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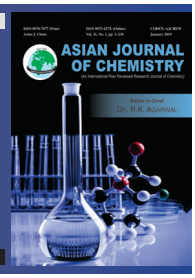

Analysis of Heavy Metals Contents in Lipsticks and Cosmetics Available in Saudi Arabia by ICP-OES

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The current paper describes the analysis of heavy metals contents in lipsticks and cosmetics being sold in Riyadh markets and compares heavy metals contents present in cosmetics of some other countries. An analytical technique called inductively-coupled plasma optical emission spectroscopy (ICP-OES) determines content for metals like As, Hg, Pb, Cd and Al in some of the most famous and widely sold lipsticks in Riyadh markets. An analysis is conducted across some expensive and some cheap brands that claim to be "organic" and "medicinal", with emphasis on the Chinese brand of lipsticks. Various parameters such as colour intensity, matte texture and glossiness, viscosity and makeup persistence were compared. Results showed serious levels of contamination from lipsticks originating from China with specimens containing above safe detectable levels. It is found that heavy metals beyond permissible limit are used in lipsticks and other cosmetic products containing fragrances and also as preservatives.

Keywords: Lipsticks, Color cosmetics, Formulations, Matte texture, Glossiness.

INTRODUCTION

The hazardness of any pollutant to the health of people is related to the amount present in the body. Some cosmetics are cause skin cancer, allergies and/or respiratory problems. For instance, an increase in cadmium level is noticed to cause restraint in DNA mismatches. Dermal exposure is one of the most compelling since the majority of the products are applied to the skin directly. The usage of underarm cosmetics is found to be a major reason of breast cancer [1].

Similarly, herbal cosmetics that were produced in India had contents of mercury and lead in some of the specimens exceeding the limit of WHO for preparing herbal cosmetics. Talcum powder contents of metals like lead and chromium and also found that it contains asbestiform and to some extents nickel and cobalt too. In Nigeria, a large amount of traces of metals were found in facial makeup produced locally [2]. The existence of chemicals in cosmetics is linked to willful use as antioxidants, pigments, fragrances, UV absorbers, *etc*. Compounds of some metals are also used in the industry, for example, UV filters and pigments in coloured cosmetics. The metals present in these products are dangerous if used in excess [3].

Originally, lipsticks are meant to be applied on lips which make them look more beautiful but the amount taken for that is due to the content of heavy metals present in it. The reason being, lipstick is one of the basic products used in the makeup kits in addition to other things like eye shadows, foundations, and different types of powder, *etc*. Actually, the content of metals present in them is small, but since they are used so much, they are significant in producing risk [4]. In the body, lead rivals with calcium. Organ systems are affected through it like the system of nerves, reproduction and hematology. Several studies have shown the content of lead present in lipsticks, but very few have been done to tell about the hazards that it causes and the health issues that come with it in a package. Depending on the quality of nutrition, some children absorb less lead and some more while adults absorb very less than children [5].

Lipsticks constitute a lot of things, such as oils, raw materials *viz*. TiO_2, silica, mica and when pigments are added, which may be organic or mineral may contain metals, as impurities in the formulation of pigments, characteristics and appearances in the final products. These products are applied to the skin directly, which may cause hypersensitivity and irritant reactions. The products used by children should be monitored

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especially because they are more fragile and thinner as compared to the skin of adults [6].

Cosmetics may contain several raw materials and pigments because of the presence of these metals. Several thousands of ingredients in these cosmetics are linked to a lot of diseases *e.g*. cancer, birth defects and reproductive harms. Cadmium is used in cosmetic products because of its characteristics of colour pigments [7]. Due to these metals, there is a probability of cancer for a lifetime when their content goes beyond the acceptable levels of risk. The non-cancer risk assessment tells if the margin of safety is lesser or not depending upon the quantity of these metals present. Some users use these products more than acceptable daily limits which is dangerous. For heavy lip cosmetics users, the quantity of these metals should be kept minimal [8].

