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Research Article

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Estimation of Lead Compounds in Cosmetic Hair Colorants Available in the Indian Market

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ABSTRACT

In the present study, Lead (Pb), a heavy metal, was quantitatively estimated in samples of hair dye sold through retail in the Indian markets. 24 hair colorant samples, being categorized into 2 groups, were analyzed for presence of Pb using Atomic Absorption Spectrophotometry technique. The concentration of Pb in the samples ranged from 1.1 to 2 ppm, which is much above the permissible limit of 0.6 ppm. Chronic exposure to any level of Pb promotes several health hazards to the users of such products. Therefore, an awareness regarding this particular route of ingestion, and also the presence of a regulatory body regarding consideration of monitoring the use of heavy metals in cosmetic products is much needed in the present scenario.

Keywords: Hair dye; Lead; Atomic absorption spectrophotometry; Paraphenylenediamine

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INTRODUCTION

Since ages the human population has been using dyes to color their hair as a form of beautification. Most notably, the ancient Egyptians used to color their hair with various vegetable and organic dyes. The first artificial dye was synthesized in laboratory in 1856, and permanent hair colorants are in commercial use for over a hundred years [1]. Its main purpose is cosmetic; to cover grey hair or to get back the original color of hair discolored due to age. But recently poisoning from hair dye is being reported from all across the globe, including India [2].

The composition of hair dyes are antioxidants, alkalis, ammonia, soaps, wetting agents, fragrances, and many other chemicals like metallic dye containing lead (Pb). Lead acetate is approved as a color additive for coloring hair on the scalp at a concentration not exceeding 0.06 ppm, calculated as metallic Pb [3]. Also, popular hair dyes contain Paraphenylenediamine (PPD); it is widely used for dyeing furs as well as for oxidizing hair dyes, and in India it is used in combination with henna (Lowsonia inermis). Henna is used traditionally to color the skin and hair, PPD accelerates the dyeing process. PPD can also produce local toxic effects in the form of skin irritation, contact dermatitis, chemosis, lacrimation, exophthalmos, or even permanent blindness [4]. Some coal tar colors also contain heavy metal impurities including Pb that can cause cancer in increased doses or can alter the hormonal balance of our bodies [5].

Pregnant women are especially vulnerable because Pb absorbed by them can well cross the placenta & enter the fetal circulation. It can also be taken up easily by breastfeeding infants since lactating mothers can excrete Pb through breast milk [6].

Keeping all these facts in mind, the present study was designed to screen the status of Pb content in various commercially available hair dyes sold across India in retail markets, and to figure out whether the available Pb level was harmful to the population using those dyes.

MATERIALS AND METHODS

Samples

24 samples of permanent hair dye from various retail stores across Kolkata, India were analyzed for the survey. They were divided into 2 categories [7];

Category 1: A solution of (i)-dye intermediates (eg- PPD), which form a permanent dye on chemical reactions; and (ii)- preformed dyes (eg- 2-nitro-p-phenylenediamine) which are already dyes and are added to achieve the intended shades; to an aqueous ammoniacal vehicle containing soap, detergents and conditioning agents.

Category 2: A solution of 6% hydrogen peroxide, in aqueous or cream solution.

14 samples of category 1 & 10 samples of category 2 were selected for the study.

Instrumentation

Atomic Absorption Specrophotometer (Perkin Elmer 2380) equipped with deuterium lamp for background correction was used for determination of lead in the samples [8]. The hollow cathode lamp for Pb was employed as a radiation source. The flames used were air/acetylene and N_2O/ acetylene. Nitrogen was used as carrier gas. Table 1 specifies the instrumental conditions for Pb analysis.

Table 1: Instrumental conditions for Pb analysis

Element	Current (mA)	Slit width (nm)	λ max (nm)	Flame Color	Flame Type	AAS Technique
Pb	10	1	217	Blue	Air/C2H2	Flame

Reagents and Standards

Analytical grade Perchloric Acid (70%, by E Merck) and Nitric Acid (65%, E Merck) were used for sample preparation. The water used throughout the experiment was Ultra pure, obtained from Milli Q water purification system. The standard solutions were prepared in 6 different concentrations to obtain a calibration curve by diluting stock solutions of 1000 ppm of Pb immediately before use. Dilution correction was applied for samples diluted or concentrated during analysis.

Sample preparation

The samples were wet digested with 4:1 mixture of Nitric Acid & Perchloric Acid for 2-3 hours. The solutions were allowed to cool and were filtered in 100 ml volumetric flasks by Whatmann No 42 filter paper, and diluted up to the mark with deionised water.

Sample analysis

The digested hair dye samples & the 6 different concentration solutions of standard 1000 ppm of Pb were analyzed in triplicate and the measurements obtained.

Quality control

Appropriate quality assurance procedures and precautions are carried out to ensure reliability of the results. Results from each batch were accepted if control samples were within 10% of the accepted value of these samples.

Ethical issues

This study was in accordance with Declaration of Helsinki [9] and guidelines on good clinical practice. It was also approved by the institutional review board and medical ethics committee.

RESULTS AND DISCUSSION

Table 2 gives a summary of the concentration of Pb in different categories of hair dye.

The concentrations of Pb as determined in 24 samples of hair dye are markedly higher than the maximum allowable limit of 0.6 ppm. Pb content in all the products tested ranges from 1.1 to 2 ppm, with category 1 hair dyes containing more Pb than category 2 products.

Table 2: Pb concentrations (ppm) in hair dye samples

Sample (n=24)	Lead (in ppm) (mean ± SD)
Category 1 (n=14)	1.96 ± 0.16
Category 2 (n=10)	1.21 ± 0.09

Hair dye consumption is not an uncommon means of intentional self-harm. It has been reported around the world, more so in the underdeveloped and developing countries. A number of case reports and series have been published on hair dye poisoning [10,11]. Numerous case reports have been reported from India [12,13], due to PPD poisoning. Not much study has been done on the potentials of Pb poisoning due to their presence in hair dyes. But according to the centre of Disease Control & Prevention (CDC), many experts agree that Pb exposure is not safe at any level. The current threshold of blood Pb levels in India is already 5 µg/dl of blood, the level at which public health actions are recommended to be initiated [14]. Lead is banned from cosmetics in Europe & Canada [15].

The presence of heavy metals in cosmetics can cause serious problems to consumers as they can cause premature ageing of the skin, skin allergies & skin cancer. Further, toxic le3vels of Pb have a role in setting up conditions that lead to inflammation in arteries & tissues resulting in osteoporosis [16]. Thus, there is an urgent need for constant quality assessment of cosmetic products in the market in order to ensure the safety of customers.

In this study, a simple, reliable, sensitive & convenient AAS method had been developed for quantitative estimation of Pb, which can currently be utilized for the quality control of cosmetic preparation at industrial level.

CONCLUSION

It can, thus, be concluded that Pb, one of the most toxic heavy metals present in hair dyes, much beyond permissible limits, can have deleterious effects on the human system on prolonged exposure, since Pb keeps on accumulating in the system. Prolonged use of hair dyes can cause serious health damage for the consumers & pose a real danger of Pb poisoning. In the present scenario, there is an urgent need to increase consumer awareness regarding this health risk, and also to have a regulatory body to monitor the use of heavy metals in cosmetic products for sustainability of safety.

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CONFLICT OF INTEREST

The authors declare no conflict of interest in the present study.

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