

Evaluation of heavy metal content of some lipsticks in Iran market

Hamed Naalbandi¹, Majid Saeedi^{1,2*}, Omid Moharrami Moghanlou¹, Jafar Akbari¹, Katayoun Morteza-Semnani³, Raouf Alizadeh⁴, Mohammad Hossein Esfahani-Zadeh⁴, Mahgol Tajbakhsh⁵

¹Department of Pharmaceutics, Faculty of Pharmacy, Mazandaran University of Medical Sciences, Sari, Iran

²Pharmaceutical Sciences Research Center, Mazandaran University of Medical Sciences, Sari, Iran

³Department of Medicinal Chemistry, Faculty of Pharmacy, Mazandaran University of Medical Sciences, Sari, Iran

⁴Central Lab., Vice Chancellor of Food and Drug, Mazandaran University of Medical Sciences, Sari, Iran

⁵Student Research Committee, Mazandaran University of Medical Sciences, Sari, Iran

Received: Jul25, 2016, Revised: Aug 30, 2016, Accepted: Sep17, 2016

Abstract

This study quantitatively estimated heavy metals as cadmium, lead, chromium and nickel (Cd, Pb, Cr and Ni) using flame atomic absorption spectrometry (FAAS) in ten lipstick products sold by local markets in Sari, Mazandaran State, Iran. All the samples were digested in HNO₃ and HClO₄ and then evaluated for heavy metal contents. All the concentrations are mean value of triplicate experiments for each sample. Analysis of variance (ANOVA) and Tukey post-hoc tests were used to determine significant variations in heavy metal contents and $p < 0.05$ was considered as significant. The determined range of cadmium, lead, chromium and nickel were 0.01-0.05 $\mu\text{g/g}$, 0.18-0.80 $\mu\text{g/g}$, 0.06-0.75 $\mu\text{g/g}$, and 0.00-0.34 $\mu\text{g/g}$, respectively. These results showed that nickel and cadmium contents were less than WHO and US FDA safe limit, while for chromium only one samples (No. 5) showed higher concentration than safe limit. The content of lead in all samples were lower than safe limit unless sample 6 which showed high level of lead.

Keywords: Cadmium, lead, chromium, nickel, lipstick

Pharm Biomed Res 2016; 2(3): 31-37

DOI: 10.18869/acadpub.pbr.2.3.31

Introduction

Cosmetics have been widely used by people all over the world since ancient times for cleaning, improving or changing the skin, hair, nails and teeth (1). These products may have various exposure frameworks (2,3). Some of cosmetics are rinsed-off (e.g. shampoos and toothpaste), other cases the products (e.g. body lotion, deodorant, lipsticks) may remain in contact with the skin over several hours, some of them may be applied over a large surface of the body (e.g. body emulsions) and some others are applied via spray, presenting the possibility of aspiration (4). Among the cosmetic products, lipsticks have the higher risk of direct oral ingestion, aggravating the negative effects of their ingredients. Therefore, people's concern about cosmetics toxicity has become an important issue. The early lipsticks presented in the market consist of beeswax, fat and pigment as the main ingredients. The worldwide use of lipsticks has been increasing due to the willing of individual beautification (5). Lipsticks are usually contain heavy metals including lead, nickel, aluminum, arsenic,

cadmium, antimony, and chromium (6). Lip products are presented in a wide variety of colors, that are produced by addition of pigments. These pigments may be mineral or organic and may contain heavy metals as impurities in the pigment formulation (7-9). It is believed that at certain specified limits, some heavy metals could be of biological importance to human (10). However, heavy metals such as lead, nickel, cadmium and chromium have been reported not to have any known biological importance and can be very toxic even at very low concentration (11-17). Cadmium is toxic at very low levels. Exposures to the cadmium may cause renal dysfunction and long term exposure to cadmium can lead to obstructive lung disease (10). Cadmium is one of the heavy metals that if it is directly subjected to the human body it would decrease the blood pressure (18). It is also connected with the diabetes (19). Absorption of lead by the body causes inhibition of haemoglobin synthesis, kidney dysfunction, reproductive and cardiovascular systems dysfunction (20-

