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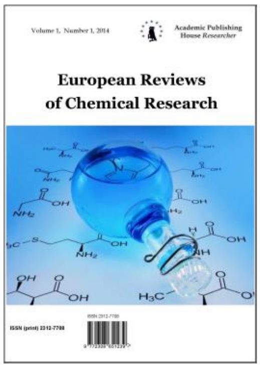

Chemical Characterisation of Scrap Brass for Jewellery Making

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Abstract

Determination of micro element of unmodified scrap brass samples gotten from various locations in Gombe metropolis through random sampling techniques was undertaken, to help in analysing the properties needed in selecting brass scrap for jewelry making. Quantitative experimental design was adapted to know the element composition of the brass scraps. Six samples of brass scraps were collected and atomic absorption spectrometer Model AA0904M046 was used to determine the content of each element found in the scraps in part per millions. All the samples collected were found to be brass due to the percentage composition of copper and zinc present in the alloys. All the six samples have different content which makes them differ from one another. The study shows that the suitability of brass scraps for jewelry making depend on its alloying element. Sample 1 (tap heads) and 2 (car parts) are suitable for jewelry making by increasing the amount of Copper content to balance the percentage content of Iron, while samples 3 (ornaments), 4 (trumpet), 5 (fuel pipes) and 6 (dishes) can be use directly alone without modification. Finally, this study can help local jewelry producer to select suitable scrap brasses for jewelry making thereby converting waste into wealth.

Keywords: jewelry making, Scrap brass, atomic absorption spectrometer, waste, micro element.

1. Introduction

Scrap brass demonstrated high potential for use in jewelries making more especially in the case of small scale jewelry industries that mostly depend on recycled scrap metals for jewelry production (Den Besten, 2011). Small scale jewelry industries dependence on recycled metals can be linked to the difficulties encountered in mining process and the economic benefit associated in using it. Small scale jeweller gathers different types of brass not minding the elemental content in the scraps metal which may alter the quality of the jewelry produced either positively or negatively and in some cases, may result in allergic reaction to the body. Jewelries production will serve as a source of an income to the producers and revenue to the government, since jewelry is personal adornment worn to enhance the beauty of the wearer. Almost all women are using jewelries in different ways such as brasseletes, earings, bangles, neckless (Den Besten, 2011). Therefore, the use of brass scrap for jewellery production will help in bursting the economy of nations more especially the developing nations like Nigeria.

Brass is a metal compose primarily of properties including strength, machinability and wear resistance. It colour varies depending on the amount of Zinc present, the more the Zinc the lighter the colour (CDA, 2005). Brass scraps are off cut of manufacturing left-over and other materials that have reach their end of life. Brass types are classified based on its colour or its intended use. For instance, red brass contains 15 % Zinc and has reddish colour while yellow Brass consist of

35 % Zinc and has a yellowish colour (Brady et al., 1997; Terence, 2016). Alpha brasses contain a minimum of 63 % of Copper and gilding Brass contain 80–90 % copper which matched gold in colour (Helmenstine, 2009). CDA (2005) recommended that gilding Brass containing 80 % to 90 % Copper is use for jewelry purposes. Hong et al. (2014) stated that gilding Brass has rich golden colour with best combination of strong ductility and corrosion resistance.

Elemental analysis of most organic and inorganic matrices requires the partial or total dissolution of the sample prior to instrumental analysis (Oliveira, 2003). Only a few direct methods allow the introduction of the sample without any preparation and in these cases lack of reliable calibration is the major problem (Oliveira, 2003). Sample preparation allows the separation and/or pre-concentration of analytes and makes possible the use of several determination methods as reported in Oliveira, (2003). In this study, wet decomposition method was adapted because of the nature of the sample used and Spectrometry is a method that requires sample preparation (Beaty, 1988; Oliveira, 2003; Welz, Sperling, 2008)

The findings from this study will help jewellery makers improve their decision making in selecting the best brass scrap metal for jewellery production. Also, it will improve the standard of jewelleries and prevent use of inappropriate metals on the body of the wearer. Finally, money value will be improved by converting waste into wealth.

2. Materials and method

The materials used for the analysis were Taps head, Car parts such as bracket, gears and key bowls, Ornament, Trumpets, Car pipes such as fuel pipes, wire pipes and water pipes and Dishes.

Method

This study adopted qualitative research technique to interpret and explained the chemical composition of brass scrap through laboratory experiment. The procedure involves collection of samples of brass scrap metal which is then characterized using atomic absorption spectrometer (AAS) model AA0904M046 to know the alloying content of the six samples.

Study area

The area of the study was Gombe metropolis in Gombe state of Nigeria

Sample collection

Random sampling of six different brass scrap was sorted out from scrap metal scavengers and at refuse dump through on-site pickups in Gombe metropolis. The samples were then sorted into six different samples 1, 2, 3, 4, 5 and 6 shown in Figures 1, 2 and 3.

