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Research Article

A STUDY ON PHYSICOCHEMICAL PARAMETERS AND HEAVY METALS IN SHARADA INDUSTRIAL EFFLUENTS, KANO, NIGERIA

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ABSTRACT

The major sources of pollutants in the environment are industries which are discharged at various levels either indirectly or directly. Hence, the study was aimed at determining the physicochemical parameters and some heavy metals concentration in effluents discharged from industries in Kano metropolis. Samples of effluents were collected in early morning hours from three different points and were subjected to physical, physicochemical, and heavy metals analysis. The effluent samples appeared with varying characteristics of objectionable odor and appearance. The values of temperature and pH fell within the acceptable limit of <40 set by FAO (1992). However, site C is slightly acidic. It could be said that the value of temperature in site C is within the safe limit while the sites A and B were above the severe hazard limit of FAO (1992). Only the value of site C was recorded as shown in Table 2 for TDS, the values of sites A and B were out of range due to the limitation of the TDS machine which is below 2000. The values of the three sites for Cd, Cr, and Pb have exceeded the standards of the WHO/FAO and FEPA. However, the values for concentrations of Pb were within the limit. The relatively higher concentration of these heavy metals has called for attention of all stakeholders. Regular monitoring, sanction, and more comprehensive research should be put in place for reducing the extent of such phenomena.

Keywords: Physicochemistry, Effluents, Assessment, Heavy metals.

INTRODUCTION

An effluent is a product generated inevitably from industrial process. The United States Environmental Protection Agency defined as untreated or treated wastewater that comes out of a sewer, treatment plant, or industrial outfall. Increase in the number of industries has led to elevation in the disposal of effluent to natural water bodies or open space. Effluent from various industries may differ in composition depending on the production source. It may contain some harmful, toxic substances, and essential nutrients. Micronutrients and macronutrients available in the effluents can increase soil fertility. However, the heavy metals and other toxic components can accumulate in soil. Soils contaminated with metals can cause health problems to human beings and animals, in general, when plants grown on such soils are consumed [22].

The major sources of pollutants in the environment are industries which discharge pollutants are various levels either indirectly or directly into the environment [9]. For example, effluents discharged from industries have been found to be carcinogenic as reported by Tamburline *et al.* [21]. However, other chemical constituents are poisonous to humans and toxic to aquatic organisms [14] (WHO, 2002). Effluents discharged from industries have been found to change the physical, chemical, and biological condition of receiving water bodies [12]. These heavy metals reach higher levels, accumulate in different plant parts, and cause dangerous health hazards through biomagnifications to human beings and animals in general [20].

Soils affected by tannery effluents were rich in Cd followed by Cr, Pb, Ni, Cu, Co, Zn, and Mn as studied by Ali *et al.* [3]. However, these metals can be stabilized to reduce or prevent their mobility, thereby reducing the threat they pose to the environment [19].

Most effluents from industries are discharged into the environment without prior treatment. In addition to organic materials which release important nutrients after decomposition, they may also contain heavy metals such as chromium (Cr), Manganese (Mn), Iron (Fe), Zinc (Zn), Cadmium (Ca), Lead (Pb), and Cobalt (Co), all of which pose a serious threat and problem to the environment.

In Nigeria, the major sources of heavy metals pollution are industrial effluents discharged from various processing industries. This increases the influx of metals, which can be transported by wind and water, thus becoming available to plants and animals. In Kano, the effluents discharged into tributaries of Sharada have been used for irrigation by local farmers. Similarly, the solid wastes were also used as manure on farmlands. Therefore, this study was aimed at determining the physicochemical parameters and some heavy metals concentration in effluents discharged from these industries.

MATERIALS AND METHODS

Study area

The study was conducted at Sharada in Kano metropolis, which lies between latitude 11^{0}57`34.0"N, longitude 8$^0$30`39.9"E, and altitude of 485 m. It harbors many industries including tannery, textile, chemical, food, and plastic. The sampling points were three farmlands along the bank stream of Sharada (Salanta River), where the stream water is mostly contaminated with industrial effluent from Sharada Industrial Area. All samples were collected from these areas.

Site description

1. Site A: Farmland in Medile. Crops grown include Moringa, okra, and lettuce.
2. Site B: Farmland in Sabuwar Gandu. Crops grown include spinach, onion, and tomato.
3. Site C: Farmland in Yahya Gusau (control). Crops grown include bitter leaf, lemongrass, and cabbage.

Effluents sampling

A sample of an effluent was collected in early morning hours in 500 ml sterile bottle; it was collected by dipping the bottle with the mouth of the bottle against the current in flowing water [13].

