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Current status of mercury level in skin whitening creams

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ABSTRACT

In the past, heavy metals like mercury, lead, arsenic, copper are found in many cosmetic preparations. Mercury blocks the melanin synthesis and is therefore added in skin whitening creams. Complications like membranous nephropathy, tubular necrosis, and CNS damage occur. Newborns whose mothers are exposed to mercury are affected through skin contact and breast milk. The aim was to analyse the current status of mercury (Hg) level in varied brands of skin whitening creams including four same brands of creams used by Agrawal. Inductively coupled plasma mass spectrometry (ICP-MS) was used for detection of Hg level. Various brands of cosmetic creams were purchased from Delhi-NCR region and Agrawal and Mazhar (2015) was used for sample preparation. Samples were run in triplicate and compared with standard curve by ICP-MS. All 11whitening creams were found to contain mercury in the range of 0.14–0.36 ppm as total mercury content. In comparison to Agrawal and Mazhar (2015), mercury level was increased in Emami Fair and Handsome, Pond's White Beauty Daily Anti-Spot Fairness Cream, Garnier Skin Natural White and Fair and Lovely. Light skin colour has become an obsession with people. Consequently, men and women of all ages are exposed to mercury toxicity through skin lightening creams. This study further validates the rising mercury level in skin whitening creams. Further exposure to mercury should be prevented by making awareness among consumers about mercury toxicity. Strict actions should be taken by regulatory bodies against manufacture and import of such cosmetic creams.

1. Introduction

Mercury is a poisonous element found in the earth's crust. Different forms of mercury are metallic, organic and inorganic differing in their toxicological effects on various systems of the body.[1] Mainly lungs, kidneys, skin and CNS are affected.[22] Mercury exposure occurs through the occupation, diet and cosmetic preparations. Human activities like industrial processes, waste incinerators, mining for mercury and other metals are major cause of mercury pollution into the environment.[3] Elemental mercury is bio-transformed to organic mercury i.e. methyl mercury by bacteria which then accumulates in aquatic fauna.[1] Biomagnification is another threat posed by methyl mercury.[4] Exposure to organic mercury is mainly through dietary intake as cooking does not eliminate mercury. Mercury poisoning is also known as pink disease or acrodynia.[4] Agrawal and Mazhar[5] has discovered that skin whitening creams are a cause of mercury toxicity. Therefore, this study was conducted to detect whether there have been any changes in mercury level. A number of people are exposed to varied degrees of mercury due to environmental factors but intentional use of mercury in skin lightening creams is not acceptable. The only logical explanation could be that mercury salts competes with copper in the action of the enzyme tyrosinase blocking the melanin formation.[6] Melanin is responsible for natural skin tone therefore blocking it, results in the depigmentation of skin. However, this is not at all ethical and justifiable. At cellular level, mercury result in changes in macromolecular structure and membrane permeability.[7–9]

Sun exposure and genetics play a pivotal role in determining the amount of melanin synthesised and its distribution pattern in the skin.[10] A major section of the world is obsessed with light skin colour and marketing teams of cosmetic companies take advantage of this mindset. Popular cosmetic agents are used to remove dark spots and lighten the skin tone. Manufacturing companies mislead consumers by not specifying mercury in the label of these creams. Skin lightening creams hold 61% of dermatological market in India.[11] Cosmetics with mercury has posed a threat to the user's family members through pervasive mercury contamination. Through mother's skin contact, it can be transferred to the babies.[12] The rate and degree of dermal absorption of mercury

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depends on the hydration of the skin, skin integrity, concentration of mercury and lipid solubility of the vehicle in the skin lightening creams.[1313] In Mexico, mercurous chloride (HgCl) at concentrations of up to 5.9% by weight (59,000 ppm) is found in facial creams resulting in elevated urinary mercury of up to 1876 μg/g creatinine according to a clinical study done on women.[1414] The main route of elimination are urine and faeces. The half-life of heavy metal, mercury is approximately 1–2 months.[1313] Other cosmetic products like lipsticks, mascara, hair dyes are also intoxicated with heavy metals like lead, cadmium, arsenic, nickel, cobalt and mercury which are widely used by people of all ages.[1515]

The most common symptoms associated with mercury exposure are headache, weakness, dizziness, anxiety, fatigue and irritability. On long-term exposure, back, joint, and limb pain with signs of insomnia and short-term memory impairment are reported.[1414] Mercury being a nephrotoxin causes serious kidney ailments. Membranous nephropathy and tubular necrosis are some of the nephrotic complications.[1616] There is an urgent need for constant quality assessment of cosmetic products in the market in order to ensure the safety of consumers.

2. Methodology

2.1. Materials and methods

2.1.1. Samples

Skin lightening creams of varied brands including four similar brands of creams used by Agrawal and Mazhar[5] were purchased from Delhi-Ghaziabad region for estimating mercury content. For each brand, two samples of same batch were purchased. The brand names were blinded. The other details are presented in Table 1. One of the two samples was subjected to digestion scheme whereas the other was kept under sealed condition for future as evidence, if needed.

