# Physiochemical properties of industrial effluents in Ibadan, Nigeria.

Segun Akanmu Adebisi[1] and Kehinde Adenike Fayemiwo[1*]

[1]Department of Chemical Sciences, College of Science, Engineering and Technology, Osun State University, P.M.B. 4494, Osogbo, Nigeria.

[*]Corresponding Author: kehindefayemiwo@yahoo.com, +2348067726800

**Abstract:** Industrial activities are mostly responsible for waste discharged into the environment, and these waste contained toxic and hazardous substances, most of which are detrimental to human health. In this study, the physicochemical properties of industrial effluents of eight (8) food processing plants and receiving water in Ibadan was carried out to determine the extent of industrial effluents pollution in Ibadan, Nigeria. There were marked variations in the electrical conductivity, hardness, turbidity, total and dissolved solids of effluents from the various industries. Dissolved oxygen was significantly higher in effluents from oil processing industries. Significant decreases were obtained in the electrical conductivity, hardness, turbidity, total solids, dissolved solids and BODs of receiving water around some of the food processing industries following effluent discharge. COD increased with effluent discharge into receiving water. The result shows that the discharges of untreated effluents by industries contaminate the groundwater of the surrounding environments.
[Segun Akanmu Adebisi and Kehinde Adenike Fayemiwo. **Physiochemical properties of industrial effluents in Ibadan, Nigeria.** Nature and Science 2010;8(12):234-238]. (ISSN: 1545-0740). http://www.sciencepub.net.

**Key words**: Industrial effluents, pollution, physicochemical properties.

## 1. Introduction

The world global growth and rapid industrial development have led to the recognition and increasing understanding of interrelationship between pollution, public health and environment. While almost industrial activities cause some pollution and produce waste, relatively few industries (without pollution control and waste treatment facilities) are responsible for the bulk of the pollution (WHO, 1982). In most developing countries like Nigeria, most industries dispose their effluents without treatment. These industrial effluents have a hazard effect on water quality, habitat quality, and complex effects on flowing waters (Ethan et. al., 2003). Industrial wastes and emission contain toxic and hazardous substances, most of which are detrimental to human health (Jimena et. al., 2008; Ogunfowokan et. al., 2005; Rajaram and Ashutost, 2008). Determination of the nature and source of chemical species in the industrial environment are of primary importance in the study of trace element pollution (Ogunfowokan and Fakankun, 1998).

Although industrialization is inevitable, various devastating ecological and human disasters which have continuously occurred over the last four decades, implicate industries as major contributors to environmental degradation and pollution problems of various magnitude (Abdel-Shafy and Abdel-Basir, 1991). Many authors have made studies regarding the physicochemical analysis of industrial effluent and concluded that it is the high rate of exploration then its recharging, inappropriate dumping of solid as well as liquid wastes, lack of strict enforcement of law and loose governance are the cause of deterioration of ground water quality (Ogunfowokan and Fakankun, 1998; Gupta and Gupta, 1999; .Mahananda et. al., 2010; Bhabindra, 2003; Sandeep and Shweta, 2008).

Physicochemical parameters like pH, hardness, TDS, chloride, sulphate, nitrate, fluoride, DO, COD and conductivity of some important heavy metals such as iron, cobalt, cadmium, lead, mercury, chromium, selenium and arsenic were first analyzed in effluent water of Okhla industrial area phase-II and then groundwater of nearby areas by Wequar and Rajiv (2009). Obtained values of effluent water were compared with ISI standard for effluent water discharge and groundwater values were compared with ISI and WHO drinking water standards. It was shown that discharge of untreated effluents by the industries is leading to contamination of groundwater of the surrounding areas. Subsequent analysis of groundwater of nearby areas was rated as unacceptable for drinking because of presence of fluoride in all the samples above the desirable limit.

Patil and Patil (2010) carried out a physicochemical characteristic of groundwater and municipal water in Amalner town was by collecting four groundwater samples. The results were compared with standards prescribed by WHO and ISI 10500-91 and it was found that the underground water was contaminated at few sampling sites. A laboratory work was undertaken to assess the waste water quality parameters of treated distillery effluent and their effect of various concentrations, and it was shown that the high value of T.S., B.O.D. and C.O.D. indicates the high inorganic and organic load. Germination percentage decreases with increasing concentration of effluent in all the tested seeds (Sandeep, 2007). Also, wastewater mixed with industrial effluent used for irrigation in the vegetable growing area of Korangi was tested for its heavy metal contents by Saleem-Saif et al. (2005), the analyzed samples of water, soil and plant showed that waste water mixed with industrial effluent contains many heavy metals quite in excess.

