako West Local Government

1. Introduction

Abattoirs, also known as slaughter houses are places where animals are butchered for food. Abattoir act (1998) defined abattoir as any premises used for or in connection with slaughter of animal whose meat is intended for human consumption and include a slaughter house, but does not include a place situated on a farm (Bridges et al., 2000). 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). The abattoir industry provides domestic meat supply to over 150 million people and employment opportunities for the Nigerian teaming population (Nafaranda et al., 2005). Discharge wastes from abattoir can be valuable for crops as fertilizers, but can becomes a major pollutant when the wastes are not properly managed (Asibor, 2017).

Abattoir operations produce characteristic highly inorganic wastes such as sulphates, phosphate, etc. with relatively high levels of suspended solid, liquid and fat. The solid waste includes condemned meat, undigested food materials, bones, hairs and aborted fetuses. The liquid waste is usually composed of dissolved solid, blood gut contents, urine and water. Adeyemo (2002). As a result of inadequate waste treatment facilities Adeyemo (2002), wastes from abattoir are deposited on the land or channeled into water resource leading to pollution. Furthermore (Adesemoye et al., 2006) reported that in many countries, pollution arises from activities in meat

production as a result of failure in adhering to Good Manufacturing Practices (GMP) and Good Hygiene Practices (GHP). To adhere to GMP and GIP, (Adesemoye et al., 2006) suggested that during dressing, the oesophagus cattle and sheep should be sealed to prevent leakage of gut content (Adesemoye et al., 2006), further reported that the inability to observe this unhealthy condition could lead to contamination of meat from hides, hooves and content of alimentary tract during evisceration and negatively impact on the environment. In essence, slaughter activities, if not properly controlled, may pose dangers to the farmers, butchers, the environment as well as the consumers. While the slaughtering of animals results in significant meat supplies, a good source of protein and production of useful by-products such as leather, skin and bones, the processing activities involved sometimes result in environmental pollution and other health hazards that may threaten animal and human health.

According to Mittal (2004) and Adeyemi-Ale (2014) waste generated at abattoirs pose a serious threat to the environment because of direct discharges of wastewaters into the ecosystems which most times are not effectively treated. These wastes are high in organics and fats (Raymond, 1977). These result to the destruction of primary producers in the water. It is one of greatest threats to surface water quality as it causes an increase in the Biochemical Oxygen Demand (BOD), Chemical Oxygen Demand (COD), Total Solids (TS), pH, temperature, turbidity, nitrate, phosphate, etc. Biodegradable organic matter in receiving waters create high competition for Oxygen within the ecosystem leading to high levels of BOD and a reduction in Dissolved Oxygen (DO), which is detrimental to aquatic life and also affects sediments and surrounding soil (Ogbonna and Ideriah, 2014). The major activities involved in the operations of an abattoir include; receiving and holding of livestock; slaughter and carcass dressing of animals; chilling of carcass products; carcass boning and packaging; freezing of finished carcass and cartooned product; rendering processes; drying of skins; treatment of wastes and transport of processed material. These meat processing activities in Nigeria are mostly carried out in unsuitable buildings and by untrained personnel or butchers who are mostly unaware of sanitary principles.

Animals (cow, goat e.tc) prepared in Fugar abattoir alone accounts for about 65% of the total animal in Etasko-West, Edo State, Nigeria. The waste from the slaughtering and dressing grounds in the abattoir are washed into open drainages untreated and the leachates from the series of decomposition processes of these wastes can introduce enteric pathogens and excess nutrients into the surrounding surface water and also percolate into the underlying aquifers to contaminate the hand-dug wares which serve the dual purpose of drinking water for the butchers and others working in the abattoir, and the people in the neighborhood (Adeyemo et al., 2002). Uncontrolled discharge of abattoir effluent on the soil surface and water could laid to serious land and water degradation causing serious economic and health problems. This paper investigates microbiological and physicochemical of effluent being discharge to the river and resulting effects on the environment. Abattoir wastes can be divided into solid wastes liquid wastes and gas wastes. The solid wastes consist mainly of bone undigested ingesta, hairs and occasionally aborted fetal, while the liquids comprise of blood, urine, water, dissolved solids and gut contents. Odors and emissions produce gas water (Adeyemo et al., 2002). Effluent generated from the abattoir is characterized by the presence of high concentration of whole blood of slaughtered food animals and suspended particles of semi-digested and undigested feeds within the stomach and intestine of slaughtered and dressed food animal.

