**Physiochemical Properties and Heavy Metals Analysis of Effluent Water from Selected Tannery Sites in Kano and Zaria.**

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**ABSTRACT**

The study was aimed to determine the physiochemical properties and heavy metal of effluent water sourced from tannery sites within Kano and Zaria metropolis. Effluent samples were taken from four different tannery sites: Kano and Zaria. Each sample was collected in plastic containers that were carefully rinsed with deionized water after being previously cleaned with detergents and 10% HNO3 acid. All of the samples were brought to the laboratory for analysis using standard methodology. The Results revealed pH (3.55-9.35), Electrical Conductivity(EC)(21410-224µs/cm), Total Suspended Solids(TSS) (2150-3546.60mg/L) and Total Dissolved Solids(TDS) (1468-8260mg/L) across the sites. Parameters such as EC, TSS and TDS were not in conformity with the WHO Standard except pH (9.35±3.55) for site1 from Kano metropolis. Heavy metal such as Cr (3.52-4.93mg/L), Pb (1.35-2.7 mg/L), and Cu (1.24-1.82 mg/L) were not in tandem with WHO standard across the sampling sites except for Fe (4.64-8.32 mg/L) that conformed. The studied effluent water showed significant deviation from WHO standard and as such monitoring to treat/determine the safety level should be promoted.

**Keywords:** Physiochemical**,** Heavy metals, Effluent water, Tannery, Kano and Zaria Metropolis

**INTRODUCTION**

Water treatment and its utilization have been the focus of many researchers. Water is an essential substance needed for so many purposes. However, water is used in the industry for both internal (for product formulation) and external use (feed water, coolant, etc.). When used for external it leads to generation of effluent water. Tanning operations generate significant amounts of wastewater, known as tannery effluent. Tanning effluent contains toxic heavy metals, including chromium, lead, cadmium, and mercury, among others. These metals are released into surrounding water bodies, posing risks to aquatic ecosystems. Several studies have investigated the physicochemical properties of these heavy metals, such as their solubility, speciation, mobility, and persistence in water systems Leung et al. (2014). Rahman et al. (2019) investigated the presence of heavy metals in vegetables irrigated with tannery effluent, highlighting the potential health risks.

 Exposure to heavy metals in tannery effluent can have severe consequences in human health. Due to their difficulty in biodegrading, heavy metals can accumulate in human essential organs and cause both acute and long-term exposure to varied degrees of sickness. Because they cannot be entirely destroyed, the accumulation also causes a number of well-documented issues in plants and animals (Malarkodi et al., 2007; Mustafa et al., 2010).

Nigeria is one of the West African countries that produces leather. In Nigeria, there are three leather institutes and roughly forty tannery enterprises that process 1860 tonnes of hides and skins. The majority of the wet tanning process takes place in Kano, and also in Zaria. Zaria (formally called Zauzzau) is one of the major cities and local government in Kaduna state. The both tannery sites produce effluent water as a result of industrial activities. Due to the health implication caused by indiscriminate and untreated discharge of the wastewater into the water bodies. This study was carried out to determine the physiochemical and heavy metal concentration in the discharged effluent water from the selected tanning sites located at Kano and Zaria metropolis.

**MATERIALS AND METHODS**

**Sampling location**

The country's most populous state, Kano, is located in Northern Nigeria between latitude 12°00' and 09.4°N and longitude 08°31' and 07°29'E. It is historically a commercial and agricultural State, and in fact the center of commerce. The high population is brought about by the much economic and industrial activities taking place in the city. The major industries in the city include tanneries, textiles, chemicals and allied products. The main industrial areas of Kano - Bompai, Sharada, and Challawa - are located within the two river basins (Bichi and Anyata, 1999). On the otherhand, Zaria (formally called Zauzzau) is one of the major city and local government in Kaduna state, North west Nigeria located at lattitude 11.1247° North and 7.7254° East. Nigerian Institute of Leather and Science Technology (NILEST) is located in Samaru Zaria. While Alhaji. Shafiu Block Industry Tannery is located at kofan Doka Kaduna-Kano Road Zaria. All The selected industrial sites were based on their appreciable size and location amongst other criteria. 

