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MYCOLOGICAL AND PHYSICOCHEMICAL PROFILING OF TEXTILE, PAPER AND PULP WASTEWATERS FROM LAGOS INDUSTRIAL ZONE

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Abstract

The increase in human population, activities and fast industrialization have results into severe pollution of water bodies and consequently on different aquatic lives. This study was undertaken to compare the physicochemical data of textile and paper and paper industrial effluents discharge with the Federal Environment Protection Agency (FEPA) as well as International (world Health Organization) discharge standards. Water samples were collected and analyzed for mycological and physicochemical properties using standard procedures and the quality compared using FEPA and WHO standards, respectively. The obtained data were also analyzed using two – way ANOVA and Dunnet comparison tool with significance threshold at 0.05. The results revealed that the both textile and paper and pulp wastewater samples were ambient in temperature, textile wastewater was alkaline while paper and pulp wastewater was acidic in pH. All the physical, chemical and fungal parameters ranging from colour to total fungal count except sulphate exceeded WHO (2004) and FEPA (1999) standard limits. Also, all the heavy metals except zinc, nickel, manganese and cobalt were high in compositions of the textile and paper and pulp wastewaters and exceeded the FEPA (1999) standard limits. The analysis of variance on the samples of the industrial effluents showed that there are significant differences ($P < 0.5$) in the physiochemical characteristics as compared with the WHO (2004) and FEPA (1999) standard limits. The findings of this present study demonstrated the unacceptable statuses of these wastewaters, hence single or a combined treatment regimen is therefore recommended.

Keywords: FEPA, Paper and Pulp wastewater, Public health safety, Textile Wastewater, WHO

INTRODUCTION

The world's environment is being significantly impacted by the massive industrialization and fast urbanization, particularly in terms of air, water, and land pollution. One of the main sources of pollution is water pollution. Generally speaking, water is deemed contaminated when many human activities negatively impact its quality (Birjandi *et al*., 2016). Some of the main causes of water pollution are excessive untreated sewage discharge from different industrial sectors, wastewater generated by human activity discharged into rivers, and coastal areas (Koli *et al*., 2018). The primary cause of water contamination has been identified as untreated pharmaceutical industry wastewater, dyes, chemicals, and radioactive waste, all of which are extremely persistent (Koli *et al*., 2018). Since consuming contaminated water is known to cause the majority of serious pathogenic diseases, dangers, and dermatological issues, it is the responsibility of all industries to change their effluent before discharging it into different water sources (Wang *et al*., 2017).

In general, the pulp and paper sector has been seen as a large consumer of energy (fossil fuels, electricity), natural resources (wood, water), and pollutants released into the environment. After the oil, cement, leather, textile and steel sectors, the pulp and paper industry is the sixth biggest polluters, releasing a range of gaseous, liquid, and solid wastes into the environment (Hossain and Ismail, 2015). Also, Among the sectors that generate a lot of wastewater—which often contains heavy metals and synthetic dyes—are the textile and dyeing industries. When this contaminated water is released into water bodies without receiving enough or suitable treatment, a number of grave environmental issues arise. Different chemical, physical, and biological techniques, as well as combinations of these, can be used to treat textile wastewater (Darwesh *et al*., 2022). The increasing public awareness of the fate of these pollutants and stringent regulations established by the various authorities and agencies are forcing the industry to treat effluents to the required compliance level before discharging in to the environment (Hossain and Ismail, 2015).

In Nigeria, there are laws put in place to guide and regulate industrial discharge practices and environmental contamination generally. The federal environmental protection Agency (FEPA) established to check environmental abuses has had little or no impact on pollution control in our environment (Emodi *et al*., 2015). In Nigeria, cities like Kaduna, Lagos and Aba depend very much on their rivers. However, the rush by African countries to industrialise has resulted in discharge of partially treated or raw wastes into the surrounding bodies of water (Emodi *et al*., 2015). Therefore, this study was undertaken to compare the physicochemical data of textile and paper and paper industrial effluents discharge with the Federal Enviornment Protection Agency (FEPA) as well as International (world Health Organization) discharge standards.

