

# World News of Natural Sciences

An International Scientific Journal

WNOFNS 59 (2025) 346-357

EISSN 2543-5426

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## Toxicological study and health risk assessments of heavy metal contents of some commercially sold beauty soaps in Owerri, Imo State, South East, Nigeria

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### ABSTRACT

It has been shown that heavy metals toxicity to humans is as a result of long term or high level exposure to pollutants common in the environment including the air, water, food and numerous consumer products such as the cosmetics and toiletries. In this study, heavy metal contents of some commercially sold beauty soaps in Owerri Imo State were determined. These items were purchased from various supermarkets at different locations within Owerri capital city. The cosmetics were analyzed for heavy metals (chromium, cadmium, lead, mercury and nickel) after digestion with concentrated acids HNO<sub>3</sub>: HClO<sub>4</sub>: H<sub>2</sub>SO<sub>4</sub>. The concentrations of the selected toxic heavy metals were determined in duplicate using an atomic absorption spectrophotometer. The samples analyzed contained a detectable amount of the metals of interest. The concentration of the heavy metals in the samples ranged from 0.056-0.092 ppm (Cr), 0.083-0.183 ppm (Ni), 0.034-0.080 ppm (Cd), 0.043-0.104 ppm (Pb) and 0.013-0.022 ppm (Hg) respectively. The results showed that toxic heavy metals were present in beauty soaps sold in Owerri, Imo State, Nigeria, and the concentrations of the toxic metals were lower than the WHO limit. The estimated chronic daily intakes were lower than the minimum tolerable daily intakes (MTDI) for the various metals. The estimated hazard quotient (HQ<1) shows the concentration of the metal may not cause immediate significant health problem. Hazard index (HI) was < 1 (Table 5) indicating that consumers are found to be safer. The cancer risk of chromium was found to be 1.13E-4 in sample C, which is lower than the negligible range, indicating no cancer risk (CR). It is obvious from the present study that the use of some beauty soap products sold in Owerri exposes users to low concentrations of toxic heavy metals which could constitute potential health risk to users since it has been known that heavy metals can accumulate in the biological system over time and are known to induce skin problems.

or diseases such as cancer. Further research to better understand the sources of heavy metals in beauty soap products is recommended.

**Keywords:** Heavy metal, health risk assessment, beauty soap and WHO

## 1. INTRODUCTION

The harmful effects of heavy metals such as arsenic (As), cadmium (Cd), chromium (Cr), lead (Pb), mercury (Hg), manganese (Mn), zinc (Zn), and nickel (Ni) are well-established. Heavy metal toxicity can impair mental and central nervous system functions, decrease energy levels, and damage the blood, lungs, liver, kidneys, and other vital organs. Prolonged exposure to certain metals or their compounds, such as chromium (Cr), nickel (Ni), and cobalt (Co), may lead to cancer, contact dermatitis, and skin irritation. Despite these dangers, exposure to heavy metals is on the rise, particularly in less developed regions<sup>[1-3]</sup>. Cosmetics are substances applied to the human body to cleanse, enhance appearance, or promote attractiveness. They are commonly used in daily personal care routines, including skin, hair, nail, and dental care. Cosmetic products come in various forms, such as creams, lotions, gels, oils, face masks, powders, soaps, perfumes, shower and bath products, deodorants, antiperspirants, depilatories, hair care products, and shaving preparations.

Cosmetics are generally categorized as either herbal, derived from natural sources and considered milder and less harmful, or synthetic, which are conventional and may pose potential risks. Common harmful ingredients in cosmetics include formaldehyde and its releasers, hydroquinone, parabens, and phthalates<sup>[4,5]</sup>. Various substances found in cosmetics, such as parabens, phthalates, p-phenylenediamine, formaldehyde, triethanolamine, and heavy metals, can cause adverse effects including skin irritation, sensitization, allergies, and photoreactions. On average, a typical woman uses 9–15 different cosmetic products daily, which may contain up to 168 individual ingredients. This underscores the importance of identifying and quantifying potentially harmful substances in cosmetics, as required by good manufacturing practices<sup>[5,6]</sup>. In the European Union, Directive 76/768/EEC mandates that cosmetics must not pose a risk to human health when used as intended and requires safety evaluations of their ingredients before market release<sup>[7]</sup>.

