

# Environmental Impact of Abattoir Waste Discharge on the Quality of Surface Water and Ground Water in Abeokuta

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## Abstract

The problem of getting quality water is increasing as untreated effluents are discharged into water bodies. The study aims at assessing the impact of various abattoirs wastewater on ground and surface water bodies in Abeokuta. Water samples were collected randomly in 9 different locations of Abeokuta (4 stream and 3 groundwater samples as well and 2 around abattoir vicinity as controls of surface and groundwater). All the samples were collected on the same day in the morning and were analysed for physical, chemical and microbiological load. The water quality parameters measured includes; Colour, Odour, pH, EC, Temperature, TDS,  $C_{12}$ , DO, BOD, COD, TS, TSS,  $NO_3$ ,  $PO_4$ , Heavy Metals (Pb, Zn, Cu, Cd, Fe), microbiological analysis. The parameters were analysed using standard procedures and the results were analysed using descriptive and inferential statistics. The ranges of the means values of all the parameters measured for pH, Temperature, Hardness, TDS,  $C_{12}$ ,  $NO_3$ ,  $PO_4$ , BOD<sub>5</sub>, DO, COD, TS and TSS were 7.23-7.36, 27.3°C-28.0°C, 164-323 mg/L, 102-518 mg/L, 20-70 mg/L, 0.005-0.706 mg/L, 0.212-0.850 mg/L, 0.570-7.400 mg/L, 1.0-6.8 mg/L, 72-504 mg/L, 0.260-0.520 mg/L, 15.4-16.1 mg/L and that of heavy metal were; 0.03-0.19 mg/L, 0.020-0.090 mg/L, 0.010-0.030 mg/L, 0.0-0.700 mg/L, 0.040-4.960 mg/L for Pb, Zn, Cu, Cd, Fe respectively while that of the Faecal Coliform was 100-300 cfu/ml respectively. The results of the study revealed that all of the measured parameters show significant difference in their mean except  $C_{12}$ , EC,  $PO_4$  TDS and Temperature. From the results, it was discovered that the concentration of Hardness, Pb, Cu, Pb, Zn, Cd, Fe and Faecal Coliform exceeded the permissible limits of both the WHO and FEPA standard for drinking and wastewater effluent. Pollution of ground and surface water through discharge of waste is an evidenced by the high concentrations of pollution indicators, nutrients and trace metals above the acceptable limits.

**Keywords:** Abattoir; Faecal coliform; Monitoring; Pollution; Quality; Waste water

## Introduction

Water is a universal resource because of its free nature, is often subject to abused, especially in the third world nations where information is not disseminated to society. Water can be gotten everywhere but safe and clean water are hard to come by in almost all part of the world [1]. Water performs three roles of transporting body nutrients to other vital organs, regulating the body temperature, as well as carrying waste out of our internal body organs and is second only to air in its importance. The highest rate that water is potentially available for human use and its management is often considered the best measure of the total water resources in any given region. The physical hazards presents are the VOCs, dissolved solids and suspended solids etc. The chemicals hazards are the iron, mercury, copper, manganese, lead, cadmium, phosphate, nitrate etc.

Surface and ground water are separate two entities requiring ever increasing need for management. Surface and ground water is the most readily available, yet the most polluted as a result of anthropogenic activities, but notably, controllable activities. In developing countries, especially the rural areas where potable water supply is a near rarity, most of the dwellers rely mainly on water in streams, brooks, rivers, ponds and lakes, well, borehole, tube wells. Groundwater is characterized with adequate aquifer protection, groundwater has excellent microbial and chemical quality and it therefore requires minimal or no treatment. Also, the capital cost of groundwater development when compared to surface water development is modest and groundwater lends itself to flexible development make it attractive as a source of potable water supply. The wells terminate in the weathered crystalline rocks and if deep enough could sustain the dry season.

Formerly, the main source of water to the residing people in Abeokuta is the public water supply through Ogun state water corporation,

the water supply situation in the city seemed to be deteriorating and retarding due to the continuous increase in the population and industrial growth. The poor and inadequate network has led to water shortage in some areas in Abeokuta. The major substitutes for pipe borne water are shallow hand dug wells in areas of low and average income. The principal sources and causes of groundwater pollution are municipal, industrial, agricultural and others.

