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RESEARCH ARTICLE

# Hidden Toxic Elements in Creams and Foundations

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## Abstract

Toxic metals' contamination in cosmetic products is a serious threat. In the past, people used only cosmetics that consisted of natural ingredients. However, nowadays, the majority of the cosmetics available in the market today consist primarily of man-made materials (chemical substances). These synthesized products help a person to appear better, beautiful, and attractive, nevertheless, in both short and the long run they may cause significant health damage to the consumers due to the presence of toxic chemicals. Therefore, the present study was aimed at assessing the presence as well as quantifying the levels of metals in selected cosmetics including body and whitening creams and foundations. The assessments were done to assess the presence of toxic elements in seven (7) creams and three (3) foundations using Energy Dispersive X-Ray Fluorescent (EDXRF) Spectrometer (The Rigaku NEX CG Model). The seven analyzed creams were: Chandni Whitening, Goldie advanced beauty, Elegance cocoa butter, Dhiindhiin body, Gold beauty, Pretty white lightening and Clinic clear whitening, while the three foundations were: Natural glow, Velvet touch (BB) and Wild rose (ChuiChui). Assessed elements included, seven metals which are Cu, Cd, Nb, Ta, Hg, Pb, and Bi, and three (3) metalloids, As, Sb, and Te. Their levels were quantified in the unit of ppm. Both types of cosmetics contained traces of copper. Overall order of occurrence of the detected metals in analyzed cosmetics for creams was: Hg > Pb > Cd > Cu. While As, Nb, Sb, Te, Ta, and Bi were not detected in the analyzed creams. For the case of foundations, the trend was Nb > Te > Cu > Ta > As, whereby no detection was noticed for Cd, Sb, Hg, Pb, and Bi. The highest level of Hg (67900.0 ppm) was found in Chandni whitening creams, whereas the highest level of Bi (54000.0 ppm) was found in Goldie cream. The level of Hg exceeded the maximum limit (1 ppm) set by WHO/FDA for skin and lightening creams. Furthermore, the data showed that Gold beauty cream contained 56.0 ppm of Pb followed by Cd at 23.0 ppm, while Cu was detected at 1 ppm in Clinic clear, Dhiindhiin and Pretty white. As and Sb were found to be below the detection limits. The level of Pb exceeded the maximum permissible limits (20 ppm) in skin and lightening creams. Therefore, continuous monitoring of cosmetic products specifically with reference to toxic elements adulteration should be adopted to ensure the good health and safety for the consumers.

## Introduction

The usage of cosmetics in the personal life in this century is inevitable. Everyone desires to appear beautiful in front of others and is inherited in the blood since civilization. Cosmetics are used by most people regardless of their age, race, culture, and gender [1]. Cosmetics can be defined as the

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### Keywords

- > Chandni whitening cream
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mixtures of surfactants, oils, and other ingredients required to be effective, long-lasting, stable, and safe for human use [2]. These products include lipsticks, lip gloss, face and body powders, face and body creams, lotions, perfumes, eyeliners, and many others [3]. These products are applied to various external parts of the body to beautify the body, change appearance, cleanse, and control body odor [4,5].

In the past, people used only cosmetics that consisted of natural ingredients. However, the majority of the cosmetics available in the market today consist primarily of man-made materials (chemical substances) [6]. Although these products help a person to appear better, beautiful, and attractive, in the long run, they may cause significant damage to their life if they contain toxic chemicals. According to [7] most of the raw materials used in the manufacturing of cosmetics contain significant amounts of metals. These metals can cause skin problems and, in some cases, they lead to severe diseases. Most of the preservatives, fragrances, and surfactants used in cosmetics have health risks ranging from mild hypersensitivity to life-threatening diseases [8].

Heavy metals are those metals whose density is shown to be five times greater than the density of water [9]. Heavy metals include Cadmium, Chromium, Cobalt, and Lead to mention but few. These metals are also known as toxic metals, however, the essential metals such as Calcium, Magnesium, Sodium, and Potassium when they appear in higher amounts (concentrations) become toxic [10,11]. Naturally, heavy metals are found in rocks, soils, and water, but also in cosmetics products as important ingredients during manufacture. Other heavy metals are used in cosmetics as preservatives and some of them remain as impurities [12].