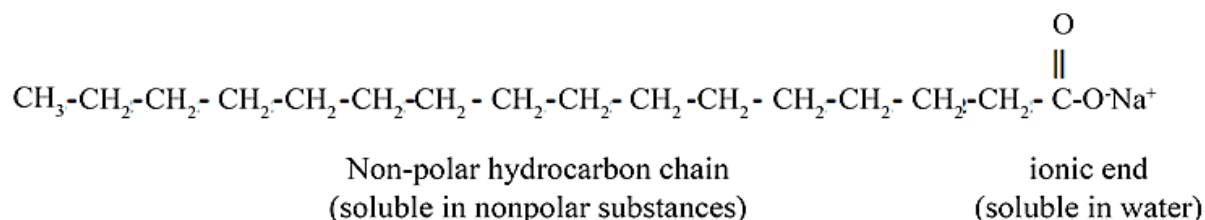
The directive bans around 1,000 substances from cosmetic formulations and prohibits the inclusion of heavy metals such as nickel (Ni), mercury (Hg), cadmium (Cd), lead (Pb), and cobalt (Co) due to their potential health risks. However, some metals and metalloids, such as zinc (Zn), silver (Ag), strontium (Sr), aluminum (Al), and zirconium (Zr), are allowed but under strict regulations. In July 2013, Directive 76/768/EEC was replaced by Regulation (EC) No. 1223/2009, which includes provisions for the safety assessment of nanomaterials used in cosmetics. U.S. legislation is somewhat less restrictive, allowing lead compounds in hair coloring products and arsenic (As), mercury (Hg), and lead (Pb) in color additives. In Canada, a wider range of heavy metals and metalloids, such as lead (Pb), mercury (Hg), cadmium (Cd), arsenic (As), and antimony (Sb), are permitted in cosmetics, subject to regulated maximum concentrations<sup>[8]</sup>.

The adage "Cleanliness is next to godliness" highlights the importance of maintaining both personal and environmental hygiene. Cleanliness, in a broad sense, refers to the state of being clean and free from dirt, sustained through habitual practices.

In practical terms, cleanliness is closely tied to hygiene and disease prevention, often achieved by washing with water and cleaning agents. Various cleaning products are used daily to maintain cleanliness by removing dirt, germs, and other contaminants from the body, clothing, dishes, and surroundings<sup>[9-11]</sup>.

Soap, a common cleaning agent, plays a crucial role in both beauty enhancement and hygiene. From a scientific perspective, soap is a mixture of sodium or potassium salts of naturally occurring fatty acids. Fatty acids, typically found in nature as triglycerides in combination with glycerol, are derived from fats and oils. Triglycerides consist of three fatty acid molecules bonded to glycerol, and these fatty acids are a primary source for soap production. The key active ingredient in soap is the potassium or sodium salt of fatty acids. This molecule has a unique structure comprising a long hydrocarbon chain (composed of carbon and hydrogen atoms) and a carboxylic acid group at one end. The hydrocarbon end is nonpolar, making it soluble in nonpolar substances like fats and oils, while the ionic carboxylic acid end is water-soluble<sup>[11,12]</sup>.

This dual solubility allows soap to efficiently remove dirt and grease. Various forms of soap products, including bars, liquids, powders, pastes, and flakes, are commercially available worldwide, catering to diverse cleaning needs. The structural characteristics of a typical soap molecule, as illustrated in Figure 1, demonstrate its ability to break down and remove dirt effectively. A wide variety of cosmetic products are available, including creams, emulsions, lotions, gels, oils, face masks, tinted bases, makeup powders, beauty soaps, perfumes, shower and bath preparations, deodorants, antiperspirants, depilatories, hair care products, and shaving products. Beauty soaps, depending on their composition, can be classified as herbal (natural origin, made with gentler and less harmful ingredients) or synthetic (conventional, often containing ingredients that may pose risks)<sup>[13-15]</sup>.



**Figure 1.** The structure of a soap molecule.

Common skin beauty soaps frequently include ingredients such as formaldehyde and its releasers, hydroquinone, parabens, and phthalates, which can be harmful to human health. These soaps may also contain substances like parabens, phthalates, p-phenylenediamine, formaldehyde, triethanolamine, and heavy metals, all of which can have adverse effects on users. These effects may include skin irritation, sensitization, allergic reactions, or photoreactions<sup>[16,17]</sup>. In Nigeria, there has been a growing number of reported cases of skin diseases linked to the indiscriminate use of various cosmetic products, particularly among young people striving to alter their skin tone or achieve a specific beauty standard. Therefore, it is essential to assess the heavy metal content of commercially available beauty soaps in Owerri, Imo State, Nigeria, to evaluate their safety and potential health risks<sup>[18-20]</sup>.

## **2. MATERIAL AND METHODS**

### **2. 1. Reagent**

All reagents used were of analytical grade and were utilized without additional purification. Concentrated nitric acid, concentrated perchloric acid, concentrated sulfuric acid ( $\text{H}_2\text{SO}_4$ ), and deionized water were sourced from Chemiscience Chemicals.

### **2. 2. Apparatus/equipment**

The glassware used included a heating mantle, fume cupboard, measuring cylinders, beakers, conical flasks, volumetric flasks, and an Agilent FS.240AA Atomic Absorption Spectrophotometer.

