Global Scientific JOURNALS

GSJ: Volume 7, Issue 12, December 2019, Online: ISSN 2320-9186

www.globalscientificjournal.com

IMPACT OF BREWERY EFFLUENT AND CORELLATION BETWEEN PHYSICO-CHEMICAL PARAMETERS AND HEAVY METALS IN OMI-ASORO STREAM FROM ILESA, OSUN-STATE, NIGERIA

[1]IBITOYE, Damilola Kingsley, [1*]IPEAIYEDA A. R., [2]ADEGOKE ADETOMI, [3]ADEYEYE SEUN & [4] ES0, Idowu J.

ibitsdamshow@yahoo.co.uk

[1, 1, 2 & 3] (Department of Chemistry, University of Ibadan, Nigeria). [4] Chemistry, Federal University of Technology, Akure, Nigeria)*

© GSJ

ABSTRACT

In view of assessing the effect of industrial effluent discharges on the water quality of the Omi-Asoro stream at Ilesa, by the International Breweries Plc, water samples were analysed for physicochemical parameters. Physicochemical parameters of the water samples were determined using standard analytical procedure. Heavy metal concentrations in water were analysed using Atomic Absorption Spectrophotometric technique. The results revealed that Omi-Asoro stream has the following mean characteristics: 6.6 ± 0.2 (pH), 156 ± 18 mg/L (TDS), 2960 ± 4200 mg/L (TSS), 3120 ± 4200 mg/L (TS), 3.7 ± 3.8 FTU (turbidity), 154 ± 43 mg/L (alkalinity), 30 ± 14 mg/L magnesium hardness, 31 ± 7.8 mg/L calcium hardness, 61 ± 11 mg/L (total hardness), 3.4 ± 2.5 mg/L (DO), 14.6 ± 5.5 mg/L (BOD), 1180 ± 300 mg/L (COD), 7.0 ± 1.4 mg/L (Cl^-), 1.1 ± 0.3 µg/mL (NO_3^-), 0.5 ± 0.3 µg/mL (PO_4^{3-}) and 110 ± 40 mg/L (SO_4^{2-}). The Pearson correlation, t – test and ANOVA were performed on the results obtained.

The result obtained for physicochemical parameter of the stream revealed that, all the parameters fall within the water quality standard set by WHO, FEPA and the levels were below the maximum permissible limit of other international water quality standard. There was an exception for TSS, and TS whose levels were above the limit set by WHO for TS 500 mg/L and by FEPA TSS > 10 mg/L and 500 mg/L for TS. The DO levels revealed that the stream receives high organic matter from the effluent that causes depression to the average DO level of the stream to 3.4 mg/L which is lower that the limit of 7.5 mg/L set by FEPA for the support of aquatic life. The result obtained for heavy metals concentrations in water revealed that some of the metals were below the maximum permissible limit set by WHO, FEPA and other international water quality standard , with exception of manganese with average level of 2.37 ± 0.85 mg/L that is

higher than the maximum permissible limit set by WHO of 0.4 mg/L, also lead (Pb) exceeded the set limits with the average level of 0.03 ± 0.01 mg/L which is higher than 0.015 mg/L limit by USEPA and 0.01 mg/L limit set by WHO.
Key words: Brewery Effluent, Correlation, Physico-chemical parameters, Heavy metals, Omi-Asoro Stream.

INTRODUCTION

The importance of water resources, particularly surface waters (rivers), in meeting the water needs of humans, animals and industries indicates the essential need to protect them against contamination. As municipal, industrial, and agricultural waste enters the water, biological and chemical contaminants including heavy metals also enter water resources. Although some of these metals are essential as micronutrients, their high concentration in the food chain can cause toxicity and environmental impacts and endanger aquatic ecosystems and their users (Kane *et al*., 2012).