Determination of physical parameters

The color, odor, and sediment of the sample were determined physically [28].

Physicochemical parameters of effluent

Collected water sample was subjected to the following physicochemical parameters:

1. Determinations of temperature: It was measured according to the method of Yakasai, [28].
2. Determinations of pH: pH of the sample was determined directly in the laboratory with plastic beaker using pH 211 Hanna instrument [1].
3. Determination of electrical conductivity (EC): The EC was determined in glass beaker by inserting the nod in the water sample using digital conductivity meter according to Adepetu *et al*. [1].
4. Determination of total dissolved solids (TDS): The TDS was measured using laboratory TDS equipment which ranges between 1 and 1990 [8].

Determination of some heavy metals

Heavy metals concentrations which include Cd, Cr, Cu, and Pb in water sample were determined after wet acid digestion using atomic absorption spectrophotometer model 210VP [4].

RESULTS

The effluent and water sample being used for irrigation in the area were assessed for quality parameters and results are presented below.

DISCUSSION

The physical characteristics of colors, odors, and sediments in the effluent and well water sample were observed to differ from one collection to the other. The effluent sample appeared with varying characteristic of objectionable odor and appearance. The color and odor originate either from natural and biological sources or processes, from chemical contamination or as a byproduct of wastewater treatment color and odor in water may be indicative of pollution or some malfunction during treatment and distribution, which may be an indication of harmful substances. Taste, odor, and color are important quality parameters affecting acceptability of water (Denloye, 2004). The physical characteristics of color, odor, and sediment are shown in Table 1. The effluents of sites A and B were found to have green-black and golden brown color, respectively. However, site C was colorless. In addition, the effluents from sites A and B have an odor characterized as strongly offensive and offensive, respectively. However, the other for site C's effluent is odorless. Sediment was present in sites A and B effluent but absent in site C's effluent.

Temperature is an important water quality parameter. It influences the solubility and availability of oxygen and affects the toxicity of some chemicals in water systems as well as the sensitivity of living organisms to toxic substances [2,17]. The temperatures observed in this study are presented in Table 2 which ranged from 23 to 32 and varied slightly with the sampling point, with site A recorded the highest then site C recorded the lowest. All the temperature values fell within the acceptable limit of (<40) of no risk for irrigation purposes set by FAO [6].

The pH values of 7.61–8.30 were recorded indicating slightly neutral to slightly alkaline from sites A and B which are all within the permissible limit. However, site C is slightly acidic. Alternatively, Ogunfowokan *et al*. [18] observed and reported lower pH ranges 5.23–6.32, while Akan *et al*. [2] observed much higher values 8.94–10.34 for effluent in Ile-Ife. The inconsistency and instability in pH measurement for the river water is a common observation due to the tendency for it to be affected by what is present at time of sampling and temperature as observed by Joshi *et al.* [11] hence their lack of emphasis on it in their assessment. Gordon and Zhang [10] did not even include it as a factor in classifying irrigation water into quality classes. The values observed in this work are within the acceptable range of 6.5–8.4 set out by FAO [6] standard which is shown in Table 2, only site C having value below the recommended limit, this suggests that the effluent may not impact negatively on the irrigation purposes with reference to pH standard.

The EC values observed in this study ranged from 0.3 to 12.0 μS/l with sites A and C recorded the highest and lowest values, respectively. FAO [6] puts values range for EC of irrigation water at <0.75, 0.75–3.0, and 3.0 μS/l as normal, increased hazard, and severe hazard, respectively. Based on this result, it could be said that the site C is within the safe limit while the sites A and B were above the severe hazard limit as described when used for irrigation as shown in Table 2.

Only the value of site C was recorded as shown in Table 2, the values of sites A and B were out of range due to the limitation of the TDS machine which is below 2000. By the recommendation of Joshi *et al*. [11], water with TDS <450 is considered good and that with >2000 is unsuitable for irrigation purpose. TDS as a measure of salinity is an important agricultural water quality parameter with respect to soil salinity. Salt effect of soil has been reported by FAO to be often determining by the salinity of irrigation water, while plant growth, crop yield, and quality of produce are advisedly affected by TDS concentration in irrigation water [6]. The major observable feature of this result is that proximity of the effluent to settlements might have contributed to the total amount of solid dissolved in them. Most of the dissolved solid in the sites A and B could have come from tannery waste particle; this might have also accounted for the much lesser come of dissolved solid in site C which is away from industrial site.

The mean concentration of Cd recorded in this study is shown in Table 3 which ranged from 0.091 to 0.15 mg/l, site A (Medile) recorded the higher value while site C (Yahya gusau) the lowest. The threshold value suggested by the WHO/FAO and FEPA is 0.01 and 0.003 mg/l, respectively. All the three values have exceeded the standards.