### **2. 3. Sample Collection**

The beauty soap samples for this research were obtained from four well-known supermarkets in Owerri, Imo State. These supermarkets were specifically selected because they are recognized for selling authentic beauty soap products, sourced directly from the manufacturers.

### **2. 4. Sample Digestion**

- 1) Approximately 2g of the dried sample were weighed and placed in to a digestion flask and add 20 ml of the acid mixture (650 ml Conc.  $\text{HNO}_3$ ; 80 ml perchloric acid; 20 ml Conc.  $\text{H}_2\text{SO}_4$ )
- 2) Heat the flask until a clear digest is obtained.
- 3) Dilute the digest with distilled water to the 100 ml mark.

### **2. 5. Preparation of reference solutions**

A series of standard metal solutions within the optimal concentration range were prepared. Reference solutions were freshly prepared daily by diluting single-element stock solutions with water containing 1.5 mL of concentrated nitric acid per liter. A calibration blank was prepared using all reagents except the metal stock solutions. Calibration curves for each metal were generated by plotting the absorbance of the standards against their corresponding concentrations<sup>[13]</sup>.

### **2. 6. Methods for the Heavy Metal Analysis**

Heavy metal analysis was conducted using Agilent FS240AA Atomic Absorption Spectrophotometer<sup>[13]</sup>.

### **2. 7. Heavy metal assessment in relation to health implication**

#### **2. 7. 1. Chronic Daily Intake (CDI)**

Health risk assessment focuses on dermal contact with cosmetic particles. When humans are exposed to target analytes, three primary pathways are possible: (a) direct ingestion, (b) inhalation through the mouth and nose, and (c) dermal absorption. For metals in the cosmetic environment, dermal absorption is the most significant pathway in the case of skincare soaps<sup>[13]</sup>.

Based on this pathway, the exposure dose, expressed as chronic daily intake (CDI), was calculated using Equation 1 below.

$$CDI = \frac{CS \times SA \times AF \times ABS \times EF \times ED \times CF}{BW \times AT} \quad (1)$$

where: CS represents the concentration at the exposure point, EF is the exposure frequency (365 days/year), ED denotes the exposure duration (30 years), AT is the average time for non-carcinogens (25,550 days), BW refers to body weight (70 kg), AF is the adherence factor (0.07 mg/cm<sup>2</sup>), ABS represents the dermal absorption fraction (0.001), and CF is the conversion factor (10<sup>-6</sup> kg/mg).

### 2. 7. 2. Non-Carcinogenic Risk

The hazard quotient (HQ), which represents the non-carcinogenic risk, was calculated for the various metals in the cosmetic samples. HQ is the ratio of the exposure to hazardous substances to the chronic reference dose (RfD) of the toxicant (mg/kg/day), and is expressed as:

$$\text{Non-carcinogenic risk; HQ} = \frac{CDI \text{ dermal}}{RF \text{ dose}} \quad (2)$$

The dermal reference doses (RfD) for lead, cadmium, chromium, and mercury are 0.04, 0.001, 0.000015, and 0.0013 mg/kg/day, respectively. To determine the appropriate RfD for calculating the HQ, it was assumed that all chromium ions in the cosmetic samples are in the trivalent form (non-carcinogenic). If HQ < 1, the exposed population is unlikely to experience significant adverse effects.

If HQ > 1, there is a potential health risk, and appropriate interventions and protective measures should be implemented<sup>[21]</sup>.

To assess the combined risk from multiple heavy metals (HMs), the hazard index (HI) is used<sup>[21]</sup>. The hazard index is the sum of the hazard quotients for all the heavy metals, which is calculated using the following equation:

$$\text{Hazard index (HI)} = HQ_{Cr} + HQ_{Ni} + HQ_{Cd} + HQ_{Pb} + HQ_{Hg} \quad (3)$$

### 2. 7. 3. Carcinogenic risk

Carcinogenic risk is defined as the increased likelihood that an individual will develop cancer over their lifetime due to chemical exposure under specific conditions. Calculating the carcinogenic risk value is essential to assess whether consumers are at risk of developing cancer, and this can be determined using the following equation:

$$\text{Carcinogenic risk} = CDI \times SF \quad (4)$$

where: CDI represents the chronic daily intake of carcinogens (mg kg<sup>-1</sup> d<sup>-1</sup>) and SF is the slope factor of hazardous substances (mg kg<sup>-1</sup> d<sup>-1</sup>) derived from the Integrated Risk Information System (IRIS) database, with a value of 2×10<sup>1</sup> (mg/kg/day) for chromium.<sup>-1</sup>

