Journal of Science and Multidisciplinary Research **Volume 4, December 2012**

www.cenresinpub.org
ISSN 2277-0135

DISTRIBUTION OF METALS IN SOME SELECTED JEWELRIES USED IN NIGERIA

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ABSTRACT

The crave for exoticity through the use of jewelries has led to the exposure of man to the danger of absorbing toxic metals. Six commonly won jewelries were investigated to determine their metal distribution using XRF-Spectromatric technique. Copper, Ni, Fe, Cr, were present in all the jewelries considered with Zn and Ca present in all except gold and copper respectively. The Percent (%) copper metal in all jewelries range from (4.19-93.2). Ni range from 0.03-35.60%, Fe, 0.21-2.78% and Cr 0.07-0.99%. The zinc level range from 0.85-33.00% and calcium 0.01-0.73%. Lead (9.71%) was found to be present in nickel-silver jewelry. These metals can be easily leached and be absorbed by human body through sweat. The presence of these metals in jewelries may pose serious health hazards to man.

INTRODUCTION

The crave for fashion by people has led to the production of jewelries that contain diverse precious and non-precious metals at various levels of concentration. Most communities used various materials such as shells cowries, bones, animals teeth, gold, copper, brass, nickel etc. as earrings, bracelets and ornaments. The use of jewelries as ornaments and adornment dates back to pre-civilization (NBK, 1980) and it was reported to reflect the social status and important changes in fashion and technology which is the way and life of the people. With increased importance attached to jewelries the art of its production is being perfected to cater for the different social class in the society. Most of the metals found in most jewelry are heavy metals that could be toxic and harmful to human. Chromium, copper, zinc, nickel and iron are in most jewelry and have been identified as toxic to plants, animals and humans (Lenntech, 2006). Heavy metals are dangerous because their concentrations can increase in a biological organisms over time compared to their chemical concentration in the environment. The heavy metals in jewelries may be removed by sweat and may eventually be washed down during bath into the ground; from here it may enter the food we eat. Aquatic organisms may be adversely affected first by heavy metals in the environment, slightly elevated metal levels in water may cause histological or morphological change in tissues, suppression of growth and development, poor swimming performance, change in enzyme activity and blood chemistry, change in behaviour and change in reproduction (Lenntech, 2003). Zinc (Zn) does not occur naturally in elemental form. The primary industrial use of Zn is as a corrosion-resistant coating for iron or steel (smith et al 1995). Zinc is one of the most mobile heavy metals in surface and ground waters because it is pressed as soluble compounds at neutral and acidic pH values (Evanko and Dzombak, 1997). This suggests the tendencies and ease by which Zinc can leave the surface of jewelries into the environment. Copper is mined as a primary ore product. Mining activities are the major source of copper contamination in water. However, Cu mobility is reduced by sorption to surfaces over a wide range of pH (Dzombak and Morel, 1990). When ingested, it may cause ulceration of gastrointestinal Mucosa, hemolysis, hepatic necrosis, and renal damage (Van Campen, 1991). The release from jewelries may be through sweat and bathing with the jewelries the concentration of Cu by this mode may be minimum but with large numbers of people wearing jewelries the concentration dissolved might be significant and cause ulceration (Lenntech, 2006). This may be responsible for some jewelry wearers long term exposure can cause kidney and liver damage and also circulatory and nerve tissues (Lenntech, 2006). Chromium (Cr) mainly is found as metallic Cr or in trivalent 3^{+} and hexavalent 6^{+} states. Chromium exposures occur in industries, using anodizing and metal plating, etching, photography and lithography, Portland cement, stainless steel, and television picture tube manufacture to list just a few (Chrostowski, et al 1991 and Geller, 1992). Trivalent Cr is poorly absorbed through the skin, but $Cr^{6+}$is readily absorbed and acts as an irritant, causing burns, ulceration, it is the most mobile element in terms of waste disposable from the associated industries (Smith et al, 1995). Nickel represents a potential hazard. No occupational exposures arise from handling metallic objects such as jewelry and coins. A high rate of Ni-allergy is associated with ear piercing and subsequently wearing of Ni alloy jewelry (Berova, et al, 1987). Nickel also causes dermatitis, respiratory disorders and inhibits the enzyme cytochrome oxidase and dehychrogease (Sunderman and Donelly, 1995).

