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DETERMINATION OF SOME TRACE ELEMENTS IN THE FOUNDATION CREAMS AND THEIR POTENTIAL HEALTH HAZARDS IN THE KINGDOM OF SAUDI ARABIA

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ABSTRACT

The concentrations of 4 heavy metals, Arsenic (As), Mercury (Hg), Lead (Pb) and Cadmium (Cd) elements were determined using Inductively Coupled Plasma-Optical Emission Spectroscopy (ICP-OES) after being digested by Microwave pressure for 25 different types of the most popular and widely sold foundation creams in Riyadh markets. Analysis was conducted for the samples of expensive and cheap brands, that advertise themselves a natural (organic) and those that advertise themselves a medical. Samples of foundation creams from different countries were analyzed but with emphasis on China. Different concentrations of investigated elements were studied with a different degree of color intensity and tone from the very dark to the very light color. The results showed that the foundation cream is void of Arsenic (As) and Mercury (Hg) elements in all samples of investigated elements, excluding the Chinese product of the foundation cream where Arsenic (As) represented 60% of all samples of the Chinese foundation creams and was not found in the remaining samples and has not exceeded the allowable limit as its concentration ranged from 0.04–0.66 ppm, while Arsenic (As) in all samples of the Chinese foundation cream has not exceeded the permissible limit and its concentration in these samples ranged from 0.01–0.04 ppm.

The study has also showed the presence of Lead (Pb) in all investigated samples groups except two samples where Lead (Pb) was not found, which were represented by one of the medical groups sample, and the group sample that includes investigating the effect of the foundation cream color intensity and gradation which is represented in the very light color, as it was shown that both samples are void of the 4 investigated samples, while in the remaining samples the Lead (Pb) has not exceeded the allowable limit except in only one sample which is represented in the Chinese product category as its concentration in the sample reached 132.0 ppm. In this study, it became obvious that China is the main manufacturer of investigated foundation cream, and it was found that one of the samples contained high and serious lead levels, while the presence of Cadmium in 80% of the investigated samples has not exceeded the permissible limit and its concentration ranged 0.01–0.09 ppm. Elements content in the samples were compared with the available data on the global limits proposed to these elements and their potential health hazards on the consumer public.

Keywords: ***Foundation cream, Arsenic, Mercury, Lead and Cadmium.***

1. INTRODUCTION

Thousands of years ago, the people of primary societies used various materials in order to beautify their faces. The use of cosmetics to enhance complexion reaches back into antiquity. "Face painting" is mentioned in the Old Testament. Ancient Egyptians used foundation in 200 B.C., and ancient Greek women applied white lead powder and chalk to lighten their skin. It was considered fashionable for Greek women to have a pale complexion. Roman women also favoured a pale complexion. Wealthy Romans favoured white lead paste, which could lead to disfigurements and death. Men also used makeup to lighten their skin tone [1]. They used white lead powder, chalk, and creams to lighten their skin tone. The cream was made from animal fat,

starch, and tin oxide. Throughout the Middle Ages in Europe, it was considered fashionable for women to have pale skin, due to the association of tanned skin with outdoors work, and therefore the association of pale skin with affluence. In the 6th century, women would often bleed themselves to achieve a pale complexion.

During the Italian Renaissance, many women applied water–soluble Lead paint to their faces. Throughout the 17th century and the Elizabethan era, women used, a lethal mixture of vinegar and white Lead. They also applied egg whites to their faces to create a shiny complexion [2]. any men and women died from using lead-based make-up. In the 18th century, Louis XV made it fashionable for men to use lead-based makeup especially the Theatrical actors. In the late 18th and early 19th centuries, Victorian women used little or no makeup, and deemed that it was not appropriate for mannerly and polite women to use it. It was only acceptable for actors or actresses to use make-up. In the late 19th century, women would apply a whitening mixture made out of zinc oxide, mercury, lead, silver nitrate and acids. Some women stayed out of the sun, ate chalk, and drank iodine to achieve whiteness. In the Edwardian era, women wore base and did not bleach their skin as much as they did in previous centuries [3].

