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Comparative analysis of heavy metal content of unregulated facial whitening creams and branded facial whitening creams

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ABSTRACT

The present study was conducted to evaluate potential health risks of Omani cosmetics considering the dangers and adverse effects on health caused by unregulated and unlabelled cosmetic products. Therefore, this current study is to examine the toxic heavy metals of unregulated facial whitening creams that are available in the Omani market and compare them with branded facial whitening creams. A total twenty-two samples were purchased from the Souqs/markets of all eleven governorates of Oman and their heavy metals content was determined by using Inductively Coupled Plasma-Optical Emission Spectroscopy (ICP-OES). The sample was digested by using ultra wave microwave at 180 °C. The percentage of heavy metals present in the unregulated whitening creams were compared with the heavy metals content of two randomly selected and branded whitening creams. The results showed that most of the unregulated samples contain significant amount of chromium, cooper and lead. In comparison, the branded face creams contained only the permissible amount of the heavy metals tested. The maximum arsenic content was found in a sample collected from Al Batinah South region (1.74 ppm). The maximum cadmium content was found in a sample collected from Al Wusta region (2.02 ppm). The maximum cobalt and chromium content were found in the samples collected from Al Buraimi region (0.10 ppm) and Dhofar region (8.04 ppm) respectively. In conclusion, unregulated face creams are not safe for human consumption because they contain significant levels of heavy metals that exceed the permissible limits.

1. Introduction

Millions of people use personal care items, beauty products, and facial cosmetics on a daily basis. Human skin is exposed to a wide range of substances in these beauty care products when they are applied directly to it. Despite the fact that our skin is designed to protect us from external pollutants, some cosmetics elements can penetrate the skin and cause toxicity. These cosmetic components may have a adverse effect on the skin, causing sensitization, irritation, photo responses, or allergy [1]. These hazardous chemicals included in cosmetics have the potential to create major health problems in the long run. Heavy metals are one of the most dangerous components of cosmetics, and they are commonly used in cosmetics [2,3].

Innocent customers are frequently duped by these items, and the indiscriminate use of unregulated cosmetics as beautifying catalysts traps people in a mirage. Consumers eventually use these contaminated goods on their faces or bodies to improve their overall appearance and preserve their allure. Heavy metals and hazardous substances accumulate in their bodies and, over time, may have an impact on men's and women's health. Hazardous chemicals including heavy metals such as lead, nickel, arsenic, mercury, and cadmium are found in most of the beauty products. Heavy metals are toxic compounds that accumulate in the body, causing various ailments such as cancer, hair loss, lung damage, reproductive issues, and developmental problems [4]. Application of cosmetic products is a norm of everyday life. An ideal cosmetic product shall contain only the permissible quantity of heavy metals in it. Unfortunately, the published literature clearly indicates that cosmetics like kohl, face creams, henna and many others, available in MENA (Middle East and North Africa) region contain heavy metals than the permissible amount. It is very common to see so many unregulated cosmetics, especially facial whitening creams, available in Omani market. Continuous exposure to most of the heavy metals may result in cancer as almost all heavy metals can potentially cause oxidative stress, DNA damage, and alteration of programmed cell death [5]. The

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availability and subsequent usage of these unregulated facial whitening creams poses serious health issues to Omani community. The potential accumulation of heavy metals in the body through the usage of unregulated facial whitening creams poses chronic health problems. There is a paucity of data regarding the heavy metal content of unregulated facial whitening creams available in the souqs/markets of Oman which may have minimal or no symptoms in the initial stages. Cosmetics, penetrates the body through the process of inhalation, through the skin, or through oral ingestion. Exposure to environmental pollutants is unintentional; whereas, exposure to these toxic heavy metals on a daily basis is pure ignorance which can be avoided by being more precautious before purchasing cosmetic products.

Cosmetics such as eyeliner and henna are popular among women in Oman. Henna is a flowering plant whose powder is used to tint and dye hair and skin. Kohl is a powdery substance that is typically made by grinding galena and other substances. These are used to darken the eyelids or as eyelash mascara. These two cosmetic products have a lot of heavy metal in them, which can create a lot of health problems if used for a long time. They're also thought to be the primary source of lead poisoning in both adults and children. The effects of lead at high concentration doses are well recognised, but a key concern in the current scenario is that low doses of lead exposure over a long period of time could cause harm. Lead is the most severe contaminant to the environment to come out of the whole span of human civilization and cause impairment to the renal and nervous system [4]. It is also known to cause deficiency in cognitive functions [5].

