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Determination of Heavy Metals in Tannery Wastes

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Abstract: Tanning Industry has contributed immensely in contaminating the environment with heavy metals due to the large quantity of chemicals employed in the tannery. These metals are introduced into the body through industrial stack gas, soil and ground water and have cumulative effects. This paper, determined concentration of some heavy metals in the tannery wastes with the view to generate empirical data showing various levels of heavy metals in the waste and also to create awareness of their effects on the environment and how to reduce them. In this paper, Incinerated tannery wastes collected from different dump sites in Challawa were analyzed for their chromium and copper heavy metal contents using Atomic Absorption Spectroscopy (AAS). The results showed high concentration of chromium and low concentration of copper. The high chromium content is probably as a result of the large scale tanning going on at Challawa Industrial Area in Kano State, resulting in high deposit from wet blue shavings, leather trimmings and buffing cakes. These incinerated wastes could be collected, acidified and re-used for tanning, to give good hydrothermal stability to the resultant leather, thereby reducing the health hazard associated with chrome to the environment.

Keywords: Tanning, Heavy Metals, Incinerated Tannery Wastes, Wet Blue Shavings, Leather Trimmings, Buffing Cakes

1. Introduction

Human activities have contributed immensely in contaminating the environment with heavy metals due to industrial activities and technological advancement in the tannery sector [1]. Most of the chemicals used are poisonous to man and aquatic life resulting in food contamination and short life expectancy. These effluents, sludge and incinerated waste helps in the bioaccumulation of heavy metals such as chromium and copper, because the standard practice and legislation for the disposal of effluent and solid waste is not adhered to [2].

In the present context of study, particular emphasis is placed on the status of metals in the tannery sector to ascertain their concentrations in soil and incinerated wastes. These heavy metals concentration depends on the quantity of the chemicals employed and the volume of waste generated [3, 4]. These wastes generated could be determined using analytical methods such as spectrophotometric or neutron activation analysis to ascertain the level of metals concentrations in the sample waste [5, 6].

2. Materials and Methods

2.1. Description of the Study Area

Kumbotso local government area lies between latitudes 11°50′S to 12°N and longitude 8°24′W to 8°4'E. It falls within the Kano State Settlement Zone bordering the south and west by Madobi Local Government Area in the North-west; Rimingado, in the North by Gwale and East by Tarauni Local Government areas respectively.

2.2. Sample Collection and Analysis

Samples were collected systematically but randomly on weekly basis and were stored in plastic bags inline with the procedure of Ayodele and Gaya, [7], labeled A1-Z1 and A2-Z2 for incinerated and soil samples. Total of 52 samples were analyzed for chromium and copper using standard methods [8, 9].

2.2.1. Metal in Soil

0.25g was digested with 10ml HF acid and 1ml aqua-regia, that is, HCl and HNO_3 (3:1) in a flask. Thereafter, 5.0ml $HClO_4$ was added and again heated on heating plate up to dryness and distilled water was added to make up to the volume of 100ml and filtered through Whatman no. 42 filter paper. Digested soil sample were analyzed for heavy metals concentrations by Atomic Adsorption Spectrophotometer (ALPHA 4 Model). A reagent blank was prepared by repeating the procedure without the soil sample [8, 9].

2.2.2. Incinerated Tannery Waste

Burnt tanneries wastes from the site were collected, crushed, mixed and sieved using 0.4mm mesh for homogeneity. One gram (1g) of each sample was weighed into a platinium crucible and was ashed at 400℃ [10] to a constant weight. The ash was quantitatively transferred from the platinium crucible using spatula into a 250cm^3 conical flask. A mixture of concentrated oxidizing acids of nitric 5cm^3, sulphuric 3.5cm^3 and perchloric 11.5cm^3 were transferred into the conical flask containing the ash. Anti-bumping granules and funnel were introduced into the conical flask. The mixture was heated on a hot plate in a fume cupboard. The initial colour of the solution varied from dirty given to orange [11]. The digesting was completed after 1½ hours the heating was stopped and the solution cooled to room temperature. 100cm^3 of distilled water was added to the solution and was further boiled for 10minutes until the free chlorine and oxides of nitrogen were expelled. The free chlorine is a colourless gas which form white fumes when held closed to ammonia bottle (NH_4Cl) and when the free chlorine is completely expelled the white fumes is not observed while the disappearance of the reddish brown gas indicate that the oxide of nitrogen has been expelled. The resultant solution was filtered through a Whatman filter paper number (1) 90mm into a 250cm^3 volumetric flask and was made up to the mark with water. The resultant solution was analyzed for chromium and copper. A reagent blank was prepared by repeating the procedure without the sample using Atomic Absorption Spectrophotometer (AAS).