Modern foundation can trace its roots to Carl Baudin of the *Leipziger Stadt* theatre in Germany. He is the inventor of greasepaint. He wanted to conceal the joint between his wig and forehead, so he developed a flesh-coloured paste made of zinc, ochre and lard. This formulation was so popular with other actors that Baudin began producing it commercially, and, as such, gave birth to the first theatrical makeup. The first foundation cream with its popular form appeared in 1914 by the famous developer Max Factor who had created groups of colors close to the skin colors, which are different from the previous ones that afford the face full whiteness. Max Factor created foundations that offered enough coverage to the skin defects and close to the original color. Specialized forms of cosmetics were also used to change physical appearances [4]. Arsenic, Cadmium, Lead and Mercury are described as heavy metals which in their standard state have a specific gravity (density) of more than about 5 g/cm^3 (Arsenic, 5.7; Cadmium, 8.65; Lead, 11.34; and Mercury, 13.549) while metals like copper, nickel, chromium and iron are essential in very low concentration for the survival of all forms of life, but, when present in higher concentration can cause metabolic anomalies [5].

Many studies have reported that cosmetic products contain relatively high concentrations of heavy metals [6]. These heavy metal have been indicted in varying concentrations in various cosmetics, also bearing in mind that some of these metals have been banned as intentional ingredients coupled with their known or probable negative effect [7]. All heavy metals are prohibited for use in cosmetics although the presence of traces is allowed if their presence is technically unavoidable in good manufacturing practice, as per the Cosmetics Product Group Standard. Most chemicals are added to cosmetic product in the form of preservatives and fragrances. Some of the preservatives and fragrance are toxic and prohibited from the usage as ingredients because it can cause cancer, mutation, reproductive toxicity, and endocrine disruption [8].

Heavy Metals Impurities can appear as impurities in finishing products. It is a byproduct during the cosmetics manufacturing process either formed by the breakdown of ingredients, or an environmental contaminant of raw ingredients [9]. It is acknowledged that heavy metal impurities in cosmetic products are unavoidable due to the ubiquitous nature of these elements, but should be removed wherever technically feasible [10]. In some countries, for example Canada, heavy metals such as arsenic, cadmium, lead, mercury, beryllium, selenium, and thallium has been banned as intentional ingredients in cosmetics [11]. Despite of being banned, it can still be found in cosmetic products as trace amounts of this element are unavoidable under conditions of good manufacturing practice. Heavy metals are also incorporated to beauty product for many purposes. The toxicity of heavy metals is well documented. At low concentration, some of these elements can cause damage to the internal body organ of animals and humans. Metal poisoning was reported to cause various mammalian cancers, respiratory diseases, failures in organ function and intellectual retardation [12].

With respect to the economic benefit, it is a challenge to a manufacturer to provide a good quality product with low cost and at the same

time environmental friendly. Despite the positive news related with cosmetics and beauty industry, one cannot run from is the fact that the safety of the cosmetic used is always at top priority. Safety of the cosmetics has become the major concern [13]. Research in metal concentration of cosmetics is raising awareness on direct ingestion and skin absorption of metals, since they are daily used and are applied to the thinnest areas of facial skin, such as the pre-ocular areas, face and lips, where absorption is very high. Mercury is used in cosmetic products such as skin whitening creams. Mercury is a neurotoxin. Mercury compounds are readily absorbed through the skin on topical application and have the tendency to accumulate in the body. They may cause allergic reactions, skin irritation or neurotoxic manifestations. There is evidence suggesting children who had been exposed in-utero from their mothers experienced developmental issues.

Heavy metals like Lead and Cadmium are common contaminants in various cosmetics products [14,15]. Iran then Saudi Arabia has the highest consumption of cosmetics in the Middle East. Cadmium is one of the major heavy metals found in some natural colors and inorganic pigments of cosmetic products [6]. Exposure to heavy metals and metalloids at relatively low levels can cause adverse effects, for example Cadmium causes kidney damage and bone degradation. Lead causes mental retardation in children and learning disability. Cadmium (Cd) and Lead (Pb) often accumulate in the human tissues when they are not metabolized by the body for absorption and utilization. Research has shown that lead can cause intrauterine fatal death, premature delivery and low birth weight [15]. Presence of cadmium in the samples can also have harmful effects on the human body [16]. Small amounts of cadmium may result in heart disease, hypertension, kidney and liver damage, and weakened immune system [17]. Health Canada has recommended that the maximum cadmium concentration is 3 μg/g in cosmetics. Therefore, a trace amount of cadmium is not safe [18].