© GSJ

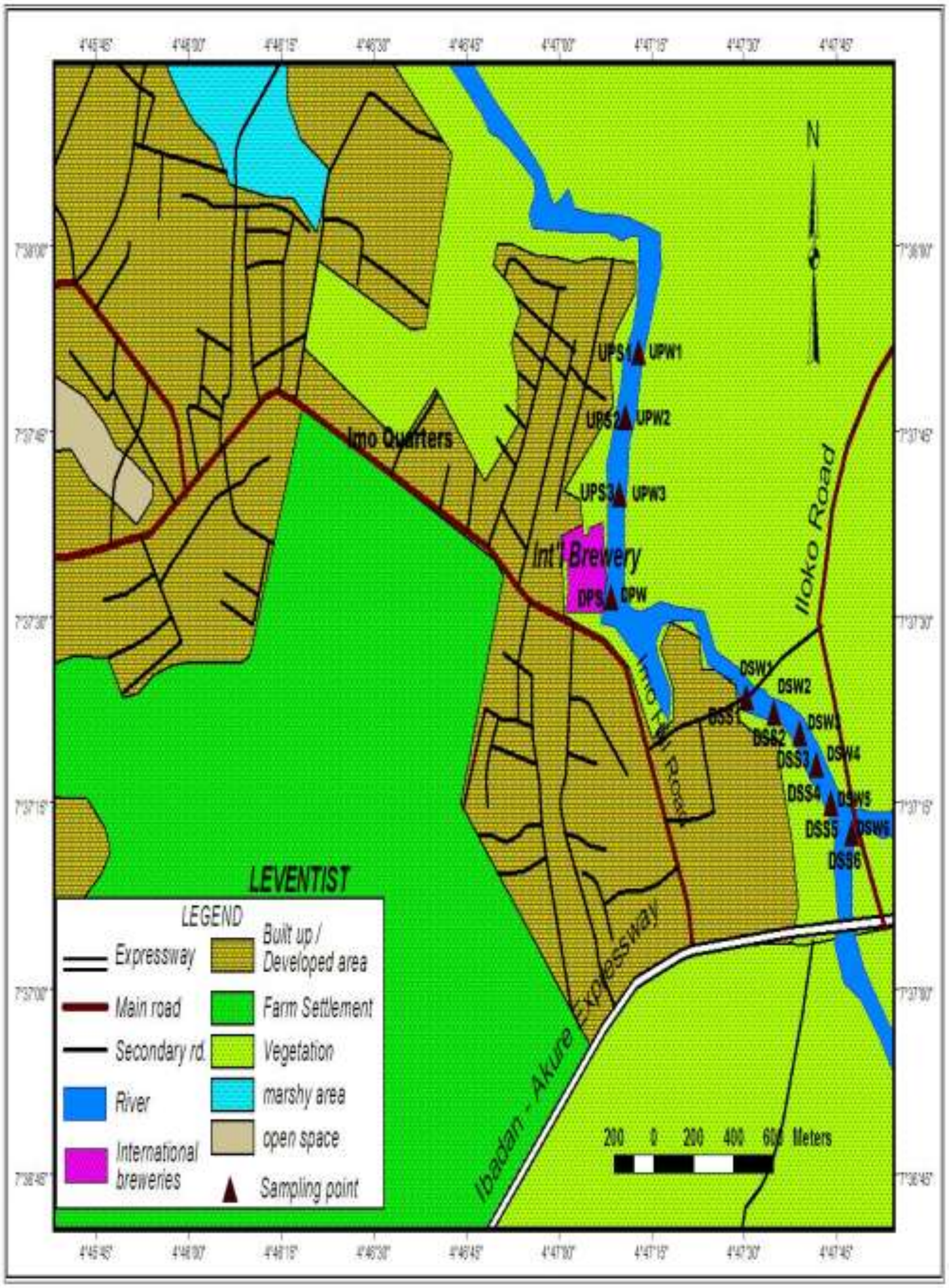
The availability of good quality water is an indispensable feature for preventing diseases and improving of life (Oluduro and Aderiye, 2007). Natural water contains some types of impurities whose nature and amount vary with source of water. Metals for example, are introduced into aquatic system through several ways which include weathering of rocks and leaching of soils, dissolution of aerosol particles from the atmosphere and from several human activities, including mining, processing and use of metal based materials. Metals after entering the water may be taken up by fauna and flora and eventually accumulated in marine organisms that are consumed by human being (Duruibe *et al.*, 2007).

Water the "elixir of life" is a unique liquid without which life on earth will be impossible (Osibanjo 1994; Hart, 2007). If water becomes polluted, its value is lost economically and aesthetically and can become a threat to our health and to the survival of the lives living in it (Nubi *et al*., 2007). The availability of good quality water is an indispensable feature for preventing diseases and improving of life (Oluduro and Aderiye, 2007). Natural water contains some types of impurities whose nature and amount vary with source of water. Metals for example, are introduced into aquatic system through several ways which include weathering of rocks and leaching of soils, dissolution of aerosol particles from the atmosphere and from several human activities, including mining, processing and use of metal based materials. Metals after entering the water may be taken up by fauna and flora and eventually accumulated in marine organisms that are consumed by human being (Asaolu *et al.*, 1997). Pollutants that are deposited in the aquatic environment may accumulate in the food chain and cause ecological damage while also posing a risk to human health (Van den Broek *et al.*, 2002).

DESCRIPTION OF SAMPLING SITE AND STUDY DESIGN

Ilesha (Ilesa) is the largest town and the capital of Ijesha (Ijesa) kingdom in Osun State, Nigeria. It Latitude lies on 8.92°N and Longitude 3.42°E. There were about 600,000 inhabitants which were recorded in 2004 population census. The town has a brewery and other local industries that manufacture nails, carpet, vegetable oil and pure water factory. There are also publishing and recording firms. There are prominent quartzite ridges which lie east of Ilesa where gold mining activities takes place, this place is known as the Iperindo goldfield. Omi-Asoro stream is located within Ilesa-East Local Government of Osun State, South Western Nigeria. The town is a fast growing agricultural community apart from having the tendency of becoming a better business environment. Water from this stream is used for drinking, agricultural, domestic and industrial purposes especially the brewery in the area. This present study will provide useful reports on the level of heavy metals on the water quality of Omi-Asoro stream that receives effluent from the International Breweries Plc. located in Ilesa. This will be able to serve as a set of data for future inquiry.

© GSJ


N
UPS1 UPW1
UPS2 UPW2
UPS3 UPW3
Imo Quarters
Int'l Brewery
DPS DPW
Iloko Road
Imo Hill Road
DSW1
DSW2
DSS1
DSS2
DSW3
DSS3
DSW4
DSS4
DSW5
DSS5
DSW6
DSS6
LEVENTIST
Ibadan - Akure Expressway
LEGEND
Expressway
Main road
Secondary rd.
River
International breweries
Built up / Developed area
Farm Settlement
Vegetation
marshy area
open space
Sampling point
200 0 200 400 600 Meters

MATERIALS AND METHODS

Sampling

For the purpose of this study, the section of the stream was segmented into three namely upstream, discharge point and downstream.

Upstream – Three sampling points were denoted UPW 1, UPW 2 and UPW 3 respectively. Water samples from these points were denoted UPW 1, UPW 2 and UPW 3. Water for heavy metals was also collected at each point.

Discharge point – The point at which the waste water is being discharged to the stream through concrete cement pipe is regarded as the discharge point. The pipe is laid underground from the premises of breweries into the stream that is receiving the wastewater just at the back of the brewery fence. This point was designated as DPW for the water sample.

Downstream – Six sampling points were located along the stream. They are denoted as DSW 1, DSW 2, DSW 3, DSW 4, DSW 5 and DSW 6 for water sample.