MATERIALS AND METHODS

Collection of Industrial Effluent Sample

The textile industrial waste water and paper and pulp industrial wastewater samples were collected from Wollen and Synthetic Textile Maufacturing Limited located at No. 88 Oba Akran Avenue, Oba Akran Ikeja, Lagos and Aren Paper Mills Limited located at Plot 1c, 23 Fatai Atere Way, Matori, Mushin both in Lagos State their GPS information (Latitude 6.34151 - 6.61024 N and Longitude 3.33621 – 5.66539 E). All the samples were collected randomly at five different points with well labeled sterile sampled 2 L bottles and later bulked together as composite samples according to the procedure of Abdullahi and Ibrahim (2018). The containers were aseptically rinsed with the samples thrice before collection. The effluent samples were placed into a sterile polythene bags in ice packed coolers and then transported to the Microbiology Postgraduate

Laboratory, Chukwuemeka Odumegwu Ojukwu University within 24 hr of collection and preserved at 4 °C in refrigerator for further analysis (Uba *et al*., 2019).

Determination of Physicochemical Parameter on Industrial Effluent Sample

The temperature, pH, conductivity and total dissolved solids of the prepared samples were determined using multi meter analytical instrument (Model Ph-2603, China) (APHA, 2012). The colour and total suspended solid (TSS) were determined according to the method of Singh *et al.* (2017). The turbidity of the samples was determined after calibrations of the turbidometer instrument with blank and standard solutions and triplicate measurements were taken (APHA, 2012). The amount of biological oxygen demand was determined using Winkler's method according to the description of APHA (2012). The amount of chemical oxygen demand was determined according to APHA (2012). The amount of phosphate was determined using molybdenum blue phosphorous method in conjunction with UV - Visible spectrophotometer according to APHA (2012) and as described by Oladeji *et al*. (2016). The sulphate concentration was determined according to the standard method of APHA (2012) and as described by Sharma and Kaur (2016). Chloride was determined using Argentometric titration method and as described by APHA (1998) and Adelowo (2016)**.**

RESULTS AND DISCUSSION

The result of the physico-chemical and mycological profile of the different waste water samples analyzed are presented in Table 4.1. The results revealed that textile wastewater had the highest values of pH (9.50±0.01), BOD_5 (419.04±2.00 mg/L), COD (4,800.00±1.00 mg/L), phosphate (295.21±0.01 mg/L), sulphate (54.85±0.01 mg/L), chloride (531.75±0.00 mg/L), dioxin (1.88±0.01 µg/L), cyanide (1.35±0.02 mg/L), phenolics (1.633±0.20 mg/L) while paper and pulp wastewater had the highest values of temperature (30.00±0.20 °C), conductivity (5,460.00±0.10

μS/cm), colour (1,878.79±3.00 unit), TDS (4,095.00±1.00 mg/L), PCBs (0.56±0.00 ppm) and total fungal count (0.12±43.00 CFU/mL), respectively.

The physicochemical and microbiological parameters of industrial wastewaters are considered as the most important principles in the identification of nature, quality and type of the water (Boateng *et al*., 2016). The result in Table 4.1 revealed that the both textile and paper and pulp wastewater samples were ambient in temperature, textile wastewater was alkaline while paper and pulp wastewater was acidic in pH. All the physical, chemical and fungal parameters ranging from colour to total fungal count except sulphate exceeded WHO (2004) and FEPA (1999) standard limits. The possible reason for these high levels of pollutants in the raw textile and paper and pulp wastewaters could be due to the use of various chemicals during textile and paper processing such as chlorides, calcium, bicarbonates, potassium, phosphates, sulfates, sodium, nitrates, and dissolved salts (Eid *et al*., 2023). The analysis of variance on the samples of the industrial effluents showed that there are significant differences ($P < 0.5$) in the physiochemical characteristics as compared with the WHO (2004) and FEPA (1999) standard limits. While the WHO (2004) and FEPA (1999) standard limits tend to tilt towards one side, there seems to be wide gap between both of them and the industrial effluent samples. These differences manifest various negative implications on the receiving aquatic and terrestrial ecosystems (Emodi, 2015). Similar observations were published by Singh *et al*. (2017) and Koli *et al*. (2018) who reported that higher physicochemical values more than WHO and USEPA standard limits on textile, dye and paper and pulp wastewaters, respectively.