### 3. RESULTS

**Table 1.** Heavy metals concentrations of some commercially sold beauty soaps in Owerri.

| Sample (mg/kg) | Chromium ppm | Nickel ppm | Cadmium ppm | Lead ppm | Mercury ppm |
|----------------|--------------|------------|-------------|----------|-------------|
| A              | 0.080        | 0.183      | 0.080       | 0.092    | 0.018       |
| B              | 0.056        | 0.083      | 0.044       | 0.048    | 0.013       |
| C              | 0.092        | 0.178      | 0.034       | 0.104    | 0.019       |
| D              | 0.064        | 0.073      | 0.050       | 0.088    | 0.016       |
| E              | 0.088        | 0.116      | 0.069       | 0.043    | 0.022       |
| WHO            | 0.000015     | 0.02       | 0.0003      | 0.01     | 0.0001      |

**Table 2.** Statistical Evaluations of Metal Concentrations.

| Samples | Mean  | Range       | WHO |
|---------|-------|-------------|-----|
| Cr      | 0.076 | 0.056-0.092 | 1.0 |
| Ni      | 0.127 | 0.083-0.183 | NA  |
| Cd      | 0.055 | 0.034-0.080 | 0.3 |
| Pb      | 0.075 | 0.043-0.104 | 10  |
| Hg      | 0.018 | 0.013-0.022 | 1.0 |

**Table 3.** Metal Concentrations in microgram per gram ( $\mu\text{g/g}$ ).

| Sample ( $\mu\text{g/g}$ ) | Chromium | Nickel | Cadmium | Lead | Mercury |
|----------------------------|----------|--------|---------|------|---------|
| A                          | 8.0      | 18.3   | 8.0     | 9.2  | 1.8     |
| B                          | 5.6      | 8.3    | 4.4     | 4.8  | 1.3     |
| C                          | 9.2      | 17.8   | 3.4     | 10.4 | 1.9     |
| D                          | 6.4      | 7.3    | 5.0     | 8.8  | 1.6     |
| E                          | 8.8      | 11.6   | 6.9     | 4.3  | 2.2     |
| WHO                        | NA       | NA     | 0.3     | 10   | 1.0     |

**Table 4.** Chronic daily intake CDI of the determined metals.

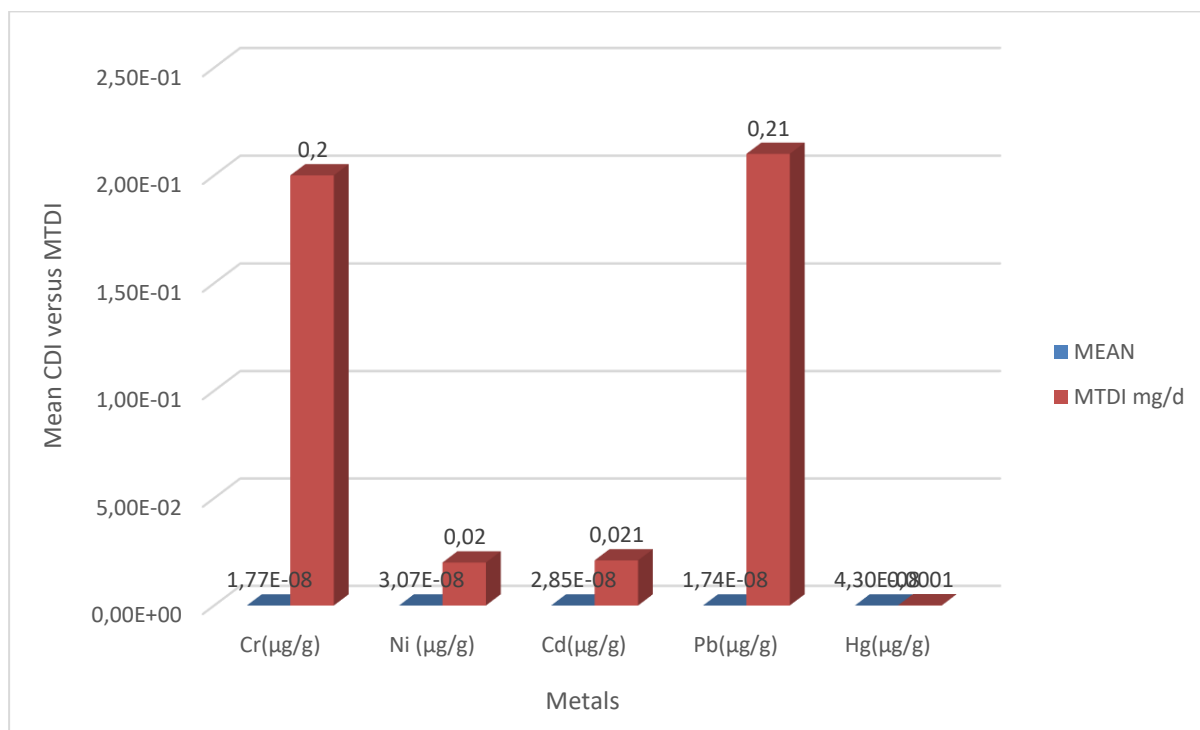
| Sample      | Cr (µg/g)  | Ni (µg/g) | Cd (µg/g) | Pb (µg/g)  | Hg (µg/g) |
|-------------|------------|-----------|-----------|------------|-----------|
| A           | 1.95E-8    | 4.47 E-8  | 1.95 E-8  | 2.25 E-8   | 4.39 E-8  |
| B           | 1.37 E-8   | 2.03 E-8  | 1.08 E-8  | 1.17 E-8   | 3.18 E-8  |
| C           | 2.25 E-8   | 4.23 E-8  | 8.31 E-9  | 2.54 E-8   | 4.64 E-8  |
| D           | 1.56 E-8   | 1.78 E-8  | 1.22 E-8  | 1.71 E-8   | 3.91 E-8  |
| E           | 1.71 E-8   | 2.83 E-8  | 1.68 E-8  | 1.05 E-8   | 5.37 E-8  |
| MEAN        | 1. 768 E-8 | 3.068 E-8 | 2.848 E-8 | 1. 744 E-8 | 4.298 E-8 |
| RFD (ug/g)  | 0.015      | 20        | 0.5       | 10         | 0.3       |
| MTDI (mg/d) | 0.2        | 0.02      | 0.021     | 0.21       | 0.0001    |