Campaign for Safe Cosmetics (2009) stated that heavy metals are not listed as ingredients in some cosmetics due to lack of manufacturer testing or regulatory oversight. Heavy metals commonly presence in cosmetic and personal care products as impurities. That explain on the very lower concentration detected in it. As product impurities, their presence in cosmetics is not required to be on the label [19]. Use of cosmetic products is increasing rapidly in KSA, and various chemicals including the heavy metals are used in the cosmetics which pose health risk to consumers, as it has becomes a concern in recent years with increasing studies conducted to detect these elements in cosmetics [20].

The present study was conducted to determine 4 heavy metals (Arsenic, Lead, Cadmium, Mercury) in different types of foundations available in the Saudi markets. The results were compared with the available standards due to the lack of a standard or reference material to compare the samples under investigation. This research aims to test and verify the level of commitment to match the samples of different qualities and type that have been purchased from the shops of commonly used international brands and from low cost retailers with the general specifications of cosmetics

2. MATERIALS AND METHODS

2.1 Samples Description

In this study 25 samples, 22 brands of foundation products, collected from different cosmetics stores in Riyadh markets, KSA. The samples were of different qualities and type and popular brands with different price ranged from cheap to expensive and from different manufacturing origin. They were arranged into groups according to the nature of the study, and five different countries were selected (USA, France, Italy, Japan, China) but one product may contain many samples, which were analyzed separately. They were imported from developing countries where quality control measures do not apply. These groups of samples include the color tone for studying the intensity of color and its effect on the foundations, as 4 colours of specific foundation brands were investigated, ranged from the medium dark and darker colors to the light and lighter colors. The samples were rated into categories of brands samples, the group which calls itself an organic and the other which advertise itself a medical.

2.2 Samples Digestions

The sample is destroyed /digested by high pressure microwave digestion using nitric acid, hydrogen peroxide and accurately weighed, to the nearest mg, 20–30 g of sample into a high pressure resistant 50 mL quarts or PTFE vessel. 6.0 mL of concentrated nitric acid (HNO_3) and 2 mL of a 30% of hydrogen peroxide solution was added. Carefully sealed the digestion vessel lid and allowed it to stand at room temperature for at least 15 minutes to ensure that the initial reaction is complete. Sealed digestion vessel was placed into microwave digestion system and digested using the specified program. After cooling to the room temperature, 20 mL±1 of double distilled water was added to the digested sample solution and filtered through Whatman No. 1 Filter Paper into 50 mL volumetric flask using further small quantities of double distilled water. From the parent solution, 6 standard solutions for each measured metal were prepared, and all necessary precautions were taken to avoid any possible contamination to the sample.

2.3 Sample Analysis

The digested samples were analyzed to determine Arsenic, Cadmium, Lead, and Mercury using Inductively Coupled Plasma-Optical Emission Spectroscopy (ICP-OES).

3. RESULTS AND DISCUSSION

In this study 25 foundation samples were investigated for the presence of heavy metals, including: Arsenic, Lead, Mercury and Cadmium. Arsenic was detected in only 7 of investigated samples, Mercury in 9 samples, Cadmium in 21 samples and lead in all samples except one of the samples under study due to different specifications of that sample. Comparison was conducted for concentration of Mercury, Lead, Cadmium, and Arsenic in the foundation samples between the most widely sold brands by different companies in Riyadh market, and significant differences were found in the concentration level of lead as its concentration ranged 0.12–1.36 ppm which showed varying concentration levels of lead in the investigated samples.

Significant differences were found in the concentration level of Cadmium in only the samples where it exists while it was not present in all samples, where its concentration ranged 0.01–0.09 ppm, while Arsenic and Mercury were vanished in this group of samples. Different contents of heavy metals, Arsenic, Lead, Cadmium and Mercury elements were investigated in the expensive brands of foundation, as they were considered that they have more safe and less harmful contents of toxic elements compared to the cheap brands, where Lead recorded its highest value of 2.38 ppm and low concentration of 1.07 ppm in the samples of this group, while the Cadmium recorded its highest value of 0.02 ppm and was not found in some samples of this group. Arsenic and Mercury were also absent in the samples of this group.