Abattoir activities may be another source 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 [2]. It has also been reported that animals which graze on contaminated plants and drink from polluted waters, as well as marine lives that breed in heavy metal polluted waters also accumulate such metals in their tissues and milk if lactating. When such animals are killed, these metals are released in the soil as natural sink but subsequently leached out into nearby streams or water bodies.

Abattoir wastes usually are multi-dimensional, mainly organics containing fat, grease, hair, feathers, grit, flesh, manure, and undigested feed, blood, bones and process water [3,4]. World Bank, 1998 access

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the total amount of waste produced per animal slaughtered to be approximately 35% of its weight. About 6 kg of manure is produced for every 1000 kg of carcass weight, a slaughtered beef produces (excluding rumen contents or stockyard manure) and 100 kg of paunch manure (partially digested food) [5].

Abattoir effluents whether it reaches the water body through a point source or nonpoint source reduce oxygen in water and endanger aquatic life and can lead to life threatening effect. The organic nutrients added to ground water produce excessive microbial growth causing unpleasant taste and odours of water from this source.

## Materials and Methods

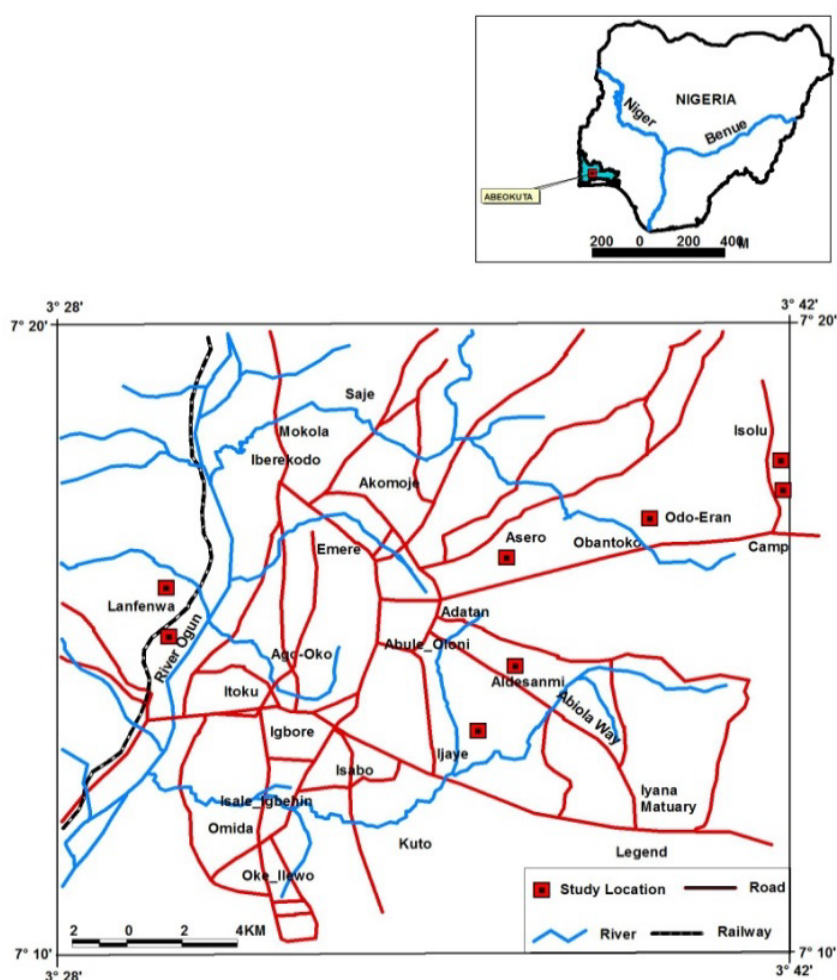
### Study area

The study area for this project is Abeokuta. Abeokuta is the capital and largest city of Ogun State with Coordinate: Latitudes ( $7^{\circ} 5' 35''$  N and  $7^{\circ} 20'$  N and Longitudes  $3^{\circ} 17'$  E to  $3^{\circ} 27'$ ).