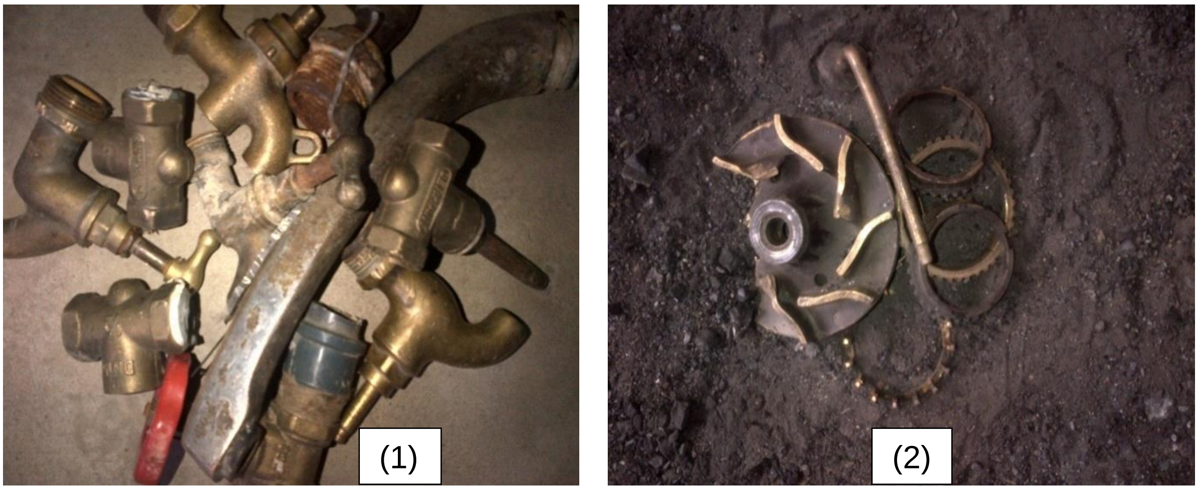

Fig. 1. Samples (1) Tap Heads (2) Car parts i.e. gears, bracket and key bowls

Fig. 2. Samples (3) Ornament (4) Trumpet

Fig. 3. Samples (5) Fuel pipes (6) Dishes

Sample preparation

The six sorted samples were separated and Atomic Absorption Spectrometer (AAS) model AA0904M046 was used to determine the content of each element in the scrap samples (i.e. in parts per million).

Wet digestion acid method was adopted for the analysis.

Preparation of reagent: The Nitric acid and Perchloric acid were both mixed together in a proportion of 3:1 (i.e. 300 mls to 100 mls) and then properly shaken.

Digestion procedure: 1 gram and less than 1 gram of the various samples were cut using Harksaw and put into a Digested flask (100 mls Cornical flask) and to each flask, 30 mls of the mixed acid was added and the flask and its contents was placed on a digested block at 25 ^{o}C for about 2 hours for digestion to take place.

After the digestion was completed, the digest was allowed 5–10 minutes to cool down. The volume of the digest was further increased to 100 mls using distilled water and properly shaken.

The micro elements were then determined from the digest using the AAS.

3. Results

Atomic absorption spectrometer was used to determine the elements in the samples as presented in Figures 4, 5 and 6.

