

Heavy Metal Levels in Commonly used Cosmetic Products in Asia

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ABSTRACT

Background: The heavy metals such as lead, arsenic, mercury, aluminum, zinc, chromium, and iron are found in a wide variety of personal care products including lipstick, whitening toothpaste, eyeliner, and nail color. **Aims and Objectives:** The main aim of our study was to find out the heavy metals in routinely used cosmetics such as surma, kajal, lipsticks, rose powder, sindoor, and turmeric powder. **Materials and Methods:** Samples of commonly used personal care products, i.e., cosmetics such as surma, kajal, lipsticks, rose powder, sindoor, and turmeric powder of different companies were purchased from local markets of Pune and Mumbai. Heavy metals such as lead, arsenic, cadmium, mercury, and strontium were estimated by X-ray fluorescence spectrometry from cosmetics of different companies. **Results:** The lead level was very high in surma and other cosmetics, i.e., kajal, lipsticks, sindoor powder, cheek rose powder, and turmeric powder are also contained the detectable amount of lead. Arsenic, cadmium, and mercury levels were also very high in surma samples. Strontium levels were above the level of detection in almost all the samples of cosmetics. **Conclusions:** All the cosmetics contained lead and strontium heavy metals. The absorption of these heavy metals might be more and affects all organs and systems. It is very essential to see the status of heavy metals in the blood, creating awareness and preventing the use of such cosmetics.

Key words: Cosmetics, cadmium, heavy metals, lead, sindoor, surma

INTRODUCTION

Cosmetics are substances or products used to enhance or alter the appearance or fragrance of the body and mainly mixtures of chemical compounds, some being derived from natural sources and some being synthetic.

Common cosmetics include lipstick, mascara, eye shadow, foundation, rouge, skin cleansers and skin lotions, shampoo, hairstyling products, perfumes, sindoor, kajal, and bindi. These cosmetics are needed for the care and beautification of the skin, hair, nails, teeth, and body.^[1]

In earlier studies have been shown that the cosmetic products contain relatively high concentrations of heavy metals, mainly lead, arsenic, cadmium, mercury, chromium, and strontium. Trace quantities of these heavy metals are present in raw materials used for the production of cosmetic and personal care products.^[2-7]

The heavy metal impurities in cosmetics are unavoidable due to ubiquitous nature of these elements; however, these heavy metals should be technically

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removed. Heavy metal concentration products are seen to be technically avoidable when they exceed the limits: Lead – 10 parts per million (ppm), arsenic – 3 ppm, cadmium – 8 ppm, mercury – 3 ppm, etc.^[8]

In various cosmetics, the strontium is added in the form of strontium chloride, strontium acetate, or a hydrate to enhance the cosmetic appearance when topically applied to the human body. The concentration of strontium in cosmetic should be up to 2.5% by weight.^[1]

Regular use of various cosmetics increased the heavy metals concentration in the body and affected all organs and systems.

Applying lead-containing cosmetics several times a day can increase the significant exposure and results in adverse effects on the central nervous system, kidneys, and the hematopoietic system reported in several studies.^[10-12] The use of leaded eye cosmetics has been observed to be strongly correlated with elevated blood lead levels.^[13] Al-Saleh *et al.* showed that the lead can be absorbed by children's and women's skin through using cosmetic products.^[14,15]

More than 90% of lead absorbed by human is concentrated in the bones with a half-life of >20 years. Lead poisoning has been a recognized health hazard for more than 2000 years. Characteristic features of lead toxicity including anemia, colic, neuropathy, nephropathy, sterility, and coma. Exposure to low levels of lead has also been associated with behavioral abnormalities, learning impairment, decreased hearing, and impaired cognitive functions in humans and in experimental animals.^[16]

Cadmium is one of the major heavy metals found in some natural colors and inorganic pigments of cosmetic products.^[17] Cadmium can concentrate primarily in kidney, bones, and teeth and long-term contact with it causes growth retardation of rat fetus and teratogenic consequences and weight loss.^[18,19] The half-life of cadmium in human is determined to be 10–35 years.^[19]

Cadmium is classified as a human carcinogen.^[20] The presence of cadmium in the products and its absorption by the body can lead to kidney damage, lower bone mineral density, bronchitis, and pulmonary edema, chemical pneumonitis including peripheral neuropathy with symptoms of tingling, numbness, and muscle weakness was reported in several studies.^[20-23]

Arsenic is one of highly toxic metals and it can be absorbed through ingestion and inhalation. Arsenic accumulates in skin, hair, and nails. Chronic exposure to arsenic can result in dermatitis, hyperpigmentation, keratosis, leukemia, kidney cancer and bladder cancer,

damage to nervous system, anorexia, liver enlargement, and death.^[24]

The contact of several chromium-containing products with skin can cause severe redness and swelling of the skin as well as skin ulcers.^[25-27]

The cosmetics such as lipstick and eye shadow have various components including antioxidants, pigments, waxes, oils, and inorganics such as silica, TiO₂, copper powder, aluminum powder, and bronze powder. Heavy metals are found in ingredients that naturally contain heavy metals or are polluted with them during production or by containers.^[17,28]

From the earlier studies, we tempted to see the health risk of cosmetics since the cosmetics, in general, may have high concentration of heavy metals. Therefore, we have quantified the heavy metals from the few cosmetic products.