Cross-reactivity is an important issue in Ni-allergy as Ni exposure often occurs in the context of multiple metal exposures, and patch tests to other metals for example Co and Cr are common. The presence of Ni as constituents of jewelries exposes man to the risk of ingesting or adding to the environment. Lead (Pb) was not common in the jewelries except in nickel-silver jewelry where it is about 8.82%. This value would be significant when released to the environment is retained in the soil (Evans, 1989). The amount dissolved in surface and ground water depends on pH and concentration of dissolved lead exposure to humans and can result in a wide range of biological effects depending on the level and duration of exposure. Lead (Pb) can substitute calcium in bone formation and children could be susceptible because developing skeletal systems require high calcium level (Lenntech, 2003). Free lead in the body system may cause neurotoxicity, neurotoxicity and hypertension. Presence of metals in jewelries serve as refiners and deoxidizers but much of them may have adverse effect. Heavy metals were found to be present in jewelries that could cause allergic reaction to the wearers. The implication is that the metals pose a potential health hazard to the society and the environment.

EXPERIMENTALS

Sample Collection

Jewelry samples were identified by the name they are called by the marketers as gold, nickel, silver, nickel-silver, copper and brass (PLATES I – VI). These were purchased from central, Mudal-Lawal, and Wunti markets, all in Bauchi, Bauchi State and stored in paper envelops.

PLATE I: GOLD JEWELRY (15.09g)

PLATE II: NICKEL JEWELRY (20.21g)

PLATE III: COPPER JEWELR (7.71g)

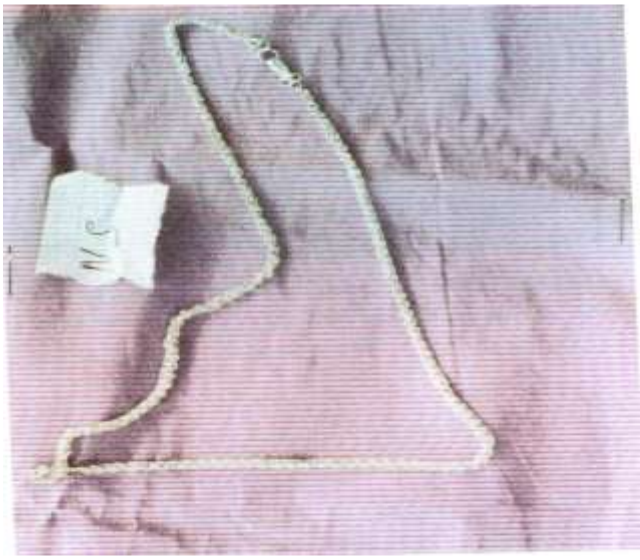


PLATE IV: NICKEL-SILVER JEWELRY (6.67g)

PLATE V: SILVER JEWELRY (8.72g)

PLATE VI: BRASS JEWELRY (15.82g)