All the sample containers were pre-washed with tap water and soapless detergent. The containers were then rinsed with plenty of deionised water. The containers were then soaked in 3M nitric acid for 48 hours and later washed and rinsed with distilled water. The containers were then inverted and allowed to stand overnight to drain out water completely before employing them for sampling.

© GSJ

Ten water samples were collected for physicochemical analysis. The water samples for physicochemical analysis were collected using one liter (1L) plastic containers. While those for heavy metals analysis were collected with (1L) plastic containers already rinsed with (1:1) HNO_3 acid. The samples were acidified with HNO_3 to pH 2. The HNO_3 acid prevents the growth of moulds and release of all metals present in the water for analysis. Samples for dissolved oxygen (DO) analysis were collected using dissolve oxygen bottles, and the oxygen were fixed immediately on the field using manganous solution and strong alkali azide reagent. The samples were filled to the brim with water to prevent atmospheric oxygen from the surface of the water. Temperature and pH of water samples were also measured at the time of collection.

Water Samples Preparation

Digestion of water samples for heavy metal analysis was achieved with concentrated nitric acid. The samples were shaken vigorously after which 200mL was measured into a clean beaker. 4mL of concentrated nitric acid was then added and the resulting solution was evaporated to about 8mL. The solution was then filtered into a 25mL volumetric flask; the digest was then made to mark with distilled water. The blank sample was also subjected to similar treatment. The concentration of heavy metals in the digested samples was then determined by means of an AAS machine. Flame Atomic Absorption Spectrophotometer (AAS) was employed for the measurement of the absorbance of the heavy metals. (Model: VGP210)

Statistical Analysis

All data generated were analyzed statistically by calculating mean, standard deviation, Anova and correlation.

RESULTS AND DISCUSSION

The Physico-Chemical parameters obtained from analysis of water sample form Omi-Asoro stream in Ilesa were presented (Table 1 and Table 2). In all water samples, the pH of the Omi-Asoro stream was ranged from 6.4 to 6.9, with a mean value of 6.6 ± 0.2. The result indicated that the Stream water is slightly acidic and falls within the limits of the USEPA and FEPA guideline for drinking water of 6.5 to 8.5, and this also falls within the brewing standard of 6.5 to 7.0 This suggests that the wastes from the industry which eventually find their way into the Omi-Asoro stream are acidic in nature (Table 3). The pH values were lower than those obtained for Iya-Alaro stream, Nasarawa stream, Kaduna and compared well with that of Shasha stream in Nigeria (Table 6). A statistical correlation between pH and other physicochemical parameters indicates that, the pH showed a relative moderate positive correlation with TDS and alkalinity ($r = 0.579$ and 0.605) at $p<0.01$. (Table 7)

On the average, TDS level of 156 ± 18 mg/L was obtained which is lower than the USEPA guideline for drinking water of 500 mg/L, brewing and food beverage industry standard of less than 800 mg/L. But, this is higher than standards for brewing effluent of 92.5 mg/L in Nigeria (Table 4). These levels of TDS are lower than the WHO discharge limits of 1000 mg/L. Based on the United State Geological Survey Water Supply (USGS, 1984), water can be classified on the basis of dissolved solids as follows: <1,000 (fresh); 1,000 - 3,000 (slightly saline); 3,000 - 10,000 (moderately saline); 10,000 - 35,000 (very saline) and >35,000 (briny); the stream water could generally be classified as fresh. The TDS level was found to be lower than the TSS level at all the points. In other cases, the TSS was extremely greater than the TDS at point DSW2 which indicates turbulence in the water body during sampling and probably because the suspended solids are largely non-settleable.

© GSJ

The TSS levels recorded in this study is higher than the level recorded by Ajayi and Osibanjo (1982), and Kakulu, (1986) for the Iya-Alaro stream Ikeja, Shasha stream, Nasarawa stream. A statistical correlation between TDS and other physicochemical parameters in the water samples revealed that TDS exhibits a moderate positive correlation with DO and pH and a strong positive correlation with Alkalinity ($r = 0.457$, 0.579 and 0.984 respectively) at $p< 0.01$ for alkalinity and $p<0.05$ for DO and pH. TDS also has a strong negative correlation with chloride in ($r = -0.8646$) at $p<0.05$. (Table 7).

The TSS level ranged from 530 mg/L to 14300 mg/L. The mean TSS level was 2960 ± 4200 which was far higher than the FEPA limit of >10 mg/L for suspended solids in drinking water (Table.3). The TSS level for all the sampling points was found to be higher than that of the recreation limits of 100 mg/L, and the TSS was also higher than those of the brewery effluent limits for Cameroun 740 mg/L, Nigeria 187 mg/L, WHO 30 mg/L, EU 30 mg/L and Indian 20 mg/L(Table 4). The result implies that the stream water is possibly undergoing biodegradation which is increasing the concentration of the solids. Hence, the water cannot be employed for industrial purposes since it may lead to the blockage of industrial spray pipes. A linear correlation between TSS and other physicochemical parameters in the stream water showed that TSS exhibit a moderate positive correlation with Magnesium hardness and high positive correlation with total hardness and very strong positive correlation with TS ($r = 0.507$, 0.643 and 1.00) at $p<0.01$. TSS also shows a moderate negative correlation with COD ($r = 0.667$) at $p<0.001$. (Table 7)

The level of total solids in the water samples ranged from 700 mg/L to 14450 mg/L. The mean level of the total solids for the entire stream water was 3120 ± 4200 which is higher than the FEPA and WHO maximum permissible level of 500 mg/L for total solids in drinking water and those recorded by Osibanjo and Kakulu on the water quality of the Iya-Alaro River of 1500 mg/L for tolerance limit (Table 6). The TS value was also higher than that of Brewing in Nigeria of 280 mg/L and domestic water supply standard, irrigation and industrial food processing of 500 mg/L (Table 4). This further confirms that the Omi-Asoro stream is undergoing self purification. A statistical correlation between TS and other physicochemical parameters in the stream water reveals that the total solids exhibits a positive correlation with magnesium hardness, total hardness and TSS (r = 0.507, 0.642 and 1.00 respectively) at $p<0.01$. TS also shows a moderately strong correlation with COD (r = 0.668) at $p<0.01$. (Table 7).

