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# Determination of lead in different brands of lipsticks marketed in Mexico
# Determinación de plomo en diferentes marcas de labiales vendidos en México

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## Abstract

Cosmetics have become a common use product among people around the world being the reason why it is important to know their components specifically, the presence of heavy metals. The content of lead in branded lipsticks was analyzed due to the cause of a large number of diseases and disorders in users. The study was aimed at assessing the levels of lead concentration in 5 lipsticks of different brands sold in Mexico but produced in different countries. Characterization was carried out through a flame atomic absorption spectrophotometry in which the analyses showed the presence of lead in all the samples with a concentration ranging between 1.1775 ppm to 1.8242 ppm, with an average concentration of 1.457 ppm, these concentrations are within the average parameter established by the FDA (Food and Drug Administration). However, lead content in daily products, even if it is below the established limit, can be harmful to health. Besides, carrying out an analysis of various investigations we can conclude that the lead concentration in lipsticks produced in the first world countries is lower than the one in those distributed in the developing countries. As a result, it is suggested the research for new components that can avoid the presence of lead, that are sustainable and don´t constitute potential health risk to users.
**Keywords:** Lead, lipsticks, FDA, atomic absorption spectrophotometry.

## Resumen

Los cosméticos se han vuelto un producto de uso común entre las personas alrededor del mundo, razón por la cual es importante conocer sus componentes, específicamente la presencia de metales pesados. El contenido de plomo en diversas marcas de labiales fue analizada debido a la larga cantidad de enfermedades y desordenes que provoca en los consumidores. El estudio tuvo como objetivo evaluar la concentración de plomo en 5 diferentes marcas de lápices labiales vendidas en México, pero producidas en distintos países. La caracterización se llevó a cabo a través de la espectrofotometría de absorción atómica con flama, cuyo análisis demostró la presencia de plomo en todas las muestras con una concentración entre 1.1775 ppm a 1.8242 ppm, con una concentración promedio de 1.457 ppm, esta concentración está dentro del parámetro establecido por la FDA (Administración de alimentos y medicamentos). Sin embargo, el contenido en productos de uso cotidiano, aunque esté debajo del límite, puede ser dañino a la salud. Por otra parte, realizando el análisis de diversas investigaciones podemos concluir que las concentraciones de plomo en lápices labiales producidos en países de primer mundo son más bajas que las que se producen en países en vías de desarrollo. Como resultado, sugerimos que se realice una búsqueda de nuevos componentes que eviten la presencia de plomo, que sean sustentables y que no constituyan un riesgo potencial a la salud de los usuarios.
**Descriptores:** Plomo, lápices labiales, FDA, espectrofotometría de absorción atómica.

## Introduction

Throughout history, the use of cosmetic products has been a recurrent activity among humanity that leaded to the development of multiple articles in order to give the skin a better appearance particularly, the face. Back in time, ancient civilizations developed the art of cosmetology such as the Egyptians, who created an alabaster powder, salt and honey-based scrubs and made creams that were composed of incense, wax, moringa oil and cypress to correct facial wrinkles (Salvater, 2015).

A cosmetic is a substance or preparation used in contact with many parts of the human body such as epidermis, hair, nails, lips and external genital organs for the purpose of cleaning, perfuming, protection and changing their appearance to keep them in good condition (Hernández *et al.,* 2009). The lips are one of the main targets of cosmetology as their skin is thinner, substantially irrigated and innervated and it perceives the temperature, taste and texture of food. Furthermore, lips fulfill various functions as they are the gateway of the food and drinks we consume, protect the oral structures, are a clue for phonetics and a main esthetic element (Cosmetólogas.com, La piel de la Web, 2016; Bonet *et al.,* 2007). Lipsticks are mainly used to moisturize and protect the lips externally and in addition, they color them in different shades for improving their physical appearance and in return, they should be harmless to health otherwise, they can develop certain pathological changes in the body (Azcona, 2008).