For many years ago, people believed that cosmetics would remain only on the skin and would never be absorbed by the body. However, modern studies have proved the ability of the skin to absorb many of the chemicals on the skin depending on their absorption magnitudes [13]. Many physical parameters lead to the absorption of heavy metals throughout the body, such as absorption of heavy metals from the diet, through medication, and exposure to cosmetics on the skin surface [14,15] explained that "High doses of some heavy metals consumed by human beings can cause death, but also long-term exposure to low doses of these metals can cause some skin and health problems for consumers". Such problems are skin irritation,

photoreaction, birth defects, and reproductive effects for both male and female consumers [16]. Moreover, the use of underarm cosmetics such as powder, perfumes, and deodorants can cause breast cancer [17]. As explained earlier cosmetic products contain several chemicals including heavy metals such as mercury, cadmium, chromium, manganese, copper, and lead are heavy metals included in it as ingredients [18].

Antimony is one of the metals used in cosmetics such as eye pencils, eye shadow, skin cream, and soap [12]. It can affect the respiratory system and cause disorders including pneumoconiosis, bronchitis, emphysema, and gastrointestinal problems such as abdominal pain, vomiting, and ulcers [19].

Applying cosmetics that have cobalt in them, can penetrate the damaged skin more easily and cause itchiness and palmar lesions. Eye makeup and Hair care products contain cadmium as a colorant ingredient [20]. Arsenic is another metal commonly used in eye pencils, eye shadow, hair gel, conditioner, and lipsticks. Long-term exposure to this metal can cause health problems such as skin problems, lung cancer, urinary system cancer, and nervous disorders [21].

Mercury is another metal used in cosmetics such as hair conditioners, hair gel, shampoo, shower body milk, skin creams, and shower body oils [22]. It can cause renal, neurologic, and dermal problems. Nickel is also used widely in cosmetics such as eyeliner, eye pencil, face paint, hair conditioner, etc. It has been prohibited due to its ability to cause health problems such as contact allergy [16]. Lead is another chemical used in cosmetics. Many studies have proved that lead has no safe exposure even to a small degree [23].

There is a rising commerce in cosmetics in Zanzibar, imported from various nations and producers, however, the quality of some cosmetics is unknown. This occurs because their identity and the amount included in a certain cosmetic product are not disclosed throughout the production and labeling processes [24]. As a result, the proliferation of new cosmetic items on the market necessitates ongoing monitoring. Furthermore, the amounts of heavy metals in cosmetic items marketed in Zanzibar are unknown when compared to WHO and ZBS maximum set standards, and the exposure dangers of heavy metals in cosmetics sold in Zanzibar are poorly understood.

Therefore, this study aimed to assess the level of some elements (Antimony, Arsenic, Bismuth, Cadmium, Copper, Lead, Mercury, Niobium, Tantalum, and Tellurium) in selected cosmetics namely; creams and foundations commercially available in the Zanzibar market.

### Dermal exposure of heavy metals and its toxicity

Dermal exposure is the predominant channel for the uptake of heavy metals from skin care cosmetic products such as creams and foundation. When these cosmetics applied directly to the skin can easily and directly absorbed by the skin and even deeper part of the body and can served as the primary defensive barrier for the body against external detrimental agents [25]. They also play crucial role in preventing harmful substances from entering internal parts of the human bodies [26]. Absorption of metal ions in a blood circulatory system (Figure 1) lead to formation of metal-complexes with different functional groups present in the human body typically thiol and amine group. This process can lead to various diseases to human and even death [27].

Interaction of heavy metals with DNA and certain nuclear proteins has been found to cause DNA damage and other health related problems [28]. Several mechanistic factors (though not completely understood) have been link to carcinogenicity and other metal toxicity [29]. Consumption of these metals are linked to oxidative stress and to biological component damages which can eventually lead to both carcinogenicity and neurotoxicity (Figure 2),

more importantly, toxicological mechanism and possibly the toxicological pathway for each metal is very unique [30]. The brain, liver, lungs, and kidneys are example of internal organs that can be endangered either by acute or chronic metal toxicity leading to a variety of illnesses [31].