**Table 5.** Non-carcinogenic risk of the metals.

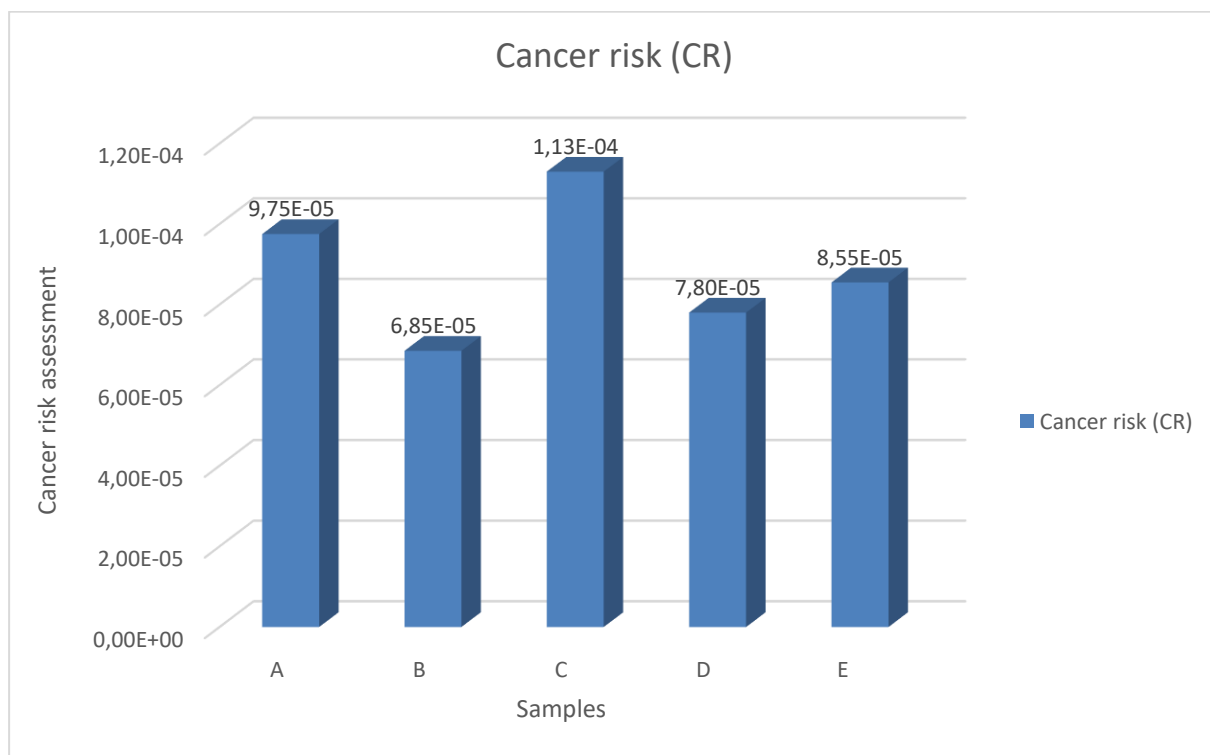
| Sample | HQ <sub>Cr</sub> | HQ <sub>Ni</sub> | HQ <sub>Cd</sub> | HQ <sub>Pb</sub> | HQ <sub>Hg</sub> | HI       |
|--------|------------------|------------------|------------------|------------------|------------------|----------|
| A      | 1.3E-6           | 2.24E-9          | 3.9E-9           | 2.25E-9          | 1.463E-10        | 1.31E-6  |
| B      | 9.13E-7          | 1.02E-9          | 2.16E-8          | 1.117E-9         | 1.06E-10         | 9.18E-6  |
| C      | 1.5E-6           | 2.12E-9          | 1.66E-9          | 2.54E-9          | 1.55E-10         | 1.51E-6  |
| D      | 1.04E-6          | 8.90E-10         | 2.44E-8          | 1.71E-9          | 1.303E-10        | 1.06 E-6 |
| E      | 1.14E-6          | 1.42E-9          | 3.36E-8          | 1.05E-9          | 1.79E-10         | 1.17 E-6 |