Very high level of lead in the metabolism and in the physiology can extremely affect the human body if it is stored in the blood. According to the World Health Organization, there is no level of lead concentration in blood that can be considered risk-free; even a blood concentration of 3.5 μg/dL can affect the development of intelligence, can cause behavior problems and carry out learning difficulties. The higher the concentration of lead in blood is, the greater the severity of the symptoms and associated diseases will be; therefore, we can assume that small amounts of lead can cause big damages to health (Organización Mundial de la Salud, 2022; Mayo Clinic, 2022).

Moreover, if high concentrations of lead are absorbed through the lips, due to the use of lipsticks, many problems can arise such as astringency (González, 2021), kidney failure (O'Brien, 2022), encephalopathy Melinda & Valdivia, 2005) and gastrointestinal symptoms (Corso & Velásquez, 2014); and more frequently, in chronic toxicity the hematopoietic, nervous, gastrointestinal and reproductive systems are compromised (Azcona & Ramirez, 2015).

Now, in the toxicokinetic mechanisms when lead is in contact with the oral cavity, it leads to an increase of its concentration in the blood and it adheres to the red blood cells and thereby reaching the tissues of the liver, kidney, bone marrow and central nervous system (Moreno & Granada, 2012). Within a measured period of 1 to 2 months, lead can diffuse into the bones where it remains inert and nontoxic causing diarrhea, vomiting and initial nausea which are derived from mild poisoning and can end up in irritation of intestinal mucosa (Ramírez, 2010). By studying the oral cavity, there are marked signs of lead poisoning caused by a long-lasting exposure to this heavy metal from astringency marked signs with symptoms such as drainage and shrinkage of the oral cavity, a metallic taste, grayish discoloration with a bluish line on the buccal mucosa (gums), chronic poisoning and ptyalism (Villalva *et al.,* 2011; Atachao, 2017).

The use of lead in lipsticks has the purpose to give a better gloss, durability and consistency, as well as, intensify the colors and give a better appearance to this type of products. On the other hand, pigments give lipsticks color coverage and its concentration can oscillate between 1 to 10 percent (Estée Lauder Companies, 2019; Álvarez, 2020). Besides giving color, lead works as a stabilizer by turning the molecules more rigid and in consequence, increasing the duration of the product on the skin (Gonzalez & Oriela, 2013). This component has been very controversial within the cosmetic industry, since it has been indicated that the presence of lead in hair dyes, makeup, shadows and lipsticks has caused certain damages to the consumer (Ruíz *et al.,* 2019). Alternatively, the FDA determined that up to 10 ppm do not cause any risk in health considering that the intake of lead is very low and the levels cannot be monitored in blood (Administración de Alimentos y Medicamentos, 2022).

Though, lead in lipsticks can be tested by using the flame atomic absorption spectroscopy which consists of sucking the sample directly into a laminar flow flame in order to create atoms in their fundamental state of the elements present in it within a temperature range of 1500 °C to 3000 °C enough to produce the atomization of a large number of elements that absorb a certain part of the radiation coming from the light source (Razmilic, 2014).

## Methodology

Five brands of red lipstick marketed in Mexico and manufactured in different countries were selected and they were weighed as follows: 0.214 g for *sample 1*, 0.219 g for *sample 2*. 0.255 g for *sample 3*, 0.208 g for *sample 4* and 0.248 g for *sample 5*. Subsequently, the analytic method of flame atomic absorption spectroscopy was carried

out in the BASE laboratory to have the quantitative determination of the heavy metal in the samples by using the Varian branded equipment at a wavelength of 185-190 nm and a Spectraa 200ht model with a serial number EL97033468 located in the State of Mexico.

## Results

Numerous studies have evaluated the presence of Pb and other heavy metals in cosmetic products and have raised concerns about the potential health impact associated with the application of these products. The toxicokinetics of Pb is relatively well understood (Philip, Gerson, 1994, Rabinowitz, 1991). Blood is the conduit for Pb transport throughout the body to and from various tissues; as a result, it is the most useful biomarker for determining a dose-response relationship for Pb-related effects (Mushak, 2003). Currently, there are several health-based standards for blood Pb levels (BLLs), and these are largely based on the occurrence of neurobehavioral defects as a result of low BLL levels. The US Environmental Protection Agency (EPA) has concluded that a BLL above 10 μg/dL poses a health risk to children (US EPA (United States Environmental Protection Agency), 1998, US EPA (United States Environmental Protection Agency), 2013, (Monnot *et al.*, 2015).