The primary objective is to evaluate the physicochemical properties of effluents from selected abattoirs in Etsako West Local Government Area. This evaluation will contribute to a better understanding of their environmental impact and support efforts towards sustainable waste management practices. In conclusion, this study highlights the necessity for comprehensive research into the physicochemical characteristics of abattoir effluents in Etsako West Local Government Area. Such research is crucial for developing effective strategies to mitigate environmental impacts while ensuring public health safety.

2. Research Methodology

Study area

The research location is Etsako West LGA of Edo State. Etsako West LGA is a local government area in Edo state, south-south geopolitical division of Nigeria and as its headquarters in Auchi. Auchi is located about 130km from the edo state capital and has an estimated population of 197,609 in the 2006 census. The LGA is made up of six clans: Auchi, Uzairue, South Ibie, Anwain, Aviele and Jagbe. It also has the prestigious Federal Polytechnic attended by students all over the state. The postal code of the area is 312. The commonly spoken language in

Etsako West is the Afemai language while Islam and Christianity are widely practiced in the area. The Auchi Kingdom is headed by a monarchy and the traditional ruler is referred to as the Otaru of Auchi Sacred Kingdom. The 8th January is Auchi Day. This commemorative day was previously called Uchi Day. Etsako West LGA has an area of 946km² and witnesses two major seasons, which are the dry and the rainy seasons. The average temperature in the area is 28.72 degrees centigrade, while the average humidity level of the LGA is 54 per cent. Samples were collected from Auchi, Jattu and Aviele abattoir, and the physiochemical parameters will be analysed.

Materials

The following materials and equipment used for the study as follows:

Burette, Volumetric flask, Conical flask, Beaker, Plastic tube, Retort stands, Filter paper, PH meter Conductivity meter, Thermometer, Secchidlisk etc.

Collection of samples

Samples of wastewater (abattoir effluents) for laboratory analysis were collected in sterilised plastic bottles; the sample bottle was rinsed on site three times with the sample to be collected. During the sample collection, the materials used include hand protective gloves and a plastic bottle. Samples were collected early in the morning between the hours of 7:00am and 8:00am when cows were normally slaughtered. Samples collected from some selected abattoirs in Etsako West Local Government Area at three (3) different locations were well labelled and taken to the laboratory for analysis immediately after collection within the scope of the research work.

Laboratory analysis

The physiochemical analysis was conducted using the standard methods for examination of water and wastewater; the physical and chemical parameters examined were temperature, pH, conductivity, colour, odour, taste, total dissolved solids (TDS), total suspended solids (TSS), biochemical oxygen demand (BOD), chemical oxygen demand (COD), turbidity, nitrate, magnesium and phosphate.

Determination of dissolved oxygen

The dissolved was determined using Winkler's method, the sample was filled into a 30ml BOD bottle, 2ml of Manganese Sulfate was added to the sample (the pipette is dipped inside the sample), then 2ml of Alkali iodide was added using the same procedure of adding Manganese Sulfate, mixed together and 2ml of concentrated Sulfuric acid was added by pipette (just above the surface of the sample) cove with a stopper and mixed together by inverting thoroughly, then the sample is stored for 8 hours in a cool and dark place. After which 201ml of the sample was poured in a conical flask and titrate against Sodium Thiosulphate then 2ml of Starch Indicator was added and the color change to blue, and the titration was continue until the sample gives a clear color.

Determination of biochemical oxygen demand

Abattoir effluent was filled into two different BOD bottles and labelled as samples 1 and 2; then Winkler's method was adopted as stated above. The dissolved oxygen in sample bottle 1 was determined shortly after the dilution, and after incubation the final dissolved oxygen was determined using the same procedure for determining initial dissolved oxygen. The BOD was calculated from the difference between the initial and the final (DO).

$$\text{BOD mg/l: } \frac{DO_2 - D0_1}{fraction\ of\ sample\ used\ (ml)} \qquad (1)$$

Determination of chemical oxygen demand (COD)

The chemical oxygen demand was determined by using the titrimetric method; 20 ml of the sample was measured into a round-bottom reflux flask, some glass beads were added to prevent bumping, then 1 ml of potassium dichromate solution was added, and 2.5 ml of sulphuric acid was added slowly. After digestion, the sample was allowed to cool to room temperature; 2 drops of ferroin indicator were added, and then it was titrated with ferrous ammonium sulphate until it turned reddish brown.

$$\text{COD mg/l} = \frac{8000 \text{ x Nx } (V_b - V_s)}{\text{volume of sample (ml)}} \qquad (2)$$

3. Results and Discussion

The results of the study reveal the physicochemical characteristics of the abattoir effluent samples from Auchi, Jattu and Aviele abattoirs. Results of physiochemical tests are shown in Table 1.