The average levels of water quality parameters at the discharge point, upstream and downstream locations of the stream are presented in (Table .2). Pollution levels were observed to be higher at the effluent discharge point than that of the upstream and downstream of the stream. This is deduced from the average levels of water quality parameters at the discharge point being irregularly higher than the corresponding levels at upstream and downstream locations (Table 2). The effluent was characterised by considerable pollutant of suspended matter, dissolved matters and low values of turbidity and high COD. The overall average levels of these parameters at the discharge point were much higher than the available discharge standards stated by WHO, European discharge standards and proposed discharge standards set for India (Table 4). The overall average pH level was 6.6 ± 0.2 with a range of 6.3 to 6.9. Most of the pH levels of the effluent during the study were below the industrial effluent discharge limits of 6.5 to 9.5 (Table 4). The low pH value is due to acidic discharges (i.e. beer and by-products) resulting from beer production. Thus, the effluent is acidic and has the potential to acidify the river water. The overall turbidity of the effluent ranging from 0.6 FTU to 11.6 FTU may indicate the level of TSS in it, particularly at such high solid concentration. Turbidity does not directly correlate with suspended concentration because colour can sometimes interfere with its measurement; nonetheless it affords a relative indication of solid levels. Apart from high organic content of brewery effluent, spent wash generated from the fermentation step also contains nutrients in the form of nitrogen. Spent wash is the dark brown distillery wastewater generated during the fermentation step of beer production (Satyawali and Balakrishnan, 2008).

Heavy Metals concentrations in water at the discharge point along Omi Asoro stream

The average levels of heavy metals in water at the discharge point, upstream, downstream locations of the stream are presented in (Table 8). No substantial levels of heavy metals were detected as expected in the effluent entering the stream since the average level of the metal such as Cr, Cd, Pb, Ni, falls within the range of metal concentrations in upstream and downstream. The level of Mn and Zn at the discharge point (1.1 mg/L and 0.16 mg/L) and this was in fact less than the average level at the upstream (2.0 ± 0.20 mg/L and 0.1 ± 0.05 mg/L) and (2.8 mg/L ± 0.8 mg/L) downstream points of the stream.

Variation in the Heavy Metal levels of Omi Asoro Stream Water

Then mean cadmium level obtained in this study were 0.002 ± 0.001mg/L. (Table 8). The average concentration of cadmium in water was found to be lower than the maximum permissible limit of United State Environmental Protection Agency (USEPA) water quality standard of 0.005 mg/L, World Health Organization (WHO) limit of 0.003 mg/L and the Federal Environmental Protection Agency (FEPA) maximum permissible limit of 0.01 mg/L (Table 9). A linear correlation between cadmium and other heavy metals in the Omi Asoro stream exhibits a strong positive correlation with cobalt (r = 0.787) and no correlation with chromium (0.255) at p<0.01 level (Table 10). ANOVA showed that F statistical (0.456) is less than F critical (4.756) for the concentration of cadmium at the upstream, discharge point and downstream. Hence there is no significant difference in the distribution of the metal.

The cobalt levels ranged from < 0.007 mg/L to 0.01 mg/L for the Omi Asoro stream (Table 8). The average concentration of cobalt in the stream was found to be extremely low in comparison with the Canadian water quality criteria for aquatic fresh water (CQC) with permissible limit of 0.05mg/L, WHO and USEPA have not proposed any guideline standards for Co in drinking water (Table 9). A linear positive correlation exists between cobalt and other heavy metals in the Omi Asoro stream water and cobalt exhibits a moderate positive correlation with manganese (r = 0.648) and a weak correlation with chromium (r = 0.324) at p<0.01(Table 10). ANOVA showed that F statistical of (2.338) is less than F critical of (4.737) for the concentration of cobalt at the upstream, discharge point and downstream of the stream. Hence there is no significant difference in the distribution of the metal.

The WHO and FEPA maximum permissible limits for nickel (Ni) in drinking water is 0.02 mg/L and 0.05 mg/L. The level of nickel in Omi Asoro stream was with an average level of 0.012 ± 0.004 mg/L with range 0.01 mg/L to 0.02 mg/L. This was found to be within these limits. On further comparison with the India proposed discharge standard of 1.0mg/L, the level of Ni in the present study is low (Table 9). A linear positive correlation exist between nickel and other heavy metals in the Omi Asoro stream water and it indicates that nickel exhibits a strong positive correlation with manganese, lead and zinc (r = 0.792, 0.875 and 0.889 respectively) and a moderate correlation with chromium (r = 0.672) at $p<0.01$ in (Table 10). ANOVA showed that F statistical of (0.7) is less than F critical of (4.737) for the concentration of nickel at the upstream, discharge point and downstream of the stream. Hence there is no significant difference in the distribution of the metal.

