Science World Journal Vol. 19(No 4) 2024 https://dx.doi.org/10.4314/swj.v19i4.3
www.scienceworldjournal.org
ISSN: 1597-6343 (Online), ISSN: 2756-391X (Print)
Published by Faculty of Science, Kaduna State University

Full Length Research Article

ASSESSMENT OF HEAVY METALS CONTAMINATION: A STUDY IN THE INDUSTRIAL TANNERY WASTE DISPOSAL SITE OF NATIONAL INSTITUTE OF LEATHER AND SCIENCE TECHNOLOGY (NILEST), ZARIA

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ABSTRACT
Heavy metals, such as chromium, cadmium, lead cupper and others, pose significant environmental risks. Elevated levels of these metals can result in soil and water contamination, adversely affecting both ecosystems and human health. This study aims at investigating the presence and distribution of heavy metal contamination in leather research tannery disposal site, to identify its sources and propose effective remediation strategies to mitigate environmental and health risks. A total of five locations within the sites were chosen. The samples were collected at depth of about 15-20cm below the earth surface and thoroughly mixed to form a composite into polyethylene bags. Analytes in solids samples were transferred into solution employing mechanical sample preparation. Elemental determination of analytes was carried out using acid digestion procedures and Nitrichydrochloric acid (HNO_3-HCl) at the ratio of 3:1. Heavy metals; (Cr, Pb, Co, Cd, Cu, Ni, Fe, Mn, and Zn) presence were identify in the samples and their concentrations determined using Buck Scientific model 210 VGP Atomic Absorption Spectrophotometer with deuterium background correction lamp. This result revealed the following heavy metal concentrations; Cr, Pb, Co, Cd, Cu, Ni, Fe, Mn, and Zn in the studied area and identified significant levels of heavy metals contamination in the tannery waste disposal site Cr, Pb, Co, Cd, Cu, Ni, Fe, Mn, and Zn, with Chromium, Iron, Manganese and Zinc showing notable amount ranging from 14.3-1249.3 mg/Kg These findings present a genuine environmental concern, contributing a valuable insight to the understanding of heavy metal contamination and provides a baseline for informed decision-making in environmental management.

Keywords: Heavy metals, environmental contamination, waste management.

INTRODUCTION
Waste being an integral part of human existence from his earliest civilization, made more prominent through the industrial revolution, intensified by technology developments of the twentieth century Waste cannot be totally eliminated from environment, but needs to be managed properly in a conservatory way that reduces its negative impact on the environment and minimize risk to human health. Waste management is a problem in urban and industrialized areas of the country. Many industrialized cities in Nigeria still have inadequate waste management; poorly controlled open dumps and illegal roadside dumping leading to pollution. Industrial wastes pollution have become one of the most crucial matters confronting society. Some disposed waste amongst others contains heavy metals which pose dangers to the ecosystem and people in contact with the contaminated soil and plants from disposal sites (Siddiqua *et al*., 2022). Waste generation and disposals have been noticed as one of the driving forces of heavy metals contamination in soil (Siddiqua *et al*., 2022).
Heavy metals adversely affect humans (Hamadani *et al*. 2020; Mohanta *et al*. 2020; Sánchez *et al*. 2022). Thus, the extent of heavy metal contamination of soil and water in industrial waste disposal sites and its potential impacts on the ecosystem and local communities poses a significant environmental and human health risk, attenuating the environmental conditions (Hamed *et al*. 2020) and can lead to long term ecological and health consequences. This work aims to investigate the presence and assessing the levels and distribution of heavy metal contamination at the tannery disposal site in National Institute of Leather and Science Technology (Leather Research).

MATERIALS AND METHODS

Materials and Reagents
HNO_3, AAS, Polyethylene bags, volumetric flasks, dropping pipette and beakers, pH meter and sample bottles. Reagents were prepared using de-ionised water. All chemicals and reagents used in this study were of pure analytical and trace metal grades. Trace metal grades 65 % HNO_3, and 30% HCl were obtained from Riedel-de Haen Germany. Stock standard solutions for each element with a concentration of 500mg/L were supplied by Agilent Technology USA. Deionized water was used throughout the study. All glassware were soaked in 5 % (v/v) HNO_3 overnight then rinsed with deionized water and dried using lab dryer Sanyo MIR-162 prior to use.

Study Area
Nigeria Institute of Leather and Science Technology (NILEST) is located at Samaru, Sabon-Gari Zaria, Kaduna state. It is an institute that houses an industrial tannery with operations mainly consisting of acquiring and pre-treating raw animal hides and skins using tanning agents such as chromium salts into leather, drying up and finishing of the leather prior to sending it to product manufacturers (Giaccherini, *et al*., 2017). Such operations are characterized by production of solid and liquid wastes disposed on the waste disposal site. About 11 ML of wastewater is produced daily based on 0.32 Mg of solid waste generated per day (Yazid and Yalo, 2018). Scanty agricultural practices are carried out besides the dump site.

Sampling and Sample Preparation
The sampling areas covered historic and modern dumpsites within and around the Institute. A random samplings in five spots around the dumpsites were taken. The samples were collected at depth of about 15-20cm below the earth surface into polyethylene bags, and each thoroughly mixed to form a composite. The samples were taken to the laboratory; air-dried and sieved into three fractions, $\theta \leq 0.25$, $\theta \geq 0.25 \leq 0.50$mm in diameter. $\theta \leq 0.25$mm samples from respective sites was used for further analysis.

