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All thanks are to the Almighty God for giving us the opportunity to produce the volume 12, Number 1 issue of the Nigerian Journal of Pharmaceutical Sciences. The Education Trust Fund (ETF) has given life to the journal and we are sincerely grateful. We want to thank all our associate editors for your prompt response when desired.

The Editorial Board would like to express its profound appreciation for all those who contributed towards this publication and urge them to continue with this good gesture for the subsequent publications.

It is pleasing to inform our teaming contributors and subscribers that the journal is already on the net and already in the process of being registered by some abstracting and indexing bodies to serve you better.

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DETERMINATION OF CADMIUM CONTENT OF WATER IN AHMADU BELLO UNIVERSITY MAIN CAMPUS ZARIA

Abdullahi, S.T.^{*1}, Yakasai, LA², Garba, M.², Musa, A.², Yakubu S.I.³

¹Department of Pharmaceutical and Medicinal Chemistry, University of Ilorin, Ilorin-Nigeria

²Department of Pharmaceutical and Medicinal Chemistry, Ahmadu Bello University, Zaria-Nigeria

³Department of Clinical Pharmacy and Pharmacy Administration, University of Maiduguri, Nigeria

Author for correspondence: saadabdullahi2013@gmail.com +2348035883569

ABSTRACT

Cadmium (Cd) is a highly toxic element that is released into the environment from diffuse sources. Contamination of drinking-water may occur as a result of the presence of Cd as an impurity in the zinc of galvanized pipes or Cd-containing solders in fittings, water heaters, water coolers and taps or from contaminated raw water sources. In this study, eleven different water samples coded A-L from Ahmadu Bello University main campus Zaria were randomly collected, digested with concentrated nitric acid and analysed for Cd using Atomic Absorption Spectrophotometer (AAS). The result indicated that the mean concentration of Cd ranged from 0.0864mg/l to 0.1690mg/l ($P < 0.05$). The mean concentration of Cd in all the eleven samples were significantly higher than the World Health Organisation guideline of 0.003mg/l ($P < 0.05$). The Pair-wise correlation studies revealed weak positive relationship (+0.276) between the pH of the drinking-water samples and concentration of Cd. Thus, the batch of water samples analysed may be hazardous to the health of the university community.

Keywords: Cadmium, contamination, metal, Zaria

INTRODUCTION

Cadmium (Cd) has been known for many years to be a highly toxic element. Health problems attributed to Cd exposure include a number of acute and chronic disorders, such as "itai-itai" disease, liver and renal damage, pulmonary emphysema, hypertension, and testicular atrophy (WHO, 1984; Leyva-Ramos, 1997; Waalkes, 1994). The need for precautions against human exposures in industrial operations involving Cd or its compounds has long been recognised. In recent times, concern has been expressed over the

possible human health effects of long-term exposure to low concentrations of Cd such as those that might develop through environmental routes (Hallenbeck, 1986). Cd, along with its compounds, is widely used in pigments, as heat stabilizers for plastics, for corrosion resistance of steel and cast iron, metal plating, phosphate fertilizer, mining, pigments, alloy industries, in soldering and brazing, and in the battery industry (Ni-Cd batteries) (Bernard and Lauwerys, 1986). The use of Cd products has expanded in recent years at a rate of 5 to 10 percent annually, and the potential for further growth is very

high (United State Geological Survey USGS, 2008). Cd occurs naturally in zinc, lead, copper and other ores which can serve as sources to ground and surface waters, especially when in contact with soft, acidic waters (Maxim and Fred, 1954). Major industrial releases of Cd are due to waste streams and leaching of landfills, and from a variety of operations that involve Cd (Fred and Maxim, 1955). Although useful applications for Cd have been recognized only in comparatively recent times, the metals with which it is commonly associated - copper, lead, and zinc - have been employed for several thousand years (Friberg *et al.*, 1974). Contamination of the environment has therefore been occurring throughout this period. With the discovery of new uses for Cd, the problem has intensified. In addition to contamination from the known applications of Cd or its compounds, the environmental burden of this element may be augmented through its unintentional presence in galvanized products, sewage sludge, and fertilizers (Friberg *et al.*, 1986).