Table 1: Physical and chemical characteristics of abattoirs effluent

Parameters	Location 1: Auchi	Location 2: Jattu	Location 3: Aviele
Temperature	27.1	26.8	26.9
PH	6.20	5.52	5.83
Conductivity	61.35	63.75	61.50
Odor	Foul	Foul	Foul
Color	20	25	20
Turbidity	64	72	68
Total solid	550	430	520
TDS	300	220	380
TSS	250	210	140
Hardness	172	155	168
Magnesium	56.08	42.10	58.18
DO	4.96	5.63	3.21
BOD	11.72	14. 28	18. 40
COD	41	35	36

Table 2: Mean of concentration in samples compare to the World Health Organization (WHO)

Parameters Test	Mean of concentration in sample	Drinking water guideline WHO	Remarks
Temperature	26.9°C	25°C - 29°C	Normal
PH	5.85	6.5- 8.5	Slightly Acidic
Conductivity	62.2μs/cm	1000 μs/cm	Low
Odor	Offensive	Odorless	Offensive
Color	22hz	5hz	Above Standard
Taste	Yes	No	Tasty
Turbidity	68cm	5 N.T.U	Above Standard
Total solid	500mg/1	-	-
TDS	300mg/l	500mg/l	Normal
TSS	200mg/1	500mg/1	Normal
Hardness	165mg/1	150mg/1	Above Standard
Magnesium	52.12mg/l	50mg/1	Above Standard
DO	4.6mg/l	7.5mg/l	Normal
BOD	14.8mg/l	<5mg/l	Above Standard
COD	37.3mg/l	120mg/l	Normal

Temperature

The temperature of the samples ranges from 26.8°C to 27.1°C, with a mean of 26.9°C, in the three sample sites and fell within the optimum temperature of 25°C-29°C of the WHO standard for drinking water. The pH of the samples ranges from 5.52 to 6.20, with the mean of 5.85, which is slightly acidic and falls within the optimum pH

value of 6.5-8.5 of the WHO standards for drinking water. The electrical conductivity (EC) level in the abattoir effluent sample ranged from 61.35 µs/cm to 63.75 µs/cm, and the mean value of EC was within the tolerance limit of 1000 µs/cm for drinking water standards.

Odour

According to the WHO Standard for Drinkable Water, it should be free from odour, i.e., odourless, but as a result of abattoir effluent flowing into water, it has an offensive odour.

Colour

The colour of the abattoir effluent samples ranges from 20Hz to 28Hz, with the mean value of 20Hz being high above the tolerance limit of 5Hz for WHO drinking water standards.

Turbidity

Turbidity of the sample, measured in situ, ranged from 64cm to 72cm in depth, with the mean of 58 cm in depth, which fell within the range of 60cm to 70cm in the conversion chart, which is equivalent to 7NTU. Hence, it is slightly higher than the optimum turbidity level of 5 5NTU for drinking water standards.

Total Dissolved Solid

The total dissolved solid (TDS) level in the abattoir effluent ranges from 220 to 380 mg/L, with the mean value of 300 300mg/l fells within the tolerance limit of 500 mg/L for WHO standards.

Total Hardness

Total hardness values obtained from the abattoir effluent sample ranged between 155 and 172 mg/L, with the mean value of 165 mg/L, which is slightly above the WHO standard.

Magnesium

The level of magnesium present in the sample (52.12 mg) which is the mean value for the samples is above the optimum value of 50 mg/l of the World Health Organisation standard.

Dissolved oxygen

Dissolved oxygen (DO) values that are obtained from the abattoir effluent sample range between 3.21 and 5.63 mg/l, which is within the range of optimum DO value of 7.5 mg/l of WHO standard.

Biochemical Oxygen Demand (BOD) and Chemical Oxygen Demand (COD)

For the biochemical oxygen demand, the values range from 11.72 mg/l to 18.40 mg/l, while that of chemical oxygen demand ranges from 35 mg/l to 41 mg/l). BOI and COD are important water quality parameters, and they are very essential in water quality assessment. Therefore, the more organic matter present in the abattoir effluent, the higher the BOD and COD.

4. Conclusion

Based on the findings of the study, it could be ascertained that the physiochemical analysis of the abattoir effluent from three different locations in Etsako West Local Government, Edo State, showed that the surrounding river and well were polluted with some heavy metals and organic matter. The result showed that the concentration of Mg, Fe, hardness and BOD were higher than the WHO tolerance limit for drinking water. The level of Total Dissolved Solid (TDS) and Total Suspended Solid (TSS) shows that the samples were heavily loaded with colloidal, organic and suspended matters. This shows that the discharge of abattoir effluent to water bodies without treatment could be a source of health risk to humans and the environment.

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