Evaluation of selected Heavy Metals concentration in Lipsticks

[1]Anandhan M, [2] Narayanan S,[3] Prabaharan T
Department of Mechanical Engineering, Mepco Schlenk Engineering College, Sivakasi, India.

Abstract— The bio accumulation of heavy metals in human being over a long period of time results in degradation of human health. In this investigation, the metal concentrations of Al, Cr, Cu, Fe, Pb & Zn present in different branded lipstick samples were analysed using Inductively Coupled Plasma – Optical Emission Spectroscopy (ICP-OES). Aluminium was detected in the concentration range of 0.09 - 0.82 mg/kg of sample taken. Iron was found to be in the range of 0.091 – 1.64 mg/kg. Chromium and Copper were found to be available in the concentration of 0.04 mg/kg, 0.01 mg/kg respectively. The Heavy metals namely lead and Zinc were not found in any of the lipsticks. The dose and intake calculation were defined based on the frequency of lipsticks applied per week. The level of metal intake in the human body for assumed frequency was found to be below the permissible limits prescribed by Indian standards and Regulations.

Keywords— *Heavy Metals, Lipsticks, ICP-OES, Permissible limits, Dose and Intake calculation.*

I. INTRODUCTION

In India, the use of different kinds of cosmetic items increases rapidly. The chemicals and heavy metals present in those items causes various health risks to the users [11]. Heavy metals are dangerous because they tend to accumulate in the human body. An increase in the concentration of a chemical, in a living organism is called bioaccumulation. The term "dose" is defined as a quantity of the material taken at a particular time. Dosage means, the frequency of a dose. Frequent dose of lipstick may cause bio accumulation of heavy metals in human beings. Cosmetic products contain chemical additives including dioxin, lead acetate, formaldehyde, paraben and phthalate [10] which may cause health problem upon prolonged exposure. The amount of colour additives added in the lipstick should not exceed 6% of its total weight [16],. The red colour additive Eosin added in Lipsticks can cause dermatitis [2]. The trace heavy metals such as Lead, Copper, Iron, Chromium, Mercury, Cadmium, Arsenic, Nickel and Aluminium were found to be available in various cosmetics applications like face, body care products, hair & herbal cosmetics [15]. There were different studies conducted by researchers on metal toxicity in cosmetics in various countries [5], [4] & [12]. This investigation focuses on Indian market especially Tamilnadu. Here the study was conducted in order to determine heavy metals like Aluminium, Copper, Chromium, Iron, Lead and Zinc in the lipstick of different brands. From the dose and frequency of application, the level of metal entering the human body was determined. The permissible limits of heavy metal concentrations in the cosmetic products are mentioned in the Indian and other National regulations. The concentration of lead allowed in the lipstick should not exceed 20 ppm and the arsenic should not exceed 2 ppm [6]. The colourant and additives added in cosmetics must comply with Drugs and Cosmetics Act, 1940; Drugs and Cosmetics Rules 1945 [1] and the Indian Standards 4707 Part I, Cosmetic Standard [7], Schedule Q. Other metals present in the cosmetic should not exceed cumulatively 100 ppm and risk associated with these metals are considered less significant when compared with lead, arsenic, cadmium, mercury and antimony [3]. The results obtained from ICP spectroscopy were compared with limit prescribed by these organizations.

II. MATERIALS AND METHODS

A. Sample Collected

Four different branded Lipsticks were purchased from the local markets for conducting the study. The lipstick samples collected were subjected to analysis by Inductively Coupled Plasma Spectroscopy. The list of collected samples which was subjected to analysis is shown in table1.

B. ICP-OES Analysis

The collected samples were analyzed by ICP-OES. The various researchers have identified the level of lead in lipsticks by Atomic Absorption Spectrometer (AAS) [9]. ICP Spectrometer is widely used for quantifying the unknown metals present in a sample [17]. The following steps were followed in order to analyze the samples by ICP-OES.

- 2% HNO_3 Solution is considered as a blank solution. A 10 ml of Concentrated HNO_3 was taken in a 500 ml Standard Measuring Flask (SMF) and the space remaining filled up with pure Millipore water. The prepared solution was mixed well in order to get homogenous solution.

- The collected sample was exactly weighed up to 50 mg by using electronic weighing machine.