Studies of Arsenic, Mercury, Lead, Cadmium concentrations in the cheap foundation have been expanded. Stores that sell the cheap Chinese products have recently widely spread in Saudi Arabia. Nine samples of foundations were selected from different Chinese brands. Table (1) and Figure (1) show the concentration of investigated elements in the sample of this grouping, as our fears stem from safety of the cheap cosmetics in many cities of Saudi Arabia including Riyadh.

Most of these products were imported from countries with poor safety, regulatory and manufacturing practice, as well as they have no conditions of manufacturing specifications, so Lead was found in one of the samples of the cheap Chinese foundation grouping, where the Lead was found above the detection limit determined by the (FDA) in concentration of 132.00 ppm while its value in the remaining samples was found above the allowable detection limit of up to 20 ppm and its value ranged between 0.35–1.63 ppm in the remaining samples of this grouping, which indicates the danger of frequent uses of these cosmetics, while the concentration of Cadmium remained within the range of detection limit in all samples of this group. Arsenic was found in some samples while Mercury was found in all samples of this groupings under study. Arsenic and Mercury had not appeared in all investigated samples except in this group of the Chinese product, but the presence of Arsenic was found with low value.

Table (1): Concentration of Arsenic, Mercury, Cadmium & Lead in Chinese brands of foundations samples.

Brands elements	Brand (1)	Brand (2)	Brand (3)	Brand (4)	Brand (5)	Brand (6)	Brand (7)	Brand (8)	Brand (9)
Pb	0.79	0.35	0.98	0.77	1.63	0.91	132.0	0.92	1.40
Cd	0.04	0.04	0.07	0.05	0.10	0.05	0.09	0.07	0.06
As	0.53	0.66	0.33	0.15	-	-	0	0.04	-
Hg	0.03	0.03	0.01	0.01	0.02	0.02	0.04	0.02	0.01

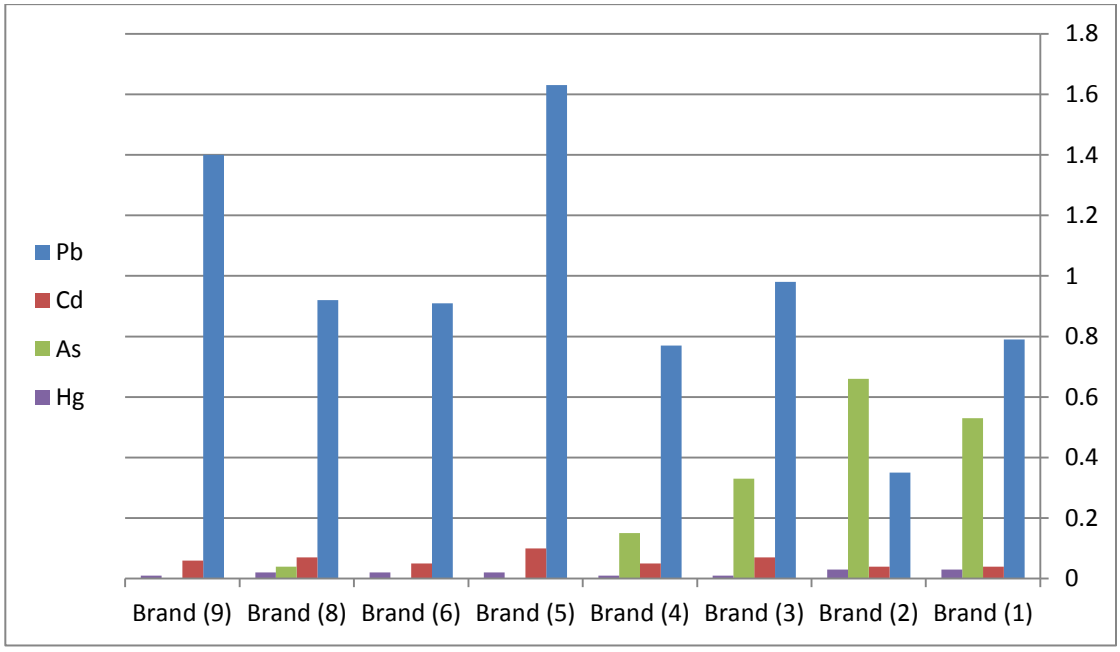

Figure (1): Concentration of Arsenic, Mercury, Cadmium & Lead in Chinese brands of foundations samples.