*E-mail: MSaeedi@mazums.ac.ir

22). The toxic effects of cadmium and lead are shown via bonding to sulfhydryl groups of proteins and depletion of glutathione. Lead is described as one of the most dangerous contaminants to arise in human civilization due to its distribution in environment as polluting element (23,24). Exposure of lead at high levels is well known to be toxic, but exposure to relatively low levels may entail adverse health effect. High levels of lead exposure may cause serious health damages including both acute and chronic poisoning, pathological change of organs and disease related to cardiovascular, kidney, bone, and liver and it can even cause cancer owing to excessive accumulation in human body (24,25). Chromium and cobalt may undergo cycling reactions to generate reactive radicals in the body (26).

Chromium is added as colorant in lipsticks. Chromium (VI) compounds are toxins and known human carcinogens, whereas chromium (III) is an essential nutrient. However, Cr is considered as toxic heavy element for human being and is a serious environmental pollution.

Breathing high levels can cause irritation to the lining of the nose, asthma and shortness of breath or wheezing. Skin contact can cause skin ulcers. Allergic reactions consisting of severe redness and swelling of the skin have been noted. Long term exposure can cause damage to liver, kidney circulatory and nerve tissues, as well as skin irritation (27). In addition, Ni, Co and Cr are well known that causing of allergic contact dermatitis (28). Small amounts of nickel are needed by the human body to produce red blood cells, but in excessive amounts, can become mildly toxic. Short-term over exposure to nickel is not known to cause any health problems, but long-term exposure can cause decreased body weight, heart and liver damage, and skin irritation (29). Therefore, it is very important to determine the concentration of these metals in lipsticks, which are used by millions of people.

Due to wide use of lipsticks in Iran, lack of data on their toxicity or their safety, the goal of this study was to assess the public health risk from certain brands of lipsticks sold at Sari region in Iran. In this context, 10 different brands of lipsticks were randomly purchased from local markets in Sari, Mazandaran State, Iran and the concentration of heavy metals such as cadmium, lead, chromium and nickel were analyzed using Atomic Absorption Spectrometry.

Materials and methods

Chemicals and instruments

All chemical compounds were pure and used without further purification. The following acids of the highest purity for heavy metal analysis were provided from Merck Company: HNO_3 (67%) and HClO_4 (60%). Stock standard solutions of Cd, Cr, Pb and Ni ions were purchased from Merck Company. Working standard solutions were freshly prepared by stepwise dilution of the stock solution with deionized water.

The concentration of metal ions was determined by atomic absorption spectrophotometry using a Rayleigh-WFX-130 Atomic Absorption Spectrophotometer.

Collection of samples

Ten samples of different brands of lipsticks in mostly used colors were collected randomly from retail shops in Sari local markets in Mazandaran State, Iran. The samples were of different qualities and popular brands with different price ranges. The lipstick samples were assigned to codes 1 to 10 instead of their brand names as shown in table 1.

Methods

Lipsticks are present in the semi solid form, so pretreatment of samples are required before analysis. For this purpose, 3.0 g of lipstick samples were exactly

Table1 The color of investigated lipsticks

sample code	1	2	3	4	5	6	7	8	9	10
Color	gold	pink	violet	blue	red	green	purple	yellow	beige	brown

weighted with electrical analytical balance and put into digestion flask. Lipstick samples were digested by using wet digestion method by repeatedly addition of 10.0 ml of 4:1 HNO₃/ HClO₄ at interval of 3 minutes for 5 times using the same ratio at atmospheric pressure under open system on hot plate at 100 °C and heated until the white fumes started evolving, which showed the completion of digestion process. The resulting digestate was filtered with filter paper and transferred to a 100.0 mL capacity volumetric flask and made up to the mark by the addition of doubly distilled deionized water and the concentration of the studied metal ions was then determined by flame atomic absorption spectrometry. Calibration solutions of heavy metals studied in this article were prepared as follows: for Cd ion, 0.0, 0.4, 0.6, 0.8, 1.0 mg L⁻¹, for Pb ion, 0.0, 2.0, 6.0, 8.0, 10.0 mg L⁻¹, for Cr ion, 0.0, 0.05, 1.0, 1.5, 2.0, 2.5 mg L⁻¹ and for Ni ion, 0.0, 0.5, 1.0, 3.0, 5.0 mg L⁻¹.