### Sampling collection

Water samples were collected randomly in 9 different locations of Abeokuta (4 samples from stream and 3 from ground water i.e.,

well around abattoir vicinity and 2 controls of surface water and groundwater). All the samples were collected on the same day in the morning for various physical, chemical and micro-biological analysis. Water samples were collected into nine (2 litres) clean dry plastic bottles in a way that the water will not mix with any other from another source. Each water sample were collected at the monitoring stations for laboratory analysis using a sample container which will help to prevent losses due to adsorption, volatilization and contamination by foreign substances. Sample bottles were rinsed twice with the water obtained from designated stream and well prior to collecting samples for testing and the sample bottles were filled completely to prevent any loss of dissolved gases from the water samples. The plastic containers are labelled appropriately using a marker with the information on collection point which will be cross-checked with the field notebook and the sample collection sheet and transported to the laboratory. Water samples were preserved in a refrigerator with a temperature between  $0^{\circ}\text{C}$  and  $4^{\circ}\text{C}$ . The water quality parameters measured includes; Color, Odor, pH, Temperature, Total Dissolve Solids (TDS), Chloride (Cl), Dissolved Oxygen, Biochemical Oxygen Demand (BOD), Chemical Oxygen Demand (COD), Total Solids, Total Suspended Solids, Nitrate, Heavy Metals (Lead, Zinc, Copper, Cadmium and Iron), microbiological analysis (Figure 1).



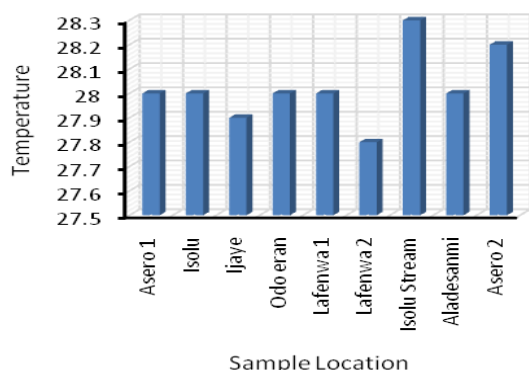
**Figure 1:** Map showing the sampling location of abattoir in Abeokuta, Ogun State. Source: Cartographic lab. (FUNAAB 2015).

Physical and Chemical parameters were determined by instrumental methods and conducted following standard analytical method (APHA 1995). Cationic and anionic constituents were determined by standard titrimetric and spectrophotometric methods, trace and heavy water were determined by Atomic Adsorption Spectrophotometer. The physico-chemical analysis of the various water quality parameters results as well as other heavy and microbial load will be compared with WHO (World Health Organisation, 1997) drinking water quality guideline.

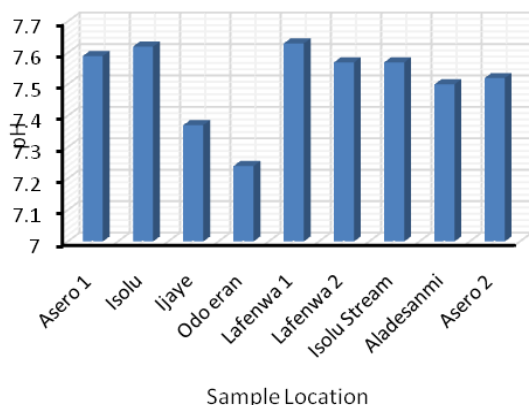
## Results and Discussion

The temperature of the samples ranges between 27.8°C-28.3°C (Figure 2), these range in results are similar to the study done by Magaji et al. [6,7], who identified in it study of most abattoir area with temperature of 28.5°C-28.8°C. The temperature falls within the WHO standard of permissible limit of <40°C, and is lower than 32°C to 34°C. Temperature influences the amount of dissolved oxygen in water which in turn influences the survival of aquatic organisms.

The pH ranged from 7.24-7.63 with a mean value of 7.51 (Figure 3) falls within WHO standards of 6.5-8.5 compares with 4.9 to 7.2 reported by Masse and Masse on similar study where all the samples were slightly alkaline [8]. Therefore, the water samples were unlikely to cause health problems such as acidosis [9]. However, pH played a significant role in determining the bacterial population growth and diversity in surface water. Microorganisms frequently change the pH of their own habitat by producing acidic or basic metabolic waste products [10].