N.B. Concentration of Arsenic, Mercury, Cadmium & Lead in brand-7 is excluded from the graph because of the high value of Lead.

Comparison was conducted in concentration of investigated heavy metals, between expensive, medium and cheap brands, and Arsenic has only been detected in the cheap brands of foundations samples with a value of 0.66 ppm, while the cadmium was not found in the medium price sample and appeared in the both expensive and cheap samples, and was found with low concentrations of 0.01 ppm and 0.08 ppm in the expensive and cheap sample respectively. Lead was found in the 3 samples grouping with a value range of 0.37–1.02 ppm, while Mercury had not recorded any presence in the samples of this group. Distributions of heavy metals under study were investigated between the companies, that advertise themselves a natural organic, and the other inorganic companies where Lead recorded slight increase of content in the samples of the inorganic companies, as it recorded its high content of 1.02 ppm in samples of this group, while in an organic group it recorded the highest value of 0.86 ppm. Cadmium recorded its highest value of 0.09 ppm and 0.02 ppm in the two groups of organic and inorganic foundations respectively. Arsenic was found in only one sample of the organic foundations, while Mercury vanished in both organic and inorganic groups.

Contents of heavy metals, Mercury, Lead, Cadmium and Arsenic were investigated in the foundations for the brands which advertise themselves a medical and less harmful than other similar brands. It was observed that the four

elements under investigation were absent in the medical groups, while Lead content was found in only one sample with a value of 0.96 ppm which is close to the non-medical foundations with a value of 1.02 ppm while Arsenic and Mercury were absent in both medical and non-medical groups of foundations. Distribution of heavy metals under study were investigated in 5 international trademarks of foundations from different countries, purchased for analysis, and there were the most prevalent in the markets. One brand may contain many samples and they were analyzed separately, and it is known that they were imported from developing countries in which the quality control does not apply. Samples were purchased from stores importing the cosmetics in Riyadh markets, these countries are (USA, France, Italy, Japan, China). The ratios of elements contents in the samples were as shown in Table (2) Figure (2).

Table (2): Concentration of Mercury, Lead, Cadmium & Arsenic in the foundation samples from (USA, Italy, Japan, and China).

Brands Element	USA	France	Italy	Japan	China
Pb	1.02	0.12	0.31	0.10	0.92
Cd	0.01	0.01	0.01	0.06	0.07
As	-	-	-	-	0.04
Hg	-	-	-	-	0.02

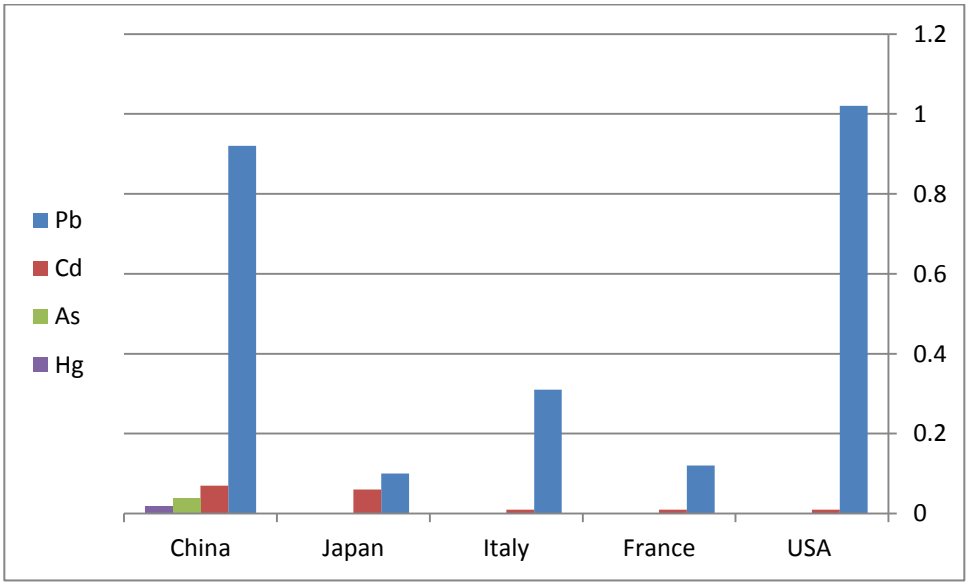

Figure (2) : Concentration of Mercury, Lead, Cadmium & Arsenic in the foundation samples from (USA, Italy, Japan, and China).