Sample Pre-treatment

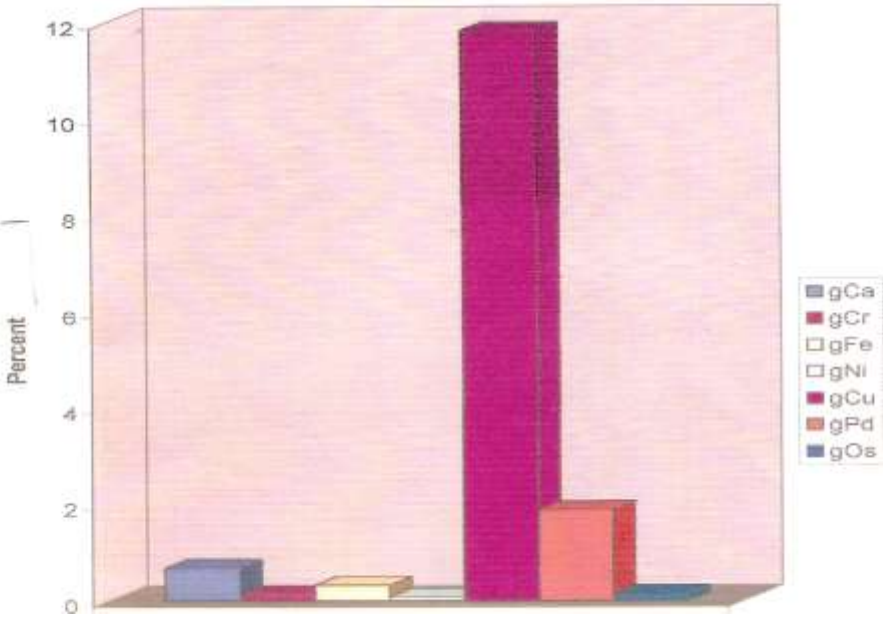
Samples were cleaned with analar grade aberglute ethanol and dried at 90^oC in an over for 30 minutes and allowed to cool before it was ground using a crushing machine; the ground sample was then stored in corked plastic cups.

Sample Analysis

Ground jewelry samples were analysed for metals on x-ray fluorescence spectrometer (XRF) model IV Panalytical. The results obtained were mean of the triplicate analysis.

RESULT AND DISCUSION

The result of metal compositional analysis of the various jewelries are shown in table 1.
Gold jewelry contained other metals with copper being in fairly higher levels. The pattern of metal distribution follows the order below; Cu > pd > Ca > Fe > Cr > Os > Ni
The presences of copper (11.90) in such an amount might be of health interest as it can be leached or undergo wear by sweat and/or scratching. With increased jewelry usage by the society, there could gradual build up of this metal in our water bodies or it can be absorbed directly by the human body. Copper has been known to cause ulceration, hemolysis, hepatic necrosis and renal damage (Van Campen, 1991). Fig. 1 shows the distribution pattern of metals in gold jewelries.


12
10
8
6
4
2
0
Percent
gCa
gCr
gFe
gNi
gCu
gPd
gOs

Journal of Science and Multidisciplinary Research *Volume 4, December 2012*

www.cenresinpub.org
ISSN 2277-0135

Fig. 1: Distribution of metals in gold jewelries

Table 1: Percentage concentration of metals in jewelries

Jewelries	Metals (%)																
	Pbo	**CaO**	**Cr_2O_4**	**MnO**	**Tro_2**	**Fe_2O_3**	**Ni O**	**CuO**	**PdO**	**Si O_2**	**O_5O_4**	**ZnO**	**As_2O_3**	**Nb_2O_5**	**Yb_2O_3**	**$5nO_2$**	**Br_2O_3**
Gold 84.90		0.73	0.13	-		0.33	0.09	11.90	1.70		0.10	-	-	-	-	-	-
Nickel		0.21	0.99	0.04		2.78	0.74	60.24				33.00	1.10	0.76	0.1		
Ni-Ag	9.71	0.40	0.26			0.42	35.60	50.10				0.85				2.70	
Silver 92.83		0.01	0.07		0.28	0.21	0.03	4.19		1.00		1.36			0.05		
Copper			0.08	0.02		0.76	0.11	93.02				5.04		0.35			
Brass		0.18	0.10	0.10		0.46	0.32	69.25				28.30		0.82			

Journal of Science and Multidisciplinary Research **Volume 4, December 2012**
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www.cenresinpub.org
ISSN 2277-0135