**Figure 2:** The temperature level of the Sample water.

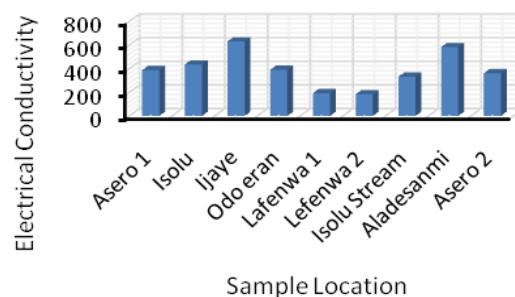


**Figure 3:** The pH level of the Sample water.

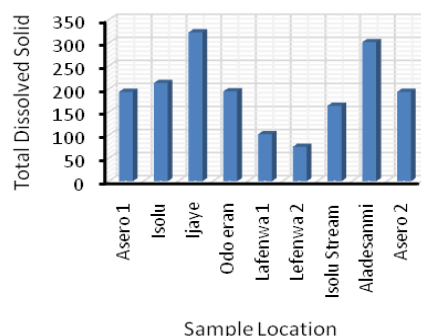
The TDS value of the result obtained from the analysis Ijaye well has the highest value of 323 mg/L while Lafenwa (100 m away from point of discharge) has lowest value of 75 mg/L, although the values ranged from 75 mg/L to 323 mg/L (Figure 4). All value obtained falls below WHO standard of <1200 mg/L. High significant values of TDS could be due to salt water intrusion because of proximity to the oceans [11]. Most often, high levels of TDS are caused by the presence of potassium, chlorides and sodium and interfere with the taste of foods and beverages, and makes them less desirable to consume. Some of the individual mineral salts that makeup TDS pose a variety of health hazards to living organisms and as reported by Efe are an indication of the degree of dissolved substances such as metal ions in the water [12].

Electrical conductivity is the ease to which a substance allows free flow of electricity through the ions in electrolytes of water sample. The values of EC ranged from 184 to 631  $\mu\text{S}/\text{cm}$ , were Ijaye well has the highest value while Lafenwa (100 m away from point of discharge) recorded lowest (Figure 5). All the samples were within the permissible limits of WHO maximum permissible level of the conductivity of 900  $\mu\text{S}/\text{cm}$ . This shows that the water samples are not saline, the concentration of salts dissolved in the water is minimal, and the salt content of a water body is determined by its ability to conduct an electric current the higher the salt concentration, the larger the current that can be conducted and the higher the EC of the water. Any level above WHO standards can pose health risk of defective endocrine functions and also total brain damage with prolonged exposure. All the water samples have their EC values less than the highest tolerable values.

The TS values of all samples analysed ranges from 0.76 to 3.4 mg/L. There is no evidence of any epidemiological reaction at high level of Total solids, but water becomes unpalatable and may lead to corrosion of containers. Consequently, WHO set the highest permissible values



**Figure 4:** The TDS level of the Sample water.



**Figure 5:** The EC level of the Sample water.

of 1000 mg/L. The palatability of water with a total solids level of less than 1000 mg/L is generally considered to be good.

TSS values ranged from 15.20 to 16.14 mg/L with mean values of 15.74 mg/L which falls within the WHO maximum permissible limit for TSS (30 mg/L). TSS relatively measures the physical or visual observable dirtiness of a water resource.

Values obtained for BOD from the analysis carried out, it was observed that (Asero 2) has the highest value of 12.2 mg/L while (Aladesanmi) has lowest value of 1.5 mg/L (Figure 6). The BOD is an important water quality parameter and is very essential in water quality assessment. Growth of aerobic and facultative anaerobic bacteria will be enhanced by the presence of dissolved oxygen in any water body. The BOD values range from 1.5-12.2 mg/L. All the values of BOD samples are within the permissible standard the WHO standard of 50 mg/L for waste water. The more organic material presents in the river the higher the BOD thus showing variance with the result of Ojekunle et al. [13].