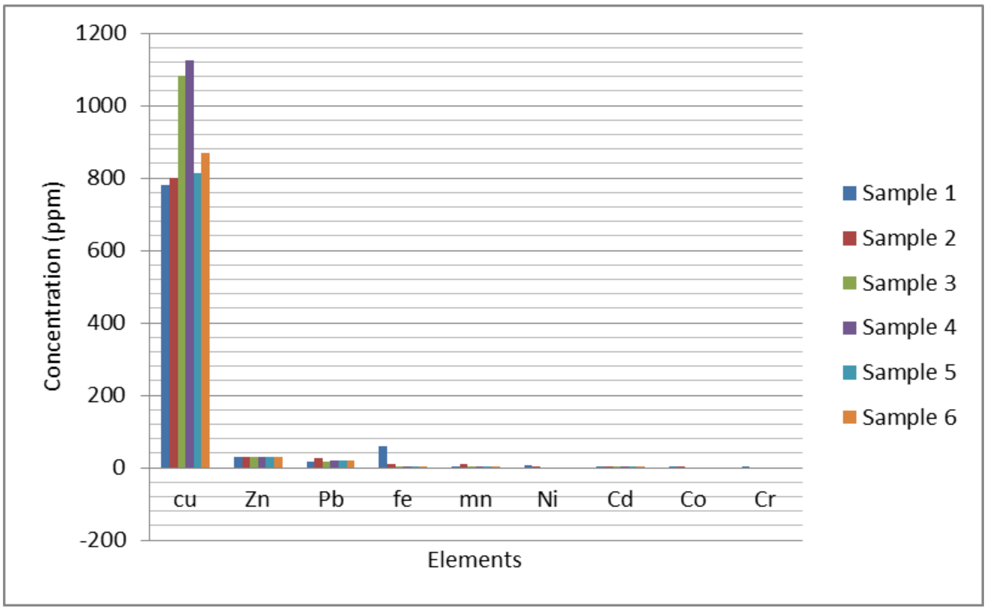

Fig. 4. Graph of sample element concentration

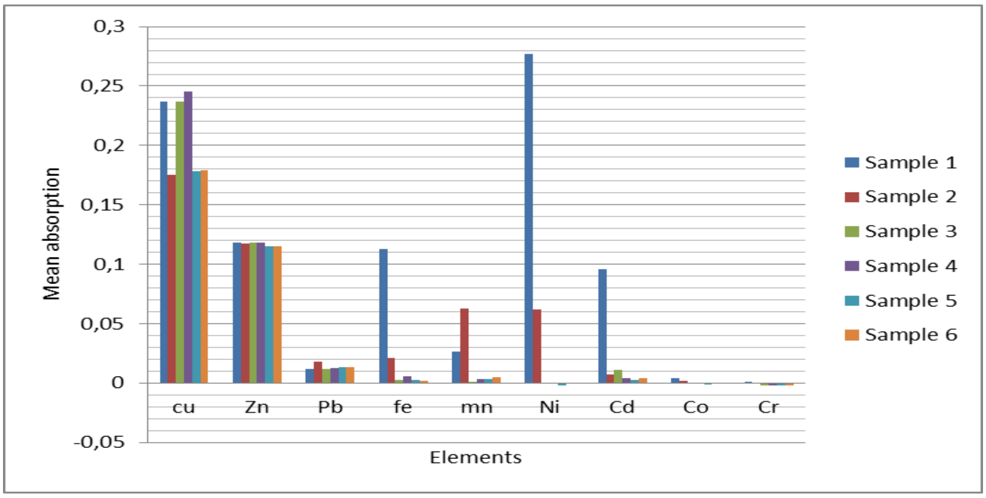

Fig. 5. Graph of sample mean absorption

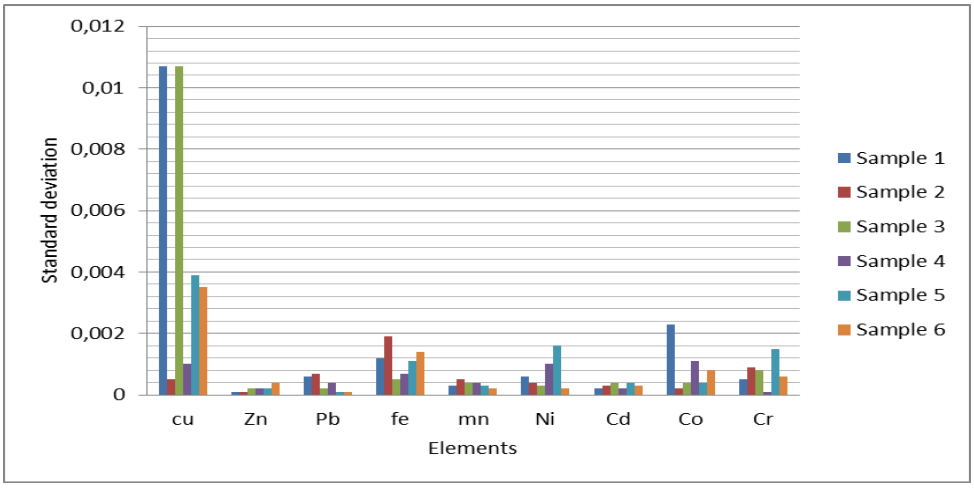

Fig. 6. Graph of sample standard deviation

3. Discussion

Brass scrap samples collected for the analysis and production contains some element with different concentration in parts per million (ppm). Analysing Sample 1, Figure 1 (Tap heads) using the AAS it was found that it contains 782.286 ppm Cu, 29.756 ppm Zn, 18.38 ppm Pb, 58.328 ppm Fe, 0.225 ppm Mn, 8.495 ppm Ni, 0.406 ppm Cd, 0.088 ppm Co, 0.055ppm Cr. In this sample, it was found that Copper is the major element found in the brass scrap, this agrees with CDA (2004), Brady et al. (1997) and Reheren (1999). The amount of iron was high which makes the metal to be too strong for cold work during production of the jewellery and the colour was doll yellowish. Also, Nickel was present in high percentage which makes its support load without breakage (CDA, 2004; Hussain, Ibrahim, 2014; Dungworth, 1997).