In this study, comparative effects of the physicochemical properties of effluents and receiving water from six major industries in Ibadan were analyzed. The levels of parameters such as pH, electrical conductivity, hardness, turbidity, dissolved solids, total solids, dissolved oxygen, BOD and COD were determined to serve as pollution indicator.

## 2.0 Experimental

The samples of effluent and receiving water were collected from different industrial locations in Ibadan, Nigeria. Effluents were collected from eight food processing industries which include four (4) confectionery, two (2) oil processing and two (2) beverage industries. Water samples were collected at receiving waters 50 m down and upper the water course adjacent to the effluent carriage system into cleaned, dry, polyethylene bottles which have been previously washed with 20% nitric acid and subsequently with demineralized water. Samples were refrigerated at $4^0$C, prior analysis. Water samples collected from upstream before the discharge of the effluent into the stream served as control.

Temperature was measured using a standard field size thermometer; pH was measured as described by Anderson and Ingram (1989) using a Model 3020 pH meter (JENWAY, UK) standardized with pH buffer. A conductivity meter (Model 4010, JENWAY, UK) calibrated with a conductivity standard (0.01 $mldm^{-3}$KCl with conductivity 1413 $\mu Scm^{-1}$) was used for conductivity measurements at $25^0$C. Biochemical Oxygen Demand (BOD) and Chemical Oxygen Demand (COD) were determined as described by APHA (1995). Hardness, turbidity, total dissolved solids, total solids and dissolved oxygen were determined using a flame photometer. Phosphate, nitrate, ammonium and chloride were determined using standard method (Oloyo, 2001). The results are expressed in mg/L for effluents and receiving water, Means triplicate readings obtained in the study were subjected to analysis of variance (ANOVA) and Ducan's multiple range tests using statistical package for Social Scientist (SPSS 10.0) computer software (FEPA, 1991).

## 3. Result and Discussion

The physiochemical properties of effluents and receiving waters of all food processing industries studied are shown in Tables 1 – 3. The pH range obtained falls within 5 – 9 recommended by FEPA (1991) except for FAN milk which had a pH of 10.20. There were marked variations in the electrical conductivity, hardness, turbidity, total and dissolved solids of effluents from the various industries. They did not follow clearly discernible pattern. Dissolved oxygen was significantly higher in effluents from oil processing industries. Significant decreases were obtained in the electrical conductivity, hardness, turbidity, total solids, dissolved solids and BODs of receiving water around some of the food processing industries following effluent discharge. COD increased with effluent discharge into receiving water. There are no FEPA (1991) recommended values for conductivity, total solids, turbidity and dissolved oxygen. The highest BODs were obtained for effluents from Sword Sweet (142.00mg/l), EFCO (161.00mg/l) (Confectionery industries), Best Oils (149.00 mg/l) and Premier Agro Oil (180.00 mg/l) Oil Processing industries). The BOD and COD values obtained for all the industries were significantly higher than FEPA (1991) recommended values (30 and 40 mg/l) respectively). The recommended COD for effluents from these industries according to UKEPA (1993) is 150 mg/l. Many of the wastes in the effluent from food processing plants are organic compounds and some lost products. As these substances undergo oxidation, they combine with some of the oxygen dissolved in the water. The amount of oxygen used is therefore a good indicator of the amount of organic waste present. USEPA (2002) noted that toxicity concerns historically occurred from the potential presence of chlorinated organic compounds such as dioxins, furans, and other (collectively referred to as absorbable organic halides) in waste waters after the chlorination/extraction sequence.

The BOD values obtained following discharge of the effluents into receiving water indicated that the amount of oxygen (mg/l) needed to oxidize these products was high. COD values were generally higher since it measures oxygen demand by both biodegradable and non-biodegradable pollutants. The high values obtained might suggest that a high amount of the product was lost to the waste stream.

