



**PHYSICOCHEMICAL AND HEAVY METAL CHARACTERIZATION OF
WASTEWATER FROM SELECTED LAUNDRIES IN BENIN METROPOLIS, BENIN
CITY, NIGERIA**

Eric O. Osazuwa* and Margaret A. Kalu

Department of Chemistry, Faculty of Physical Science, University of Benin, Benin City, Nigeria.

***Corresponding Author: Eric O. Osazuwa**

Department of Chemistry, Faculty of Physical Science, University of Benin, Benin City, Nigeria.

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ABSTRACT

Background: Laundry wastewater refers to untreated waste water that is obtained from washing clothes. Pollution discharges containing surfactants cause severe changes to biota because the activities of many aquatic organisms depend fundamentally on water surface tension. Modern detergent formulations the entire product just the surfactant- contain several components. These compounds when not adequately broken down before being released into the environment constitute a nuisance to both the environment and the health of man. The physicochemical and heavy metal characterization of wastewater from selected laundries in Benin metropolis was studied. **Methods:** Wastewater samples were collected in triplicates from three (3) different laundries namely Olivera, Leblanc and Radiance laundry located, in Oredo, Ikpoba Okha and Uhunmwode Local Government Area respectively over a period of two (2) weeks. They were collected with sterilized plastic containers (350ml). The samples collected were then subjected to physiochemical and heavy metal content was analyzed. **Results:** The physicochemical analysis revealed the dissolved oxygen (2.96-3.78 mg/l), total dissolved solid (157-562 mg/l), total suspended solid (22-235 mg/l), chemical oxygen demand (160-1320 mg/l), turbidity (65-306 mg/l), Alkalinity (32-188 mg/l), Sulphate (78-296 mg/l), chloride (13-60 mg/l), chlorine (0.34-1.28 mg/l), nitrate (15.8-64.6 mg/l), phosphorus (0.42-2.46 mg/l) and nitrogen (0.66-2.58 mg/l). The heavy metal content showed the lead(0.30-0.35mg/l), Nickel (0.25-0.50mg/l), manganese(0.13-0.43mg/l), cadmium (0.10-0.68mg/l), copper (0.13-0.44mg/l) and zinc(1.59-4.00mg/l). **Conclusion:** The results show the characteristics of laundry wastewater do not meet the approved standard of the Federal ministry of environment (FMENV) and as such pose negative environmental and health effects.

KEYWORDS: Laundry, wastewater, pollution, discharge, physicochemical, heavy metal, environment, FMENV.

1.0 INTRODUCTION

Quantitative assessments of the quality of wastewater are made by considering many criteria, including temperature, dissolved oxygen level and concentration of organic as well as inorganic compounds. The most frequently used parameters are: Biochemical Oxygen Demand (BOD), Chemical Oxygen Demand (COD), Total Organic Carbon (TOC), Alkalinity, Chlorides, Nitrogen, Oil and Grease, Dissolved Oxygen, pH, Phosphorus, Gases, Sulphur, Solids, Temperature, Metals as well as Micro-organisms (Casanova *et al.*, 2001).

Physically, domestic wastewater is usually characterised by a grey colour, musty odour and has a solid content of about 0.1%. The solid material is a mixture of faeces, food particles, toilet paper, grease, oil, soap, salts, metals, detergents, sand and grit (Boardi and Kuitunen, 2005). The solids can be suspended (about 30%) as well

as dissolved (about 70%). Dissolved solids can be precipitated by chemical and biological processes. From a physical point of view, the suspended solids can lead to the development of sludge deposits and anaerobic conditions, when discharged into the receiving environment.