### Objectives

- To assess the levels of metals in selected Foundation and Cream cosmetics.
- To assess the differences in levels of metals between foundation cosmetics and cream.
- To examine the most prevalent metals in the tested cosmetic products.
- To examine the cosmetics with highest level of the detected metal.

### Methodology

**Samples collection:** A total of ten (10) cosmetics including seven (7) body and whitening creams and three (3) foundations were purchased at Darajani markets in Zanzibar, all of which were within the expiry dates. The samples were collected through the following criteria:

- Creams, and foundations that people most frequently use, while their expiry dates are still valid.
- The cheapest brands that are affordable by many people.

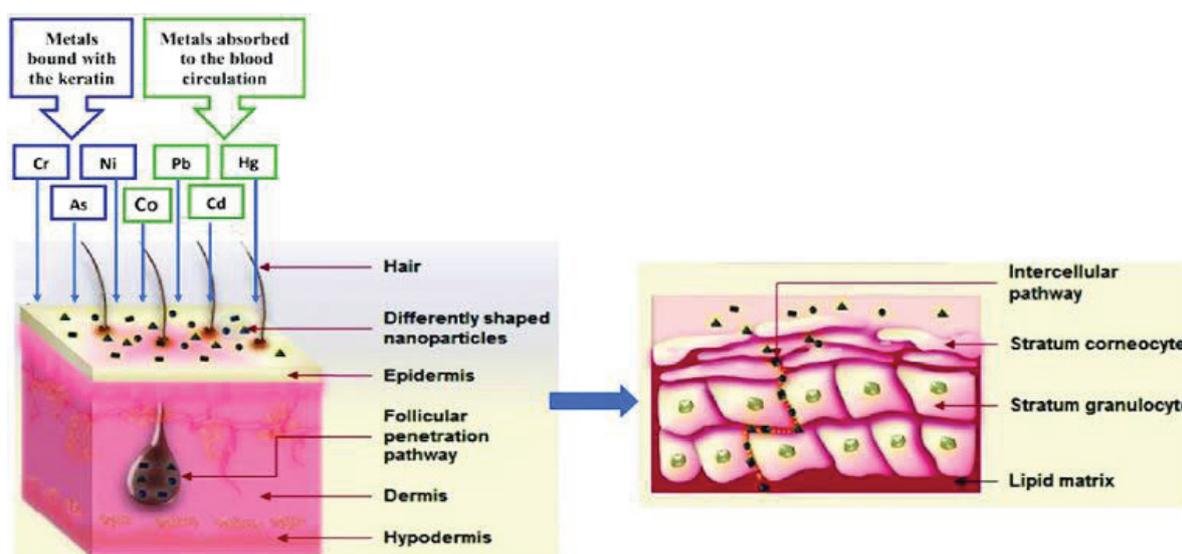
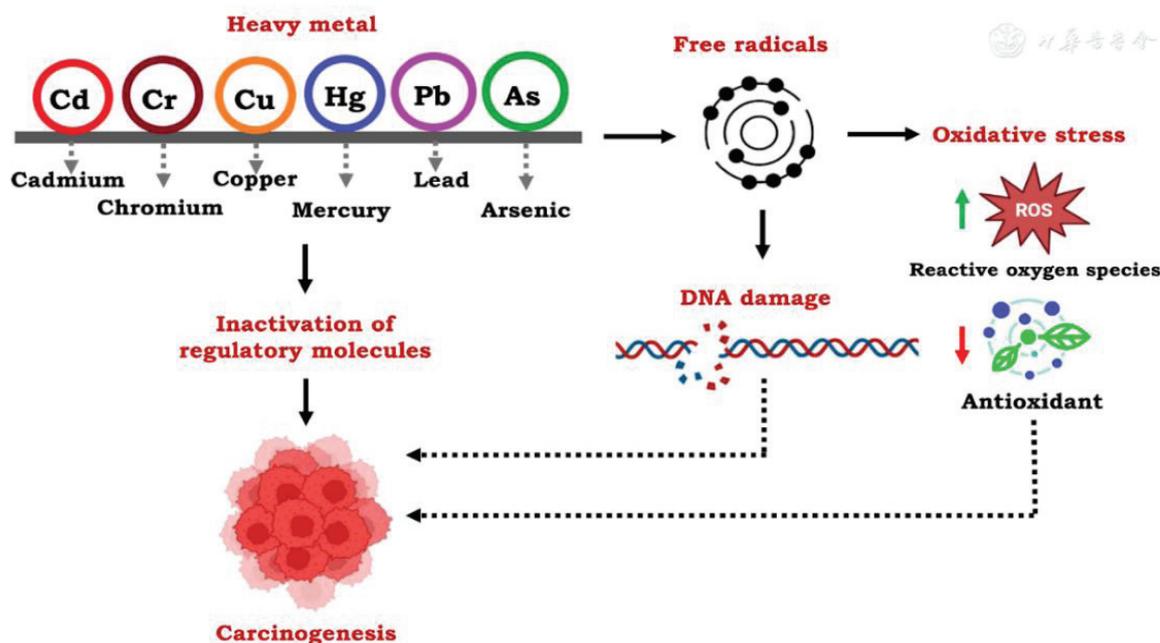