Table 1: Mean Physicochemical properties of effluents and receiving waters from confectionery industries

| Industry | Location | pH | Electrical Conductivity | Hardness | Turbidity | Dissolved Solids | Total Solids | Dissolved Oxygen | BOD | COD |
|---|---|---|---|---|---|---|---|---|---|---|
| Diamond Foods | Effluent | 9.10 ± 0.26 | 12.00 ± 0.35 | 27.50 ± 0.79 | 35.21 ± 1.02 | 1000.00 ± 28.87 | 2800.00 ± 80.83 | 7.50 ± 0.22 | 41.00 ± 1.18 | 52.00 ± 1.50 |
| | RW (Upper) | 7.20 ± 0.21 | 29.30 ± 0.85 | 100.00 ± 2.89 | 21.91 ± 0.63 | 400.00 ± 11.55 | 170.00 ± 4.91 | 8.40 ± 0.24 | 39.17 ± 1.13 | 29.41 ± 0.85 |
| | RW (Lower) | 6.90 ± 0.20 | 18.50 ± 0.53 | 84.00 ± 2.42 | ND | 350.00 ± 10.10 | 850.00 ± 24.54 | 11.10 ± 0.32 | 68.00 ± 1.96 | 51.00 ± 1.47 |
| Sword Sweets | Effluent | 7.50 ± 0.22 | 8.40 ± 0.24 | 125.00 ± 3.61 | 21.10 ± 0.61 | 1000.00 ± 28.87 | 2400.00 ± 69.28 | 5.22 ± 0.15 | 142.00 ± 4.10 | 160.00 ± 4.62 |
| | RW (Upper) | 7.80 ± 0.23 | 16.40 ± 0.47 | 44.00 ± 1.27 | 2.77 ± 0.08 | 550.00 ± 15.88 | 1750.00 ± 50.52 | 7.20 ± 0.21 | 120.30 ± 3.47 | 65.80 ± 1.90 |
| | RW (Lower) | 7.40 ± 0.21 | 2.05 ± 0.06 | 40.00 ± 1.15 | ND | 350.00 ± 10.10 | 1050.00 ± 30.31 | 8.40 ± 0.24 | 98.00 ± 2.83 | 125.00 ± 3.61 |
| EFCO | Effluent | 7.40 ± 0.21 | 10.00 ± 0.29 | 85.00 ± 2.45 | 18.41 ± 0.53 | 800.00 ± 23.09 | 1800.00 ± 51.96 | 14.15 ± 0.41 | 161.00 ± 4.65 | 180.00 ± 5.20 |
| | RW (Upper) | 7.40 ± 0.21 | 3.65 ± 0.11 | 36.00 ± 1.04 | 4.92 ± 0.14 | 200.00 ± 5.77 | 1200.00 ± 34.64 | 6.40 ± 0.18 | 91.50 ± 4.65 | 50.24 ± 1.45 |
| | RW (Lower) | 7.20 ± 0.21 | 1.76 ± 0.05 | 46.00 ± 1.33 | ND | 300.00 ± 8.66 | 1100.00 ± 31.75 | 9.60 ± 0.28 | 70.60 ± 2.04 | 70.62 ± 2.04 |
| Sumal Foods | Effluent | 7.50 ± 0.22 | 10.00 ± 0.29 | 80.00 ± 2.31 | 5.17 ± 0.15 | 1000.00 ± 28.87 | 3600.00 ±103.92 | 8.00 ± 0.23 | 59.00 ± 1.70 | 36.00 ± 1.04 |
| | RW (Upper) | 7.30 ± 0.21 | 0.53 ± 0.02 | 600.00 ± 17.32 | 128.00 ± 3.70 | 150.00 ± 4.33 | 1400.00 ± 40.41 | 6.00 ± 0.17 | 90.90 ± 2.62 | 70.20 ± 2.03 |
| | RW (Lower) | 7.10 ± 0.21 | 0.37 ± 0.01 | 240.00 ± 6.93 | ND | 250.00 ± 7.22 | 1550.00 ± 44.74 | 10.80 ± 0.31 | 181.00 ± 5.23 | 78.80 ± 2.27 |