Cadmium and Chromium was present to improve corrosion resistance of the metal. Stromeyer (2010) and CDA (2005) works showed that Cadmium provide excellent protection from highly corrosive chemicals like acid and base. Also, Cobalt was present to improve the colour of the brass.

Lead was present which enhance the machinability, lower melting temperature of the metal, facilitate chip fracture and reduce tool wear of the metal for casting (Eco Metals Recyclers, 2014; CDA 2005; Dungworth, 1997; Hussein and Ibrahim, 2014). The lead level must be maintained at certain level because once it is high it can lead to lead poisoning more especially in children. Sample 1 was found to be the strongest and heaviest brass scrap among the samples analysed.

Sample 2, (Figure 1 Sample (2) (car parts)), the major elements are Copper 800.527 ppm and Zinc 29.504 ppm. Iron and manganese were present in almost same proportion, 10.815 Fe and 110.895 Mn these improve the strength and compactability of the metal which makes it not to break easily (CDA, 2004). Lead was present in high percentage to improve the machinability which makes the casting of the jewelleries to look smooth more than how it looks in Sample 1, but the high lead concentration may cause lead poisoning. The colour of the sample looks yellowish but darker than that of Sample 1 because the percentage of Copper is higher than that of Sample 1.

Sample 3 in Figure 2 (Ornament) consist of Copper and Zinc as the major elements present with concentration of 1082.683 ppm Cu and 29.756 ppm Zn. In the sample, the amount of Iron and Manganese is small which makes the alloy to be softer than Samples 1 and 2. This makes it easier to be cold working during production of the jewelleries. Lead was present to improve the machinability of the metal that allowed the metal to be melted and cast easily. Cadmium was present to improve corrosion resistance to the brass.

After analysing sample 4 Figure 2 (Trumpet) it was found that Copper has the highest percentage which is 1123.584 ppm Cu, which makes the metal to be softer, but the amount of iron was higher than that of sample 3, 5, and 6 that makes sample 4 to be stronger. The presence of Manganese and Iron improves the strength of the brass scrap this make's the sample to be malleable during production. Both casting and cold working can be used during production of the jewelleries. Cadmium was present to improve resistance to corrosion and cobalt to improve its colour.

Sample 5 Figure 3 (Fuel pipes) was analysed. Copper and Zinc was found to be the major alloying element and that prove that the scrap was brass scrap. Lead was present to improve the machinability in during casting. Iron and manganese was present in small amount, this makes the metal to be soft and easy for cold working. Cadmium was present to improve resistance to corrosion. There was no presence of cobalt and chromium in the sample. Due to low percentage of Zinc in Sample 5, the colour was found to be richer than sample 3 and 4.

In Sample 6 Figure 3 (Dishes) Copper and Zinc are the major elements. Lead was present to improve the machinability. Iron and manganese were present in small quantities making Sample 6 softer than all the samples selected. The colour of sample 6 is reddish and its glittering colour led to the production of fine smooth jewelleries in different design.

Copper and Zinc are the major alloying element of brass as presented in Figure 4. Iron, Manganese and Nickel present in the alloy, improves the strength. Also, Cadmium and Chromium serve as corrosion resistance and Cobalt improves the colour of the metal. That was why Cobalt was found only in Sample 1 which has high amount of Iron.

Figures 5 and 6 represent the mean absorbance and standard deviation of the elements analysed respectively. Each sample absorbance is measure five times and the mean and standard deviation is displayed and recorded.

In all the six samples collected the concentration of Lead, Chromium, Cadmium and Nickel did not exceed the Adult Jewelry Safety Standard ASTM F2999 2013 which stated that Lead content should not exceed 600 ppm, Chromium 60 ppm, Cadmium 75 ppm and Nickel 1500.14 ppm. This proves that the samples are allergy free, unless if they corrode.

4. Conclusion

Elemental analysis of brass scrap samples was successful carried out in the study. The result of the study shows that good quality of brass scraps is directly proportional to its alloying element composition.

The study showed that not all the 6 brass scrap samples will be used for jewellery in the unmodified form. Samples 3, (ornament) 4, (trumpet) 5 (fuel pipes) and 6 (dishes) possesses all the necessary characteristics for brass jewellery making, while samples 1 (Tap heads) and 2 (car parts) are not due to their high iron and manganese content. Hence it is necessary to modified the two samples by using additives such as Copper, Chromium and Cadmium thereby reducing the percentage composition of Iron and Manganese present. Samples 3, 4, 5 and 6 can be used directly for jewellery making without additives according to ASTM 22500 standard. Sample 2 has the highest percentage composition of lead among all the samples considered. Therefore, there is a need to monitor it lead poisoning potential especially if the jewelleries will be used on children. Finally, this study will help small scale jewellers in selecting suitable scrap brasses for jewellery making.

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