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Full Length Research Paper

Heavy metal levels in Sokoto metropolis as a result of local production of aluminium utensils

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Assessment of the levels of heavy metal pollution due to production of local aluminum articles have been carried out. Atomic absorption spectrophotometric method of analysis was used for the determination of Cu, Cd, Cr, Fe, Mn and Pb, while ethylenediaminetetraacetic acid (EDTA) back titration with $ZnSO_4$ was used for Al. Results show that the various concentration obtained follows the order, Al > Cu > Fe> Mn > Ni > Cr > Pd. Although, the concentrations of the metals were found to be generally low and fall below the threshold limit, continued discharge without regulation could cause future problem.

Key words: Heavy metal, aluminium utensils, pollution, Sokoto.

INTRODUCTION

Increasing rate of environmental pollution as a result of natural disasters (such as flood, earth quake, landslides and geological factors) or human activities (industrial and agricultural activities) is one of the greatest environmental issues facing the world today (Onwardi and Dan-Suleiman, 2010; Danbonne et al., 2010). Bagudo et al. (2009) and Francis (2005) revealed that the local aluminium industry generates metallic wastes that may result in the accumulation of aluminium and the alloying metals (Mn, Ca, Zn, Cr, Cd, Fe. Ni, Pd etc) with consequent cause damage to the environment (Dabonne et al., 2010; Dayan and Paine, 2001).

The continuous discharge of this waste will result in the accumulation of aluminium and the associated metals in the immediate and surrounding environment. Most of these metals are toxic and result in health impacts when present in elevated concentrations in the environment (Jarup et al., 1998; Nagowa et al., 2004; Hayes, 2007; Eastman, 2008).

The aim of this work was to examine the level of accumulation of heavy metal; aluminium, cadmium, chromium iron, copper, manganese, nickel and lead in the soil as a result of the production of aluminium utensils. The production sites for these local aluminium articles are mostly located in city centers particularly in market places were a lot of people are put at risk. The raw materials used for this purpose are usually scrap aluminium alloys like block engines, carburetors and wheels obtained from automobiles, and building materials like the aluminium roofing sheets and furniture, as well as many other scrap aluminium articles. The raw scraps are cut into smaller pieces and fed into steel vessels and heated to melt. The molten metal is then poured into prepared moulds to form the desired product on cooling while the remaining solid mass is discarded as waste. Considerable amount of metallic waste is also generated in the process of cutting the raw scrap metals and when filing the products to the required shape and design. This waste is directly discharged into the surrounding environment without any consideration.

MATERIALS AND METHODS

Sample collection

Grab samples of the soil were collected at Kwanni, a street in

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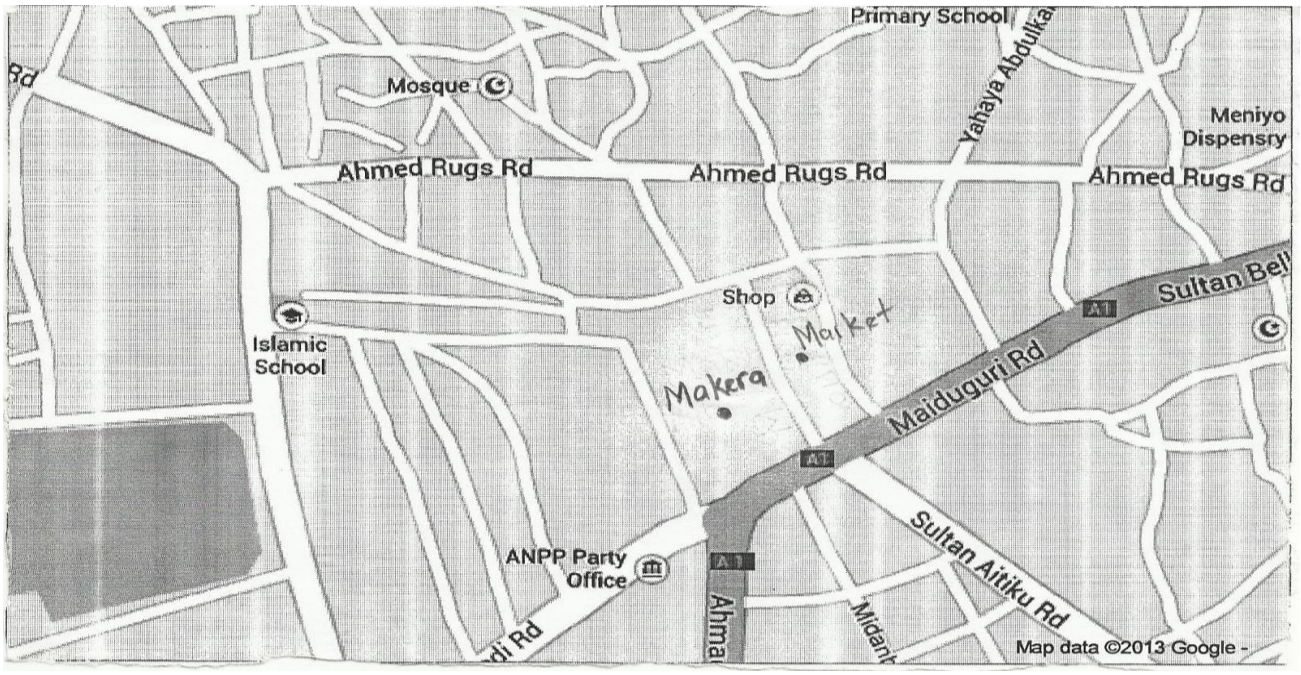

Figure 1. Map of the study area (Google Maps).

