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*Original Research Article*

# Physico-chemical properties and heavy metals concentration in waste water discharged from two industries in Agbara, Lagos State, Nigeria

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**Olorunfemi Ogundele[1] and Gabriel Olarinde Mekuleyi*[2]**

[1]Department of Chemistry, Faculty of Sciences, Lagos State University, Nigeria
[2]Department of Fisheries, Faculty of Sciences, Lagos State University, Nigeria.

*Corresponding Author Email: gabrielmekuleyi@gmail.com

**The present study investigated some of the important physico-chemical parameters such as pH, total dissolved solids(TDS), alkalinity, dissolved oxygen(DO), total hardness, biochemical oxygen demand(BOD), sulphate, nitrate, chemical oxygen demand(COD), phosphate, chloride, and some heavy metals (Cu, Fe and Zn) in industrial effluents collected from Pharma-Deko and Unilever industries in Agbara, Lagos State, Nigeria. Water samples were collected from three stations in each industry and analyzed using standard methods. The average values ±standard error of physico-chemical parameters of the effluents from Pharma-Deko and Unilever respectively are as follow; alkalinity (17.35 ± 0.87mg/L and 22.74 ± 12.76mg/L), pH (5.69 ± 0.43 and 7.53 ± 0.20), chloride (44.45 ± 13.98mg/L and 108.70 ± 57.02mg/L),TDS (82.98 ± 44.67mg/L and 156.75 ± 59.07mg/L), DO (2.86 ± 1.22 mg/L and 1.12 ± 0.49mg/L), total hardness (43.02 ± 30.94mg/L and113.56 ± 89.79mg/L), BOD (260.80 ± 17.38mg/L and 184.80 ± 17.28mg/L), COD (222.56 ± 191.19mg/L and 159.84 ± 61.79mg/L), sulphate (4.57 ± 0.53mg/L and 26.42 ± 1.34mg/L), nitrate (8.31 ± 3.60mg/L and 10.59 ± 3.42mg/L) and phosphate (0.32 ± 0.01mg/L and 0.99 ± 0.10mg/L). The heavy metal concentrations in the waste water from Pharma-Deko and Unilever respectively are copper (0.03 ± 0.01mg/L and 0.06 ± 0.03mg/L), iron (3.45 ± 1.24mg/l and 6.77 ± 5.26 mg/L), and zinc (0.30 ± 0.24 mg/L and 0.24 ± 0.14mg/l). All the physico-chemical properties of the waste water (except COD and DO) examined in the two industries are lower than WHO and USEPA's maximum permissible limits. Similarly, Zn concentrations in the water sample of both industries as well as Cu concentration in the waste water from Pharma-Deko are below the maximum recommended limit. However, Cu concentration in Unilever waste and Fe concentration in both industries exceeded the maximum recommended limit. The present study has clearly shown that Pharma-Deko and Unilever waste waters had very low level of pollutants as indicated by the physico-chemical properties of the water. However, standard methods of waste water treatment should be maintained by these industries, in order to preclude problems often associated with industrial effluents.**

**Key words**: Industrial effluents, heavy metals, treatment, safety

## INTRODUCTION

The adverse environmental effects associated with waste disposal activities, particularly industrial waste water discharge, have been of great concern. Most of the industries in Lagos, Nigeria are situated along the river banks for easy availability of water and also disposal of the wastes. These wastes contain a wide range of contaminants

such as detergents and heavy metals which immensely affect the physico-chemical properties of water as well as aquatic organisms (Lokhande et al .,2011). Industrial waste is one of the leading cause of pollution of surface and ground water and thus rendered available water non-potable and drinkable (Singare et al., 2011). Natural levels of metals have significantly increased in the last decades with increase in industrial activities. Water contaminations deserve attention due to its environmental hazardous effects, risk to human health and economical damages. Of the wide diversity of pollutants affecting water resources heavy metals are of particular interest due to their strong toxicity even at low concentrations. They have been reported to cause various human health related problems such as cancers, cardiovascular and neurological disease and effects on aquatic life (UNECE, 1995, Lawson, 2011). The study of behaviour of heavy metals may be sensitive indicators for pollution levels in the water environment. Thus accurate determinations of heavy metals and other physical and chemical parameters in aquatic environment are of ultimate importance for water quality monitoring.

Several authors such as Mekuleyi and Fakoya (2017) and Adeboyejo et al. (2013) have documented reports on the status of water bodies around Agbara axis. However, to the best of our knowledge, sampling of effluents directly from reservoir of individual industry in Agbara, particularly Pharma-Decko and Unilever has yet to be reported. The objective of this study therefore, is to investigate some physical and chemical properties and some heavy metal levels of waste water from these two industries.