**Fig. 1:** Location of major Tannery Industries in Nigeria.

 **Materials Used**

Plastic Containers, Effluent samples, Atomic Absorption Spectrometry (AAS), Detergent, HNO3.

**Collection/Treatment of Effluent Samples**

Samples were taken from four different tannery sites: S1, S2 (Challawa in kano) and S3, S4 was taken from tannery sites in Zaria (NILEST and Alh Shafiu Block Industry Tannery). Each in plastic containers that were carefully rinsed with deionized water after being previously cleaned with detergents and 10% HNO3 acid. After taking 100cm3 of the sample, it was acidified with concentrated HNO3 to a pH of 2.0 in order to avoid precipitation and preserve the stability of the individual elements' oxidation states in solution. All of the samples were brought to the laboratory and kept in a refrigerator at 4ºC until the analyses were finished. 100 cm3 of sample was obtained, 5 cm3 of concentrated HNO3 was added, and the sample was digested. The amounts of chromium, iron, copper, and lead were measured in the digested samples using an Atomic Absorption Spectrophotometer (Buck Scientific 210 Model). The conductivity and pH were measured with meters, and the TDS (Total Dissolved Solids) and TSS (Total Suspended Solids) were measured using the gravimetric method (APHA, 1998).

**RESULTS AND DISCUSSION**

Physicochemical properties of the effluent samples

 **Table 1.** Physiochemical analysis of Tannery Effluent Samples from Kano metropolis

**S/N Sample pH Cond. (**$µs/cm$**) TSS(mg/L) TDS (mg/L)**

**1** S1 7.06­+1.54 8560 + 135.63 3546.60+115.63 1468+63.62

**2** S2 3.55+ 1.22 2240 + 18.40 2534.33 + 33.45 1795+53.50

FEPA Max. Limit 6-9 - 30.00 2000

WHO MAX LIMIT 6-9 1000 - 2000

**Table 2.** Heavy metals analysis of tannery effluent samples from Kano metropolis

**S/N Sample Cr (mg/**L**) Pb(mg/L) Fe(mg/L) Cu(mg/L)**

**1** S1 4.93+ 0.83 2.7+ 1.43 4.64+2.13 1.82+0.82

**2** S2 3.52+0.64 1.35+0.32 6.13+0.65 1.53+0.44

FEPA Max. Limit <1.00 <1.00 20 <1.00

WHO Limit 1.00 1.00 15 0.5

­­­­­­­­­­**Table 3.** Physiochemical analysis of Tannery Effluent Samples from Zaria metropolis

**S/N Sample pH Cond. (**$µs/cm$**) TSS(mg/L) TDS (mg/L)**

1 S3 9.35±3.55 21410 ± 425.32 2243 ±100.52 8260±88.56

2 S4 7.11±2.18 7624±100.44 2150±64.27 5583±63.62

FEPA Max. Limit 6-9 - 30.00 2000

WHO MAX LIMIT 6-9 1000 - 2000

**Table 4.** Heavy metal analysis of effluent samples from tannery sites in Zaria metropolis

 **S/N Sample Cr (mg/**Ll**) Pb(mg/L) Fe(mg/L) Cu(mg/L)**

1. S3 4.33+2.53 2.33+1.52 6.44+ 0.78 1.24+0.55
2. S4 4.26+1.82 2.66+1.11 8.32+1.06 1.43 +0.35

FEPA Max. Limit <1.00 <1.00 20 <1.00

WHO Limit 1.00 1.00 15 0.5

The chemical character of any water determines its quality utilization (Elueze et al., 2004). The quality is a function of the physical, chemical, and biological parameters to which it could have been subjected to and a particular use it is intended for (Tijani, 1994).