Values are means of triplicate readings ± SEM

RW: Receiving water

Table 2. Simulation results under designed operation condition

| Industry | Location | pH | Electrical Conductivity | Hardness | Turbidity | Dissolved Solids | Total Solids | Dissolved Oxygen | BOD | COD |
|---|---|---|---|---|---|---|---|---|---|---|
| FAN Milk | Effluent | 10.20 ±0.29 | 14.00 ± 0.40 | 100.00 ± 2.89 | 152.00 ± 4.39 | 1600.00 ± 46.19 | 3400.00 ± 98.15 | 17.41 ± 0.50 | 95.00 ± 2.74 | 136.00 ± 3.93 |
| | RW (Upper) | 8.60 ± 0.25 | 29.13 ± 0.84 | 61.00 ± 1.76 | 6.29 ± 0.18 | 300.00 ± 8.66 | 800.00 ± 23.09 | 7.80 ± 0.23 | 53.00 ± 1.53 | 125.00 ± 3.61 |
| | RW (Lower) | 7.30 ± 0.21 | 7.25 ± 0.21 | 53.00 ± 1.53 | 7.29 ± 0.21 | 250.00 ± 7.22 | 950.00 ± 27.42 | 9.60 ± 0.28 | 37.69 ± 1.09 | 84.00 ± 2.42 |
| NBL | Effluent | 6.50 ± 0.19 | 1.70 ± 0.05 | 50.00 ± 1.44 | ND | 300.00 ± 8.66 | 1000.00 ± 28.87 | 13.00 ± 0.38 | 72.00 ± 2.08 | 63.00 ± 1.82 |
| | RW (Upper) | 7.90 ± 0.23 | 10.37 ± 0.30 | 92.00 ± 2.66 | 54.70 ± 1.58 | 850.00 ± 24.54 | 3100.00 ± 89.49 | 5.60 ± 0.16 | 110.50 ± 3.19 | 62.55 ± 1.81 |
| | RW (Lower) | 7.60 ± 0.22 | 1.67 ± 0.05 | 70.00 ± 2.02 | 55.70 ± 1.61 | 450.00 ± 12.99 | 2400.00 ± 69.28 | 5.00 ± 0.14 | 130.00 ± 3.75 | 80.00 ± 2.31 |

Values are means of triplicate readings ± SEM
RW: Receiving water

Table 3. Mean Physicochemical properties of effluents and receiving waters from individual oil processing industries

| Industry | Location | pH | Electrical Conductivity | Hardness | Turbidity | Dissolved Solids | Total Solids | Dissolved Oxygen | BOD | COD |
|---|---|---|---|---|---|---|---|---|---|---|
| BestOils Ltd | Effluent | 6.70 ± 0.19 | 2.10 ± 0.06 | 65.00 ± 1.88 | 2.65 ± 0.08 | 400.00 ± 11.55 | 1200.00 ± 34.64 | 31.62 ± 0.91 | 149.00 ± 4.30 | 172.50 ± 4.98 |
| | RW (Upper) | 7.30 ± 0.21 | 24.00 ± 0.69 | 70.00 ± 2.02 | 202.00 ± 5.83 | 350.00 ± 10.10 | 1100.00 ± 31.75 | 4.52 ± 0.13 | 56.80 ± 1.64 | 130.00 ± 3.75 |
| | RW (Lower) | 7.20 ± 0.21 | 13.10 ± 0.38 | 50.00 ± 1.44 | 203.00 ± 5.86 | 350.00 ± 10.10 | 1400.00 ± 40.41 | 5.60 ± 0.16 | 32.25 ± 0.93 | 78.34 ± 2.26 |
| Premier Agro Oils | Effluent | 5.50 ± 0.16 | 17.00 ± 0.49 | 55.00 ± 1.59 | 96.40 ± 2.78 | 800.00 ± 23.09 | 2200.00 ± 63.51 | 24.00 ± 0.69 | 180.00 ± 5.20 | 130.00 ± 3.75 |
| | RW (Upper) | 9.50 ± 0.27 | 15.75 ± 0.45 | 160.00 ± 4.62 | 33.20 ± 0.96 | 550.00 ± 15.88 | 1600.00 ± 46.19 | 7.11 ± 0.21 | 95.00 ± 2.74 | 25.10 ± 0.72 |
| | RW (Lower) | 9.30 ± 0.27 | 4.86 ± 0.14 | 182.00 ± 5.25 | 34.20 ± 0.99 | 450.00 ± 12.99 | 1850.00 ± 53.40 | 7.00 ± 0.20 | 76.26 ± 2.20 | 32.00 ± 0.92 |

Values are means of triplicate readings ± SEM
RW: Receiving water

## 4. Conclusions

This study has shown that receiving water and soil quality are significantly influenced by effluent discharge from the considered food industries. The presence of a wide range of pollutants components in the effluents from the food industries in Ibadan metropolis underscores the need to further process the effluents prior to discharge into receiving waters.

**Acknowledgements**

The authors would like to acknowledge the following industries: Diamond Food Nigeria Limited, Sword Sweets, EFCO, Sumal Foods, FAN Milk Limited, NBL, Best Oil and Premier Agro Oil for their support as well as helpful assistance rendered for samples collection.

**References**

[1] WHO. Rapid assessment of sources of air, water and land pollution, WHO offset Publication, 1982; No. 62, England.

[2] Ethan, J.N., Richard, W.M., and Michael, G.K. The effect of an industrial effluent on an urban stream benthic community: water quality vs. habitat quality. *Environmental Pollution* 2003; 123 (1):1-13.