Contamination of drinking-water may occur as a result of the presence of Cd as an impurity in the zinc of galvanized pipes or Cd-containing solders in fittings, water heaters, water coolers and taps (WHO, 2011). Although Cd is not a major component of these solders, it may still be present as an impurity. It is therefore important to study the extent of leaching of Cd from these solder-joints into drinking water supplies. The potential for drinking water contamination from the leaching of Cd from plumbing equipment joined with Cd-based solders in the water supply systems can pose a public health hazard (Subramanian *et al.*, 1991). Ahmadu Bello University (A.B.U.) main campus like most communities in Zaria is not exempt from traces of heavy metals environmental contamination (Yakasai *et al.*, 2004; Musa *et al.*, 2008). Other study done in Zaria

showed the presence of Cd in water (Farouk *et al.*, 2006).

This study therefore aimed at determining the levels of Cd in water samples from A.B.U. main campus, Zaria, and comparing the levels obtained with the standard limit of 0.003mg/l set by the World Health Organisation (WHO) for safe drinking water.

MATERIALS AND METHODS

Reagents and Equipment

Reagents used were of analytical grade: from British Drug House (BDH) Poole. All solutions were prepared using redistilled, deionised water. Portable pH meter model H198107 (Hanna Instruments) and AAS Shimadzu AA-6800- with hollow cathode lamp- for Cd (lamp current at 6mA), air-C₂H₂ burner (2.0 L/min), slit width 1.0nm were employed.

Sampling Sites

The sampling sites were market areas, shops and faculties on the main campus.

Sample Collection

Five (2L) water samples were randomly collected into plastic containers from each of the sampling sites. The plastic containers were previously cleaned by washing in non-ionic detergent, rinsed with tap water and later soaked in 10% HNO₃ for 24 hours and finally rinsed with deionised water prior to usage. During sampling, sample bottles were rinsed with the sampled water three times before collection. The water when from the taps was allowed to run freely for 1-2 minutes before collecting the samples. The pH of the water samples was taken immediately after collected using the portable pH meter. The collected samples were acidified by adding 2-3 drops of

concentrated HNO_3 . The samples were coded. pH, time, date and place of collection were indicated on the samples. They were transported to the laboratory in cooler with ice packs, stored in the refrigerator at about 4°C prior to analysis. All samples were collected in the month of March, 2010.

Sample Pre-treatment

Nitric acid digestion method (Association of Official Analytical Chemist, AOAC, 1990) was used for the pre-treatment of the samples. A 50ml water sample was pipetted into a 100ml beaker. Concentrated nitric acid (10ml) was added with the aid of an acid dropper. The beaker with the content was placed on a hot plate and digested in a fuming cupboard until when brown fumes of nitric acid had escaped. Heating was continued until when content had been reduced to about 10ml volume. The content was allowed to cool and washed into a 50ml volumetric flask through a Whitman filter paper supported on a glass funnel and made to mark with the redistilled, deionised water. The digest obtained was then analysed for Cd using AAS at 228.8nm.

Statistical Analysis

All the data were subjected to statistical evaluation. One way analysis of variance

(ANOVA) and the post hoc test using the Duncan multiple range test (DMRT) were applied to find the significant difference in the mean concentration of the metals in the different studied areas. The mean concentrations of Cd at each location were compared with the WHO standard using the Independent Sample t-test. The pair-wise linear relationship between Cd and the water pH was also analysed by employing the Pearson's product-moment correlation coefficient using SPSS software.