Makera district adjacent to the Sokoto old central market in Sokoto metropolis Figure 1. Four samples were collected at depth of 0.15 cm using a spade at the production site 100, 200, 300 and 400 m away from the production site and were labeled A, B, C and D, respectively, and then kept in polythene bag for further analysis (Dauda, 2011).

Sample treatment and digestion

The collected samples were air-dried grinded using a pestle and mortar and sieved through 2 mm sieve (Tan, 1983). One gram of dried and grinded sample was placed in 1000 cm^3 micro Kjeldhal flask previously washed with nitric acid and distilled water, 10 cm^3 of concentrated nitric acid and 20 cm^3 of concentrated sulphuric acid was added. The mixture was heated and digested under fume cupboard until white fumes appeared. The mixture was cooled and filtered into 100 cm^3 volumetric flask and then diluted to the mark (Tan, 1983).

Apparatus and reagents

Determination of Cd, Cu, Fe, Mn, Ni and Pb was done using atomic absorption spectrophotometer (AAS) (Perkin - Elm 4000 model) at suitable wavelength for each metal. Standard solutions were prepared from 1000 ppm stock solution of each metal. The reagents were all of analytical grade.

Determination of Al: EDTA titration

25 cm^3 portion of the sample solution containing Al^{3+} was taken is a clean conical flask and 30 cm^3 (excess) 0.01 M EDTA solution was added and pH was adjusted to 7.5 using ammonia. The solution was heated for few minute for complete complexation and later cooled, monitoring the pH at 7.5, 50 mg of solo chrome black T/KNO_3 mixture was added as indicated and titrated against 0.01 M $ZnSO_4$ until when the colour changed from blue to wine red. The procedure was repeated five times for each sample (Jeffery et al., 1989).

RESULTS AND DISCUSSION

The result of the analysis conducted revealed different concentration of the analyte with aluminium recording the highest concentration as shown in Figure 2. The distribution pattern follows the order: Al> Cu> Fe> Mn> Ni> Cd> Cr> Pd.

Highest concentration observed for aluminium with the production site having the highest concentration is due to the fact that aluminium and its alloys are the major raw materials for the local industry and therefore a lot of it goes with the waste. Copper and iron are also high because they are the most frequently used alloying metals in that perspective. The concentration of cadmium is low ranging between 3.73 and 11.8 mg/kg and falls below the threshold limits of 20 mg/kg for commercial and industrial purposes (Rodojeyei and Baskin, 1992). Calcium is toxic even in low concentration and causes liver and kidney impairment if injected into human system (Hayes, 2007).

Chromium concentration ranges between 1.36 and 3.48 mg/kg which is lower than the soil threshold limit of 500 mg/kg for residential industrial and commercial purpose (Rodojayei and Baskin, 1992), chromium is toxic and carcinogenic. Accurate oral toxicity ranges between 50