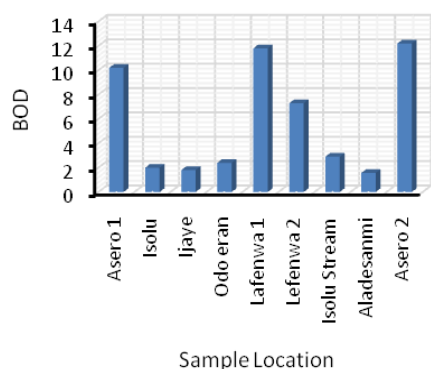
The DO is a measure of the degree of pollution by organic matter, the destruction of organic substances as well as self-purification capacity of the water body (Figure 7). The standard for sustaining aquatic level is 5 mg/L. Concentration below this value adversely affect aquatic biological life, while concentration below 2 mg/L may lead to death of most fishes, [14]. The higher the concentration of DO the better the water quality. The DO values ranges from 1.0- 6.8 mg/L. (Asero 1) and (Asero 2) has high DO of 5.4 and 6.8 mg/L as a result of Abattoir waste and Tie and Dye activities carried out in the area (Lafenwa 1) and (Isolu Stream) also has high DO values of 4.4 and 3.9 mg/L though the other values at other points re within

the expected WHO value of 2.0 mg/L, two points namely Ijaiye and Aladesanmi are experiencing hypoxia which are complete variance with the study carried out by Ojekunle et al. on similar abattoir study [13,15].

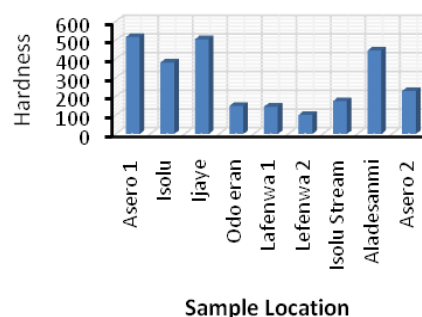
The COD values have it highest concentration of 80 mg/L at Asero 1, Isolu, Aladesanmi and Asero 1 while it was not detected in other points, although all these values were within the permissible limit standard of 1000 mg/l (WHO 2006). High level of COD indicates the presence of chemical oxidants in the effluent while low COD indicates otherwise. High COD could likely cause nutrient fixation in the soil resulting to reduce rate of nutrients fixation in the soil resulting to reduced rate of nutrient availability to plants. Chemical oxidants affect water treatment plants by Chemical oxidants affects water treatment plants by causing rapid development of rust [15].

From the result obtained from the analysis (Figure 8) total hardness ranged from 102-518 mg/L. (Asero 1) has the highest value of 518 mg/L while (Lefenwa 2) has the lowest value. All the values exceeded WHO permissible limit of 100 mg/L. Abattoir wastewater contribute to the elevated total hardness values, exposure to hard water has been suggested to be a risk factor that could exacerbate eczema. The environment plays an important part in the etiology of atopic eczema. A suggested explanation relative to hard water is that increased soap usage in hard water results in metal or soap salt residues on the skin (or on clothes) that are not easily rinsed off and that lead to contact irritation especially to local users.

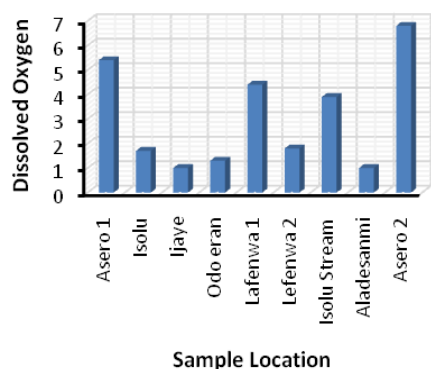
The chloride values range from 20-71 mg/L (Figure 9) which falls within the WHO standard of <250 mg/L). The little concentration of  $Cl_2$  was basically due to the diffusion of ocean water into the river as a result of tidal action [16]. The chloride sources could be soluble salt (NaCl and KCl).



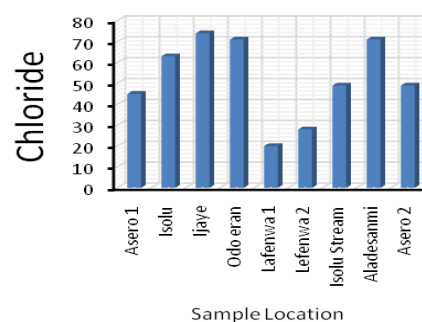
**Figure 6:** The BOD level of the Sample water.