Chemically, wastewater is composed of organic (70%) and inorganic (30%) compounds as well as various gases. Organic compounds consist primarily of carbohydrates (25%), proteins (65%) and fats (10%), which reflect the diet of the people (Christova-Boal *et al.*, 2000). Inorganic components may consist of heavy metals, nitrogen, phosphorus, pH, sulphur, chlorides, alkalinity, toxic compounds, etc. Modern detergent formulations the entire product just the surfactant- contain several components. Three main ingredients are builders (50% by weight, approximately), the alkylbenzene sulfonate surfactant (15%), and bleaches

(7%), perfumes. There are various brands of detergents namely Ariel, Zip, Good Mama, Klin, Magic, Sunlight, so easy, WAW detergents and these various detergents have varying composition.

2.0 MATERIALS AND METHODS

Wastewater samples were collected in triplicates from three (3) different laundries namely Olivera, Leblanc and Radiance laundry located, in Oredo, Ikpoba Okha and Uhumwode Local Government Area respectively over a period of two (2) weeks. They were collected with sterilized plastic containers (350ml), to avoid additional contamination of samples. The samples collected were subjected to physiochemical and heavy metal analysis using standard methods according to Aslam *et al.*, 2001.

3.0 RESULTS AND DISCUSSION

Table 1 showed the physiochemical analysis of wastewater from Olivera, Leblanc and Radiance laundry services in Benin City. The results obtained during the study is in agreement with Forastiera, 2011, The results from the physicochemical analysis showed an elevation on some of the physiochemical parameters such as Alkaline, DO- dissolved oxygen, TDS- total dissolved solid, TSS- total suspended solid, COD- chemical oxygen demand which is an important factor that determines the suitability of water for various purposes, including toxicity to human. The alkaline nature of the laundry wastewater could be attributed to the buffering properties of some inorganic substances.

Biological oxygen demand is a measure of the oxygen in the water that is required by the aerobic organisms. The biodegradation of organic materials exerts oxygen tension in the water and increases the biochemical oxygen demand. Water with low BOD has low nutrient levels; therefore, much of the oxygen remains in the water (Faruqui and Al-Jayyousi, 2002).The increase in

chloride and nitrate concentration in the laundry wastewater could be due to the increase use of chloride and nitrate by some industries or factories in detergent production.

The pH of the various wastewater samples collected from the different laundries range from 5.98 – 10.04, having radiance laundry as the highest, while Olivera laundry as the lowest. When compared with Federal Ministry of Environmental national limit, it showed that Olivera laundry had met with the standard. More so the dissolved oxygen of wastewater collected from the three laundries range from 2.93 – 3.48 mg/l, having Radiance laundry washing with zip as the highest, while Olivera laundry as the lowest. The total suspended solid of wastewater collected from the different laundries range from 103.3 – 745.7 mg/l, having Olivera laundry as the lowest and Leblanc laundry as the highest. The chemical oxygen demand of wastewater collected from the various laundries range from 98 – 1160 mg/l, having Leblanc laundry as the highest, while Olivera laundry as the lowest. The Sulphate content of wastewater collected from the three laundries range from 48.7 – 272 mg/l, having Olivera laundry as the lowest and Leblanc laundry as the highest. The chlorine content of wastewater collected from the different laundries range from 11.5 – 171.6 mg/l, having Olivera laundry washing with ariel as the lowest, while Radiance laundry washing zip as the highest. The physiochemical results obtained in the wastewater from the three different laundry services were above were above Federal Ministry of Environment standard (0.02-1.0 mg/l) for regulation of toxic pollutants in the environment.

Table 1: The physiochemical analysis of wastewater from Olivera, Leblanc and Radiance laundry services in Benin City.