RESULTS

The mean $\pm$ SEM concentrations of Cd in the samples analysed range from $0.0864 \pm 0.0160\text{mg/l}$ to $0.1690 \pm 0.0079\text{mg/l}$ (Table 1). The mean concentration of Cd varied across the sampled locations but the variations were not significantly different ($P < 0.05$). The mean concentration of Cd in all the sampled locations significantly ($P < 0.05$) exceeded the WHO guideline of 0.003mg/l . Pair-wise correlation studies revealed a weak positive (+ 0.276) relationship between the pH of the drinking water samples and Cd concentration.

Table 1: Concentration of Cadmium in Potable Water Samples from Ahmadu Bello University Main Campus, Zaria

Sample Codes	pH $\pm$ 0.1	Concentration (mg/l) mean $\pm$ SE
A	6.8	0.0958 ± 0.0328
B	6.9	0.0864 ± 0.0160
C	6.9	0.1052 ± 0.0307
D	7.1	0.1080 ± 0.0218
E	6.9	0.1014 ± 0.0260
F	7.5	0.0937 ± 0.0058
G	7.7	0.1108 ± 0.0202
H	7.4	0.1117 ± 0.0189
I	6.9	0.1098 ± 0.0125
J	7.6	0.1690 ± 0.0079
K	5.7	0.1088 ± 0.0331
L	6.9	0.1305 ± 0.0326

Note: samples size (n) = 5

DISCUSSION

From the result in table 1, it can be seen that the mean concentration of Cd for samples B, A, F were lower compared to the mean concentrations of other samples. The source of Cd may be due mainly to municipal and probably industrial wastes that emptied into the reservoir. The indiscriminate discharge of untreated effluent from tanneries is a growing problem in a city like Zaria; with a lot of local leather industries and the Federal College of Chemical and Leather Technology CHELTEC at Samaru where A.B.U. main campus is also located. The primary pollutants that leather tanning creates are heavy metals such as chromium, cadmium, lead, cobalt and zinc (Kazmi, 1995). In addition, air pollution may also be on the rise due to tanneries burning residuals (i.e. hair) from the tanning process or due to dumping and incinerating of other Cd containing solid waste into the atmosphere (Page *et al.*, 1986).

Another potential environmental source of the Cd is through diffuse pollution caused by contamination through the use of agricultural phosphate fertilizers which may contain up to 100ppm Cd due to the presence of Cd in the phosphate rock used for their manufacture (Stokinger, 1981; Friberg and Elinder, 1983). Similar studies in Zaria revealed water and some vegetable samples cultivated around Galma and Kubanni rivers tested positive to Cd (Farouk *et al.*, 2006).

Cd may also be extracted from black polyethylene pipes in which Cd compounds are incorporated as stabilizers. In addition, extraction from sources is likely to be appreciable only when water has been standing for extended periods, and extracted Cd would therefore be expected to be present in the first-drawn samples (Lymburner, 1974).

The possible source of Cd contamination in the packaged water may be due to leaching of Cd used as heat stabilizer in plastic storage tanks which is widely employed in packaged water production factory. Cadmium sulphide and selenide are commonly used as pigments in plastics (Friberg *et al.*, 1986; Ros and Slooff, 1987). The leached Cd may not be completely removed during the treatment process.

CONCLUSIONS

The results of the study showed that the concentration of Cd in potable water of ABU main campus Zaria significantly exceeded the allowable set limit of 0.003mg/l by WHO.