At high contents, some of the metals may also cause cancers, respiratory diseases, organ failure, and learning problems. A large amount of cadmium causes dysfunction in the kidney as well. Other metals may cause diarrhea, depression, pneumonia *etc*. Sometimes weakness in muscles, insomnia and hallucinations are also observed [9]. The continuous use of these products may absorb these metals right into human skin. Metals have environmental and health significance because they become a cause of a lot of problems like neurological disorders, kidney and lung problems [10]. Mostly, some chemicals are added as means of preservation and for added fragrances but some of the chemicals are toxic in nature because they are a source of causing cancer, mutation and kidney problems [11-13]. This paper reports the analysis of heavy metals by using inductively-coupled plasma optical emission spectroscopy (ICP-OES) present in cosmetic products manufactured by several companies based on American, Chinese, Italian, French and Japanese markets.

EXPERIMENTAL

Specimens: Thirty-two specimens were collected comprising 23 brands of the makeup merchandise *e.g*. lipsticks, foundations and lip balms available different stores in the markets of National capital [14]. The specimens consist of various qualities and fashionable brands with different costs betting on different producing origins. They were organized into completely different teams and five different countries namely America, France, Italy, Japan and China. Some specimens were foreign from developing countries where standards of quality are not applied as control specimens. These embody the colour cluster to uncover any significant metal correlations with colours starting from shady colours, brown, red, dark pink, beige and light weight orange, light pink and purple. Specimens were rated into brands labeled organic and also the others publicized as medicative [15].

The soft lipsticks were compared with the solid lipsticks and additionally, the solid dry lipsticks were compared with the lip glosses (water-colour) and salve (white colour) and with the long-lasting lipsticks.

Specimen preparations: Specimens were processed by controlled microwave digestion. A specimen (0.2-0.3 g) was mixed with 6 mL of targeted acid (HNO_3) and a few mL of 30 % H_2O_2 and sealed in a Teflon-line autoclave. It was completely allowed to face at temperature for a minimum of 15 min to create certain that the beginning reaction is complete. The sealed vessel was heated at fixed intervals in the microwave. Once cooling to room temperature, 20 ± 1 mL of double refined water was added to the digestible specimen and the solution was filtered through Whatman No. 1 paper into 50 mL volume flask using very minimum quantity of water. Six traditional solutions for each measured metal were prepared and necessary precautions were taken to avoid any possible contamination to the specimen [16].

Specimen analysis: Digestible specimens were analyzed arsenic, cadmium, lead and mercury using ICP-OES. The statistical analysis (SPSS) is manipulated to work out the descriptive and inferential statistics like t-test and Mann-Whitney test to seek out whether or not they cause vital alterations within the content of components in lipstick specimens [17].

RESULTS AND DISCUSSION

In this work, 32 specimens constituting lipstick brands were examined for arsenic, lead, mercury, cadmium and aluminium. Arsenic was detected in only two of examined specimens and its content in one of the two specimens was beyond the allowed maximum restriction of 2 ppm. The heavy metals left under attention were found in different quantities. Lead and mercury were already in interest in the earlier researches of lipstick brands, as kead was above FDA set limits of 20 ppm in three specimens while its existence in the specimens left was 0.70-12.43 ppm in agreement with previous findings [3].

Mercury was detected above the maximum limit of 1 ppm in only one specimen. However, in four specimens it was below detection limits, while the remaining specimen had contents approximately 1.0 ppb. Cadmium was found in all specimen with a huge range of contents between 0.06-8.81 ppm and aluminium was found in high content due to its use as a common colourant in the lipsticks, with ranges between 8.76-2.3 × 10^4 ppm.

Statistical analysis of the lipsticks specimen shows compelling differences ($P < 0.05$) in the content level of lead, cadmium and aluminium in the specimen. There are no statistically compelling differences in the content level of mercury with the concurrence of its content level among the specimens. Arsenic was found in 2 specimens, so it was not inducted in the statistical analysis [4]. The levels of lead, mercury, cadmium and alumium in the lipsticks among the most widely sold brands by different companies in Riyadh markets were compared and showed compelling differences in Fig. 1. Mercury showed the highest content at 0.07 ppm, while absent in many specimens. lead was found in all lipsticks ranging from 0.70-2.8 ppm and ppm. Cadmium showed a 100-fold range 0.06-6.06 ppm in these specimens and aluminium recorded its high value of 23410 ppm and lowest content of 85 ppm and is often measured at high content in lipsticks and cosmetics in general.