## MATERIALS AND METHODS

### Study Area

Agbara is located at the West of Ologe Lagoon and north of Badagry Creek, in Lagos State Southwest Nigeria, on Longitude of 2° 42$^{1}$ and 3°23$^{1}$ E, and Latitude of 6°23$^{1}$ and 6°28$^{1}$N (Figure 1). It is an industrial area with various kinds of industries including Pharma-Deko and Unilever.

### Collection of Samples

Waste water effluent samples were collected between may and July 2008, randomly twice in a month from three sampling points (20m apart from one another) in Pharma-Deko (pharmaceutical industry) and Unilever (fine chemical industry) respectively. Samples were collected by following methods described by APHA (2005) and Rahman et al. (2012). Prior to sampling, sample bottles were treated by soaking them in 10% nitric acid for 24 h and rinsed with distilled water. The water samples were collected at a depth of about 20 cm below water surface, into 1 L plastic containers with screw caps. Immediately after sample collection, 5 mL nitric acid(AnalaR grade) were added to the sample to reduce adsorption of metals onto the walls of the plastic (APHA, 2005). All samples were stored in a deep freezer at -10°C. Physico- chemical parameters of biochemical oxygen demand (BOD), total dissolved solid (TDS), pH, dissolved oxygen (D0), total hardness, chloride, sulphate, nitrate, phosphate, chemical oxygen demand and alkalinity were measured in triplicate. pH was measured *in situ* using a pH meter (Metrohm Herisau E520). Dissolved oxygen, alkalinity, sulphate, nitrate, phosphate, chloride and total hardness were determined by titration (Boyd, 1981). Total Dissolved Solids (TDS), chemical oxygen demand (COD) and biochemical oxygen demand (BOD) was determined sequel to APHA (2005). Additionally, samples prepared for metal analysis was carried out following methods of Kamaruzzaman et al.(2011) and Rahman et al. (2012). However, only three metals(Fe, Cu and Zn) were analyzed in this study.

### Sample treatment for metal analysis

Samples were defrosted at room temperature (25°C) and aspired into the flames of an atomic absorption spectrophotometer (Alpha-4 Cathodeon) for heavy metal determination, with values expressed in mg $L^{-1}$(APHA, 2005).

### Statistical analysis

Data were computed using Statistical Package for the Social Sciences, windows version 17.0, (Chicago, USA). Monthly variations in the means values of physico-chemical parameters and heavy metals of water samples in the two industries were determined using t-test and where there is significant variation, use of Fisher's least significant difference separate the means at a level of significance $p < 0.05$.

## RESULTS

Monthly Mean and Standard Deviation of physico-chemical properties of water samples is presented in Table 1. There were significant monthly variation ($p<0.05$) in the most of mean values of the physico-chemical characteristics of the waste water collected from the two industries. However, there were no significant differences ($p>0.05$) in pH and phosphate; and DO of the waste water in the month of May and June, respectively. Similarly, the mean values of DO, nitrate and phosphate, in the month of July were not significantly different ($p>0.05$) in the two industrial sites.

The ranges of the physico-chemical parameters in Pharma-Deko are alkalinity (14.20 ± 0.85mg/L - 20.50 ± 0.90mg/L), DO (0.60 ± 0.35mg/L - 5.12 ± 2.08mg/L), TDS (67.25 ±50.48mg/L - 98.70 ± 38.85mg/L), pH (4.0 ± 0.41 - 7.38 ± 0.44), total hardness (33.41 ± 26.08mg/L - 52.62 ± 35.80 mg/L), chloride (41.14 ± 18.61mg/L - 47.75 ± 9.36mg/L), BOD (227.5 ± 14.90mg/L - 294.10 ± 19.85mg/L),COD (222.15 ± 191.03mg/L - 222.98 ± 191.34mg/L), sulphate (4.27 ± 0.82mg/L - 4.86 ± 0.24mg/L), nitrate (8.04 ± 3.32mg/L - 8.58 ± 3.90mg/L),