Analytical Methods
The organic carbon contents of all samples were separately determined by the dichromate oxidation of Walkly and black method as obtained in literature (IITA, 1979; Abdus-Salam and Adekola, 2005b). The pH of the soil samples was measured in water by glass electrode method involving 1:1 soil water mixture using a MicropH 2000 model of a Hanna pH-meter (IITA,1979).
The moisture contents of the air-dried $\varphi \leq 0.25$ samples were determined (Kunze and Dixon, 1986). Each experiment was carried out on triplicate samples from each location and results recorded as mean value of the triplicate.

Extraction Procedure
Two essential extraction procedures were employed. The toxicity characteristic leaching procedure EPA Method 1311 that utilizes dil. / conc. HNO_3 and gives the common sequential modified Tessier method was separately used. The EPA 1311 gave a single composite extract, and Tessier method that gives rise to five fractions (Tessier *et al*, 1979). The product of extractions (filtrates) were separately analyzed for trace elements using an Alpha 4 Chem. Tech. Analytical Atomic Absorption Spectrometer (AAS) with graphite atomiser.

Heavy metal analysis
Heavy metal concentrations in the samples were measured using Buck Scientific model 210 VGP Atomic Absorption Spectrophotometer with deuterium background correction lamp. A standard curve was obtained by running a prepared standard solution of each heavy metal. Hundred milliliters of each sample was transferred into a beaker. 5-mL conc. HCl was added and heated using a hot plate until the volume was reduced to 20 mL. The sample was cooled and then filtered. The pH of the digest sample was adjusted to 4 by adding 5.0 N NaOH. The sample was transferred to a 100-mL volumetric flask and then diluted to the mark with deionized water. The digest samples were used for the heavy metal analysis. A standard solution containing a 1000 mg/L of 2% HNO_3 was used to prepare the spiking experiments and calibration standards. Three working standards of each heavy metal were prepared from these standards (Thomas *et al*., 2019).

RESULTS

Table 4.1 Showing heavy metals identified and concentration from NILEST Zaria Tannery disposal site

	Concentration of element (mg/Kg)								
Sample	Cr	Pb	Co	Cd	Cu	Ni	Fe	Mn	Zn
A	791.4	-0.206	-0.214	-0.064	-0.057	-0.061	1247.3	90.7	33.16
B	1181.2	2.800	-0.252	-0.058	-0.177	-0.001	24.7	83.5	117.00
C	1249.3	-0.150	-0.277	-0.063	-0.121	-0.066	1435.9	117.8	99.00
D	121.8	-0.351	-0.271	-0.075	-0.144	-0.066	221.6	110.0	71.24
E	14.3	-0.608	-0.236	-0.075	-0.168	-0.075	221.5	66.9	31.59

A, B, C, D and E represent different sample collection area within same waste disposal site

DISCUSSION
This investigation reveals the presence of the following heavy metals identified in the tannery waste disposal site Cr, Pb, Co, Cd, Cu, Ni, Fe, Mn, and Zn in significant levels, thus confirming the occurrence of heavy metal, characterizing contamination in the studied area, the sources of such heavy metals ascribed as aftermath of industrial effluents, among others. Since heavy metals cannot be degraded, they accumulated and persist over time, giving rise to either bioaccumulation by living systems especially plants or biosorption by both living and dead biomass, increasing the human exposure and eventually causing serious adverse environmental consequences. This is comparable to the findings of Abdus- Salam., (2009), on assessment of heavy metals pollution in dumpsites in Ilorin Metropolis leading to soil degradation and water pollution, and also similar to the study of Amuah *et al*., (2024), in which notable amount of Cr, Cu, Zn Pb and Fe were found in waste disposal site in Ghana.
From the study the concentration of Cr was significantly higher in most of the samples compare to the maximum permissible limit set by WHO (100 mg/Kg). This concentration is far above the permissible limit for soil as set by WHO, and can pose deleterious effects on human health, similar to the finding of Amuah *et al*., (2024), which shows a significant higher chromium concentration on dumpsite. Lead (Pb) concentration was low in almost all the samples collected from different point in the waste disposal site compare to the limit for soil set by WHO. But lead shows a significantly higher concentration in point B compare to the limit set by WHO. Therefore, lead is within tolerable range in most point with the exception of point B. The concentration of Fe shows significantly lower amount compare to WHO maximum permissible limit in almost all the samples. The study of Amuah *et al*., (2024), in which notable amount of Fe was found in various part of Ghana.

The levels of zinc (Zn) were above the maximum permissible limit set by WHO (50 mg/Kg) in all the points of sample collection similar to the finding of Osobamiro *et al.,* (2019) in which it shows higher level of zinc from major industrial area in Abeokuta. Also, Mn shows lower concentration when compare to the standard by WHO of 437 mg/Kg, which in contrast to the study of Bawwab *et al,* (2022), in which the level of Mn exceeds the permissible limit set by WHO. The concentration of Co, Cd, Cu, Ni were below WHO maximum permissible limit in almost all the samples this result is similar to the study of Olu *et al*, (2021), which shows also lower concentrations of those heavy metals at water collected close to dumpsite. These samples had values below the set standard at all the point of sample collection within the disposal site.

Conclusion

The findings of the study highlight the presence of heavy metals in the waste disposal site of NILEST Tannery dump site; Cr, Pb, Co, Cd, Cu, Ni, Fe, Mn, and Zn were identified. The heavy metals were notable; chromium, Iron, Manganese and Zinc showed high concentration compare to the others with lead having least amount. These findings contribute empirical data on the concentration of heavy metal that can furnish valuable insights to the broader understanding of heavy metal contamination and provide a foundation to policy makers for informed decision-making in environmental management.

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