Oman's cosmetics sector is quickly expanding, with an increasing number of women and adolescent girls buying them. Some of these cosmetics are high in heavy metals and hazardous compounds, putting everyone's health, especially women's, at risk. Heavy metals particularly lead, can cause major harm to the eyes and other organs if they are exposed to them. For quite some time, the scientific community has been debating the consequences of using traditional cosmetic kohl in Oman and other Middle Eastern nations. Surma and kohl have long been suspected of being causes of lead poisoning, which affects the ocular system in a huge number of children and adults [3]. Heavy metals such as chromium, zinc, nickel, iron, and cadmium have been tested in a variety of other cosmetics and beauty goods. Heavy metal is found in the majority of cosmetic products available on the Omani market. According to a research published in Contact Dermatitis, 75% of 88 eye shadow samples from 49 different sellers had at least one of these heavy metals, such as lead, nickel, cobalt, arsenic, and chromium [6].

According to a recent study in Oman, on average, a woman uses 12 cosmetic items every day, totalling more than 160 individual chemicals. According to the study, 1 in every 13 women is exposed to carcinogenic substances on a daily basis as a result of their daily use of these items [7].

Traditional Arabian and African cosmetics and beauty items include a significant amount of lead, which is extremely detrimental to one's health. One of the most common sources of heavy metal toxicity is kohl, which is used as an eye shadow [8].

Skin lightening treatments, such as hydroquinone (HQ), are among the most dangerous substances. Ochronosis has been reported, as well as the possibility of mutagenicity. Ochronosis is a particularly negative effect of HQ, characterised by a dynamic obscuring of the area where a cream containing high HQ convergences has been in touch with skin for a long time [9].

Sun-screening specialists can cause aggravation, unfavorably susceptible, phototoxic, or photograph hypersensitive responses. Benzophenones are the most well-known sensitizers; while, debenzoylmethanes, para-aminobenzoic acid (PABA), and cinnamates may cause photo hypersensitive dermatitis [5].

A number of chemicals are utilized as a part of beauty care products as fixings and some are utilized as additives. These chemicals have diverse and severe health impacts. Hexavalent chromium (Cr+6) is destructive and sensitive to the skin. Cr+ 6 mixes are listed as carcinogenic by the International Agency for Research on Cancer (IARC). Antagonistic impacts of the Cr+ 6 on the skin may incorporate ulcerations, dermatitis, and hypersensitive skin responses. Inhalation of Cr+ 6 can bring about erosion and rupture of the mucous layers of the nasal septum, affecting the pharynx and larynx, and it also causes causes hypersensitivity of respiratory tract and edema [10].

Mercury presence in skin creams has turned into a worldwide medical issue. Mercury mixes ingested through the skin on topical application and tend to amass in the body. Similarly, lead and other heavy metal causes damage by accumulating in the body. Pregnant ladies and kids are more susceptible as these heavy metals can cross the placenta effortlessly and enter the fetal circulation [11].

Lead intoxication has been linked with unsuccessful labour, hormonal changes and menstrual anomalies. Lead and inorganic lead compounds have been named as potential carcinogenic agents to people [12].

Epidemiological studies show that these metals pile up in the body leading to health disasters like chronic diseases, multiple organ failure, or different skin-oriented cancers [13].

The concentration of cadmium is often present in excess in cosmetic creams. Majority of skin brightening and creamy lotions contain supra-optimal amount of cadmium. Cobalt and chromium are often used in cosmetics as a coloring pigment and poses serious threat to the consumers [14].