3. Result

Table 1. *Concentrations of Chromium and Copper in Incinerated Wastes and Tannery Soil (farm).*

CODE/NO	Incinerated waste Chromium (mg/kg)	Incinerated waste Copper (mg/kg)	CODE/NO	Tannery soil (farm) Chromium (mg/kg)	Tannery soil (farm) Copper (mg/kg)
A_1	19428	395.75	A2	983.68	180.62
B_1	22068	416.75	B2	788.5	150.88
C_1	20833	323.00	C2	886.32	132.13
D_1	20985	448.00	D2	997.10	95.07
E_1	20888	468.75		877.04	122.03
F_1	20873	156.75		755.01	119.04
G_1	20900	343.75		780.01	125.06
H_1	20900	31.25		984.15	133.08
I_1	18525	302.00		877.15	142.01
J_1	20888	281.25		922.11	160.00
K_1	21053	260.50		974.04	183.00
L_1	21110	406.25		964.01	159.37
M_1	20638	427.00		954.02	252.01
N_1	20928	270.75		958.01	260.01
O_1	21025	354.25		964.77	222.07
P_1	20845	125.00		951.08	189.53
Q_1	20860	427.00		945.06	177.00
R_1	20970	364.50		981.07	180.36
S_1	21068	395.75		935.01	199.36
T_1	20943	239.50		932.04	198.14
U_1	21095	479.25		936.11	187.66
V_1	20985	385.50		941.80	175.38
W_1	20845	343.75		963.11	130.37
X_1	21000	406.25		918.86	144.38
Y_1	20833	93.75		913.11	164.57
Z_1	21013	31.25		908.19	196.87

4. Discussion

The result obtained for this study seeks to highlight the concentration of some heavy Metals such as chromium and copper, this was necessitated because of the outrageous disposal of tannery effluent via its solid waste without pretreatment which constitute chromium (as a tanning salt) and copper compounds (as preservatives). The results are presented in Table 1.

4.1. Chromium

Chromium in the incinerated waste was 2082. 88±6103mg/kg although no work has been done to relate this findings while the concentration of tannery soil (farm) was 922.74±63.48mg/kg which was below the set standards for sludge and soil contaminated with tannery waste. The relative high amount of chromium in the incinerated waste could be attributed to the tanning activities going on in Challawa with high amount of chromium salt used in the tanning of various leather articles, trimmings from wet blue and crust, shavings and the waste chromium bags used for packaging [12-16]. The high concentration of chromium in the incinerated waste could lead to infertility of the soil. The trace element (Cr^{3+}) is efficient in plants and minute quantity can produce. Optimum result, a sight deficiency or excess is harmful to plant and a fertile soil is not necessarily a productive soil due to poor drainage, drought and insect attack on the plants. Continuous exposure to chromium in fumes from the burnt waste could lead to health hazard to the people residing in the locality [17, 18]. Fume from waste dump may cause poor visibility on the Challawa industrial highway during the dry Season [19, 20]. Furthermore, Chromium deposited on land does not degrade naturally but remain bound to the organic matter unless remobilized by water or air [21, 22]. The environment may thus overload beyond the normal capacity [23-25], consequently, these incinerated wastes could be collected, acidified and reused for tanning to give a good hydrothermal stability to the resultant leather thereby reducing the health hazard associated with chrome to the environment and the dump site a gold mine for basic chromium salt extraction and utilization.

4.2. Copper

The data for copper concentration in both incinerated waste and tannery soil (farm) samples were found to be 31460±130.74mg/Kg and 168.58±40.00mg/Kg respectively. Although no work has been done to relate this finding for incinerated waste but the value for tannery soil was below the set standard for sludge and soil contaminated with tannery waste. The presence of copper in the waste could be attributed to its usage as preservatives on fresh hides and skins, tanned leathers and finishing dopes, dyes and polyphenolic tanning agents [26]. Copper is an essential metal for plant and mammalian as a component of metallo-enzymes in which they act as electron donor or acceptor. Exposure to copper inhalation could lead to health hazards [27, 28]. The use of plants for the preservation of raw hides/Skins and leather be encouraged, such plants could include. *Mormodica basalmina* donor or acceptor. Exposure to copper inhalation could lead to health hazards [27, 28]. The use of plants for the preservation of raw hides/Skins and leather be encouraged, such plants could include. *Mormodica basalmina* (Garafunic in Hausa*), Khaya sunegalensis* (Madaci-Hausa, Mahogany-English). *Garcina cola* (Bitter cola) and *neem* tree, this is aimed at making the environment more eco-friendly.

5. Conclusion

This paper determined concentration of some heavy metals in the tannery wastes with the view to generate empirical data showing various levels of heavy metals in the waste and also to create awareness of their effects on the environment and how to reduce them. In this paper, Incinerated tannery wastes collected from different dump sites in Challawa were analyzed for their chromium and copper heavy metal contents using Atomic Absorption Spectroscopy (AAS). The results showed high concentration of chromium and low concentration of copper. The high chromium content is probably as a result of the large scale tanning going on at Challawa Industrial Area in Kano State, resulting in high deposit from wet blue shavings, leather trimmings and buffing cakes as presented in Plates 1-3. The use of natural plants should be encouraged in the preservation of hides, skins or leather materials to reduce the amount of biocides used.

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