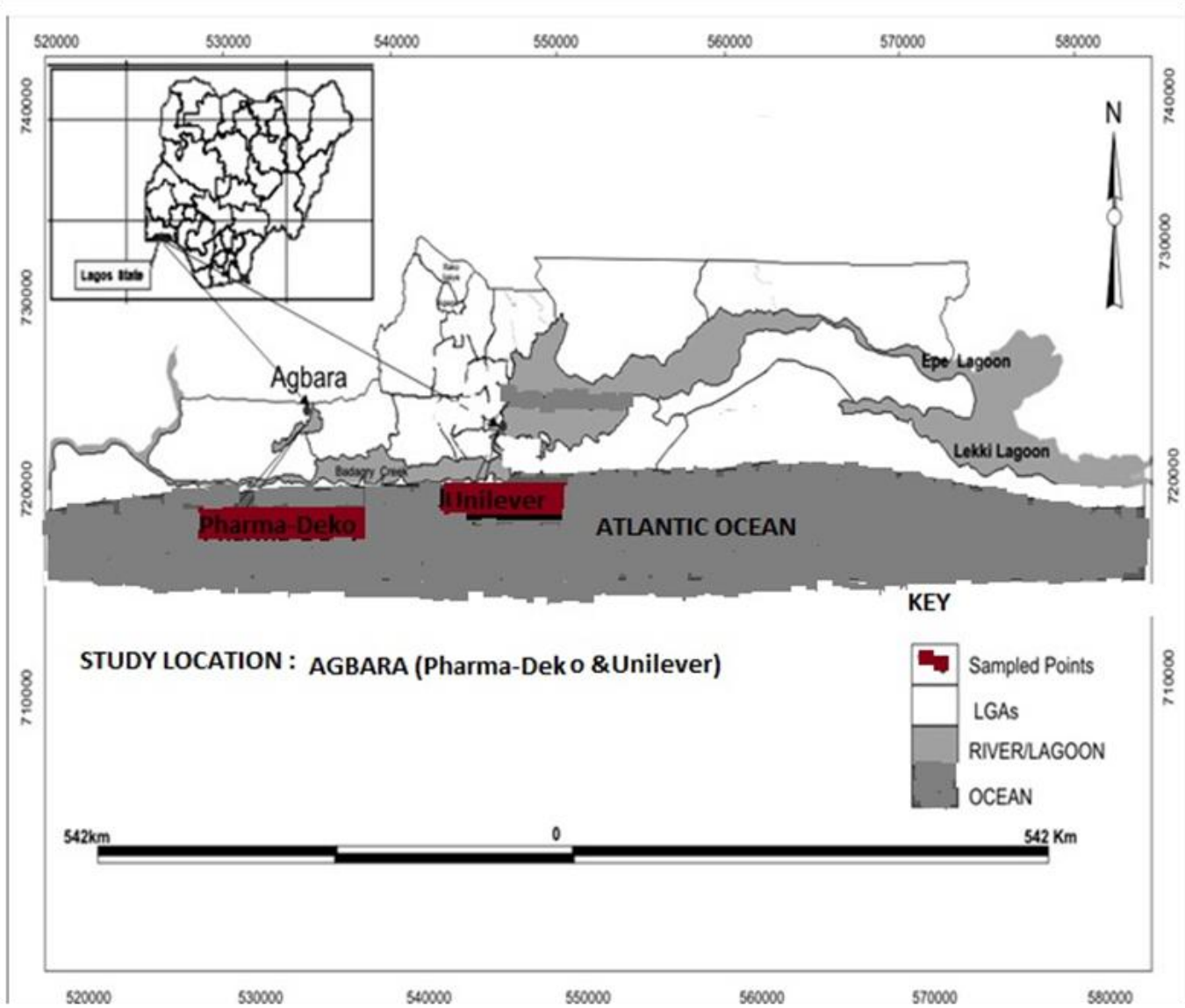


**Figure 1**; Map of the sampling areas(Pharma-Deko and Unilever) in Agbara, Lagos State Nigeria

and phosphate (0.07 ± 0.01mg/L - 0.58 ± 0.01mg/L).Waste water in Unilever had the following ranges of physico-chemical properties, alkalinity (21.63 ± 12.73mg/L - 23.85 ± 12.78mg/L), DO (0.58 ± 0.06mg/L - 1.65 ± 0.92mg/L), TDS (131.75 ± 46.44mg/L - 181.75 ± 71.69mg/L), pH (7.31 ± 0.37mg/L - 7.74 ± 0.01mg/L), total hardness (96.55 ± 68.38mg/L -130.56 ± 111.2mg/L), chloride (75.24 ± 27.34mg/L - 142.16 ± 86.71mg/L), BOD (182.90 ± 14.70mg/L - 186.70 ± 19.85mg/L), COD (127.30 ± 70.83mg/L - 192.38 ± 52.75mg/L), sulphate (10.31 ± 2.08mg/L - 42.54 ± 0.60mg/L), nitrate (6.65 ± 2.54mg/L – 14.53 ± 4.30mg/L), and phosphate (0.45 ± 0.18mg/L - 1.52 ± 0.03mg/L). Comparatively, the mean values of DO, BOD and COD are greater in the waste water from Pharma-Deko than Unilever. On the contrary, mean values of alkalinity, TDS, pH, total hardness, chloride, sulphate, nitrate and phosphate of the waste water in Unilever are greater than Pharma-Deko waste water.