Copper jewelries (Table 1) with 93.02% in May also undergo wear and leaching and consequently get absorbed by the human body. Other metals present in copper jewelries occur in the order below. Zn > Fe > Nb > Ni > Cr > Mn

The same fate may be facing copper jewelries where the metals undergo leaching and subsequently be absorbed by the body or are run into body of water for plants and animals uptake. The distribution pattern is shown in Fig. 2. Zinc levels might be of much concern as it is essential for human Health. When people absorb too little zinc there may be loss of appetite, decreased sense of taste and smell, slow wound healing and skin sores. However large concentrations of zinc can cause stomach cramps, skin irritations, vomiting, nausea and anaemia (Lenntech, 1998-2005) and may affect copper utilization, (Solomons, 1983).

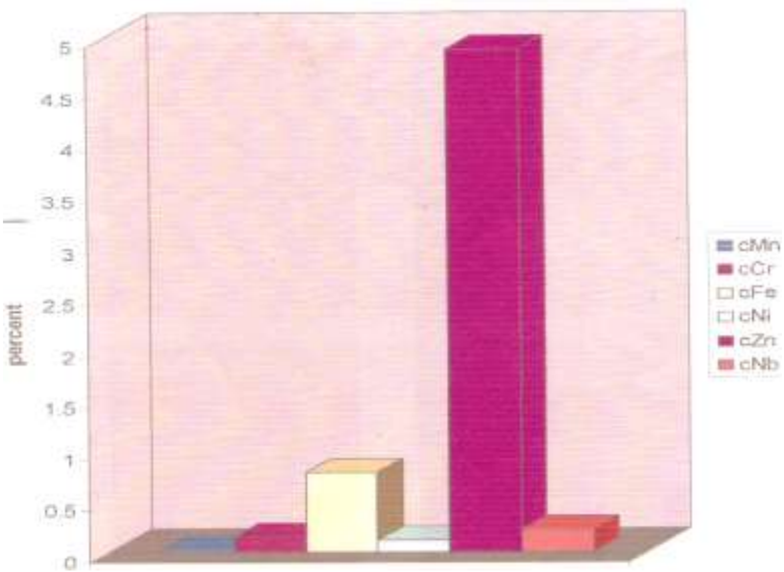

Fig. 2 Distribution of Metals in copper jewelries

Nickel-silver jewelries contain eight detectable metals which occur in the order below.
Cu > Ni > pb > Sn > Zn > Fe? Ca > Cr.

These metals can be transferred into human body by absorption and most of them can be toxic. Lead can cause rephrotoxicity, neurotoxicity and hypertension (hamanci et al. 1997, McMichael et al. 1985). Fig. 3 gives the distribution pattern of metals in nickel-silver jewelries. The presence of more metals in this jewelry might be of dermatological interest as some of these metals can easily be absorbed by human skin or may cause rashes or support the growth of microbes.