The cosmetics deemed as "organic" analysis showed statistically significant differences ($P < 0.05$) in the lead content among specimens of this group. Mercury in these organic lipsticks showed an average 66 % reduction with detected levels near 1.0 ppb, while cadmium and aluminum have consistent levels whereas, arsenic was not detected in these organic specimens.

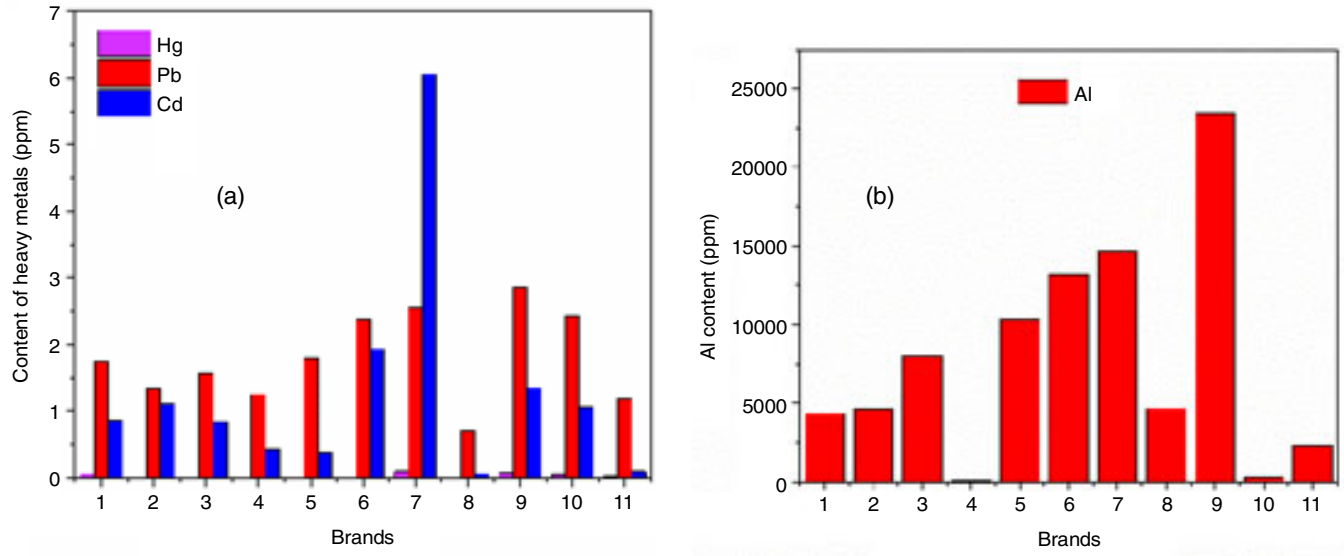

Fig. 1. (a) Comparison of the content of Hg, Pb and Cd, in top brands in markets of Riyadh. Note the wide fluctuations in Cd levels and relative consistent Pb levels; (b) Comparison of the content of Al, in the companies selling top brands in markets of Riyadh

Comparing organic lipsticks to non-labeled lipsticks displayed the biggest difference in the measured merucry levels with organic products of 1 ppb *versus* 55 ppb in non-organic products. The other heavy metals showed no significant statistical difference in content between these groups determined using the Mann-Whitney test [5].

Medicated lipsticks showed undetected levels of mercury in some specimens but reached 0.013 ppm and found no compelling contrasts in the content of mercury in this group of specimen. Compelling differences were found for lead levels that ranged from a high value of 2.56 ppm down to 0.07 ppm. Alteration in the content of cadmium was noted in these specimens as it recorded a range from 0.06-6.06 ppm. Aluminum levels had a range of 2103-14658 ppm and no arsenic was detected in the medicated lipstick products. In a similar comparison, medicated lipsticks had statistically significant differences for mercury *versus* non-medicated products, however, cadmium and aluminum levels were higher in the medicated lipsticks and no differences were found for lead [6].

The expensive brands group should elicit a general sense of improved safety, however lead content was between 1.07-2.38 ppm and cadmium and aluminum were found with varying contents in all examined specimens. No compelling differences were found in the content of cadmium and aluminum in the examined specimen. These specific results showed that expensive cosmetics are not necessarily safer in terms of heavy metal content.