MATERIALS AND METHODS

Commonly used cosmetic samples, i.e., surma, kajal, lipsticks, rose powder, sindoor, and turmeric powder were purchased from local markets of Pune and Mumbai. Turmeric powder was included in this study due to its use in face pack. We had purchased locally manufactured five samples of each cosmetic category and packed in plastic bags. All these cosmetic samples were labeled with the name of brand and category. Heavy metals such as lead, arsenic, cadmium, mercury, and strontium were estimated by X-ray fluorescence (XRF) spectrometry from these cosmetics. The principle of XRF is based on that individual atoms, when excited by an external energy source, emit X-ray photons of a characteristic energy or wavelength. By counting the number of photons of each energy emitted from a sample, the elements present may be identified and quantitated.^[29] Modern XRF instruments are capable of analyzing solid, liquid, and thin-film samples for both major and trace (ppm level) components.

Samples were introduced into handheld quantitative XRF spectrometry.^[29] On multielemental mode from S to U measures 80 different elements and total element concentration (independent of chemical form). The level of detection (LOD), linearity, accuracy, and precision of XRF are mentioned below:

- LODs: 1–10 ppm at best (depends on source, element, matrix, etc.)
- Linearity: Linear response over three orders of magnitude
- Accuracy: Relative errors ~ 50% with factory calibrated instrument

- Relative errors <10% using authentic standards for calibration
- Precision: Relative standard deviations <5% (must have homogeneous sample).

XRF spectrometry does not destroy the sample and requires less specimen preparation. It has a very fast sample turnaround time. These factors lead to a significant reduction in the analytical cost per sample when compared to other elemental analysis techniques.

RESULTS

The name of cosmetic and various metals have been tabulated in the Table 1 given below.

DISCUSSION

The Food and Drug Administration (FDA) recommended a maximum lead level of 10 ppm in certain cosmetics including lipstick, lip gloss, eye shadow, blush, and body lotion.^[30] However, we found very high lead level (845,230 ppm) in surma brand number 1. Detectable amount of lead was also present in cosmetics powders such as sindoor (mean of five brand samples – 70 ppm), cheek rose (mean of two brand samples – 64.5 ppm), turmeric (mean of two brand samples – 28 ppm), and kajal (mean of two brand samples – 68 ppm). However, the lead levels were less than LOD in almost all lipstick brands. Surma contained very high levels of other heavy metals such as arsenic (43,350 ppm), cadmium (652 ppm), and mercury (2924 ppm). Strontium levels

were above the LOD in almost all the samples of cosmetics except surma [Table 1].

In earlier studies showed that the highest lead level in surma and kajal samples and even in lipsticks. It has been observed that the blood lead level of eye cosmetics consumers in Pakistan, India, and Saudi Arabia in comparison with non-consumers was 3-fold.^[13] Many studies have proven the relation between consuming leaded cosmetics (lipstick and eye shadow) and elevated blood lead levels.^[10,31]

In recent study, it was showed that the concentration of lead and cadmium in the lipsticks was within the range of 0.08–5.2 µg/g and 4.08–60.20 µg/g, respectively. The eye shadow samples had a lead level of 0.85–6.90 µg/g and a cadmium level of 1.54–55.59 µg/g. The content range of the heavy metals in the eye shadows was higher than that of the lipsticks.^[3]

The US FDA has shown that the average concentration of lead in 400 samples of lipsticks was 1.11 µg/g.^[7] In 2007, a study on the lead concentration of 33 brands of lipsticks showed that 61% of tested lipsticks have measurable lead (0.03–0.65 µg/g).^[32,33]

We also observed the less lead levels than LOD in almost all lipstick brands and more lead levels in kajal and this indicates that our results are consistent with earlier results.^[3]

It has also been proved that by increasing one microgram lead per deciliter (µgPb/dL) of blood, the intelligence quotient of children is reduced by 0.25 points.^[34] Lead has also been related to infertility and miscarriage.^[31] The continuous use of cosmetics may have adverse effects on the ocular system.^[13] These