Figure 1 Absorption of heavy metals from the skin to the blood circulatory System [34].



**Figure 2** Mechanism of heavy metals toxicity and cell carcinogenesis [34].

**Samples preparation and analysis:** The samples were prepared under established Safe Operating Procedures (SOPs) and laboratory protocols, adhering strictly to the guidelines outlined in the field sample preparation process. Approximately 5.0 grams of each sample were accurately weighed using a beam balance and placed in sample holders for further analysis. The sample were analyzed using an Energy Dispersive X-Ray Fluorescence (EDXRF) spectrometer (The Rigaku NEX CG model). These fluorescent X-rays are captured in a detector and counted by a multi-channel analyzer. The NEX CG software then calculates the concentration of each element present in the sample.

## Results and Discussion

The main objective of this study is to assess the levels of some heavy metals in selected cosmetics. The selected cosmetics were seven (7) creams and three (3) foundations. To fulfill the objectives of the study, the descriptive analysis of the data was done by IBM SPSS (v. 20) to obtain the mean, standard deviation, minimum, and maximum values of the metals as well as plotting the graphs. Analysis of Variance (ANOVA) was applied to evaluate the significant differences among the samples.

During sample analysis, seven (07) metals which are: Cu, Cd, Nb, Ta, Hg, Pb, and Bi, and three (3) metalloids (arsenic (As), antimony (Sb), and tellurium

(Te), their levels were assessed in each sample in unit of ppm.

The data from the sample analysis were analyzed using Descriptive Statistics techniques, to determine the mean, standard deviation, minimum and maximum levels as well as p-values of metals in the analyzed samples (Table 1).

The differences in analyzed metals between and within the cosmetics were employed statistically using ANOVA in order to evaluate whether there are significant differences or not. The results indicate that the samples were significantly at 95% confident level and p-value < 0.05. For example, Cu, As, Nb and Te in cosmetic samples were found to have p-values of 0.001, 0.035, 0.054 and 0.011 respectively. On top of that other metals (Nb, Cd, Sb, Ta, Hg, Pb, and Bi) did not show significant differences in all analyzed cosmetics because p values were above 0.05.

The overall sequential arrangements of all identified metals and the list of metals that were below detection limits in each analyzed sample were also summarized (Table 2).

Overall statistical data analysis indicated that, Te, Cu, Nb and As had significant differences (p- values were 0.011, 0.054 and 0.035 respectively). While Ta, Cd, Hg, Pb and Bi did not show a significant differences (p - values exceeded 0.05) (Table 1).