Next, we tend to measure brands that were of medium worth, finding important variations in the content of lead and cadmium because it ranged within the specimens from 1.33 to 2.86 ppm and 1.06 to 2.10 ppm, respectively, whereas no important variations were found in content levels of aluminum and mercury and no arsenic was detected during this group. There includes a pervasive inflow of Chinese merchandise into stores of Kingdom of Saudi Arabia, with these lipsticks priced nearly five hundredth cheaper. Eight specimens of lipsticks were taken from some different Chinese brands. Table-1 shows the content of the elements within the specimen of this group.

Most of those merchandises were from foreign countries with poor safety standards and restrictive standards. Arsenic was found in two specimens of low-cost Chinese lipsticks with levels on top of FDA suggested levels at 3.44 ppm. Metallic element levels were terribly high in three specimens of this group and well on top of the safe sure of upto 20 ppm, confirming the danger of frequent use of those cheaper foreign cosmetics, whereas the content of mercury and cadmium remained among the variety of acceptable limits all the mentioned specimens of this group (T) [10].

Comparison across the expensive, medium and cheap brands, it is found that in general expensive lipsticks contain lower/safer levels of the heavy metals studied. Lead levels were quite high in the cheap brands and precipitously decreased for the medium price and expensive brands. Cadmium was highest in cheap brands and lowest in inexpensive brands, while alumnium however, recorded highest levels in medium price lipsticks.

Now, the next focussed to correlate the heavy metals from international brands from five developed countries. The content of elements in ratios of the specimens are presented in Fig. 2. In Chinese products, contents of lead and cadmium were very high compared to other products. Mercury and aluminum had

TABLE-1
CONTENT (ppm) OF As, Hg, Cd AND Al LIPSTICK SPECIMENS

S. No.	1	2	3	4	5	6	7	8
As	0	3.46*	0	0	0	0.08	0	0
Hg	0.07	0.17	0.03	0.03	0.03	0.06	0.22	0.046
Pb	6.93	9234.6*	129.0	4.47	158.2*	4.64	3.85	12.48
Cd	0.22	1.75	0.68	0.89	0.25	8.86	0.47	2.98
Al	2387	1269	6215	19597	798	1044	19594	5425