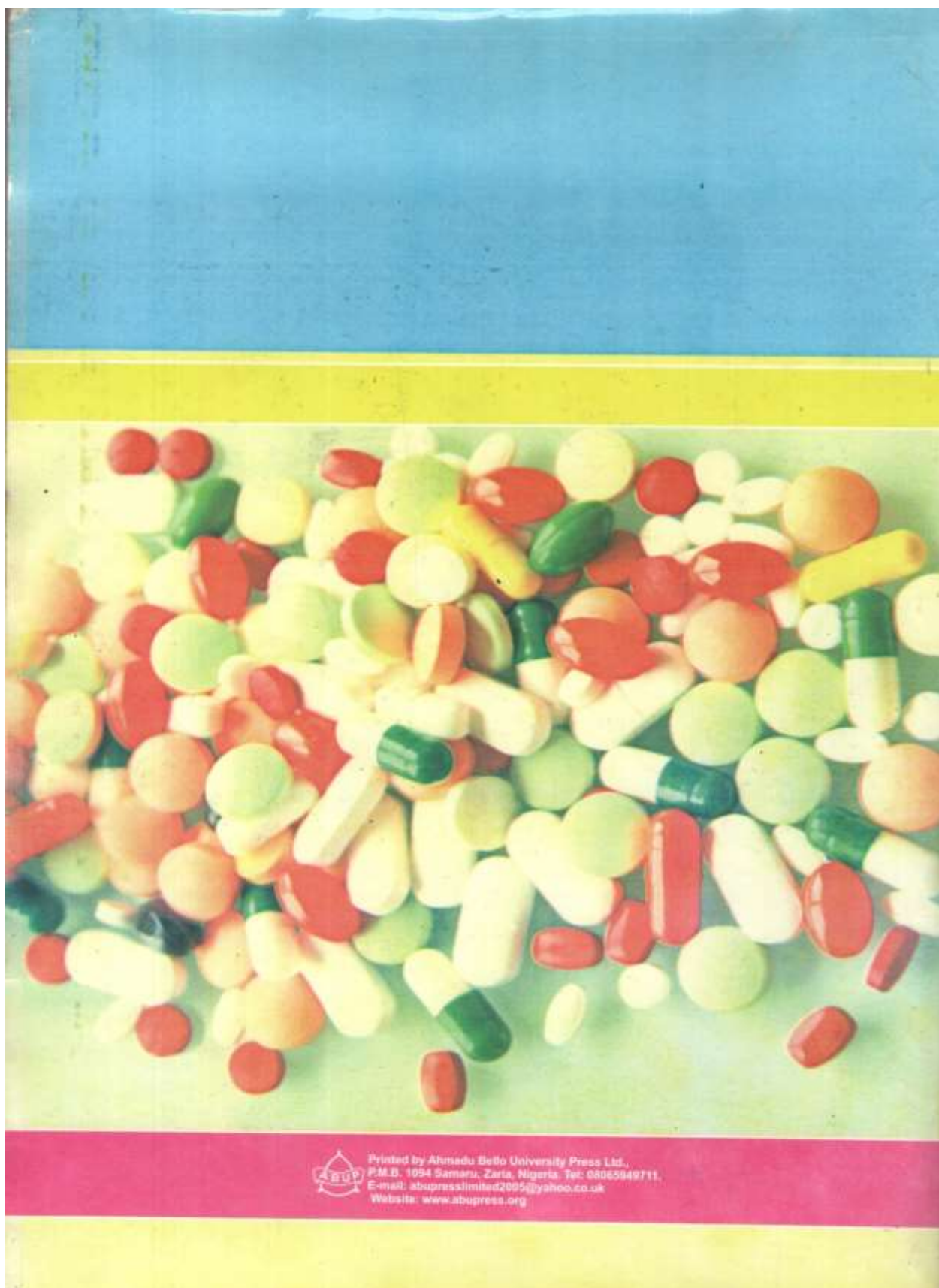
RECOMMENDATIONS

There is need for the tanneries to have waste treatment facilities such as process treatment, waste recycling and end of pipe treatment. The use of poly vinyl chloride (PVC) pipes and engineering practices to minimise plumb solvency in water treatment and water distribution systems should be encouraged. A testing protocol for the identification of pipes, and soldered fittings which contribute to Cd contamination in drinking water should be carried out. This program should include measures for reduction or elimination of Cd contamination from pipes and fittings by ensuring that they are repaired, permanently removed or replaced.

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