Parameters	Units	Olivera Laundry (ariel)	Leblanc Laundry (zip)	Radiance Laundry (omo)	Federal ministry of environment (fmenv)
pH		5.98	9.68	10.04	7.19
DO	mg/l	3.43	2.93	3.48	1.5
TDS	mg/l	103.3	727	745.7	500
TSS	mg/l	12.7	244	85.7	25
Turbidity	mg/l	49	338.3	212.7	5
COD	mg/l	98	1160	800	90
Alkalinity (CaCO ₃)	mg/l	16.3	131.7	112	150
(Sulphate) SO ₄ ²⁻	mg/l	48.7	272	228.7	250
Chloride	mg/l	11.5	66.7	171.6	250
Chlorine	mg/l	0.22	1.45	0.99	0.5
(Nitrate) NO ₃ ⁻	mg/l	24.5	41.1	51.7	10
Phosphorus	mg/l	0.85	2.80	1.59	2.0
(Nitrogen) N ₂	mg/l	0.39	2.30	1.41	1.0

Key--- EC- electrical conductivity, DO- dissolved oxygen, TDS- total dissolved solid, TSS- total suspended solid, COD- chemical oxygen demand

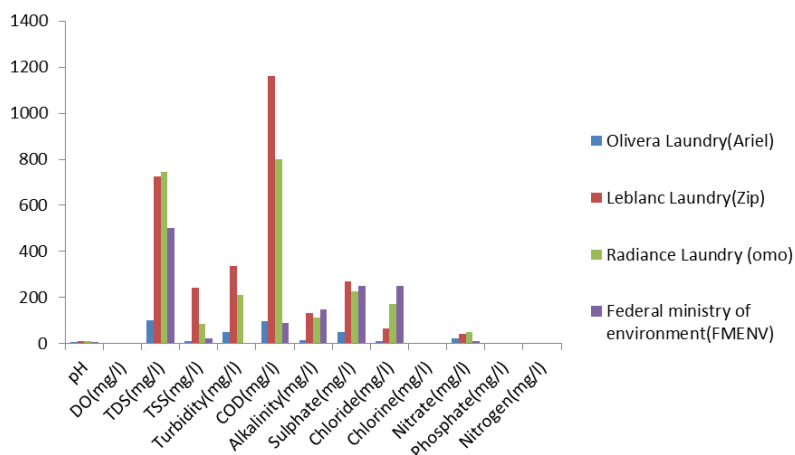


Fig 1: Showing the physiochemical characteristics of Olivera laundry, Leblanc laundry, Radiance laundry, Federal ministry of environment(FMENV).

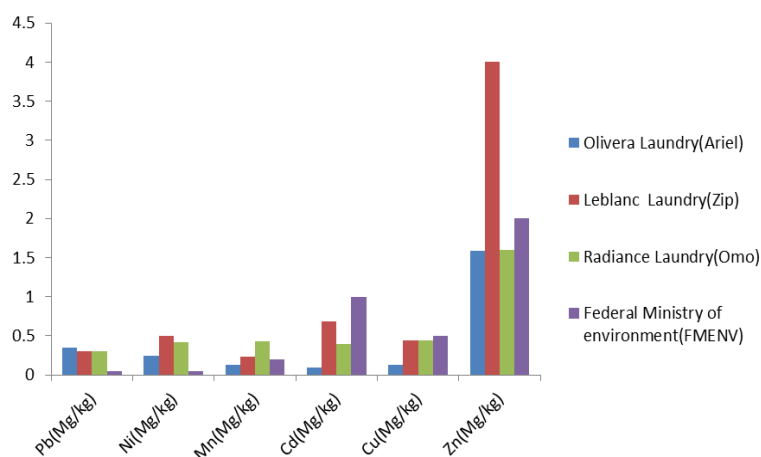
Table 2 showed the heavy metal content of wastewater from Olivera, Leblanc and Radiance laundry service in Benin City. The lead content of wastewater obtained from the three laundry industries range from 0.30 – 0.35 mg/kg, having Olivera laundry as the highest, while Leblanc and Radiance laundry as the lowest. The nickel content of wastewater from the three laundry industries range from 0.25 – 0.50 mg/kg, having Olivera laundry as the lowest and Leblanc laundry as the highest. The manganese content of wastewater from the various laundry industries range from 0.13 – 0.43 mg/kg, having Olivera laundry as the lowest, while Radiance laundry as

the highest. The cadmium content of wastewater from the three laundry industries range from 0.10 – 0.68 mg/kg, having Leblanc laundry as the highest, while Olivera laundry as the lowest. The copper content of wastewater from the different laundry industries range from 0.13 – 0.44 mg/kg, having Olivera laundry as the lowest and Radiance and Leblanc laundry as the highest. The heavy metal concentration in the different laundry wastewater were far above Federal Ministry of Environmental national limit (0.05 - 1.0mg/kg) for regulation of heavy metal in the environment.