Statistical analysis

Analysis of variance (ANOVA) and Tukey post-hoc tests were performed on each brand of lipsticks to find out if there were significant variations in the concentrations of heavy metals in different colors of each brand. The statistical significance was determined as 0.05 ($p < 0.05$) alpha levels. SPSS 15.0 version (SPSS Inc., Chicago, IL, USA) statistical package was used for the statistically analyses. All the concentrations are mean value of triplicate experiments for each sample.

Results

Table 1, shows the color of the investigated lipsticks in this project. The samples numbered from 1-10. The content of cadmium ($\mu\text{g/g}$) in the lipstick samples 1-10, using Flame Atomic Absorption Spectrophotometry method, is depicted in figure 1 and figure 2, presents the lead concentration ($\mu\text{g/g}$) of lipstick samples used in this study. Figure 3, shows chromium content ($\mu\text{g/g}$) in the samples and concentration of nickel in the samples is given in figure 4.

All the concentrations are mean value of triplicate experiments for each sample.

Discussion

The contents of cadmium, lead, chromium and nickel in lipstick samples are presented in figures 1-4 respectively. As it is clear from these figures, all the samples contain variable concentration of Cd, Pb, Cr and Ni ions, some within the acceptable limits and some out of the safe range. The limited value for cadmium reported in the literature is about 0.9- 3 $\mu\text{g/g}$ (18, 19). All the samples showed cadmium in their formulation in the range of 0.01- 0.05 $\mu\text{g/g}$ (Fig. 1). So trace amount of cadmium in all tested lipsticks is safe.

The USFDA (US Food and Drug Administration) limit for lead as color additive in cosmetics is 20 g/g (30). The campaign for safe cosmetics has given the 0.1 $\mu\text{g/g}$ lead level in candy (31). Safe level of lead according to EPA lead safe level is 0.5 $\mu\text{g/g}$ (32). The lead content of samples measured by Flame Atomic Absorption (FAA) Spectrophotometer in this study was in the range of 0.18- 0.80 $\mu\text{g/g}$ (Fig. 3). This result shows that all the samples have lead concentration below FDA limit but according to EPA lead safe level, only sample 6 showed a higher concentration.

According to EPA the safe level of chromium is 1 $\mu\text{g/g}$ (33). The content of chromium in the lipstick samples investigated in this study by Flame Atomic Absorption spectrophotometer is depicted in figure 3. As it is clear in this figure, only one sample (sample 5) shows higher concentration than safe limit (1 $\mu\text{g/g}$), while the others show chromium concentration in the range of 0.06-0.75 $\mu\text{g/g}$ lower than safe level.

Investigation for safe levels of nickel in household products reported that it should not contain more than 5 $\mu\text{g/g}$ and that the ultimate target level should be 1 $\mu\text{g/g}$ (29, 34). The FAA spectrophotometry measurement of nickel content in the lipstick samples in this study is shown in figure 4. As it is seen in figure 4, the concentration of nickel in samples is in the range of 0.0- 0.34 $\mu\text{g/g}$ which is well below the safe level. However, samples 7 and 8 do not show any detectable nickel by FAA spectrophotometer. The possible influence of colors on heavy metal contents was investigated also for different colors of each brand. The one-tailed Student's *t*-test was