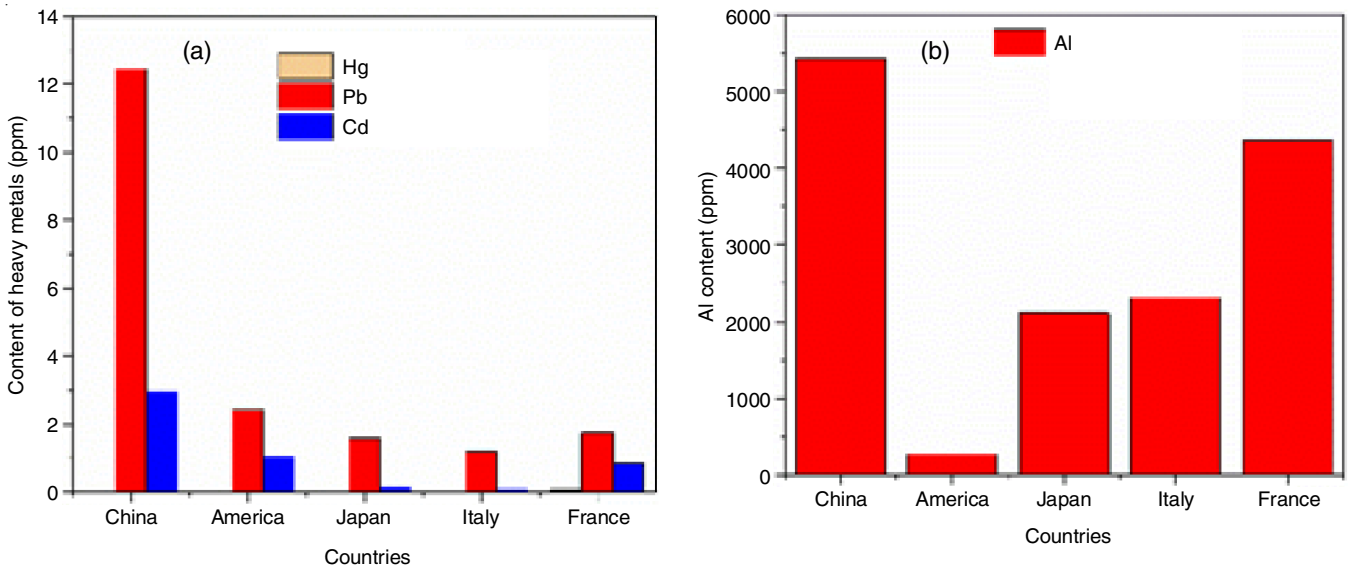

Fig. 2. (a) Content (ppm) of Hg, Pb and Cd in the lipsticks specimens from American, French, Italian, Japanese, Chinese manufacturers; (b) Content (ppm) of Al in the lipsticks specimens from American, French, Italian, Japanese, Chinese manufacturers

common contents from all countries except for a lower content of aluminum in the USA products [12].

The analysis research on matt waterless lipsticks and shiny lipstick of similar colour levels, it was found higher content of heavy metals in dry lipsticks over shiny lipsticks. The enhanced content of mercury, lead and cadmium indicates that the shiny lipsticks are safer than the matte dry lipsticks. Of note, there have been elevated aluminum levels within the dry lipsticks (9484 ppm *versus* 5491 ppm). The distributions within the lipsticks (solid and liquid) of the same colour were investigated and alterations found within the content level of four parts, and with higher quantitative relation as shown in Table-2, wherever the contents of mercury, lead, cadmium and aluminum within the lipstick (solid) that surpassed their contents within the lipsticks (liquids) because the content of heavy metals [14].

TABLE-2
CONCENTRATION (ppm) OF Hg, Pb, Cd and Al IN LIQUID AND SOLID LIPSTICKS

Elements	Lipsticks (solid)	Lipsticks (liquid)
Mercury	0.018	0.008
Lead	1.86	1.29
Cadmium	5.26	0.54
Aluminum	7500	2208

When examined the alteration in the content of significant metals and aluminum, huge variations were found in contents of those parts between the two teams, wherever the content of those parts within the liquid lip glosses was found to be not up to the content within the common lipsticks. The content of mercury was 0.055 ppm within the lipstick whereas its contents of mercury in the lip glosses was 0.037 ppm and the content of metal within the lip gloss was 1.75 ppm which has become 1 ppm. The content of cadmium dropped to 0.15 ppm from 0.86 ppm, 4358 ppm was the content of aluminum within the lipstick which has dropped to 15 ppm in the lip glosses, which shows output of colours within the presence of aluminum in high contents because it is employed in these lipsticks specimens as a colour stabilizer [18].

The contents of four elements (Hg, Pb, Cd, Al) in lip balm and lipsticks, an exceptional variations were found in contents of parts among the two groups, because Hg, Pb, Al and Cd contents in the pearl balm was below than found to be in the lipsticks. Heavy metal contents, Hg, Pb and Cd has not exceeded 1 ppm within the balm compared to their content within the common lipsticks. Aluminum content recorded 16 ppm within the balm whereas its content within the lipsticks was found to be 4358 ppm, which showed that lip glosses and balm have a low content of hazardous metals means under permissible than the common lipsticks [19].

The long-lasting lipsticks were compared with the common lipsticks, where long lasting lipsticks are able to stay for a bigger time as compared to common lipsticks. The analyses show a decrease of Hg, Pb, Al and Cd which occurred in the long-lasting lipsticks as compared to common lipsticks [20].

Conclusion

The use of cosmetics can enhance our beauty and change many aspects of the physical appearance. However, we should be aware of consequences of damage skin, internal organs, and physiological function that can be caused by certain cosmetics. In this work, a number of toxic heavy metals were found to be at contents exceeding acceptable limits determined by governing bodies of various countries. The regular use of these items increases the level of heavy metals in the human body above the restrictions. The cosmetics that are costly do not guarantee that they are safe in terms of metals content. Regardless of the cost of product, efforts should be made to aware people about the harmful effects of cosmetics. The import of unsafe cosmetics should be banned as these products might not cause an acute problems of health but their cumulative reactions due to regular usage may manifest far down the road.

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CONFLICT OF INTEREST

The authors declare that there is no conflict of interests regarding the publication of this article.

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