Table 1: Heavy metal levels in various cosmetics

Name of cosmetics	Lead	Arsenic	Cadmium	Mercury	Strontium
Surma brand 1	845,230	43,350	652	2924	<LOD
Kajal brand 1	83	<LOD	<LOD	<LOD	57
Kajal brand 2	53	<LOD	<LOD	<LOD	56
Lipstick brand 1	<LOD	<LOD	<LOD	<LOD	16
Lipstick brand 2	<LOD	<LOD	<LOD	<LOD	10
Lipstick brand 3	<LOD	<LOD	<LOD	<LOD	30
Lipstick brand 4	<LOD	<LOD	<LOD	<LOD	16
Lipstick brand 5	18	<LOD	<LOD	<LOD	30
Sindoor powder brand 1	106	<LOD	<LOD	<LOD	53
Sindoor powder brand 2	83	<LOD	<LOD	<LOD	67
Sindoor powder brand 3	54	<LOD	<LOD	<LOD	47
Sindoor powder brand 4	82	<LOD	<LOD	<LOD	553
Sindoor powder brand 5	25	<LOD	<LOD	<LOD	31
Cheeks rose powder brand 1	45	<LOD	<LOD	<LOD	36
Cheeks rose powder brand 2	84	<LOD	<LOD	<LOD	50
Turmeric powder brand 1	<LOD	<LOD	<LOD	<LOD	37
Turmeric powder brand 2	35	<LOD	<LOD	<LOD	53
Turmeric powder brand 3	21	<LOD	<LOD	<LOD	47

All levels are in PPM (parts per million), LOD: Level of detection

harmful effects can be caused by constant skin contact of cosmetics.^[35]

It has been determined that women unintentionally swallow 4 pounds of lipstick during their life.^[36] Iran among the Middle East countries is the third biggest user of cosmetic products.^[37]

The US FDA has suggested that the concentration of some heavy metals such as lead should be <20 µg/g.^[38]

According to Bureau of Indian standard, the permitted synthetic organic colors and natural organic colors used in the cosmetic should not contain more than 2 ppm of arsenic (arsenic trioxide), 20 ppm of lead, and 100 ppm of heavy metals other than lead calculated as the total of the respective metals.^[39]

Dermal exposure is expected to be the most significant route because most of the cosmetics products are directly applied to the skin. Oral exposure can occur from wearing of cosmetics products containing heavy metal impurities around the mouth and also from hand to mouth contact. The heavy metal ions when come in contact with human body get absorbed and form complexes with carboxylic acid (-COOH), amine (-NH₂), and thiol (-SH) of proteins resulting in malfunctioning or death of the cells and consequently lead to a variety of diseases.^[17]

The use of leaded cosmetics such as lipstick and eye shadow has been found to severely affect human beings, especially pregnant women, young children, and fetus. In pregnant women, lead can easily cross the placenta and produce congenital lead poisoning. Oral exposure can occur from wearing of cosmetics products containing heavy metal impurities around the mouth and also from hand to mouth contact.^[40]

Detectable amount of strontium was present in various cosmetics powders such as sindoor (mean of five brand samples - 150.2 ppm), cheek rose (mean of two brand samples - 43 ppm), turmeric (mean of three brand samples - 45.6 ppm), and kajal (MEAN of two brand samples - 56.5 ppm) [Table 1].

The human body absorbs strontium like calcium since these elements are chemically similar and stable strontium isotopes do not pose a significant health threat. The average human has an intake of about 2 mg of strontium a day.^[41] In adults, strontium consumed tends to attach only to the surface of bones, but in children, strontium can replace calcium in the mineral of the growing bones and thus lead to bone growth problems.^[42]

The biological half-life of strontium in humans has variously been reported as from 14 to 600 days,^[43,44] 1000 days,^[45] 18 years,^[46] 30 years,^[47] and, at an upper

limit, 49 years.^[48] However, by averaging all excretion paths, the overall biological half-life is estimated to be about 18 years.^[49] The elimination rate of strontium is strongly affected by age and sex, due to differences in bone metabolism.^[50]

The drug strontium ranelate aids bone growth, increases bone density, and lessens the incidence of vertebral, peripheral, and hip fractures.^[51,52] However, strontium ranelate also increases the risk of venous thromboembolism, pulmonary embolism, and serious cardiovascular disorders including myocardial infarction. Its use is, therefore, now restricted.^[53] Its beneficial effects are also questionable since the increased bone density is partially caused by the increased density of strontium over the calcium which it replaces. Strontium also bioaccumulates in the body.^[54]

Strontium has been shown to inhibit sensory irritation when applied topically to the skin.^[55,56] Topically applied, strontium has been shown to accelerate the recovery rate of the epidermal permeability barrier (skin barrier).^[57] Therefore, the high levels of strontium in various cosmetics are injurious to human health.

We conclude that all cosmetics contained lead and strontium heavy metals. Surma contained the very high levels of lead, arsenic, cadmium, and mercury and regular use of such cosmetics for longer time might be increased the absorption of these heavy metals and affects all organs and systems. Therefore, it is very essential to see the status of heavy metals in the blood of women's who are using the cosmetics regularly and we should create the awareness and prevent the use of such cosmetics. This is small and primary study and detailed study is necessary to know the contents of heavy metals in all brands of cosmetics and their adverse health effects.

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