**Figure 8:** The total hardness level of the Sample.



**Figure 7:** The DO level of the Sample water.



**Figure 9:** The Cl level of the Sample water.



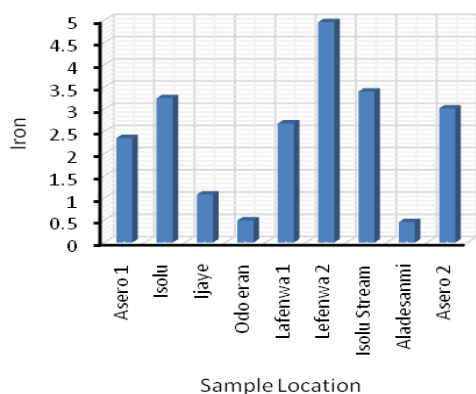
From the phosphate result obtained from the analysis shown, (Ijaiye) possesses the highest value of 0.850 mg/L while has lowest value of 0.212 mg/L. Although from the analysis the values ranged from 0.212 to 0.850 mg/L which were within WHO maximum permissible value of 0-5 mg/L. Wastewater treatment into tertiary waste could lead to a decline in phosphorous concentration according to the work carried out by Correll, 1998, in Lake Leman [17]. Nitrate is a nitrogenous compound that when it is in excess in our drinking water can cause reduction of oxygen capacity of blood, shortness of breath and blueness of skin. From the nitrate value obtained, the concentration ranged between 0.074-0.705 mg/L values below the WHO guideline value of 50 mg/L and if exceeded it is regarded as one of the causes of methamoglobin-anaemia (Blue Baby Syndrome) in infants as well as a potential risk of stomach cancer in adults. High concentration of nitrate in both surface and shallow groundwater can probably due to poor sanitation and latrine construction, fertilizer and other agrochemical use.

Sulphate does not have a health-based guideline value. The sulphate value obtained ranged between 0.64-68.24 mg/L however the WHO recommends that a concentration higher than 450 mg/L is unhygienic due to problems to the gastro intestinal tract. All the water samples collected have their Sulphate values lower than the limit. This may be attributed to the depth and the concrete slab on which prevent abattoir effluents having access into them.

The concentration of Cu obtained ranged between 0.01-0.03 mg/L. Isolu stream has the highest value of 0.03 mg/l while 5 other points making up 70% has the lowest value of 0.01 mg/L (Figure 10). All the results are below the WHO standard of 1.0 mg/L.

Iron concentration in the collected samples ranged between 0.46-4.96 mg/L (Figure 11) and it is above the maximum contaminant levels of the iron content based on WHO of 0.3 mg/L. This implies that if the abattoir discharges its wastewater into other water bodies used for drinking purposes downstream, it could be a contaminant and hence, hazardous to human health. Despite not being a health concern, high concentration of iron affects the quality of water, leading to bad taste and colouration of cooking utensils and food. There is no noticeable taste at iron concentration below 0.3 mg/l, although turbidity and colour may develop. This high iron content may probably be attributed to influx of waste blood may be carried by runoff and deposited into the streams, shallow wells and boreholes.

The concentration of Zinc ranged between 0.02-0.09 mg/L, In the month of May, Asero 1 has the lowest concentration of Zinc of 0.02

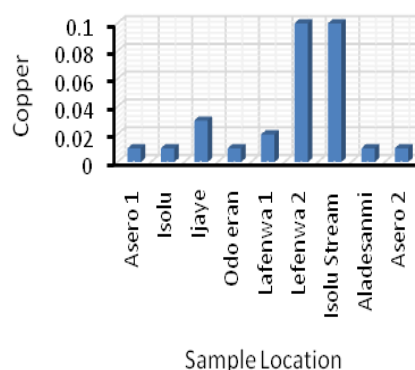


**Figure 10:** The copper level of the Sample water.

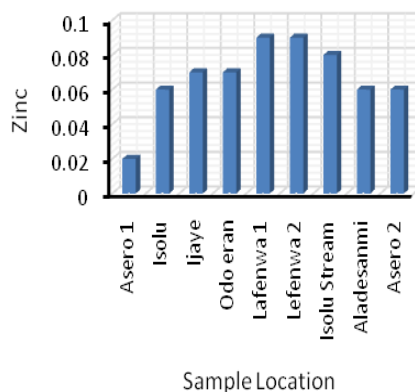
mg/L while Lafenwa 1 and Lafenwa 2 have the highest concentration of Zinc (0.09 mg/L) respectively (Figure 12), all of which was within the permissible limit of the WHO standard of 1.5 mg/L. They are within the range reported for African inland waters.