Zinc is sourced from industries involved in smelting, electro galvanizing, mining, metallurgy and in the production of pesticides, rubber and plastics of various alloys. Zinc is also present in mixed effluents; dungs, poultry droppings and fertilizer. The level of zinc (Zn) in the Omi Asoro water ranged from 0.04 mg/L to 0.35 mg/L with average level of 0.2 ± 0.1 mg/L, this fell within the maximum permissible limits of FEPA, USEPA and WHO drinking water of 5.0 mg/L, 0.5 mg/L and 3.0 mg/L. This also fell within the proposed discharge standards for India which is 5.0mg/L (Table 9). Level of zinc (0.2 mg/L) in the present study is comparable to the Zn level of (0.174mg/L) obtained by (Oguzie and Okhagbuzo, 2009) on Ikpoba river which has also received effluent discharges. A linear positive correlation exists between zinc and other heavy metals in the Omi Asoro stream water and zinc exhibits a very strong positive correlation with lead and chromium (r = 0.945 and 0.819 respectively) and a strong positive correlation with manganese (r = 0.768) in (Table 10). ANOVA showed that F statistical of (1.288) is less than F critical of (4.737) for the concentration of zinc at the upstream, discharge point and downstream of the stream water. Hence there is no significant difference in the distribution of the metal.

The level of lead (Pb) in the Omi Asoro stream ranged from 0.02 mg/L to 0.04 mg/L with an overall average of 0.03 ± 0.01 mg/L. Comparison of the average level of lead with WHO and USEPA water quality standards of 0.01 mg/L and 0.015 mg/L respectively showed that, the level of lead in Omi Asoro stream is high. The permissible limit for Pb in the Canadian water quality criteria (CQC) for aquatic fresh water is 0.017 mg/L, the level of lead in Omi Asoro stream is still higher than this limit. However, the lead level obtained in the study is still lower than the 0.1 mg/L discharge limit for the proposed India discharge standards (Table 9). A linear positive correlation exists between lead and other heavy metals in the Omi Asoro stream water and lead exhibits a moderate positive correlation with chromium and manganese (r = 0.687 and 0.655 respectively) at $p<0.01$ in (Table 10). ANOVA showed that F statistical of (1.135) is less than F

© GSJ

critical of (4.737) for the concentration of lead at the upstream, discharge point and downstream of the stream water. Hence there is no significant difference in the distribution of the metal.

The level of chromium (Cr) ranged from < 0.01 mg/L to 0.02 mg/L with average values of 0.01 $\pm$ 0.01mg/L in water. The level of chromium in Omi Asoro stream is less than the WHO, FEPA and CQC maximum permissible limits of 0.05 mg/L (Table 9). A linear positive correlation exists between chromium and other heavy metals in the Omi Asoro stream water and it exhibits a strong positive correlation with manganese ($r = 0.750$) at $p<0.01$ in (Table 10). ANOVA showed that F statistical of (1.135) is less than F critical of (4.737) for the concentration of chromium at the upstream, discharge point and downstream of the stream water. Hence there is no significant difference in the distribution of the metal.

Manganese (Mn) level in water ranged from 1.1 mg/L to 4.31 mg/L with an average level of 2.37 $\pm$ 0.85 mg/L. This level is found to be far above the WHO maximum permissible limit of 0.4 mg/L in drinking water. Manganese level ranged from 0.1 mg/L to 0.18 mg/L reported by (Abdo and Nasharty, 2010) for Ismailia Canal in Egypt, and this level is lower than the level obtained in this study. Manganese does not show correlation with any metal. ANOVA showed that F statistical of (2.884) is less than F critical of (4.737) for the concentration of manganese at the upstream, discharge point and downstream of the stream water. Hence there is no significant difference in the distribution of the metal

Conclusion

The relative abundance of the heavy metals in water are: Mn>Zn>Pb>Cr>Ni>Co>Cd. However, this as shown that there is no significant difference in the distribution of these metals in water. The levels obtained may not presently result in any deleterious or harmful effect, however, further discharge of the said metals from any source, in any of the points examined may have dangerous effects on the surrounding environment. This study revealed that Omi-Asoro stream was among the most vulnerable of water bodies to pollution. The stream Omi-Asoro is a recipient of effluent from the international brewery of a fair quality that does not meet the stipulated minimum requirement for discharge into surface water. Effluent from this brewery has a high organic load of matter which inevitably leads to the deterioration and pollution of the receiving Omi-Asoro stream. This constitutes a considerable factor of pollution that has an impact on the physicochemical characteristics of the stream. The level of parameters responsible for water quality downstream were significantly higher than upstream which serves as the control, except for TDS of 180 mg/L obtained upstream and 147 mg/L downstream and alkalinity of 215 mg/L obtained upstream and 129 mg/L downstream. Therefore, the elevation in levels of indicator parameters downstream subsequently render the stream water unwholesome for intended beneficial purposes, such as cooking, drinking, irrigation and aquatic life support. (Ipeaiyeda and Oniawa, 2009)

Recommendations

There is the need for more research on surface water in Nigeria so as to ascertain whether the levels of pollutants are still within permissible limits due to increased urbanization and industrialization. The pollutants to be determined should include more heavy metals, pesticides, polychlorinated biphenyls and other persistent organic pollutants in the study area because of the farmer in the study area who might be using fertilizer that could pollute the stream, sediments, soils and other aquatic plants and animal in this environment. Although there is the need to carry out further investigations with respect to other pollutants particularly organic pollutants in this area. There is a need for close monitoring of the stream such that not just anybody is allowed into the stream for any activity, because such people may be source of pollution. Aside the pollution obtained, the stream water can still serve as a good source of potable water if it can be properly treated for the community around the international brewery.

© GSJ

Table 1: Levels of physicochemical parameters of water samples from Omi-Asoro Stream, Ilesa.