The abnormal amount of heavy metals often instigates various types of allergies, skin irritation, inflammation of tissue, granuloma, and allergies pertaining to skin and respiratory system. Sensitive skins are more prone to eczema on the areas of application. Sensitization often occurs in cases where there is prolonged contact of cosmetics with higher amount of heavy metals like nickel. Various individuals are susceptible to allergies depending over the different sensitivity level towards various metals. In addition, dermatologists confer that it is complex process to eliminate these heavy metals or detoxify it within the human body [15]. The current study examined the heavy metal content of these facial whitening creams and compare them with heavy metal content of branded facial whitening creams available in Omani hypermarkets.

2. Materials and methods

2.1. Materials

Analytical grade reagents were used in all experiments. The apparatus and devices employed in the present research were calibrated for accuracy before all experimental sessions. All the glassware was rinsed with 10% concentrated nitric acid (HNO_3, purity 92%) to eliminate the presence of potential heavy metals on the surface of equipment. Heavy metals analysis were performed by using Inductively Coupled Plasma-Optical Emission Spectroscopy (ICP-OES, Model 8000) loaded with SYNGISTIX FOR ICP software. Sample digestion were completed using Ultrawave Microwave (Model number ETHOS One 2010), at 180 °C. The stock solution for arsenic (As), cadmium (Cd), cobalt (Co), Chromium (Cr), cupper (Cu), iron (Fe), manganese (Mn), nickel (Ni), lead (Pb), and zinc (Zn) were purchased from PerkinElmer, Inc.

2.2. Sample collection and processing

Twenty-two different facial creams that are unregulated were purchased randomly from cosmetic venders across eleven governorates across the Oman. The current research defined an unregulated facial whitening cream as those that did not underwent the standard quality control process and sought formal approval from the Government of Oman but available in the souqs/markets of Oman. Convenient and purposive sampling techniques were followed to collect two samples each from all eleven Governorates of Oman. Two branded facial whitening creams available at either of the two prominent hypermarkets (Carrefour and Lulu) in Muscat served as standards for the study. The

Table 1
Concentration of heavy metal content in unbranded facecreams in Oman with branded control creams.

Location	Arsenic	Cadmium	Cobalt	Chromium	Copper	Manganese	Nickel	Lead
Al Buraimi Sample 1	1.59	0.32	nd	0.08	7.25	0.12	3.26	29.85
Al Buraimi Sample 2	1.26	0.56	0.10	2.65	6.52	0.52	2.23	25.36
Al Batinah North Sample 1	1.45	1.08	0.09	4.65	9.33	1.52	2.99	14.65
Al Batinah North Sample 2	1.66	nd	0.03	2.89	8.36	1.24	1.32	12.32
Al Batinah South Sample 1	1.74	1.33	0.01	4.66	5.22	nd	1.86	17.78
Al Batinah South Sample 2	0.29	1.73	0.05	7.86	11.66	1.48	1.12	19.88
A'Dhahirah Sample 1	0.36	nd	0.07	5.26	nd	1.33	3.58	22.22
A'Dhahirah Sample 2	0.64	nd	0.02	6.54	10.69	1.27	1.16	20.07
A'Dakhiliya Sample 1	nd	0.09	0.06	4.68	nd	0.15	0.23	20.15
A'Dakhiliya Sample 2	nd	nd	0.08	nd	4.59	0.85	0.65	12.13
A'Sharqiyah North Sample 1	0.99	0.65	0.10	2.15	nd	0.54	nd	29.37
A'Sharqiyah North Sample 2	0.66	nd	nd	8.02	nd	0.95	0.95	25.29
A'Sharqiyah South Sample 1	nd	0.88	nd	7.02	2.66	nd	0.26	17.45
A'Sharqiyah South Sample 2	1.24	1.59	0.05	nd	nd	0.26	0.59	25.13
Al Wusta Sample 1	nd	2.02	nd	2.69	7.66	0.36	nd	28.32
Al Wusta Sample 2	1.33	1.06	0.02	3.66	2.55	nd	0.99	nd
Dhofar Sample 1	nd	nd	0.03	8.04	5.641	0.63	1.01	25.65
Dhofar Sample 2	0.12	0.65	0.02	nd	nd	0.98	2.25	18.63
Musandam Sample 1	0.02	0.04	0.00	0.36	0.20	0.36	0.14	0.09
Musandam Sample 2	0.03	0.25	nd	nd	11.26	0.94	2.00	14.66
Control 1	0.01	0.04	0.00	0.38	0.00	0.04	0.15	0.08
Control 2	0.03	0.07	0.00	0.62	0.01	0.02	0.26	0.06

nd=not detected

samples were thoroughly mixed to get homogeneous and representative samples before analysis.