- Weighed samples were taken in the beakers and Aqua regia (concentrated HCl: HNO_3 = 3:1) was added (3 ml HCl with 1 ml HNO_3).

- After a rhythmic agitation of this acid mixture, it was then kept in a hot- plate at the temperature of 100^0C until all liquids get evaporated.

- The residues settled on the bottom of the beaker were rinsed with Blank Solution and transferred into 50 ml SMF.

- From this 50 ml solution, 0.5 ml was taken in another 50ml SMF and the remaining space filled up with Blank Solution. This was the final solution, considered as a 10 mg/L sample solution and ready to be injected in ICP Spectroscopy.

- The Merck Standard solution was used as a reference solution. This solution has twenty three heavy metals in the equal concentration of 10 mg/L which also includes Al, Cr, Cu, Fe, Pb and Zn.

- 0.5 ml of this standard solution was taken in a 50ml SMF and then it was filled up with Blank Solution.

- The blank solution was injected into the ICP spectroscopy by means of nebulizer. The instrument was kept at 4-6 bar pressure. The blank solution may contains trace amount of metal elements. These concentrations were set to zero value in the instrument.

- The standard solution was next injected to the instrument and the 23 metals in this standard solution were set to 10 mg/L in the ICP Spectroscopy. Finally, the sample solution was injected and results were observed. This result was in mg/L and can be converted in to mg/kg by multiplying the dilution factor of 10.

III. Results and Discussion

A total of 4 lipsticks were tested to determine the concentration of Aluminium, Chromium, Copper, Iron, Lead and Zinc. The level of Iron was found to be higher when compared with all other metals tested. Aluminium was found to be available in all branded lipsticks in the concentration range of 0.09 - 0.82 mg/kg. The metal Iron was in the concentration range of 0.091 – 1.64 mg/kg respectively. Chromium and Copper were detected only in sample III and in a concentration of 0.04 mg/kg, 0.01 mg/kg respectively. The Heavy metals Pb and Zn were not found in any of the lipsticks. The results for all four samples are shown in table 1.

TABLE I. Detected Heavy Metal Concentration in Lipstick Samples

#	Sample Id	Concentration in mg/kg					
		Al	*Cr*	*Cu*	*Fe*	*Pb*	*Zn*
1.	I	0.61	0	0	0.13	0	0
2.	II	0.15	0	0	0.25	0	0
3.	III	0.82	0.04	0.01	0.85	0	0
4.	IV	0.09	0	0	1.64	0	0

A. Dose and Weekly Intake Calculation

The study carried out by Sibeli Daenecke et al., conclude that the average length of the upper lip was around 2x 21mm and the average length of the philtrum was around 12mm [14]. Based on this, an area of 35mm x 18 mm lipstick was applied in a blank white paper and it was found to be 0.1-gram in weight. Two cases were assumed here. In case 1 it was assumed that each day a person applies lipstick one time per day. So the amount of lipstick applied in a week is about 0.7 gram. In case 2, a person was assumed to apply lipstick two times per day. For both the cases the level of expected metals entering in a human body was calculated and listed in table 2. The sample dose calculation is shown here for the metal Aluminium present in sample I.

Case 1: lipstick applied one time per day

Detected 'Al' concentration = 0.61 mg/kg,
'Al 'present in 1 gram of sample I
= (0.61 mg)/1000
= 0.00061 mg
For 0.1 gram of sample I, (for a day)
'Al' concentration = (0.00061x1000)/10 µg
= 0.061 µg
For 0.7 gram, (for week)
'Al' concentration = 0.061x 7 µg
= 0.427 µg

Case 2: lipstick applied two times per day

Detected 'Al' concentration = 0.61 mg/kg,
For 1.4 gram,
'Al' Concentration = 0.122 x 7 µg
= 0.854 µg

TABLE II. Weekly Metal Intake for Specified Dosages

Sl.No	Sample Id	Metal	Detected Concentration (mg/kg)	Weekly Metal Intake (case 1) (µg)	Weekly Metal Intake (case 2) (µg)
1	I	Al	0.61	0.427	0.854
		Cr	0	0	0
		Cu	0	0	0