**Table 6.** Carcinogenic risk of chromium for dermal exposure rout for beauty soap.

| Sample | Slope factor      | Cancer risk (CR) |
|--------|-------------------|------------------|
| A      | 2.0E <sup>4</sup> | 9.75E-5          |
| B      | 2.0E <sup>4</sup> | 6.85E-5          |
| C      | 2.0E <sup>4</sup> | 1.13E-4          |
| D      | 2.0E <sup>4</sup> | 7.80E-5          |
| E      | 2.0E <sup>4</sup> | 8.55E-5          |



**Figure 1.** Chronic daily intake of the metal with reference to MTDI.



**Figure 2.** Cancer risk assessment of the various beauty soap sample

#### **4. DISCUSSION**

Cosmetics are recognized as one of the primary sources of heavy metals entering both the environment and the human biological system. Given this, there is an increasing need to examine the concentrations of toxic metals in commonly used cosmetic products. It is well-established that high doses of heavy metals can be fatal, and even prolonged exposure to low levels of these metals can lead to certain cancers. Additionally, there is growing concern about the physiological and behavioral impacts of toxic metals on the general population. For example, while the toxicity of lead at high exposure levels is well-documented, a significant concern today is the potential health risks posed by continuous exposure to even relatively low levels of toxic metals in cosmetics<sup>[22]</sup>. The presence of these metals may also increase the likelihood of skin allergies and contact dermatitis. The heavy metals detected in the tested products are considered unintentional contaminants. These metals are not deliberately added to the formulations but are impurities that occur in the product, often as byproducts of the manufacturing process, as a result of ingredient breakdown, or as environmental contaminants in raw materials. As such, they are not required to be listed on product labels.

In this study, different soap products were tested for the presence of mercury, chromium, cadmium, lead, and nickel. Table 1 shows the concentrations of heavy metal for each of the soaps in ppm while Table 2 shows statistical evaluations.

Tables 1 and 2 present the concentrations and mean values of mercury in various brands of commercially available soaps sold in Owerri, Imo State. The results indicate that the mean mercury concentration is 0.018 ppm, with a range of 0.013–0.022 ppm. These values exceed the WHO standards for mercury in cosmetics.

Mercury in cosmetics exists in two forms: inorganic and organic. Inorganic mercury (e.g., ammoniated mercury) is commonly used in skin-lightening soaps and creams, while organic mercury compounds, such as thiomersal (ethyl mercury) and phenyl mercuric salts, are used as preservatives in cosmetic products like eye makeup removers and mascara. Chronic exposure to mercury, even at very low levels, can lead to persistent neurological and kidney disturbances. Mercury in skin-lightening preparations can be absorbed through the skin, accumulating in body organs and potentially resulting in severe mercury poisoning.

The mean concentration of chromium in the analyzed soap samples was 0.076 ppm, with a range of 0.056–0.092 ppm. These values exceed the WHO limit for chromium concentrations in cosmetics. Numerous studies have highlighted the potential toxic effects of chromium exposure through various routes. These effects include blood, liver, and kidney toxicity from oral exposure, lung cancer from inhalation, and allergic contact dermatitis from dermal exposure.

Chromium has the ability to penetrate intact human skin, with significantly higher levels observed in damaged skin compared to intact skin. This is likely due to chromium's strong binding affinity to skin proteins, which facilitates its absorption. Sweat further increases the rate of chromium absorption into the skin, potentially causing sensitizing effects. Additionally, contact allergies have been reported in sensitive individuals through dermal exposure to chromium compounds<sup>[3,13]</sup>.

Cadmium is classified as a heavy metal, characterized by a density greater than 5 g/cm<sup>3</sup> in its standard state. While cadmium is essential for the survival of living organisms in very low concentrations, higher levels can lead to metabolic disturbances. Cadmium, known for its deep yellow to orange pigment, is commonly found in lipsticks and face powders.

