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## Original Research

# Evaluation of Cd, Cr, Cu, Ni, and Pb in selected cosmetic products from Jordanian, Sudanese, and Syrian markets

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## ABSTRACT

**Objectives:** There is no sufficient data that evaluate heavy metal content in cosmetic products in Jordan as well as Sudan and Syria. This study aims to assess metal levels which include Cadmium (Cd), Chromium (Cr), Copper (Cu), Nickel (Ni), and Lead (Pb) in cosmetic products. These elements have draft limits because they are identified as potential impurities and are known to be toxic. This study aims to provide information to the population that may be beneficial to public health.

**Study design:** Samples were collected from different brands obtained from markets in Jordan, Sudan, and Syria. Some of the selected cosmetic products were eyeliner, eye pencil, mascara, lipstick, powder, face cream, body cream, sun block, Vaseline, and the traditional eye cosmetic (kohl). The heavy metal content in these samples were determined by atomic absorption spectrometry (AAS). Based on analysis of variance analysis, a significant difference in heavy metal levels was found for samples obtained from Jordanian and Sudanese markets.

**Methods:** The acid digestion method used in this study was based on procedures recommended by Nnorom et al. with some modifications as follows. (i) A weight of 2.0 g of cosmetic sample was dissolved in a mixture of 6 mL of high quality concentrated 69% nitric acid (HNO<sub>3</sub>; Merck, Darmstadt, Germany) and 4 mL of concentrated 37% hydrochloric acid (Scharlau, Spain) in a porcelain crucible and heated on a hotplate to near dryness. (ii) An aliquot of 15 mL HNO<sub>3</sub> (1.00 M) was added to the digested sample and filtered through a Whatman No. 40 filter paper. (iii) The digested sample was transferred quantitatively into a 25 mL volumetric flask and then diluted with deionized water. (iv) Each digested sample was evaporated at 70 °C to about 1 mL and transferred into a polyethylene flask and diluted with 25 mL deionized water. (v) Blank was treated in the same procedure.

**Results:** In Jordan the concentration ranges of heavy metals in the collected samples were: Cd (0.03–0.10 µg/g), Cr (0.0–1.00 µg/g), Cu (0.60–7.40 µg/g), Ni (0.50–3.60 µg/g), and Pb (0.30–15.4 µg/g). Whereas, in Sudanese market the concentration ranges were: Cd (0.01–0.15 µg/g), Cr (0.00–27.9 µg/g), Cu (0.60–10.10 µg/g), Ni (0.00–5.70 µg/g), and Pb (0.02–3.80 µg/g). Also, the concentration ranges of heavy metals in Syrian market were: Cd (0.04–0.056 µg/g), Cr (0.24–0.83 µg/g), Cu (0.61–1.27 µg/g), Ni (0.73–1.41 µg/g), and Pb (4.85–27.70 µg/g). Results revealed that kohl samples have the highest concentration of most of the studied metals, particularly Pb.

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*Conclusions:* Based on the results obtained, it is likely to conclude the following: (i) It is not possible to completely eliminate the presence of heavy metals from cosmetic products after manufacturing. However, the quality of the products can be improved by careful selection of raw materials, taking in consideration heavy metal levels. (ii) Heavy metal concentration in lipstick differs with different manufacturers' colors and shade. Statistically significant associations between Pb level and the cosmetic type were found. (iii) Heavy metals levels including Cd, Cr, Cu, Ni, and Pb may impose risk in daily use and repeated application as well as in ingestion through the mouth even at concentration below the allowed limits. (iv) It is the manufacturers' responsibility to ensure that the finished cosmetic product contains the lowest levels possible of heavy metals. So it does not exceed the limits set by health authorities.