		Fe	0.13	0.091	0.182
		Pb	0	0	0
		Zn	0	0	0
2	II	Al	0.15	0.105	0.21
		Cr	0	0	0
		Cu	0	0	0
		Fe	0.25	0.175	0.35
		Pb	0	0	0
		Zn	0	0	0
3	III	Al	0.82	0.574	1.148
		Cr	0.04	0.028	0.056
		Cu	0.01	0.007	0.014
		Fe	0.85	0.595	1.19
		Pb	0	0	0
		Zn	0	0	0
4	IV	Al	0.09	0.063	0.126
		Cr	0	0	0
		Cu	0	0	0
		Fe	1.64	1.148	2.296
		Pb	0	0	0
		Zn	0	0	0

Figure 1 to 4 furnishes the level of detected metals in the collected samples. From the figures, we can say that the sample III was higher in metal concentration when compared with all other samples, so the chance of metal absorbance by the skin was higher than that of all other lipsticks.

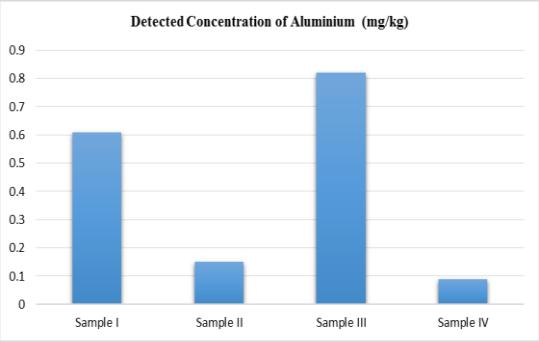

Fig 1: Detected Aluminium concentration in samples

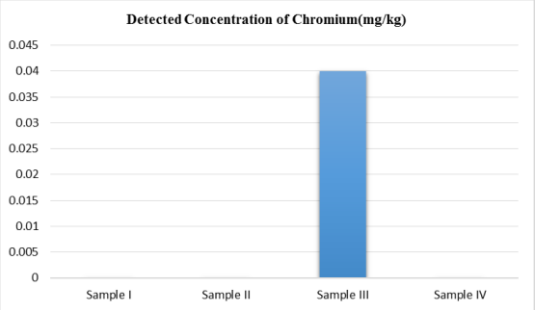

Fig 2: Detected Chromium concentration in samples

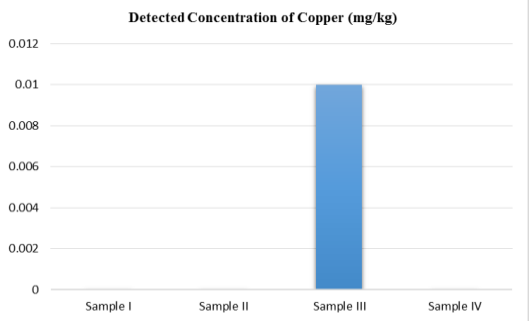

Fig 3: Detected Copper concentration in samples

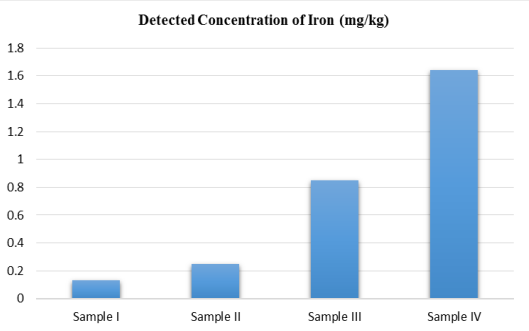

Fig 4: Detected Iron concentration in samples

IV. CONCLUSION

Heavy Metals Lead and Zinc were not found in any of the Lipstick samples. Other metals like Al, Cr and Fe were detected in all samples taken and the concentration levels were below the permissible limits. But, these heavy metals slowly accumulate in the human body over a prolonged usages. The accumulation of these metals will cause serious chronic health risk such as discolouration of the skin, allergic reactions, stomach pain, lung and throat problems. Some of the metals like Arsenic, Cadmium, Chromium, Silver, Mercury and Lead have tendency to cause cancer when it exceeds the permissible limit [13] & [8]. Heavy metals enter into the human body not only by use of cosmetics items, but also through the food, water and

air. Several industries use these heavy metals, so the workers may be exposed to these kinds of environment and have possibilities of metal accumulation in the human body. Long term exposure of these metals can cause above said problems. So, it is better to reduce the frequency of such cosmetic usages.

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