The concentration of Lead found in the water samples from the water sample range from 0.03-0.19 mg/L and it exceeded the permissible WHO limit of 0.1 mg/L, thus, it could be attributed to dilution from the dump site and discharging of abattoir effluent into the water bodies (Figure 13).

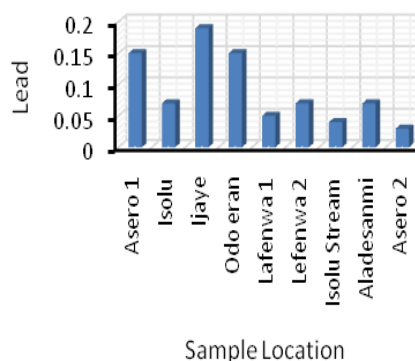
The presence of total coliform provides evidence of recent faecal contamination and the detection should lead to further action. It is



**Figure 11:** The Iron level of the Sample water.



**Figure 12:** The Zinc level of the Sample water.



**Figure 13:** The Lead level of the Sample water.

present in high number in human and animal faeces and rarely found in the absence of faecal pollution. From the TFC values obtained from (Figure 14). Ijaiye abattoir has the highest value of 300 cfu/ml while lafenwa 1 has the lowest value of almost nil. The presence of coliform reveals regrowth and possible biofilm function or contamination. They occur in both sewage and natural wastes and can also be excreted with human and animal faeces. WHO (2006) recommends zero values for total coliform. However, none of the water samples taken are free from these bacteria Lafenwa 1. This implies that there is possibility of additional pollutants from humans operating within and around the abattoir thus the drainage outside the abattoir is more polluted than that within the abattoir. This result corroborates Coker et al. that abattoir wastewater is heavily polluted regardless of the point from which it is taken from [3].

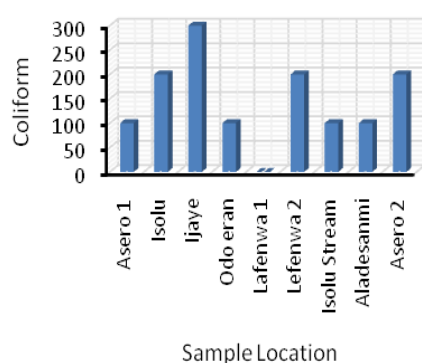
## Conclusion

The major source of surface and groundwater pollution is indiscriminate discharge of untreated abattoir effluents directly into the ground surface or the surface water bodies resulting in serious surface and groundwater contamination. This loss of water quality is causing health hazards and death of human beings. This problem is aggravated by inadequate awareness, scarce financial resources, lack wastewater treatment facilities, and the inefficient ineffective environmental laws. The concentration of the heavy metals verification like Cd, Pb, Cu reported above indicate that there is significant difference in the concentration of the pollutants taken at different sample points. Furthermore, the concentration of heavy metals in the sample water was discovered to be significantly higher than the permissible limits of WHO standard, 2006. Although some of the results like EC and TDS are slightly in line with permissible limits of WHO standard, 2006. However, our environment is under threat if the present habit of discharging untreated abattoir wastes continues. The toxic level of harmful materials can aggravate due to the continuous generation of the effluents. This calls for concern, as most of the analysed values were above the recommended standards, which obviously signals danger to human health and that of plants life. Residents living in abattoir vicinity may in no distant time begin to experience severe consequences of pollutants from abattoir activities located in their neighbourhood. It was also found out that the shallow wells water quality in area of Abeokuta abattoir is being contaminated due to the discharge of the effluents from animal processing into the land surface, channels and surface water and eventually finds its way to the groundwater source. This is because of soil porosity, permeability and also the rocks nature of Abeokuta which permits easy movement of ground and surface water. From the analyses, it will be logical to say that the abattoir effluent from

the production meat has its impact on the quality of both the shallow well and river water in the sampling site of the study area (Abeokuta).

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**Figure 14:** The TFC level of the Sample water.