The pressure was set at 40 pounds per square inch (PSI). Prepared solutions were then directly analyzed in the ICP/OES machine without dilution and pressure for 45 min.

2.3. Preparation of standard curve

The stock solution containing As, Cd, Co, Cr, Cu, Fe, Mn, Ni, Pb, and Zn were diluted using deionized water to give mixtures corresponding to concentrations of 1, 3, 5, 7, and 9 ppm. Total volume of each concentration was 25 ml. These solutions were later analyzed to generate calibration curves for all samples tested. Dilution of standard solution was done based on stoichiometric equation using the following equation.

$$M_1V_1 = M_2V_2 \quad (1)$$

Where,

M_1 is the concentration in molarity (moles/Liters) of the concentrated solution,

V_2 is the volume of the concentrated solution,

M_2 is the concentration in molarity of the dilute solution.

2.4. Microwave digestion of the cream samples

Exactly 0.5 g from each sample was weighed and placed in an Erlenmeyer flask. Nitric acid (4 ml) was added to each of the cream sample. The samples in the flasks were digested in the microwave at 180^0 C for 45 min to give clear solutions [13].

3. Results and discussion

Heavy metals are toxic substances and they accumulate in the bodies over the time. They have a significant negative impact on human health. Toxic heavy metals such as lead, nickel, arsenic, mercury, and cadmium are found in most beauty products. All those heavy metals are toxic compounds that accumulate in the body, causing ailments such as cancer, hair loss, lung damage, reproductive issues, and developmental problems [15,16]. Application of cosmetic products is a norm of everyday life. An ideal cosmetic product shall contain only the permissible quantity of heavy metals in it.

One of the two samples collected from the Al Buraimi contained 29.85 ppm of lead in it and the same sample did not contain cobalt. The other sample contained significant amount of lead, copper and chromium (25.36, 6.52 and 2.65 ppm respectively). Two samples each from Al Batinah North and Al Batinah South regions were collected and analyzed. The maximum arsenic content was found in a sample collected from Al Batinah South region (1.74 ppm). The maximum copper and manganese content were found in the samples collected from Al Batinah South region (11.66 ppm) and Al Batinah North region (1.52 ppm) respectively (Table 1). The lead content in both samples collected from the Al Dhahirah Governorate were high (22.22 and 20.07 ppm respectively). On the other hand, neither of the samples contained cadmium. One sample contained 10.69 ppm of copper but the other sample did not contain any copper. The two samples collected from Al Dakhiliya did not contain arsenic. One of the samples did not contain chromium and the other did not contain copper. Both the samples contained lead (20.15 and 12.13 ppm respectively) (Table 1). Two samples each from Al Sharqiyah North and Al Sharqiyah South regions were collected and analyzed. Both the samples collected from Al Sharqiyah North contained significant amount of lead (29.37 ppm and 25.29 ppm respectively) (Table 1). BotNeither of the samples collected from Al Sharqiyah North contained copper. Nickel was absent in one sample and cadmium and cobalt were absent in the another sample. Chromium and copper were not detected in one sample collected from Al Sharqiyah South region and the other sample did not contain arsenic, cobalt and manganese. The only sample that did not contain lead was collected from Al Wusta region. That same sample did not contain manganese either. The other sample from the same region had the lead level of 28.32 ppm (Table 1). One of the samples collected from the Dhofar region did not contain