[3] Jimena, M.G., Roxana, O., Catiana, Z., Margarita, H., Susana, M. and Ines-Isla M. Industrial effluents and surface waters genotoxicity and mutagenicity evaluation of a river of Tucuman, Argentina. *J. of hazardous Material*, 2008; 155(3): 403-406.

[4] Ogunfowokan, A.O., Okoh, E.K., Adenuga, A.A. and Asubiojo, O.I. An assessment of the impact of point source pollution from a university sewage treatment oxidation pond on a receiving stream – a preliminary study.*Journal of Applied Sciences* 2005; 5(1):36 – 43.

[5] Rajaram, T. and Ashutost, D. Water pollution by industrial effluents in India: discharge scenario and case for participatory ecosystem specific local regulation. *Envr. J.* 2008; 40(1): 56-69.

[6] Ogunfowokan, A. O. and Fakankun, O. A.(1998) 'Physico-chemical characterization of effluents from beverage processing plants in Ibadan, Nigeria'. International Journal of Environmental Studies, 54: 2, 145 — 152

[7] Abdel-Shafy, H.I. and Abdel-Basir, S.E. Chemical treatment of industrial wastewater. *Environmental Management and Health* 1991; 2(3): 19 – 23.

[8] Gupta, B. K. and R. R. Gupta. Physio-chemical and biological study of drinking water in Satna, Madhya Pradesh.Poll. Res. 1999; 18: 523-525.

[9] Mahananda, M.R.; Mohanty, B.P. and Behera, N.R. Physico-chemical analysis of surface and ground water of Bargarh district, Orissa, India. *IJRRAS* 2010, **2**(3): 284-95.

[10] Bhabindra, N. Comparative effects of industrial effluents and submetropolitan sewage of Biratnagar on germination and seedling growth of rice and blackgram. *Our Nature* 2003 1: 10-14

[11] Sandeep, K..P. and Shweta,,T. Physico-chemical analysis of ground water of selected area of Ghazipur city-A case study.*Nature and Science*, 2008; 6(4), 25-8.

[12] Wequar, A. S. and Rajiv, R. S. Assessment of the impact of industrial effluents on groundwater quality in Okhla industrial area, New Delhi, India.*E-Journal of Chemistry* http://www.e-journals.net 2009, 6(S1), S41- S46

[13] Patil, V.T. and PATIL, P. R.Physicochemical analysis of selected groundwater samples of Amalner town in Jalgaon district, Maharashtra, India.*E-Journal of Chemistry*. http://www.e-journals.net 2010, 7(1), 111-116

[14] Sandeep K. Pandey, PallaviTyagi and Anil K. Gupta. Physico-chemical analysis and effect of distillery effluent on seed germination of wheat (*Triticumaestivum*), pea (*Pisumsativum*) and lady's finger (*Abelmoschusesculentus*).*ARPN Journal of Agricultural and Biological Science,* 2007; 2(6) pp 35-40.

[15] Saleemsaif, M., Midrar-Ul, H. and Kazi S. Heavy metals contamination through industrial effluent to irrigation water and soil in Korangi area of Karachi (Pakistan) *Int. J. Agri. Biol,* 2005, 7(4): 646-8

[16] Anderson, J.M. and Ingram, J.S.I. Tropical soil biology and fertility: A handbook of methods CAB International, U.K., 1989:100-101.

[17] APHA. Standard methods for the examination of water and wastewater. American Public Health Association, Washington, DC, 1995: 2-4, 29-179.

[18] Oloyo, R.A. Fundamentals of research methodology for social and applied Sciences. In: ROA Educational Press, Federal Polytechnic, Ilaro, Nigeria. 2001:286-7.

[19] FEPA. Guidelines and standards for environmental pollution control in Nigeria. Federal Environmental Protection Agency (FEPA). 1991:197-198.

[20] United Kingdom, Her Majesty's Inspectorate of Pollution, 1993. Chief Inspector's Guidance To Inspectors, Environment Protection Act 1990. Process Guidance Note IPR 4/9: Pharmaceutical Processes. Her Majesty's Stationery Office, London.

[21] USEPA, 2002. EPA Office of Compliance Sector Notebook Project Profile of The Pulp and Paper Industry. 2nd Edition November 2002 Office of Compliance.Office of Enforcement and Compliance Assurance. U.S. Environmental Protection Agency. 1200 Pennsylvania Avenue, NW (MC2224 – A) Washington, DC 20460.

11/17/2010