Its use in cosmetic products is primarily due to its color properties, as it has long been utilized as a pigment in various industries.

In this study, the mean concentration of cadmium in the analyzed soap samples was 0.055 ppm, with a range of 0.034–0.080 ppm. These values exceed the WHO permissible limits for cadmium in cosmetics. Cadmium is considered a carcinogenic metal, and even at low concentrations, prolonged exposure can pose significant health risks.

Lead is one of the primary elements of concern due to its widespread presence in cosmetics. It is highly toxic to humans and can cause severe health issues, including hepatotoxicity, neurotoxicity, and nephrotoxicity, when it comes into contact with vital organs. Lead exposure has been linked to hormonal imbalances, miscarriages, reduced fertility in both men and women, and delayed puberty in girls. Additionally, lead compounds are classified as suspected carcinogens for humans.

In this study, the mean concentration of lead in the analyzed soap samples was 0.075 ppm, with a range of 0.043–0.104 ppm observed in commercially available soaps sold in Owerri.

The mean concentration of nickel in the analyzed soap samples was 0.127 ppm, with a range of 0.083–0.183 ppm. Chronic exposure to nickel can lead to allergic skin reactions, such as rashes and other dermatological conditions. Additionally, the International Agency for Research on Cancer (IARC) classifies nickel compounds as Group 1 (carcinogenic to humans) and metallic nickel as Group 2B (possibly carcinogenic to humans).

Nickel is a significant cause of allergic contact dermatitis in both children and adults. Currently, there are no established international standards for nickel impurities in cosmetics<sup>[3]</sup>. Studies on nickel sensitivity have shown that approximately 5% of nickel-sensitized individuals may react to an occluded dose of 0.44 µg nickel/cm<sup>2</sup>/week

#### **4. 1. Toxicological and health risk concerns of metal exposures**

The toxicity of heavy metals to humans is influenced by their daily intake. The chronic daily intake (CDI) of metals such as lead, chromium, cadmium, and mercury was calculated based on their mean concentrations. Table 4 and Figure 1, presents the CDI and maximum tolerable daily intake (MTDI) for the analyzed metals. The findings indicate that the estimated CDIs are below the minimum tolerable daily intake levels for these metals. The calculated mean CDI values are 1.68E-8, 3.068E-8, 2.848E-8, 1.44E-8, and 4.298E-8 for chromium (Cr), nickel (Ni), cadmium (Cd), lead (Pb), and mercury (Hg), respectively. These values are lower than the corresponding minimum tolerable daily intake thresholds. However, continuous daily exposure to these heavy metals, even at very low concentrations, may still pose health risks over time

The non-carcinogenic risk was assessed using the hazard quotient (HQ), which is critical in evaluating whether the concentrations of heavy metals in the soaps pose immediate health concerns. HQ is calculated as the ratio of the determined dose of a pollutant to its reference dose level. If  $HQ > 1$ , the exposed population is likely to experience adverse effects<sup>[21]</sup>. The results in Table 5 show that all HQ values are below 1, indicating that the metal concentrations are unlikely to cause immediate significant health issues.

The hazard index (HI), which represents the combined non-carcinogenic effects of multiple elements, was also calculated. For the analyzed soap samples, the HI values were  $< 1$  (Table 5), suggesting that the soaps are generally safe for use without posing significant non-carcinogenic risks. The carcinogenic risk factor is calculated to know the possibility of the beauty soap causing cancer. Due to the lack of a dermal slope factor (SF dermal) for lead, cadmium, nickel, and mercury, the carcinogenic risk (CR) was calculated only for chromium.

The results, presented in Table 6, and Figure 2, indicate that a carcinogenic risk (CR) value between  $10^{-6}$  and  $10^{-4}$  is considered acceptable. For chromium, the cancer risk in sample C was found to be  $1.13\text{E}^{-4}$ , which falls within the acceptable range. This suggests no significant carcinogenic risk from chromium exposure through dermal contact with beauty soaps sold in Owerri, Imo State, Nigeria<sup>[13,19,20]</sup>.

## 5. CONCLUSION

Although the levels of the toxic heavy metals in some of the studied cosmetic products is not alarming, exposure to low concentrations of these metals could be harmful to biological system if allowed to accumulate over time. Due to their longer half-life, these metals are known to accumulate in the human body organs. There are some reports that these metals can interfere with essential nutrients with similar oxidation states like calcium and zinc which could cause deleterious effects human. Finally, the continuous uses of this soaps could be detrimental to the end users in the long run.