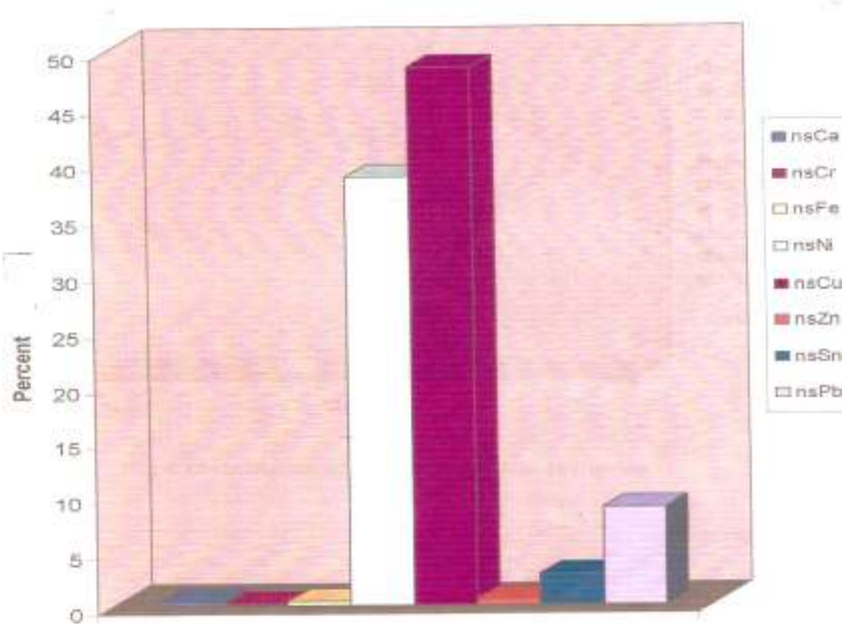

Fig.3 Distribution of Metals in Nickel-Silver Jewelries

Nickel jewelry is composed of predominantly copper (60.34%) and is followed by zinc (32.93%). The order in which the metals occur in nickel jewelry is;
Cu > Zn > Fe > As > Cr > Nb > Ni > Ca > Yb > Mn
Most of these metals are in trace amount except Cu, Zn and Fe that might be of health interest. The distribution of the metals in nickels is presented in fig. 4.

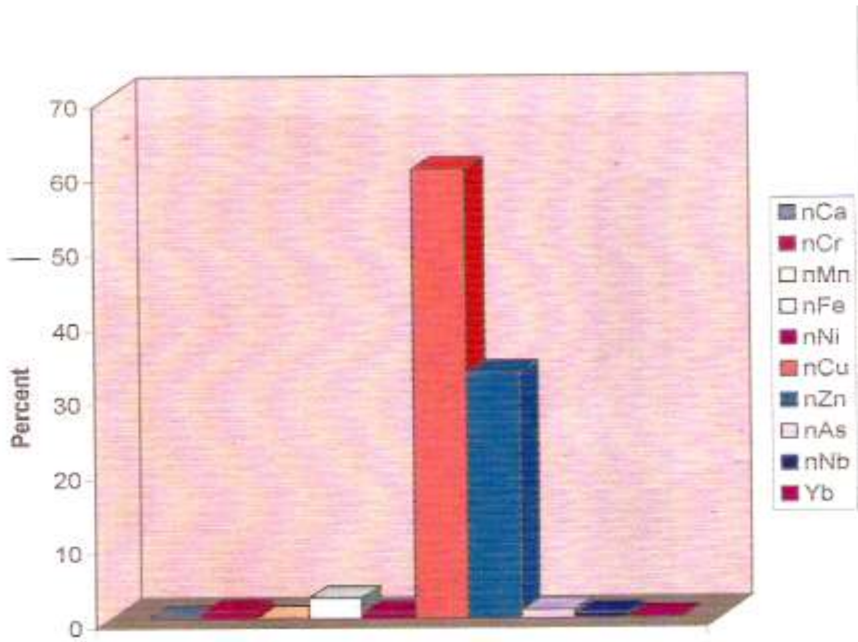

Fig.4 Distribution of Metals in Nickel Jewelries

The metal spread in silver jewelry is not uniformed. Silver (92.83%) constitute the highest and its followed by Cu (4.19%) zinc (1.36%) silicon (1.00%). The rest of the

metals are in trace amounts. Their health implications can only be appreciated in the order they occur in the jewelry.
Ag > Cu > Zn > Si > Te > Fe > Cr > Yb > Ni > Ca
This patter is shown in fig. 5.