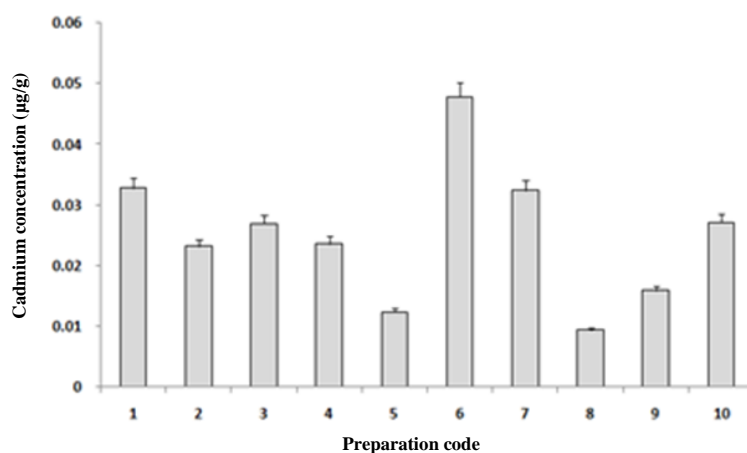


Figure 1 Cd concentration (µg/g) in the lipstick samples

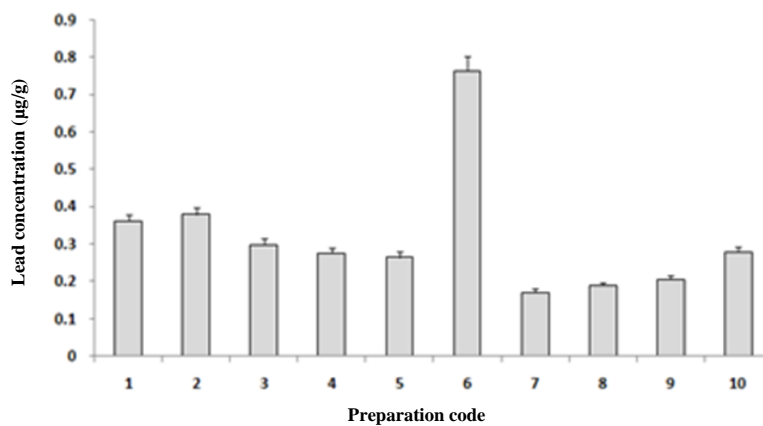


Figure 2 Pb Concentration (µg/g) in the lipstick samples

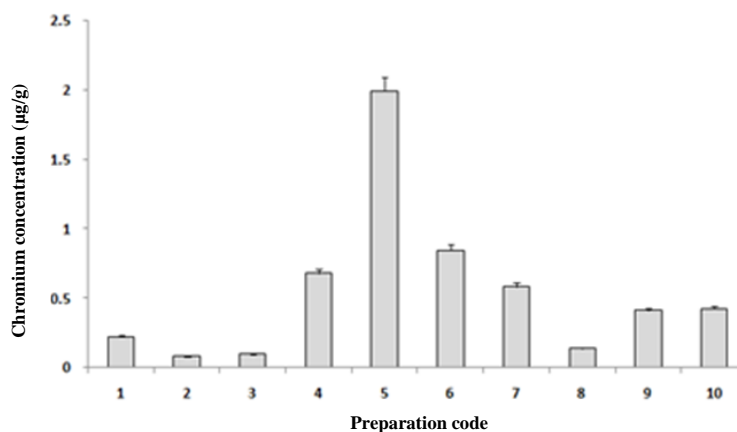


Figure 3 Cr concentration (µg/g) in the lipstick samples

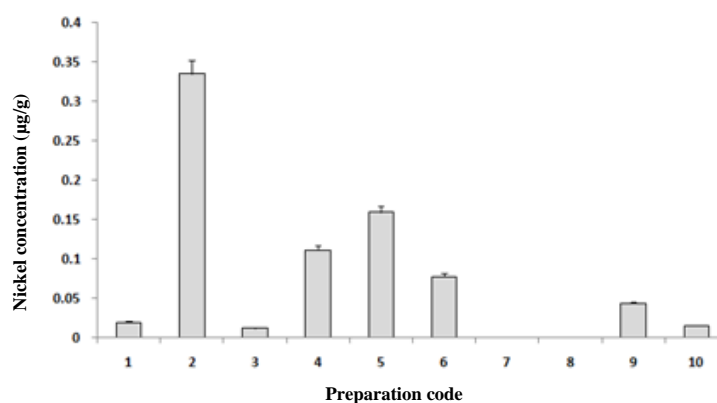


Figure 1 Ni concentration ($\mu\text{g/g}$) in the lipstick samples

applied to compare the mean heavy metal contents of different colors. Results showed that the mean value of lead for green lipsticks ($0.8 \pm 0.46 \mu\text{g/g}$) was statistically higher than that for purple lipsticks ($0.16 \pm 0.22 \mu\text{g/g}$) at 95% probability. Even though this seemed to suggest a tendency of green lipsticks to contain more lead than the other colors, and particularly than the purple ones, statistically the average lead content for the various colors did not show any significant difference at 95% probability, except for the green. Similar results were obtained comparing the average chromium content of different colors. The chromium level ($2.1 \pm 0.78 \mu\text{g/g}$) was significantly higher in red materials. The results in the case of lead and chromium showed that the type of pigment used in lipsticks contributes to its heavy metal content.

In the cases of nickel and cadmium, the one-tailed Student's *t*-test did not show any statistically significant difference among the various color categories at 95% probability, thus it has to be remembered that the type of pigment used in lipsticks has no relation to its heavy metal content.

Conclusion

Ten samples of lipsticks mostly used in Mazandaran state, Iran, were collected from local

markets in Sari, were evaluated for heavy metals (Cd, Pb, Cr and Ni) levels by flame atomic absorption spectrophotometer.

Cadmium concentration was lower than safe limit. The lead content of the samples were lower than FDA safe limit, but only one sample was higher than EPA lead safe limit (sample 6). All the samples showed Chromium content less than $1 \mu\text{g/g}$ unless one sample (sample 5) showed higher than safe limit. None of the samples showed nickel content higher than safe limit ($1 \mu\text{g/g}$). Although content of heavy metals in the tested lipsticks was reasonable, but the continuous use of lipsticks can increase the absorption of heavy metals into the body by swallowing or through dermal absorption of these products. Therefore, informing the users of lipsticks specially teenagers, of the harmful consequences of lip products should be a big concern.

Conflict of Interest

The authors declared no conflict of interest.