The average values of physico-chemical parameters of the waste water from Pharma-Deko and Unilever respectively are alkalinity (17.35 ± 0.87mg/L and 22.74 ± 12.76mg/L), pH (5.69 ± 0.43 and7.53 ± 0.20), chloride (44.45 ± 13.98mg/L and 108.70 ± 57.02mg/L), TDS (82.98 ± 44.67mg/L and 156.75 ± 59.07mg/L),DO (2.86 ± 1.22 mg/L and 1.12 ± 0.49mg/L), total hardness(43.02 ± 30.94mg/L and 113.56 ± 89.79mg/L), BOD (260.80 ± 17.38mg/L and 184.80 ± 17.28mg/L), COD (222.56 ± 191.19mg/L and 159.84 ± 61.79mg/L), sulphate (4.57 ± 0.53mg/L and 26.42 ± 1.34mg/L), nitrate (8.31 ± 3.60mg/L and 10.59 ± 3.42mg/L) and phosphate (0.32 ± 0.01mg/L and 0.99±0.10mg/L).

The levels of the three heavy metals (Cu, Fe and Zn)

Table 1. Mean and Standard Deviation of Physico-Chemical Parameters of Waste Water in Pharma-Deko and Unilever in Agbara, Lagos, Nigeria

| Parameter | May | | June | | July | |
|---|---|---|---|---|---|---|
| (mg/L) | PD | UN | PD | UN | PD | UN |
| Alkalinity | 14.20 ±0.85 | 21.83±6.81 | 19.90 ±7.04 | 21.63±12.73 | 20.50 ±0.90 | 23.85±12.78 |
| DO | 5.12 ±2.08 | 1.65±0.92 | 0.77±0.60[a] | 0.67 ±0.16[a] | 0.60 ±0.35[a] | 0.58±0.06[a] |
| T DS | 67.25±50.48 | 181.75±71.69 | 96.75±38.78 | 131.75±46.44 | 98.7±38.85 | 142.00±23.26 |
| pH | 7.38±0.44[a] | 7.74±0.01[a] | 5.29±0.21 | 7.55±0.76 | 4.0±0.41 | 7.31±0.37 |
| Hardness | 33.41±26.08 | 97.42±53.66 | 50.22±41.41 | 96.55±68.38 | 52.62±35.80 | 130.56±111.23 |
| Chloride | 41.14±18.61 | 142.16±86.71 | 46.90±8.19 | 105.84±46.83 | 47.75±9.34 | 75.24±27.34 |
| BOD | 294.10±19.85 | 186.7 ±19.85 | 274.8±16.65 | 185.3 ±17.89 | 227. 5±14.90 | 182.9 ±14.70 |
| COD | 222.15±191.03 | 192.38±52.75 | 222.86±191.22 | 174.96±69.10 | 222.98±191.34 | 127.30±70.83 |
| Sulphate | 4.27±0.82 | 42.54±0.60 | 4.57±0.10 | 10.31±2.08 | 4.86 ±0.24 | 10.66±6.85 |
| Nitrate | 8.04 ±3.32 | 14.53±4.30 | 8.36 ±4.45 | 6.65±2.54 | 8.58±3.90[a] | 8.64±4.52[a] |
| Phosphate | 0.07±0.01[a] | 0.45±0.18[a] | 0.52±0.01 | 1.52±0.03 | 0.58±0.01[a] | 0.60±0.09[a] |

PD = Pharma-Deko, UN =Unilever, Values with no superscript = significantly different