**Table 1:** Descriptive statistics of analyzed metals with their *p*-values.

Descriptive							
Elements	Cosmetics	Mean (ppm)	Std. Deviation	Minimum (ppm)	Maximum (ppm)	F	<i>p</i> -value
Cu	Foundation	9.3	4.9	6	15	25.6	0.001*
	Cream	0.6	0.5	BDL	1		
As	Foundation	2.7	3.1	BDL	6	6.4	0.035*
	Cream	NA	NA	BDL	BDL		
Nb	Foundation	12.7	16.3	BDL	31	5.099	0.054*
	Cream	NA	NA	BDL	BDL		
Cd	Foundation	NA	NA	BDL	BDL	0.4	0.545
	Cream	3.3	8.7	BDL	23		
Te	Foundation	18.0	15.9	BDL	30	10.8	0.011*
	Cream	NA	NA	BDL	BDL		
Ta	Foundation	4.7	8.1	BDL	14	2.8	0.133
	Cream	NA	NA	BDL	BDL		
Hg	Foundation	NA	NA	BDL	BDL	1.382	0.274
	Cream	20014.3	28486.4	BDL	67900		
Pb	Foundation	NA	NA	BDL	BDL	0.4	0.545
	Cream	8.0	21.2	BDL	56		
Bi	Foundation	NA	NA	BDL	BDL	0.607	0.458
	Cream	9385.7	20150.5	BDL	54000		

BDL = Below Detection Limit; \* = Significance at 95 % Confident Level and *p*-value < 0.05

**Table 2:** Overall order of occurrence of the detected metals in analyzed cosmetics.

Cosmetics	Trend of metals	Metals below detection limit
Creams	Hg > Bi > Pb > Cd > Cu	As, Nb, Sb, Te, and Ta.
Foundations	Nb > Te > Cu > Ta > As	Cd, Sb, Hg, Pb, and Bi,

Metals analysis in analyzed cream and foundation cosmetics.

### Cream samples

**2.1.1. Level of Hg and Bi in cream:** The highest level of Hg (67900.0 ppm) was found in Chandni whitening creams, whereas the highest level of Bi (54000.0 ppm) was found in Goldie cream (Figure 3). The level of Hg exceeded the MAA (1ppm) set by WHO/FDA for skin and lightening creams. The trend of these metals was: Hg > Bi

**Levels of Cd, Cu, Pb, and Sb in creams:** Furthermore, the data showed that Gold beauty cream contained 56.0 ppm of Pb followed by Cd at 23.0 ppm while Cu was detected at 1 ppm in Clinic Clear, Dhiindhiin, and Pretty white (Figure 4). The level of Pb exceeded the maximum permissible limits (20 ppm) in skin and lightening creams, while As and Sb were below the detection limits.

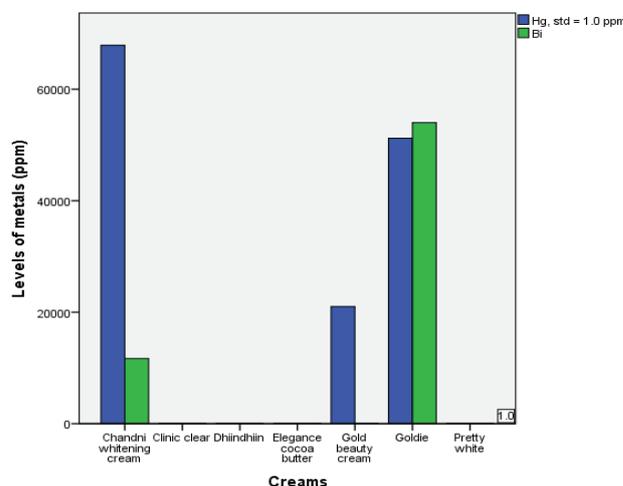
The trends of these metals were: Pb > Cd > Cu.