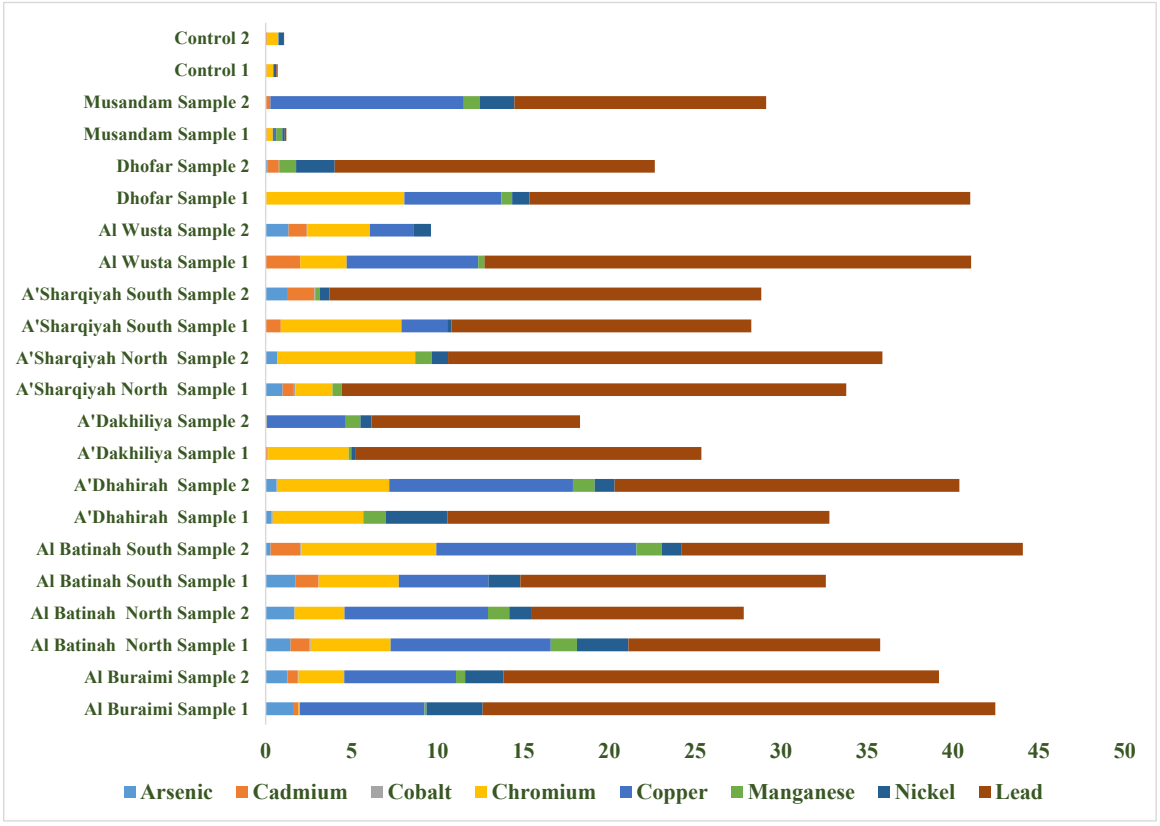

Fig. 1. Comparative illustration of heavy metal content in unbranded facecreams in Oman with branded control creams.

chromium and copper. The other sample did not contain arsenic and cadmium. Both the samples contained significant amount of lead (25.65 ppm and 18.63 ppm respectively (Table 1). The maximum chromium content was found in the sample collected from Dhofar region (8.04 ppm). One of the samples collected from the Musandam region contained the permissible amount of lead (0.09 ppm) and the other sample contained 14.66 ppm of lead. Cobalt and chromium were not detected in the same sample that had abnormal levels of lead (Table 1). Both branded creams that were analyzed contained traces of all heavy metals but within permissible limits. None of the heavy metals tested exceeded 1 ppm in either of the branded face cream tested.

The results showed that most of the unregulated samples contain significant amount of chromium, cooper and lead. In comparison, the branded face creams contained only the permissible amount of the heavy metals tested. The maximum arsenic content was found in a sample collected from Al Batinah South region (1.74 ppm). The maximum cadmium content was found in a sample collected from Al Wusta region (2.02 ppm) (Table 1). The maximum cobalt and chromium content were found in the samples collected from Al Buraimi region (0.10 ppm) and Dhofar region (8.04 ppm) respectively (Table 1). The maximum copper and manganese content were found in the samples collected from Al Batinah South region (11.66 ppm) and Al Batinah North region (1.52 ppm) respectively. Lead content was abnormally high in all but two unregulated face creams (Fig. 1). The maximum lead content was found in a sample collected from Al Buraimi region (29.85 ppm) (Table 1).