References

1. European Union. Council Directive 76/768/EEC of 27 July 1976 on the approximation of the laws of the Member States relating to cosmetic products. Official Journal L 262, 27/09/1976, p. 169.
2. Loretz L, Api AM, Barraji L, Burdick J, Dressler W, Gettings S, et al. Exposure data for cosmetic products: lipstick, body lotion, and face cream. *Food Chem Toxicol* 2005; 43:279-91.
3. Loretz L, Api AM, Barraji L, Burdick J, Davis DA, Dressler W, et al. L. Exposure data for personal care products: hairspray, spray perfume, liquid foundation, shampoo, body wash, and solid antiperspirant. *Food Chem Toxicol* 2006;44:2008-18.
4. Bocca B, Pino A, Alimonti A, Forte G. Toxic metals contained in cosmetics: A status report. *Regul Toxicol Pharm* 2014; 68: 447-67.
5. Soares AR, Nascentes CC. Development of a simple method for the determination of lead in lipstick using alkaline solubilization and graphite furnace atomic absorption spectrometry. *Talanta* 2013;105:272-7.
6. Al-Saleh I, Al-Enazi S. Trace metals in lipsticks. *Toxicol Environ Chem* 2011; 93: 1149-65.
7. Valet B, Mayor M, Fitoussi F, Capellier R, Dormoy M, Ginestar J. Colouring agents in cosmetic products (excluding hair dyes): types of decorative cosmetic products. *Anal Cosmet Prod* 2007:141-52.
8. Volpe M, Nazzaro M, Coppola R, Rapuano F, Aquino R. Determination and assessments of selected heavy metals in eye shadow cosmetics from China, Italy, and USA. *Microchem J* 2012; 101: 65-9.
9. Barros AI, Silva TV, Ferreira EC, Gomes Neto JA. Determination of lead in eye shadow and blush by high-resolution continuum source graphite Furnace atomic absorption spectrometry employing direct solid sampling. *J Brazil Chem Soc* 2015;26:140- 6.
10. Duruibe JO, Ogwuegbu MO, Egwurugwu JN. Heavy metal pollution and human biotoxic effects. *Int J Phys Sci* 2007;2:112-8.
11. Holum JR. Elements of general and biological chemistry, 6th edition, John Wiley and sons, New York 1983; pp 324, 326, 353, 469.
12. Fosmire GJ. Zinc toxicity. *Am J Clin Nur* 1990;51: 225-7.
13. Cluggage D. Mc. Heavy metal poisoning, NCS Magazine, Published by The Bird Hospital, CO, USA 1991. available at www.cockatiels.org/articles/diseases/metals.html
14. Ferner DJ. Toxicity, heavy metals. *E Med J* 2001;2:1-3.
15. European Union. Heavy metals in wastes, European Commission on Environment, 2002. Available at http://ec.europa.eu/environment/waste/studies/pdf/heavy_metalsreport.pdf.
16. Nolan KR. Copper toxicity syndrome. *J OrthomolPsychiatry* 1983; 12: 270-82.
17. Young RA. Toxicity Profiles: Toxicity summary for cadmium, risk assessment information system, RAIS, University of Tennessee, 2005, available at rais.ornl.gov/tox/profiles/cadmium.html.
18. Alissa EM, Ferns GA. Heavy Metal Poisoning and Cardiovascular Disease. *J Toxicol* 2011: 21 pages.
19. Godt J, Scheidig F, Grosse-Siestrup C, Esche V, Brandenburg P, Reich A, et al. The toxicity of cadmium and resulting hazards for human health. *J Occup Med Toxicol* 2006;1:1-6.
20. Duruibe J, Ogwuegbu M, Egwurugwu J. Heavy metal pollution and human biotoxic effects. *Int J Phys Sci* 2007; 2: 112-8.
21. Institute of Environmental Conservation and Research (INECAR). Position paper against mining in Rapu-Rapu, Published by INECAR, Ateneo de Naga University, Philippines 2000. available at www.adnu.edu.ph/institutes/inecar/pospaper1.asp.
22. Lenntech Water Treatment and Air Purification. Water treatment, Published by Lenntech, Rotterdamseweg, Netherland 2004. available at www.excelwater.com/thp/filters/water-purification.htm.
23. Smith DR, Flegal AR. Lead in the biosphere: recent trends. *Ambio* 1995;24:21-3.
24. Järup L. Hazards of heavy metal contamination. *Br Med Bull* 2003; 68: 167-82.
25. Koller K, Brown T, Spurgeon A, Levy L. Recent developments in low-level lead exposure and intellectual impairment in children. *Environ HealthPersp* 2004;112:987-94.
26. Jomovaa K, Valko M. Advances in metal-induced oxidative stress and human disease. *Toxicol* 2011;283:65–87.
27. Singh RP, Heldman DR. Introduction to food engineering. Gulf Professional Publishing; 2001.
28. Bocca B, Forte G, Petrucci F, Cristaudo A. Levels of nickel and other potentially allergenic metals in Ni-tested commercial body creams. *J pharm Biomed Anal* 2007;44:1197-202.
29. Basketter DA, Briatico-Vangosa G, Kaestner W, Lally C, Bontinck WJ. Nickel, cobalt and chromium in consumer products: a role in allergic contact dermatitis. *Contact Derm* 1993;28:15-25.
30. FDA U. Summary of color additives listed for use in the United States in food, drug, cosmetics and medical devices. Color additives approved for use in cosmetics. 2007.

31. US Food and Drug Administration. Lead in Candy Likely To Be Consumed Frequently by Small Children: Recommended Maximum Level and Enforcement Policy. US Department of Health and Human Services. Food and Drug Administration. Available from: <http://www.cfsan.fda.gov/~dms/pbguid3.html>. 2006.
32. Environmental Protection Agency (EPA) (1986). "Test Methods for Evaluating Solid Waste," 3rd ed. Washington, D.C.
33. Corazza M, Baldo F, Pagnoni A, Miscioscia R, Virgili A. Measurement of nickel, cobalt and chromium in toy make-up by atomic absorption spectroscopy. *Acta Derm-Venereol* 2009;89:130-3.
34. Basketter DA, Angelini G, Ingber A. Nickel, chromium and cobalt in consumer products: revisiting safe levels in the new millennium. *Contact Derm* 2003;49:1-7.