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## Introduction

Cosmetics are substances used as personal care products to enhance or protect the appearance or mask the odor of the human body. The demand for cosmetic products has increased recently, resulting in massive production by the cosmetic industry. Different products are marketed under the name of cosmetics, such as creams, beauty soaps, talcum and facial powder, lotions, shampoos, hair products such as hair colors, baby products, bath oils, personal hygiene products, perfumes, lipsticks, skin care products, makeup products, shaving creams, body lotions, fingernail polish and polish removal.<sup>1–5</sup> In addition, the use of herbal medicinal preparations is common in most developing countries due to poverty and disillusionment with conventional medical care.<sup>6,7</sup>

On the other hand, there has been growing consumer concern that cosmetics may contain harmful levels of toxic substances such as heavy metals. Heavy metals are naturally occurring in the environment and can make their way in trace quantities into raw materials.<sup>8,9</sup>

The focus is on heavy metals with known significant toxicological properties such as Lead (Pb), Arsenic (As), Cadmium (Cd) and Mercury (Hg). Also, the essential elements such as Copper (Cu) and Zinc (Zn) at high levels may cause adverse effects to human health.

Heavy metals that build up in the body over time are known to cause various health problems, such as: neurological and developmental disorders, reproductive disorders, cardiovascular diseases, skeletal, blood, immune system, gastrointestinal disorders and renal problems, headaches, lung, skin and soft tissue disorders, and brittle hair and hair loss as well as cancer. Some are identified as dysfunction hormone disruptors while others are respiratory toxins. Heavy metals have been implicated in cosmetics commonly used by women.<sup>10,11</sup>

Cd found in body and hair creams are absorbed into the body through dermal contact then stored in the kidneys and liver, although it can be found in almost all adult tissues.<sup>9,12</sup> The essential metals such as Cu, Zn, Nickel (Ni), and Iron (Fe) can produce toxic effects when the metals intake is in high concentrations.<sup>13</sup>

Oral exposure can occur with cosmetics used in and around the mouth as well as through hand-to-mouth contact

after exposure to cosmetics containing heavy metal impurities.<sup>14,15</sup>

Dermal exposure is expected to be the most significant route because most of the cosmetic products are directly applied to the skin.

Cosmetics and their ingredients have to be safe under the conditions of normal use and must be thoroughly evaluated prior to marketing. Safety assessment should be performed on finished products taking into consideration the toxicological profile of the ingredients, their chemical structure, and their potential to produce local and systemic effects. In humans the concentration of heavy metals in cosmetic raw materials and finished products has been strictly monitored and controlled by health authorities such as United States Food and Drug Administration (US FDA).<sup>16</sup> Guidelines on safety assessment of cosmetic ingredients have been published by the EU Scientific Committee on Consumer Safety.<sup>17,18</sup> The Notes of Guidance include the toxicological test procedures reported in Commission Regulation (EC) No. 440/2008. They enclose the basic toxicity testing procedures needed to evaluate different human health related toxicological endpoints and are internationally accepted as being the result of long term scientific agreement. The Commission Regulation (EC) No. 440/2008 includes Reduction and Refinement and Replacement methods. Given the fact that Regulation (EC) No. 1223/2009 imposes the use of validated replacement methods not only for finished cosmetic products but also for their ingredients, much attention is given to the use of validated replacement methods in the safety evaluation of cosmetic substances and finished cosmetic products.

Since ancient times, kohl has been used as eye cosmetic especially in the Middle East, Far East, and Northern Africa.<sup>19</sup> Studies showed that kohl contains toxic metals, such as Pb and have revealed that the Pb levels in the blood were significantly higher in individuals who used kohl compared to those who did not.<sup>20,21</sup>

A study in Nigeria reported that facial makeup creams have Chromium (Cr), Fe, and Zn at much higher levels compared to non-essential metals such as Pb, Cd, and Ni. These creams are relatively safe to use. Comparative amounts of Pb were found in eyeliners and eye pencils.<sup>22</sup> Similar studies of traditional eye makeup products in Nigeria have reported very high levels of trace metals in locally produced eye makeup and eye

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