Our findings are in line with the findings of Abdulla and Hamidi's research [13]. As a result, a high percentage of these heavy metals accumulate in the body through the skin, eventually settling in the body's key organs, leading to multiple organ failures and a high level of toxicity. Additionally, pregnant women and children are especially vulnerable to the harmful effects of lead since these groups of people are more vulnerable. The quantity of lead in most of the tested samples were very high. The use of hazardous lead in cosmetics, particularly by nursing and pregnant women, poses a risk of lead poisoning not only to the women, but also to the foetus and new-born babies, who are more sensitive to lead poisoning [13].

Al-Trabulsy et al. found that lead exposure is particularly chronic and that there is no typical range of lead exposures [4]. Their research revealed that a significant factor, namely lead, is responsible for the decrease in blood count. A panel of medical specialists has been suggested by CBC. As a result, the findings suggest that lead will decrease neuro characteristics and affect performance levels in both d children and women. Lead has also been linked to infertility and miscarriage. Al-Trabulsy et al. [4]. continued their investigation by searching PubMed for more than a decade and determined that lead was one of the biggest contributors to environmental pollution caused by noxious wastes, which had a negative influence on the reproductive system [4].

According to a study conducted by Amit et al., the concentration of nickel in cosmetic creams also exceeds the legal limit. Even if it has been proven that using nickel-containing cosmetics produces various skin allergies, the intensity of the allergy is entirely dependent on the ratio of nickel applied to the epidermis; as the area of application grows, so does the severity of the allergy. The level of heavy metals in cosmetics causes a ratio of adversities not only to the skin, but also to other key organs such as the bones, kidneys, and intestine. Heavy metals' irregularity and erroneous compositions cause allergies, dermatological irritation, necrotic tissue inflammation, granuloma, and other common side effects. Sensitization is common when cosmetics are exposed to high levels of nickel ions for an extended period of time. As fashion trends shift, women of all ages, from children to adults, are drawn to cosmetics without appropriate knowledge of the risks they provide. As a result, women are more susceptible to these disorders than males. In comparison to men, approximately 20% of women worldwide are victims of heavy metal deposits in their bodies, compared to approximately 5% of men. Furthermore, research shows that different people are susceptible

to allergies depending on their level of sensitivity to specific metals [15].

4. Conclusion

The highest arsenic levels were found in samples (1,74 ppm) collected in the Southern Al Batinah region. Maximum cadmium levels were found in samples collected from the Al Wusta area (2.02 ppm). Maximum cobalt and chromium values were found in samples collected in the Al Buraimi region (0.10 ppm) and the Dhofar region (8.04 ppm), respectively. The largest copper and manganese were found in samples collected from the South Al Batinah (11.66 ppm) and North Al Batinah (1.52 ppm) regions, respectively. Lead levels were unusually high in all but two of the analyzed unregulated face creams. The highest lead content was found in a sample from the Al Buraimi region (29.85 ppm). These results indicate that the manufacturers of the analyzed creams did not comply with the protocols and standards proposed by international regulatory agencies. Because producers are not adhering to the norms, regulatory authorities in Oman should be established to take the required actions against these unbranded cosmetics in order to protect the interests of consumers who are unaware of the dangers posed by the penetration of hard metals. Most of the face cream samples are unfit for human use because they contain significant levels of heavy metals that exceed the permissible limit. As a result, unregulated goods should be avoided, and long-term use of these creams will increase heavy metal absorption in the body, leading to chronic health concerns.

CRediT authorship contribution statement

SSA was principal investigators and statistical analysis of this present study and drafted the manuscript. GSST and RMSA were samples processed and data creator. the of the study. All authors contributed to the design and data analysis and assisted in the preparation of the final version of the manuscript. All authors read and approved the final version of the manuscript.

Declaration of Competing Interest

The authors declare the following financial interests/personal relationships which may be considered as potential competing interests: Dr Amzad Hossain reports administrative support and statistical analysis were provided by University of Nizwa. Dr Amzad Hossain reports a relationship with University of Nizwa that includes: employment. Dr Amzad Hossain has patent N/A pending to N/A. N/A.

Data availability

The data that has been used is confidential.

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