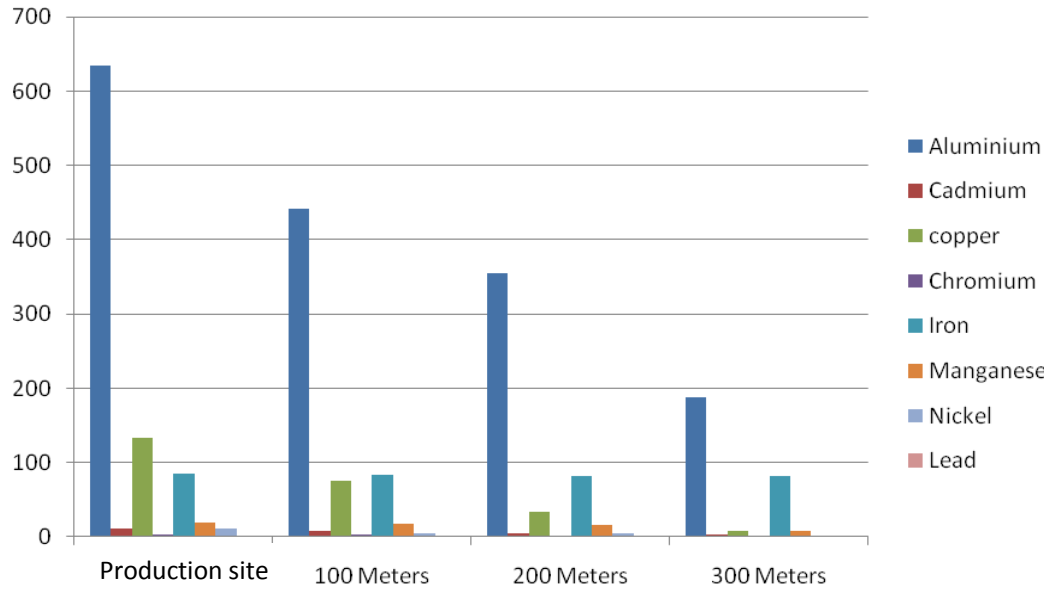

Figure 2. Concentration (mg/kg) of analytes in the soil samples.

and 150 µg/kg (Katz et al., 1992). It damages liver and blood cells by oxidation (Dayan and Paine, 2001).

Manganese, iron and nickel shows low concentration ranging between 0.11 and 133.4 mg/kg which falls below the threshold limit of 440, 500 and 30 to 75 mg/kg, respectively, for industrial and commercial purposes. The metals are needed by human system but can be toxic and poisoning to mammals if inhaled or injected in higher concentration (Normandin and Hazell, 2002; Takeda, 2003; Howard, 1991).

Copper is also an essential element but it can also be poisoning. Concentration range of 8.46 to 133.4 mg/kg was recorded which also falls below the threshold limit of 500 mg/kg. Lead shows the lowest concentration of 0.11 to 0.32 mg/kg and the values fall below the limit of 5.0 mg/kg for lead. Lead even in low concentration can be poisoning to the children which could lead to hypersensitivity or impulsive behavior, it also affects fertility in adults leading to miscarriage. Excess poisoning cause blood disorder in mammals and damage to nervous system or brain (Leedleman et al., 1990).

Conclusion

Decreasing concentration of heavy metals observed with increasing distance from the production site indicate gradual accumulation of these toxic metal as a result of indiscriminate discharge of metallic waste generated from the production of the local aluminium utensils.

Although, the concentration of the metals is generally below the tolerance limit for agricultural, industrial and commercial purposes, it needs to be regulated as continued accumulation could cause serious future problem.

REFERENCES

Bagudo BU, Birnin -Yauri UA, Farouq UZ (2009). Determination of hazardous metal in locally made aluminium utensils. Niger. J. Basic Appl. Sci. 10:45-52.

Danbonne BPK, Due EA, Koffi EJR, Koff AG, Kaume LP (2010). Traditional utensils: potentials sources of poisoning by heavy metals. Br. J. Pharmacol. Toxicol. (2):90-92.

Dauda A (2011). An Introduction to Atomic Absorption Spectrophotometry. Omo-Ojo Print and Publishers Nig. Coy, Lagos Nigeria. pp.11-24.

Dayan AD, Paine AJ (2001). Mechanisms of Chromium Toxicity, Carcinogenicity or Allegenicity: Review of the literature from 1985 to 200. Hum. Exp. Toxicol. 20 (9):439-451.

Eastman DA, MacGregor JT, Slensinski RS (2008). Trivalent Chromium: Assessing the Genotoxic Risk of an Essential Trace Element and widely used Human and Animal Nutritional Supplement. Crit. Rev. Toxicol. 38(3):173-190.

Francis OA (2005); Trace Metals Contamination of Soil and Vegetation in the vicinity of Livestock in Nigeria. Electron. J. Environ. Agric. Food Chem. 4(2):863-870.

Hayes AW (2007): Principles and Methods of Toxicology. Philadelphia: CRC press. pp. 858-861.

Jarup L, Berglund M, Elinder CG, Nordberg G, Vahter M (1998). Health Effects of Cadmium Exposure - A review of the literature and a risk estimate. Scand. J. Work Environ. Health 24 Suppl 1:1-51

Jeffery GH, Basset J, Mendham JW, Danney RC (1989). Vogel's Text Book of Quantitative Chemical Analysis fifth edition, Longman Scientific and Technical, New York. pp. 256-272.

Google Maps. Retrieved from https://maps.google.com.ng/ on 30th May 2013.

Nagowa K, Kaboyashi E, Okuso Y, Suwazono Y (2004). Environmental cadmium exposure, adverse effects and preventive measuring in Japan. Biometals 17(15):581-587).

Normandin L, Hazell AS (2002). Manganese neurotoxicity: An update of pathophysiologic Mechanisms. Metab. Brain Dis. 17 (4): 375.

Onwardi CT, Dan-Suleiman SB (2010). Physico-chemical characterization of heavy metals of effluents from glass processing plant in agbera industrial estate, Ogun State. Nigeria. Arch. Appl. Serv. Res. 2(1):212-217.

Takeda A (2003). Manganese action in brain function. Brain Res. Rev. 41(1)79.

Tan KH (1983). Soil sampling, preparation and analysis. Dekker, New York. pp. 114-127.