**Table 2**. Mean and Standard Deviation of Heavy metals concentration of Waste Water in Pharma-Deko and Unilever in Agbara, Lagos, Nigeria

| Heavy Metals | May | | June | | July | |
|---|---|---|---|---|---|---|
| (mg/L) | PD | UN | PD | UN | PD | UN |
| Copper | 0.04±0.01[a] | 0.05±0.02[a] | 0.01 ±0.01[a] | 0.06±0.03[a] | 0.02±0.01 [a] | 0.05±0.02[a] |
| Iron | 0.48 ±0.31 | 9.36±8.41 | 6.41±2.16 | 4.38±2.91 | 4.38±1.90[a] | 4.18±2.10[a] |
| Zinc | 0.13 ±0.06 | 0.18±0.11 | 0.47 ±0.43 | 0.34±0.18 | 0.46 ±0.30 | 0.15±0.10 |

PD = Pharma-Deko, UN =Unilever, Values with no superscript = significantly different

examined in this study is shown in Table 2. The mean values of the heavy metals in this study showed no monthly or site significant differences ($p>0.05$) except in iron where there was significant different ($p<0.05$) in the month of May and June. The average heavy metals concentrations in the waste water from Pharma-Deko and Unilever respectively are copper (0.03 ± 0.01mg/L and 0.06 ± 0.03mg/L), iron (3.45 ± 1.24mg/l and 6.77 ± 5.26 mg/L), and zinc (0.30 ± 0.24 mg/L and 0.24 ± 0.14mg/l). The mean concentrations of measured heavy metals in the waste water followed an increasing order of Fe>Zn>Cu.

## DISCUSSION

BOD values recorded in the present study is below USEPA (2002) and WHO (2004) maximum limit and also lower than those reported by Singare et al.(2011) on effluent discharge from Gove industrial area of Maharashtra, India. However, the values are higher than BOD reported by Kumolu-Johnson et al. (2005), and Ndimele and Kumolu - Johnson (2012) from Ologe Lagoon and Badagry creek, Nigeria, respectively . Low BOD is an indicator of good quality water, thus implying that the waste water in these industries has undergone treatment.

The Chemical Oxygen Demand (COD) is a measure of the oxygen equivalent of that portion of the organic matter in a sample that is susceptible to oxidation by a strong chemical oxidant. COD test is used to measure the load of organic pollutants in the industrial waste water .COD values in this study exceeded the maximum limit recommended by WHO (2004). The present COD was lower than those reported by Chavan et al. (2005) in Thane Creek water, Kumolu-Johnson et al.(2005) and Singare et al. (2011) . Similarly, DO recorded in this study fall out of the WHO minimum recommended limit. The value is also lower than Kumolu-Johnson et al.(2005) records.

*TDS* content in water is a measure for salinity and its high content affects the density of water, influences freshwater organisms and reduces solubility of gases (like oxygen). *TDS* recorded in this study is still within the standard permissible limit. Therefore, the water is suitable for irrigation as reported by Singare et al.(2011). However, the TDS in this study is lower than values reported by Ndimele and Kumolu-Johnson (2012).

The pH of a water body is very important because it has effect on the organisms living in the aquatic ecosystem (Tepe and Boyd, 2002). pH controls vital metabolic processes like respiration, which is the process by which living organisms produce energy (adenosine triphosphate) required for their activities. The pH values from (PD) is lower than minimum recommend limit, but pH in (UN) is below the maximum WHO permissible limit. However, both pH values are lower than those from Badagry creek (Ndimele and Kumolu-Johnson (2012). The alkalinity, sulphate, chloride, phosphate, nitrate and total hardness

contents in this study are lower than the maximum permissible limit of WHO. This , therefore, affirmed that the waste had been treated. Also, the values of these parameters as recorded in this study are lower than those recorded in Hosahalli Tank in Shimoga India, (Basavaraja et al., 2005) and in Mining area of Mongola (Bolormaa et al.,2006).

The average concentrations of metals in the waste water samples (except Zn) exceeded the USEPA (2002) and WHO (2004) guidelines. Although copper is an essential substance to human life, however, in high concentrations, it can cause anemia, liver and kidney damage, stomach and intestinal irritation (Tepe, 2014). Zn is a naturally abundant element present as a common contaminant in agricultural, food wastes, manufacturing of pesticides as well as antifouling paints (Badr et al., 2009). Therefore, its concentration being low in this study implies that the waste is contaminated with zinc. All the values of heavy metals in this study are lower than those reported by Kamaruzzaman et al.(2011) and, Mortuza and Al-Misned (2017). Therefore, it could be concluded that Pharma-Deko and Unilever waste waters had very low level of pollutants as indicated by the physico-chemical properties of the water. However, standard methods of waste water treatment should be maintained by these industries, so that problems commonly associated with industrial effluents can be averted.

**Conflict of interest**

No conflict of interest exits in the submission of this manuscript.

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