### Foundation samples

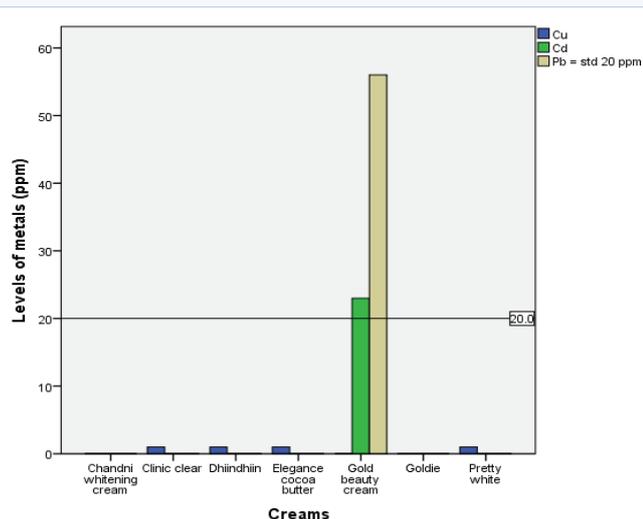
Three (3) samples of foundations (Natural glow, Wild rose and Velvet touch) imported from China were

taken for metals analysis. The levels of the metals detected are presented in figure 5.

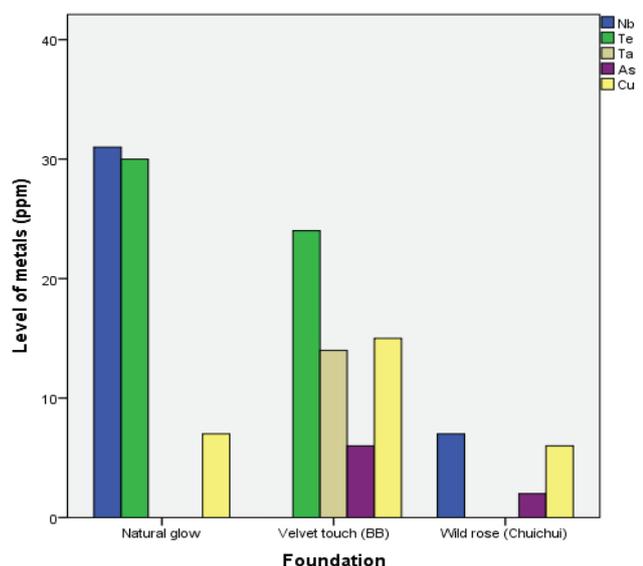
**Levels of As, Cu, Nb, Ta and Te in foundations:** Nb, Te, Cu, Ta, and As were also detected in some brands at the maximum levels of 31.0 ppm, 30.0 ppm,



**Figure 3** Levels of Bi and Hg in cream samples.



**Figure 4** Levels of Cd, Cu, Pb and Sb in creams.



**Figure 5** Levels of As, Cu, Nb, Ta and Te in foundations.

15.0 ppm, 14.0 ppm, and 6.0 ppm respectively (Figure 5) and (Table 1). The trend of analysed metals was: Nb > Te > Cu > Ta > As

## Conclusion

This study revealed that both creams and foundations had same proportions of heavy metals that were analyzed. Statistically also highlighted that there were a significant differences in metals concentration of certain metals between and within the creams and foundations such as Cu, As, Nb, and Te. This suggests that the composition of heavy metals varies among the specific metals presents within each

products, not only between creams and foundations.

Although, copper (Cu) was the only element detected in both cream and foundation samples, mercury (Hg) also detected in high levels (concentration) in whitening and lightening creams which exceed the standard limit set by World Health Organization (WHO) and United State Food and Drugs Administration (USFDA). Mercury can be absorbed through the skin, and easily can reach the bloodstream even in small extents causing depigmentation inside the nucleus [32]. The use of skin-lightening creams which contains element mercury can have major health implications endangering the circulatory system, urinary systems and nervous system [33]. Therefore the responsible authorities needed to have a strictly regulations to prevent the importation of cosmetics containing toxic ingredients to safeguard the health of consumers. Alongside this, education on the proper use of cosmetics is necessary so that the community can be aware of the dangers posed by toxic ingredients found in these products.

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