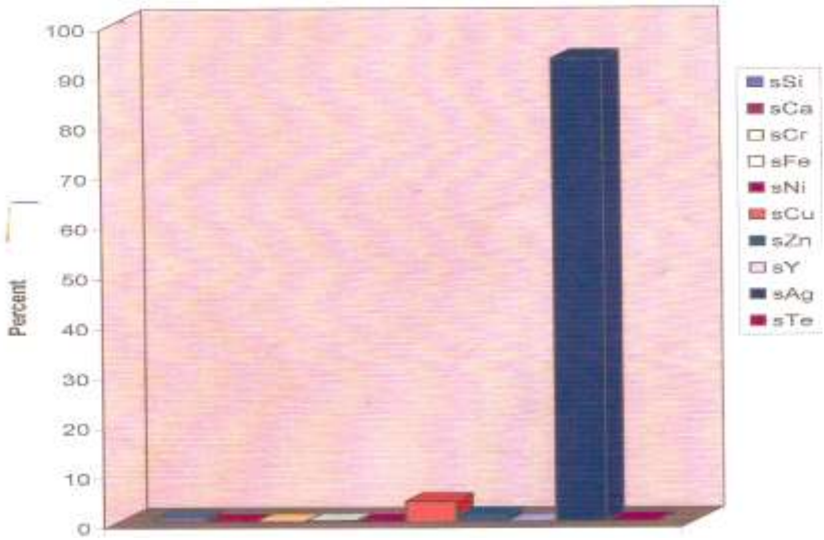

Fig.5 Distribution of Metals in Silver Jewelries

The distribution of the metals in Brass jewelry is such that copper (6.925%) and zinc (28.30%) are in high percentage. This might be because brass is a mixture of Cu and Zn with the rest of the metals being in trace amounts. The order in which they occur in the geology is Cu > Zn > Nb > Fe > Ni > Ca > Cr = Mn = Er

The elements of health concern might be copper and zinc that can easily be accessed into the human body by the absorption of sweat. The distribution pattern of the metals in the brass jewelry is presented in figure 6.

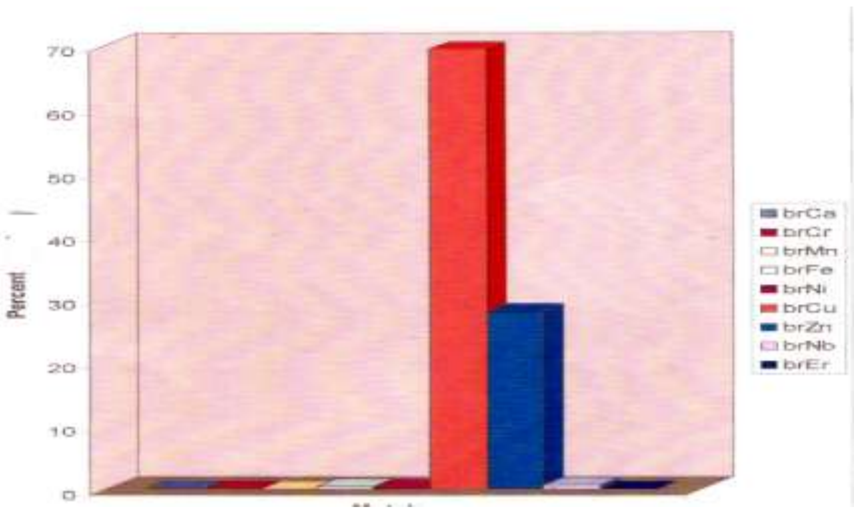

Fig.6 Distribution of Metals in Brass Jewelries

CONCLUSION

Common jewelries won by people in the North Eastern part of Nigeria have been found to contain metals other than the jewelry metal itself. Such metals could be of much health concern since the body can absorb traces, through sweat or can depreciate the quality of the jewelry. Some of these metals are added to improve their properties, either as grain refiners or deoxidizers (Ott, 1997). Some other metals acts as Pb acts as impurities in jewelries (Kenneberg and Williams, 1997). It was also found that the name of a jewelry does not signify the metals present but represents the coating on the jewelry frame. It is therefore recommended that jewelries produced should have the percentage prescription of the metals in the jewelries to enable users identify which jewelry may be an allergen.

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