Concentration of Lead in USA and Japanese products were found to be very high compared to their concentration in the products of other countries under study. Mercury was found with highest concentration in the Chinese and Japanese products respectively, while cadmium was found with similar contents in all investigated products of other countries. Arsenic and Mercury were not present in all investigated samples of foundation excluding their presence with lower content in the Chinese products.

Differences between the investigated samples were analyzed to know if there were significant differences in concentration of heavy metals: Arsenic, Lead, Cadmium and Mercury elements in different colors of foundations for one trademark represented in the color intensity of the foundation which is graded from the dark - medium dark - light and - more lighter. Arsenic and mercury elements has not recorded any concentration in this color tone of foundations

while Cadmium and Lead were absent in foundations with more light color, while they recorded their highest values in the foundation with a very dark color as shown in the Table (3) Figure (3).

Table (3): Concentration of Lead & Cadmium in the foundation samples of color tones: (very dark, medium dark, light and more light).

Element	Very dark	Medium dark	Light	Lighter
Pb	0.89	0.72	1.10	0.00
Cd	0.09	0.06	0.06	0.00

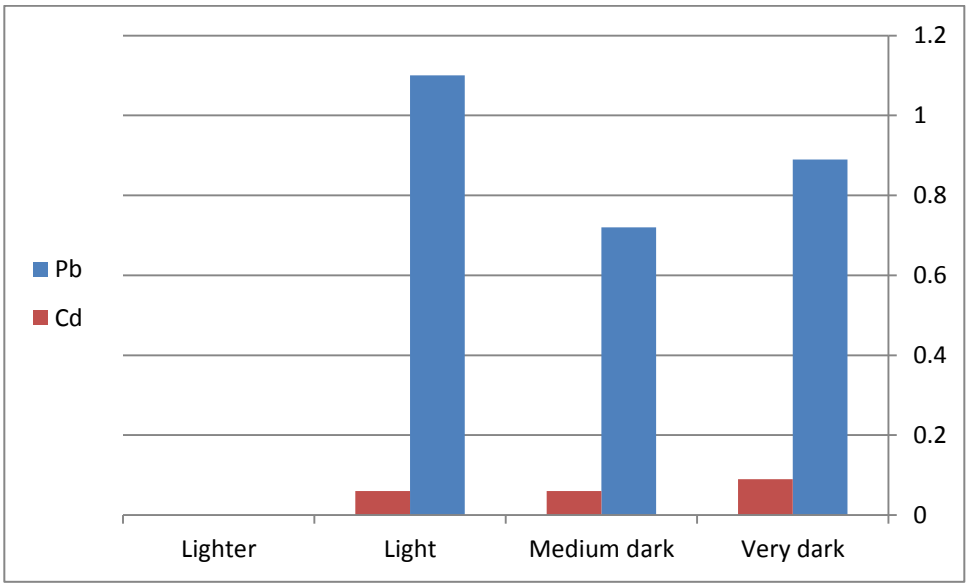

Figure (3) : Concentration of Mercury, Lead, Cadmium and Arsenic in the foundations samples of color tones: (very dark, medium dark, light and more light).

4. CONCLUSION

Cosmetics allow us to change many aspect of our physical appearance by enhancing our beauty. Nevertheless, we need to be careful not to cause any damage to our skin by using cosmetics. Foundations examined in this work were observed to be safe in respect of the heavy metals investigated in this study, excluding one sample in which the lead content was found to be with a ratio exceeding the acceptable limit determined by FDA. Daily and continuous use of these cosmetics could result in an increase in the heavy metals level in the human body beyond acceptable limits. There is an urgency to halt importing unsafe cosmetics as Lead in foundation might not cause an immediate health problem but its accumulative effects due to repeated application cannot be eliminated. Consumers should also play their role by keeping themselves updated with knowledge and aware of the ingredients presence in the products they used.

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