Heavy metal content of textile, paper and pulp industrial waste water analyzed using AAS as shown in Table 2.0, revealed textile waste water had the highest concentration of copper (14.15±0.01 mg/L), chromium (177.58±1.90 mg/L), lead (32.63±0.67 mg/L), cadmium (29.22±0.29 mg/L), nickel (0.05±0.02 mg/L), arsenic (27.48±0.08 mg/L), mercury (38.66±0.45 mg/L), cobalt (0.09±0.04 mg/L) while paper and pulp waste water had the highest concentration of manganese (0.41±0.06 mg/L), respectively. The accumulation of metals in an aquatic environment has direct consequences to man and to the ecosystem. Some metals like Zn and Cu are needed for metabolism in organisms. Interest in such metals lies in the thin line between their toxicity and essentiality. Some metals like Al, Cr, As, Cd and Pd are extremely toxic even at trace levels (Ogemdi and Gold, 2018). The result in Table 2.0 revealed that all the heavy metals except zinc, nickel, manganese and cobalt were high in compositions of the textile and paper and pulp wastewaters and exceeded the FEPA (1999) standard limit. On the basis of these data from the two wastewaters, Cr, Hg, Cu, Pb, Cd and As were selected and removal capacities were examined in further study with the *Aspergillus niger* S9, *Colletotrichum* sp. S6 and mycosynthesized nano-composites, respectively.

Table 1: Physicochemical and mycological profile of the waste water sample

Sample / Parameter	Textile wastewater	Paper and pulp wastewater	WHO (2004) standard	FEPA (1999) standard
Colour (Unit)	901.52±2.50	1,878.79±3.00	5.13	7.00
Temperature (°C)	26.93±0.03	30.00±0.20	Ambient	30.00
pH	9.50±0.01	5.08±0.01	6.00 – 9.00	6.00 – 9.00
Conductivity (µS/cm)	3,442.67±0.03	5,460.00±0.10	1,250.00	1,000.00
TDS (mg/L)	2,582.50±5.00	4,095.00±2.00	2,000.00	2,000.00
TSS (mg/L)	1,456±3.00	1,845.00±7.00	30 - 200	30

Turbidity (NTU)	126.77±2.00	191.78±3.00	5.00 – 10.00	10.00
BOD_5 (mg/L)	419.04±2.00	320.00±1.00	30.00	20.00
COD (mg/L)	4,800.00±1.00	3,360.00±3.00	250.00	80.00 – 100.00
Phosphate (mg/L)	295.21±0.01	184.34±0.00	5.00	5.00
Sulphate (mg/L)	54.85±0.01	41.92±0.00	500.00	500.00
Chloride (mg/L)	531.75±0.00	203.84±0.00	350.00	600.00
Polychlorinated biphenyl (PCBs) (ppm)	0.20±0.00	0.56±0.00	ND	0.003
Dioxin (µg/L)	1.88±0.01	1.57±0.001	0.00001	ND
Cyanide (mg/mL)	1.35±0.02	1.026±0.01	0.07	0.10
Phenols (mg/L)	1.633±0.20	1.552±0.10	1.00	0.20
Total fungal count (CFU/mL X 10^5)	0.10±25.00	0.12±43.00	ND	ND

Key: WHO = World Health Organization; FEPA = Federal Environmental Protection Agency; °C = Degree centigrade; µS/cm = Micro Siemen per centimeter; NTU = Nephelometric turb.idity unit; mg/L = Milligram per litre; ppm = Part per million, µg/L = Microgram per litre; TDS = Total dissolved solid; TSS = Total suspended solids; CFU/mL = Colony forming unit per millilitre

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Table 2: Heavy metal profile of textile, paper and pulp industrial waste water

Metal (mg/L)	Textile waste water	Paper and pulp waste water	FEPA (1999) standard
Copper	14.15±0.01	12.38±0.02	< 1.00
Chromium	177.58±1.90	132.82±0.56	< 1.00
Lead	32.63±0.67	20.34±0.05	< 1.00
Zinc	0.00	0.00	< 1.00
Cadmium	29.22±0.29	18.94±0.94	< 1.00
Nickel	0.05±0.02	0.02±0.02	< 1.00
Arsenic	27.48±0.08	17.74±0.01	0.10
Mercury	38.66±0.45	24.00±0.24	0.05
Manganese	0.32±0.05	0.41±0.06	5.00
Cobalt	0.09±0.04	0.07±0.02	1.00

Key: FEPA = Federal Environmental Protection Agency; mg/L = Milligram per litre;

CONCLUSION

The whole study revealed that the raw wastewater samples collected from the two studied areas contained variable organic and inorganic pollutants. Some of these pollutants were found to be higher than WHO and FEPA standards and therefore treatment techniques in single or combined regimen is hereby recommended.

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