Parameters	UPW1	UPW2	UPW3	DPW	DSW1	DSW2	DSW3	DSW4	DSW5
pH	6.6	6.8	6.9	6.7	6.6	6.6	6.6	6.5	6.4
TDS (mg/L)	190	170	180	140	150	150	145	145	150
TSS (mg/L)	4810	530	1720	1260	1050	14300	1660	960	2050
TS (mg/L)	5000	700	1900	1400	1200	14450	1805	1105	2200
Turbidity (FTU)	0.6	0.8	3.8	1.1	11.6	6.4	8.0	1.4	3.0
Alkalinity (mg/L)	220	215	210	115	125	130	130	130	130
Mg Hardness (mg/L)	38	26	20	28	16	48	4	28	46
Ca Hardness (mg/L)	24	28	32	26	32	32	52	28	30
Total Hardness(mg/L)	62	54	52	54	48	80	56	56	76
DO (mg/L)	6.1	7.3	6.0	1.2	4.5	2.5	2.7	0.5	0.4
BOD (mg/L)	14.2	13.5	9.7	28.5	16.4	10.3	10.8	17.7	12.1
COD (mg/L)	1040	960	1160	1440	1080	600	1200	1280	1720
Cl^- (mg/L)	5.0	5.6	5.0	7.1	7.1	8.5	9.2	7.1	7.1
NO^{3-} (µg/mL)	0.9	0.8	1.3	0.7	1.3	1.2	1.4	0.7	1.4
PO_4^{3-} (µg/mL)	0.3	0.1	0.8	0.5	0.7	0.6	1.04	0.3	0.6
SO_4^{2-} (mg/L)	76.1	76.1	86.7	124	81.4	101	81.4	198	119

© GSJ

Table 2 Average levels of water quality parameters at Upstream, Discharge point and Downstream along Omi-Asoro Stream, Ilesa.

Parameter	Upstream	Discharge point	Downstream
pH	6.8 ± 0.2	6.7	6.5 ± 0.1
TDS (mg/L)	180 ± 10	140	147 ± 4
TSS (mg/L)	2350 ± 2210	1260	3550 ± 5300
Total solids (mg/L)	2530± 2220	1400	3700 ± 5300
Turbidity (FTU)	1.7 ± 1.8	1.1	5.2 ± 4.2
Alkalinity (mg/L)	215 ± 5	115	129 ± 2
Total hardness (mg/L)	56 ± 5.3	54	65 ± 13
Ca (mg/L)	28 ± 4	26	34 ± 9.2
Mg (mg/L)	28 ± 9.2	28	31 ± 18
DO (mg/L)	6.5 ± 0.7	1.2	2.3 ± 1.6
BOD (mg/L)	12.5 ± 2.4	29	13.3 ± 3.0
COD (mg/L)	1053 ± 101	1440	1200 ± 363
Cl^- (mg/L)	5.2 ± 0.4	7.1	7.8 ± 0.9
NO_3^- (µg/ml)	1 ± 0.3	0.7	1.1 ± 0.3
PO_4^{3-} (µg/ml)	0.4 ± 0.3	0.5	0.6± 0.3
SO_4^{2-} (mg/L)	80 ± 6.1	124	122 ± 46

© GSJ

GSJ: Volume 7, Issue 12, December 2019
ISSN 2320-9186

Table 3 Caparison of the average levels of Omi-Asoro Stream, with water quality standards.

Physicochemical Parameters	Mean±SD (This study)	Range	*FEPA	*WHO	**USEPA	**
pH	6.6 ± 0.2	6.4 - 6.9	6.5 – 8.5	-	6.5 – 8.5	
TDS (mg/L)	156±18	140 - 190	-	-	500	
TSS (mg/L)	2955±4200	530 - 14300	>10	-	-	
TS (mg/L)	3120±4200	700 – 14450	500	500	-	
Turbidity (FTU)	3.7±3.8	0.6 – 11.6	1	-	-	
Alkalinity (mg/L)	154±43	130 - 220	-	-	-	
Mg Hardness (mg/L)	30±14	4 - 48	-	-	-	
Ca Hardness (mg/L)	31±7.8	24 - 52	-	-	-	
Total Hardness(mg/L)	61±11	48 – 80	200	-	-	
DO (mg/L)	3.4±2.5	0.4 – 7.3	7.5	-	-	
BOD (mg/L)	14.6±5.5	9.7 – 28.5	0	-	-	
COD (mg/L)	1180±300	600-1720	-	-	-	
Cl^- (mg/L)	7.0±1.4	5.0 – 9.2	250	-	250	
NO^{3-} (mg/L)	1.1±0.3	0.7 – 1.4	10	50	10	
PO_4^{3-} (mg/L)	0.5±0.3	0.1 – 1.04	>5	-	-	
SO_4^{2-} (mg/L)	110±40	76 – 198	500	-	250	

© GSJ

Table 4. Comparison of the quality of effluent discharged into Omi-Asoro stream and brewery effluent qualities of some countries with some effluent quality standards.

	Effluent discharge into Omi-Asoro Stream		Effluent qualities of some countries		E
Parameters	*Overall average	Range	a Brewery effluent in Yaounde, Cameroun	b Brewery effluent in Benin, Nigeria	c WHO Disc limits
pH	6.6 ± 0.2	6.4 – 6.9	4.9–4.2	6.41	6.5–9.5
TS (mg/L)	3120 ± 4200	700 – 14450	–	280	–
TDS (mg/L)	156 ± 18	140 – 190	480 ± 92	92.5	1000
TSS (mg/L)	2960± 4200	530 – 14300	740 ± 115	187	30
Turbidity (FTU)	3.7 ± 3.8	0.6 – 11.6	245 ± 98	150	5
Total hardness (mg/L)	61 ± 11	48 – 80	–	–	–
Alkalinity (mg/L)	154 ± 43	130–220	–	–	–
Cl^- (mg/L)	7.0 ± 1.4	5.0 – 9.2	–	–	–
NO^{3-} (µg/ml)	1.1 ± 0.3	0.7 – 1.4	–	3.2	–
Mg (mg/L)	30 ± 14	4 – 48	–	11.4	–
SO_4^{2-} (mg/L)	110 ± 40	76 – 198	–	–	–
PO_4^{3-} (µg/ml)	0.5 ± 0.3	0.1 – 1.0	–	–	–
DO (mg/L)	3.4 ± 2.5	0.4 – 7.3	–	0.81	–
BOD (mg/L)	14.6 ± 5.5	9.7 – 29	925 ± 82	360	50
COD (mg/L)	1180 ± 300	600–1720	1195 ± 170	729	150
Ca (mg/L)	31 ± 7.8	24–52	–	–	–

© GSJ

Table 5. Comparison of overall average of upstream and downstream levels of Omi-Asoro stream with some water quality standards.