## References

- [1] Oyedeji F.O, Hassan G.O, Adeleke B.B, Hydroquinone and heavy metal levels in cosmetics marketed in Nigeria. *Trends Appl. Sci. Res.* 6(7) (2011) 622-639
- [2] Abdel-Fattah A. Pingitore N.E, Low levels of toxic elements in Dead Sea black mud and mud-derived cosmetic products. *Environ Geochem Health.* 2009, 31(4), 487-492
- [3] Basmatker G, Jais N, Daud F, Aloe Vera: A Valuable multifunctional cosmetic ingredient. *International Journal Arom. Plants* 1 (2011) 338-341
- [4] Amit S.C, Rekha B, Singh A.K, Lodhi S.S, Chaturvedi D.K, Tomar V.S, Determination of Lead and Cadmium in cosmetic products. *J. Chem. Pharm. Res.* 2(6) (2010) 92-97
- [5] Liu, L., Wang, Z., Zhao, S. *et al.* Determination of total phthalate in cosmetics using a simple three-phase sample preparation method. *Anal Bioanal Chem* 410 (2018) 1323-1331
- [6] Banfalvi, G. Cellular effects of heavy metals. Springer UK, (2011), 6-13
- [7] Chanchal, D., Pharm, M, Swarnlata, M. Novel approaches in herbal cosmetics. *Journal of Cosmetic Dermatology* 7 (2008) 89-95
- [8] Abulude, F.O, Ogunkoya, M.O, Ogunleye, R.F, Emidun, Abudule, A.I, Assessment of the content of Pb, Cd, Ni and Cr in Soaps and detergents from Akure, Nigeria. *Research Journal of Environmental Toxicology* 4 (2010) 202-204
- [9] Basketter D.A. Angelini G, Ingber A, Kern P.S, Menne T. Nickel, chromium and cobalt in consumer products: revisiting safe levels in the new millennium. *Contact Dermatitis*, 49(1) (2003) 1-7
- [10] Ayenimo, J.G, Yusuf, A.M, Adekunle, A.S, Heavy metal exposure from personal care products. *Bulletin of Environmental Contamination and Toxicology* 84 (2010) 8-14

- [11] Bingol, D, Akcay, M. Determination of trace elements in fly ash samples by AAS after applying different digestion procedure. *Quantitative Spectroscopy and Radioactive Transfer Journal* 101 (2005) 146-150
- [12] [Aceto, M., Abollino, O. Bruzzoniti, M. Determination of metals in wine with Atomic Spectroscopy (AAS, GF-AAS AND ICP-AES). *Food Additives and Contaminations Journal* 19 (2002) 126-133
- [13] Gentscheva, G. D., Stafilov, T. Ivanova, E. H. (2010). Determination of some essential and toxic elements in herbs from Bulgaria and Macedonia using Atomic Spectrometry. *Eurasian Journal of Analytical Chemistry* 5, 104-111
- [14] Haque, Z, Rout, A, Jalil, A, Islam, B, Islam, M. Ahsan, A. Studies on the production of musabbra from Aloe vera. *Journal of advanced scientific Research* 3 (2012) 51-54
- [15] Chauhan, A.S, Bhadauria, R, Singh, A.K, Lodhi, S.S, Chaturvedi, D.K, Tomar, V.S. Determination of lead and cadmium in cosmetic products. *Journal of Chemical and Pharmaceutical Research* 2 (2010) 92-97
- [16] Dayan, A.D, Paine, and A.J, Mechanisms of chromium toxicity, carcinogenicity and allergenicity: Review of the literature from 1985 to 2000. *Human and Experimental Toxicology* 20 (2001) 439-451
- [17] Debjit, B, Chiranjibl, J,Y, Tripathi, K.K, And Kamar, K.P.S, Herbal remedies of Azadirachta indica and its medicinal application. *Journal of Chemical and Pharmaceutical Research* 2 (2010) 62-72
- [18] Al-Ashban, R.M, Barratt, D.A, Shah, A.H, Mercury contents of skin lightening creams marketed in Saudi Arabia. *Journal of Saudi Chemical Society* 10 (2006) 383-388
- [19] Ibe F.C, Ihenetu S.C, Njoku V.O. Ahmad A.S. Bello Y, Physicochemical, pollution, health risk, and irrigation quality evaluation of some surface water sources in Nwangele, Southeastern, Nigeria. *International Journal of Energy and Water Resources*, (2023), 1-21. <https://doi.org/10.1007/s42108-023-00273-w>
- [20] Linnila, P.M. Zinc, lead and cadmium speciation in deeper water bodies. *Lakes and Reservoirs: Research and Management* 5 (2000) 261-270
- [21] Chen S.C, Liao CM, Health risk assessment on human exposed to environmental polycyclic aromatic hydrocarbons pollution sources. *Science Tot Environ* 366 (2006) 112-123