Table 2: The heavy metal analysis of wastewater from Olivera, Leblanc and Radiance laundry service in Benin City.

Parameters	Units	Olivera laundry (Ariel)	Leblanc laundry (Zip)	Radiance laundry (Omo)	Federal Ministry of Environmental (Fmenv)
Pb	Mg/kg	0.35	0.30	0.30	0.05
Ni	Mg/kg	0.25	0.50	0.42	0.05
Mn	Mg/kg	0.13	0.23	0.43	0.20
Cd	Mg/kg	0.10	0.68	0.39	1.00
Cu	Mg/kg	0.13	0.44	0.44	0.50
Zn	Mg/kg	1.59	4.00	1.60	2.00

Key--- Cu-Copper, Ni-Nickel, Zn-Zinc, Mn-Manganese, Pb-Lead, Cd-Cadmium



The heavy metal analysis showed an elevation on some of the concentrations of metal present such as Pb-Lead, Ni-Nickel, Cu-Copper, Mn-Manganese and Cd-Cadmium. The lead content of wastewater obtained from the three laundry industries range from 0.30 – 0.35 mg/kg, having Olivera laundry as the highest, while Leblanc and Radiance laundry as the lowest. The values obtained were found to be above Federal Ministry of Environmental standard (0.05 - 1.0mg/kg). The concentration of lead in the wastewater sample was high, showing that the content of lead in the different laundry wastewater discharged in that region is posing a great threat to people and the surrounding environment when it contaminates their food and water source. Alyaqout and Hamoda (2005) has reported that the first indication of lead is poisonous to animals and humans, results to damaging of the nervous system and causing brain disorders. Excessive lead also causes blood disorders in mammals.

The nickel content of wastewater from the three laundry industries range from 0.25 – 0.50 mg/kg, having Olivera laundry as the lowest and Leblanc laundry as the highest, the value obtained were above the Federal Ministry of Environment standard. Nickel poisoning has been reported to cause severe stomach pain (El-Fadel *et al.*, 2007), as nickel is corrosive to the lining of the gastrointestinal tract including the stomach.

The manganese content of wastewater from the various laundry industries range from 0.13 – 0.43 mg/kg, having Olivera laundry as the lowest, while Radiance laundry as the highest. Also the cadmium content of wastewater from the three laundry industries range from 0.10 – 0.68 mg/kg, having Leblanc laundry as the highest, while Olivera laundry as the lowest, these values were also above Federal Ministry of Environment standard. Inhalation of cadmium fumes or particles can be life threatening, and although acute pulmonary effects and deaths are uncommon, sporadic cases still occur (Giusti, 2009). Cadmium exposure may cause kidney damage. The copper content of wastewater from the different laundry industries range from 22 – 235 mg/kg, having Olivera laundry as the lowest and Radiance laundry as the highest.

4.0 CONCLUSION

The physicochemical properties of laundry wastewater from the three different laundries were found to be elevated in comparison to the known environmental standard while the heavy metals reveals concentration of Cu-Copper, Ni-Nickel, Zn-Zinc, Mn-Manganese, Pb-Lead, Cd-Cadmium. Hence this result shows that the discharge of this wastewater without treatment would pose a possible environmental hazard or health effect. Therefore environmental agencies should therefore set up and enforce laws for the treatment of laundry wastewater before discharged into environment.

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