	Omi-Asoro Stream		Water quality sta		
Parameters	Upstream	Downstream	a WHO	b CQC	c FQC
pH	6.8 ± 0.2	6.5 ± 0.1	6.5–9.5	6.5–9.0	6.5–8.0
TS (mg/L)	2530± 2220	3700 ± 5300	–	–	–
TDS (mg/L)	180 ± 10	147 ± 4	<1200	500	–
TSS (mg/L)	2350 ± 2210	3550 ± 5300	–	–	–
Turbidity (FTU)	1.7 ± 1.8	5.2 ± 4.2	5	–	–
Mg (mg/L)	28 ± 9.2	31 ± 18	-	-	-
Ca^{2+} (mg/L)	28 ± 4	34 ± 9.2	–	–	–
Total hardness (mg/L)	56 ± 5.3	65 ± 13	500	–	–
Alkalinity (mg/L)	215 ± 5	129.2 ± 2.0	–	–	–
Cl^{-} (mg/L)	5.2 ± 0.4	7.8 ± 0.9	250	250	200
NO_3^{-} (mg/L)	1 ± 0.3	1.1 ± 0.3	50.0	–	10.0
SO_4^{2-} (mg/L)	80 ± 6.0	122 ± 46	500	500	250
PO_4^{3-} (µg/ml)	0.4 ± 0.3	0.6± 0.3	–	–	0.30
DO (mg/L)	6.5 ± 0.7	2.3 ± 1.6	–	5.5–9.5	≥5.0
BOD (mg/L)	12.5 ± 2.4	13.3 ± 3.0	–	–	
COD (mg/L)	1050 ± 101	1200±370	–	–	≤6.0

© GSJ

Notes: WHO=WHO drinking water guidelines, CQC=Canadian water quality criteria for aquatic freshwater life, FQC=Flemish quality criteria for aquatic freshwater, USEPA=US Environmental Protection Agency.

Table 6. Effect of industrial pollutants on the quality of some Nigerian streams compared to quality parameters for the other Nigerian rivers and Ajayi and Osibanjo o. 1982; Kakulu

Parameters	Iya-Alaro stream, Ikeja	Shasha stream, Ikeja	Nasarawa stream, Kaduna	WHO Recommended limit	Tol
Colour	Coloured variable	Coloured variable	Coloured variable	Colourless	C
Temperature ^{0}C	36.0	36.0	-	-	
pH	11.0	6.5	11.5	7.0 - 8.5	(
Total solids (mg/L)	1150	800	2685	500	
Suspended solids (mg/L)	73	165	145	-	
BOD (mg/L)	80	230	-	-	
COD (mg/L)	330	750	-	-	
Lead (mg/L)	0.06	0.20	-	0.05	
Manganese (mg/L)	0.05	0.16	-	0.05	
Iron (mg/L)	4.9	4.8	-	0.10	

GSJ: Volume 7, Issue 12, December 2019
ISSN 2320-9186

Table 7.Correlation levels of physicochemical parameters of water samples from Omi-Asoro Stream, Ilesa

	pH	*TDS*	*TSS*	*TS*	*Turbidity*	*Alkalinity*	*Mg. Hardness*	*Ca Hardness*	*Tot. Hardness*	*DO*	*BO*
pH	1										
TDS	0.579	1									
TSS	-0.051	-0.014	1								
TS	-0.049	-0.01	1	1							
Turbidity	0.025	-0.31	0.183	0.182	1						
Alkalinity	0.6052	0.9844	-0.06	-0.06	-0.366	1					
Mg. Hardness	-0.477	-0.044	0.507	0.507	-0.476	-0.05	1				
Ca Hardness	0.025	-0.271	-0.02	-0.02	0.6098	-0.261	-0.637	1			
Tot. Hardness	-0.597	-0.247	0.643	0.642	-0.185	-0.247	0.8408	-0.118	1		
DO	0.3883	0.3571	-0.09	-0.09	-0.159	0.3722	-0.126	-0.274	-0.355	1	
BOD	0.0394	-0.318	-0.31	-0.31	-0.242	-0.344	-0.08	-0.39	-0.377	0.406	
COD	-0.379	-0.306	-0.67	-0.67	-0.276	-0.309	-0.008	-0.051	-0.046	-0.32	0.3
Cl	-0.524	-0.846	0.272	0.269	0.4533	-0.832	-0.054	0.619	0.3652	-0.32	-0
NO3	0.0118	-0.042	0.199	0.198	0.7302	-0.095	-0.24	0.628	0.1324	-0.44	-0
PO4	0.0705	-0.293	0.081	0.08	0.7172	-0.351	-0.476	0.772	-0.071	-0.45	-0
SO4	-0.549	-0.535	-0.16	-0.17	-0.401	-0.505	0.3151	-0.283	0.2072	-0.5	0.3

© GSJ

Table 8. Heavy metals concentrations (mg/L) in water at upstream, discharge point and downstream of Omi Asoro stream, Ilesa.