pH measures the degree of acidity or alkalinity of water and it determines some reactions (APHA, 1998). The results of the tannery sites for both sites conformed with the WHO permissible limit of 6-9 respectively. Conductivity is the ability of a solution to pass electric current; it gives the total ionic strength readings of the solution. The conductivity range measured in this study was 7624±100.44μs/cm, which was higher than the WHO and FEPA's maximum allowable values. Additional values documented were 6020 μs/cm (Ram, 2002) and 3668–4370 μs/cm (Assefa and Ayalew, 2014). Elevated conductivity results suggest a greater ion concentration (Deepali et al., 2009). TSS range of 1026.00 - 3365.60 mg/L was recorded; however, values as low as 204 mg/L (Assefa and Ayalew, 2014) and as high as 3491.9 - 9485.33 mg/L (Deepali et al., 2009) have previously been reported. Water with a high TDS value is more salinized and therefore may not be suitable for drinking or irrigation. This study was supported by an earlier examination by Ogabiela et al. (2007), which reported conductivity, TSS, and TDS values that were greater than the allowable limit in Kano.

It has been demonstrated that a continuous release of low concentration Cr can upset the aquatic food chain and be harmful to aquatic life. The majority of the research that is currently accessible reports that it predominated in the tannery effluent with the highest departure from the permitted concentration. From table 2 and 4, the chromium ion concentration in S1, S2, S3 and S4 exceeded the FEPA and WHO standards of <1.00 and 1.00 respectively. Chronic chromium exposure has been linked to high blood pressure, DNA damage, chronic eye impairment, and allergic dermatitis in humans (Scragg, 2006).

The reported concentration range for lead (Pb) at site S4 was 2.66-1.11mg/L, which exceeded the permissible limit. The majority of researchers from India (Begum et al., 2009) and Nigeria (Sangadoyin, 1995; Dan'Azumi and Bichi, 2010) matched with the findings. Elevated levels of lead can cause metallic poisoning, which could lead to human cancer (Bakare-Odunola, 2005).

The range for Fe (Table 2&4), as determined by the analytical data, was 3.53 - 8.12 mg/L, which was within the permitted limit. A number as high as 4.41 - 14.556 mg/L has also been observed (Dan'Azumi and Bichi, 2010). Previous investigations in the region found 1.23 - 1.16 (Fatoki et al., 2005) and 2.14 mg/L (Rehman and Anjum, 2010; Yusuff and Sonibare, 2004). Conversely, much lower levels of 0.351 mg/L (Tariq et al., 2006) and 0.75 mg/L (Deepali, 2010) were found in effluent that was discharged from Indian tanneries.

From table 2 and 4, S1, S2, S3 and S4 showed non conformity with the permissible limits of FEPA and WHO standard of <1.00 and 0.5 respectively. Similar high quantities were previously documented in Lagos (Sangadoyin, 1995) and Kano State (Dan'Azumi and Bichi, 2010). However, Deepali (2010) stated that the Cu concentration in Indian water was 0.022 mg/L.

Cu is a cofactor in several enzymes, including ferrooxidase (ceruloplasmin), cytochrome c oxidase, superoxide dismutase, and others. Maintaining normal copper homeostasis is crucial for human growth and development as well as the prevention of disease in cattle and poultry. It affects the formation of melanin, iron metabolism, and central nervous system performance (Fisher, 2001), but studies have shown that at high concentrations, it damages the liver, kidneys, and gastrointestinal tract. It has also been linked to bone disorders, renal failure, dermatitis, and lung cancer (Hogan, 2010).

**CONCLUSION**

According to the findings, the tannery effluents were detrimental to the surrounding environment. Therefore, it is strongly advised against discharging untreated tannery effluent into water bodies and lands, and frequent soil, plant, and water quality monitoring to determine the safety level should be promoted.

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