2.1.2. Chemicals

Potassium permanganate ($KMnO_4$), conc. sulphuric acid (H_2SO_4), conc. nitric acid (HNO_3), hydrochloric acid (HCl), NaCl–hydroxylamine solution (12%), water used was ultra pure water obtained from Milli-Q-water purification system.

2.1.3. Inductively coupled plasma mass spectrometry (ICP-MS)

Mercury content was determined at the low μg/L concentration range accurately and precisely using the ICP-MS.

2.2. Sample preparation

Samples of mercury were prepared by application note provided by Agrawal and Mazhar (2015) for mercury estimation.[1717] In this study, inductively coupled mass spectrometer (ICP-MS) was used instead of AAS due to its high sensitivity for detection of mercury level.[18] Skin lightening creams commonly use inorganic mercury in the form of ammoniated mercuric chloride and mercuric iodide.

1. Samples were dissolved/dispersed in acidic medium. 0.2 g sample of creams were taken into a digestion tube to which 2 mL each of conc.
2. H_2SO_4 and conc. HNO_3 were added and heated to 80 °C for 1.5 h. Cooled to room temperature. Then, 7 mL of 5% $KMnO_4$, 5 mL of 3% HCl were added to each tube and heated to 95 °C for 2 h. The tubes were loosely capped during heating.
3. Cooled to room temperature, 3 mL of 12% NaCl–hydroxylamine solution were added to reduce the excess permanganate and shaken.
4. Final volume was made up to 25 mL with 3% HCl with thorough mixing and immediately subjected to ICP-MS. The measurement of all the samples was run in triplicate.

2.3. Preparation of standard curve

For standard curve, mercury nitrate [$Hg(NO_3)_2 2{\cdot}H_2O$], assay limit 97%, with molecular weight 342.62 g/mol had been used. The standard solutions were prepared in five concentrations 10 μg/L to 50 μg/L to obtain calibration curve as shown. The measurement of standard solutions was run in triplicate.

Table 2 showing comparison in mercury levels of skin whitening creams analysed in 2016 with previous year 2015. The following are the four brands of skin whitening creams which were again analysed this year for estimation of mercury levels.

According to the above data, there was marked elevation in the mercury level when compared with Agrawal and Mazhar.[5]

3. Results

Mercury was detected in all the samples of the skin lightening creams in the range of 0.14–0.36 ppm as shown in Table 1. In comparison to study done by Agrawal and Mazhar,[5] mercury level was increased in Emami Fair and Handsome, Pond's White Beauty Daily Anti-Spot Fairness Cream, Garnier Skin Natural White and Fair and Lovely. Since skin lightening creams use inorganic mercury in the form of mercuric chloride, the concentration of total mercury was converted to mercuric chloride by considering the molecular weight of Hg as 200.592 and that of $HgCl_2$ as 271.496 assuming all mercury (total Hg) in the skin lightening creams is $HgCl_2$.[1515] Highest mercury concentration of 0.36 ppm was found in Pond's White Beauty and lowest being 0.14 ppm in Lakme 9 to 5 Insta Light as total mercury.

Table 1
The mercury levels in various brands of skin whitening creams.

Code	Product name	Batch no.	Mfg. date (DD/MM/YY)	Mercury content (ppm)	Mercury as $HgCl_2$ (ppm)
A	Emami Fair and Handsome (manufactured by Emami Limited at A)	AJ203	05/15	0.17	0.23
B	Pond's White Beauty Daily Anti-Spot Fairness Cream (manufactured by L.B.C.P)	B212	31/05/15	0.36	0.50
C	Garnier Skin Natural White (manufactured by L'Oreal India Pvt. Ltd.)	B518290	17/3/15	0.35	0.50
D	Fair and Lovely (manufactured by Hindustan Unilever Ltd.)	B52	04/15	0.28	0.40
E	Olay Natural White	B6581	05/15	0.22	0.30
F	Vaseline Healthy White Lotion (manufactured by Hindustan Unilever Ltd.)	B51	21/04/15	0.20	0.27
G	Fair and Lovely BB Cream (manufactured by Hindustan Unilever Ltd.)	B29	05/15	0.27	0.36
H	Fair and Lovely SPF 15 (manufactured by Hindustan Unilever Ltd.)	B03	16/01/15	0.25	0.33
I	Lakme 9 to 5 Insta Light (manufactured by Hindustan Unilever Ltd.)	B010	02/15	0.14	0.20
J	Jovees Saffron and bearberry Fairness Cream	B6043	07/15	0.24	0.32
K	Lotus Herbals White Glow (manufactured by Kanidi Cosmoceuticals)	B58	08/15	0.23	0.30