Despite the fact that Cd is a rare metal [27], it is still detectable in the waters of the rivers. This is due to its usage in products such as batteries and alloys which are discarded as municipal solid wastes dissolve and are washed into river bodies as alleged by Wild [27]. This may explain the higher concentration associated with Medile

Table 1: Physical characteristics of the effluents at different sites

Site	Color	Odor	Sediment
Site A Medile	Greenish-black	Strongly offensive	Present
Site B Sabuwar Gandu	Golden brown	Offensive	Present
Site C Yahya Gusau (control)	Colorless	Odorless	Absent

Table 2: Mean values of some physicochemical parameters of sampled effluents

Site	pH	Temperature (°C)	EC (μS/l)	TDS (ppm)
Site A Medile	7.61	32.0	7.0	O.R
Site B Sabuwar Gandu	8.30	31.0	12.0	O.R
Site C Yahya Gusau (control)	5.72	23.0	0.30	260
FAO (1992)	6.5-8.4	40.0	0.70	450

Table 3: Mean concentrations (mg/l) of some heavy metals in effluents from different sites

SITE	Cd (mg/l)	Cr (mg/l)	Cu (mg/l)	Pb (mg/l)
Site A Medile	0.15	2.00	0.82	0.07
Site B Sabuwar Gandu	0.13	1.54	5.91	0.073
Site C Yahya Gusau (control)±S.E	0.091±0.17	1.39±2.33	5.00±8.37	0.06±0.094
WHO/FAO (2001)	0.01	0.10	0.20	0.10

*WHO/FAO maximum acceptable limits for heavy metals in wastewater

which receives appreciable amounts of solid wastes due to their proximity to the city. Other factors such as the presence of the metal in agrochemicals and industrial and domestic wastewaters could have contributed to its levels in the sectors of the rivers. The values were higher than the values of Wakawa *et al.* [24] whose total mean was <3.0 mg/l in the Challawa River which may due to vary spatial and temporal variation.

The mean of chromium of the three respective sites is shown in Table 3, by the standard shown of 0.1 mg/l as suggested by the WHO/FAO, the entire site has the concentration above the maximum limit. Cr is an element that is known to be associated with industrial wastewaters, especially the tanning industries [15]. The tanning industry is an especially large contributor of Cr pollution to water resources. This fact could explain the larger concentrations at the site of Medile, which receives much discharge from the Sharada industrial layout where the largest tanning factory is located. However, the amount at the Sabuwar Gandu showed slightly higher values than the Medile. The site C is having lowest amount because there is no influence of industrial discharges. The high concentrations recorded here may not be unexpected, especially at the site A where tanning wastewater contributes significantly to the total content in the river. Watto *et al.* [25] recorded concentrations as high as 147.50 mg/l in tannery wastewaters in Kasur area in Pakistan. In the work of Wakawa *et al.* [24] at some segments of the Challawa River, values reached as high as 2.0 mg/l. Although this is far less than what is obtained here, there is the tendency for concentration to vary spatially and temporally [4].

The mean of Cu in the site is shown in Table 3 which between 5.00 and 6.82 mg/l. The threshold limit for the WHO/FAO is 0.2 mg/l; by this recommendation, the water in sites are described as unsafe for irrigation. The result is showing that areas receiving industrial wastewater (sites A and B) recorded higher means. The tendency for higher values in such waters has already being highlighted by Mohsen and Mohsen [16] for the Firozabad River in Tehran that receives both industrial and domestic wastewater. In fact, they recorded values almost 5 times the recommended levels. The probable exception is site C of the control, as neither the industrial wastewater enters it. The suspected contamination source here could have been runoff from fields treated with copper-containing agrochemicals because they are also acclaimed to be sources of contamination [5].

The mean of Pb in the three sites is shown in Table 3. Although the concentration at the site B is high followed by sites A and C, respectively, the maximum level for Pb in irrigation water by the WHO/FAO is 0.1 mg/l. Therefore, by this standard, none of the site is polluted because all are within the safe limit.

CONCLUSION

It can be concluded that effluents appeared with varying characteristics of objectionable odor and appearance. pH, temperature, EC, and TDS were all within the limit. However, the values for TDS in sites A and B were out of range, indicating probable presence of sediments and unsuitability for irrigation. The concentrations of Cd, Cr, and Cu in effluents were all above the permissible limit with the exception of Pb. The relatively higher concentration of these heavy metals has called for attention of all stakeholders. Regular monitoring, sanction, and more comprehensive research should be put in place for reducing the extent such phenomena.

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