Point	Cd	Co	Ni	Zn	Pb	Cr	Mn
UPW1	0.001	< 0.007	0.01	0.14	0.02	0.013	2.05
UPW2	0.002	<0.007	0.01	0.08	0.02	< 0.01	1.81
UPW3	0.002	0.007	0.01	0.04	0.02	<0.01	2.17
DPW	0.001	< 0.007	0.01	0.16	0.03	< 0.01	1.1
DSW1	0.002	0.007	0.01	0.2	0.03	0.01	2.76
DSW2	0.003	0.01	0.02	0.3	0.04	0.01	3.0
DSW3	0.003	0.01	0.02	0.35	0.04	0.02	4.31
DSW4	0.003	0.007	0.01	0.1	0.02	< 0.01	2
DSW5	0.003	0.008	0.01	0.12	0.02	< 0.01	2.27
DSW6	< 0.001	< 0.007	0.01	0.1	0.02	< 0.01	2.27
Mean±SD	0.002±0.001	0.008±0.001	0.01±0.004	0.2±0.1	0.03±0.01	0.01±0.01	2.37±0.85

Table 9. Comparison of the average level of heavy metals in water from Omi-Asoro stream with water quality standards

Parameters	Overall average	Range	CQC	USEPA	WHO (2004)	FEPA (1991
Cd	0.002±0.001	< 0.001-0.003	-	0.005	0.003	0.01
Co	0.008±0.002	<0.007-0.01	0.05	-	-	-
Ni	0.012±0.004	0.01-0.02	0.025	0.05	0.02	0.05
Zn	0.2±0.1	0.04-0.35	0.03	0.5	3	5
Pb	0.03±0.01	0.02-0.04	0.017	0.015	0.01	0.05
Cr	0.01±0.01	<0.01-0.02	0.05	0.1	0.05	0.05
Mn	2.37±0.85	1.1-4.31	-	-	0.4	-

Table 10. Correlation levels of heavy metals in water samples from Omi-Asoro stream, Ilesa

	Cd	Co	Ni	Zn	Pb	Cr	Mn
Cd	1						
Co	0.787275	1					
Ni	0.450578	0.52648	1				
Zn	0.376168	0.448095	0.888374	1			
Pb	0.368654	0.456504	0.875	0.944566	1		
Cr	0.254619	0.323758	0.67212	0.818638	0.687103	1	
Mn	0.404655	0.647907	0.792116	0.76753	0.654841	0.750407	1

© GSJ

REFERENCES

Ajayi and Osibanjo, O. 1982. Effect of industrial pollutants on the quality of some Nigerian streams compared to quality parameters for other Nigerian rivers.

Ajayi and Osibanjo, O. Kakulu. 1986. Effect of industrial pollutants on the quality of some Nigerian streams compared to quality parameters for other Nigerian rivers.

Asaolu, S. S., Ipinmoroti, K. O, Adeyinowo C. E. and Olaofe, O. 1997. Interrelationship of heavy metals concentration in water, sediments as fish samples from Ondo State coastal Area, Nig. *Afr. J. Sci* 1: 55 – 61.

Duruibe, J. O., Ogwuegbu, M. O. and Egwurugwu, J. N. 2007. Heavy metal pollution and human biotoxic effects. *International Journal of Physical Science* Vol. 2(5), pp. 112-118.

Ipeaiyeda, A. R. and Onianwa, P. C. 2009. Impact of brewery effluent on water quality of the Olosun River in Ibadan, Nigeria. *Chemistry and Ecology* Vol. 25(3), pp. 189 – 204.

Kane, P. Lazo, and A. Vlora, Eds., Ohrid, Macedonia, 2012. Assessment of heavy metals in some dumps of copper mining and plants in Mirdita Area, Albania," in *Proceedings of the 5th International Scientific Conference on Water, Climate and Environment*,

Nubi, O. A., Ajao, E. A. and Nubi, A. T. 2008. Pollution assessment of the impact of coastal activities on Lagos Lagoon, Nigeria. *Science World Journal* 3(2).

Oguzie and Okhagbuzo. 2009. Impact of effluent discharge on Ikopoba River, Benin.

Oluduro, A. O. and Adewoye, B. I. 2007. Efficiency of *moringa Oleifera* seed extract on the *microflora* of surface and ground water. *J. plant Sci.* 6: 438 – 453.

Osibanjo, O. and Hart, B. T. 2007. Australian water quality criteria for heavy metals. *Australian Resources Council Technical Paper* No 77.

Satyawali, Y. and Balakrishman, M. 2008. Waste water treatment in molasses based alcohol Distilleries for COD colour removal: a review. *J. Environ. Manage*. 86 pp. 481-497.

USEPA. 1986. Ambient water quality criteria for bacteria Office of water regulations and standards, Washington, D. C. pp 17.

USEPA. 2000. National water quality inventory. Retrieved Aug. 6, 2003, from http://www.epa.gov/305b/2000report/

USEPA. 1999. Integrated risk information system (IRIS) National centre for environmental assessment Office of research and development Washington DC.

USEPA. 2001. National primary drinking water regulations; arsenic and clarifications to compliance and new source contaminants monitoring final rule federal register 66(14), 6976.

United State Geological Survey Water Supply USGS 1984.

Van den Broek, J. L., Gledhill K. S. and Morgan, D. G. 2002. *Freshwater Ecology Report Department of Environmental Sciences University of Technology, Sydney*. pp. 1-25.

WHO. 1993. Guidelines for drinking-water quality In: Recommendations Vol. 1 WHO, Geneva.

WHO. 1999. Guideline for drinking water quality 2nd edn. Recommendation WHO Geneva. Vol. 1, pp. 30 – 113.

WHO. 2003. *Guidelines for Safe Recreational Water Environments in Coastal and Fresh Waters* WHO, Geneva, Switzerland. Vol. 1, pp. 220.

WHO. 2002. Report.

© GSJ