Considering the results hereby presented that show the concentration of lead in lipsticks marketed in Mexico it was decided to reduce the number of variables while testing the same red tone in all the selected samples as it seems to be the most popular among women and men due to its great versatility on any skin color, its elegance and the optimization of the user´s image (Villarreal, 2013). On the Figure 1 and on the Table 1 we can identify the lead concentration detected in the samples as it follows: the content of lead in *sample 1* was of 1.1775 ppm, 1.559 ppm in *sample 2*, 1.200 ppm in *sample 3*, 1.8242 ppm in *sample 4* and 1.5285 ppm in *sample 5*. The sample with the highest concentration of lead is number 4, produced in China containing about 18 % of

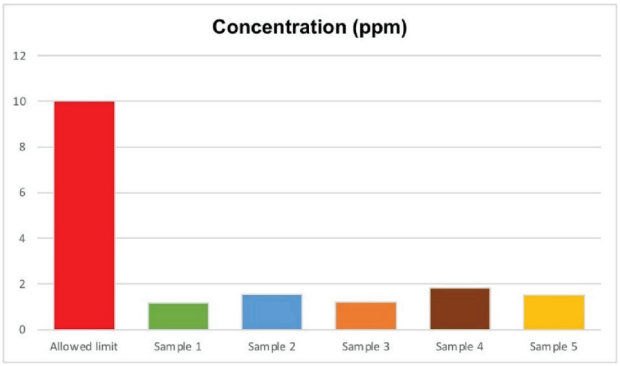


Figure 1. Lead concentration in the lipstick's samples

the maximum concentration permitted by the FDA. The average lead concentration in the tested samples is of 1.457 ppm taking into consideration that in all of them the presence of lead was detected.

As reported by a study conducted in California, USA in 2013, 32 lipsticks samples were analyzed and whereof 75 % contained an average lead concentration of 0.36 ppm and a maximum concentration of 1.32 ppm (Liu *et al.*, 2013). Another study that was released in 2012, 400 lipsticks that were sold in United States averaged a lead concentration of 1.11 ppm and only the 3.25 % of the samples exceeded the concentration of 3.06 ppm (Hepp, 2012). Meanwhile, a study made to a 26 lipsticks brands imported from countries where the security regulations are not highly stringent and were sold in South Arabia resulted in an average lead concentration of 0.73 ppm (Al-Saleh *et al.*, 2009). Likewise, 223 lip products of 55 different brands sold among some countries of the European Union were also analyzed, the results revealed that 49 samples (22 %) contained lead at a level above 1ppm, representing 31 % of the lipsticks tested and 4 % of the lip glosses. On average, the lead content found in lipsticks (0.75 ppm) was almost twice that found in lip glosses (0.38 ppm (mg/kg)) and this difference was considered statistically significant at 95 % probability. Apart from brown, statistically significant

Table 1. Lead concentration in five different brands of lipsticks and the country where they were produced

| Sample | Country of origin | Determined value (ppm) | Maximum permitted value (ppm) |
|---|---|---|---|
| 1 | France | 1.1775 | 10 |
| 2 | United States | 1.5559 | 10 |
| 3 | United States | 1.2000 | 10 |
| 4 | China | 1.8242 | 10 |
| 5 | Mexico | 1.5285 | 10 |

lead levels were also found when comparing the average lead contents in lipsticks and lip glosses of the same shade: pink (0.81 and 0.38 ppm), purple (0.88 and 0.37 ppm) and red (0.58 and 0.25 ppm). The influence of price on lead content was studied for the two types of lip products separately. In the case of lip glosses, no differences were found. In the case of lipsticks, the more expensive items (price category III) contained significantly less lead compared to the cheaper items (Piccinini *et al.,* 2013). A study in Peru of 24 lipsticks of 5 different brands resulted in an average lead concentration of 2.1 ppm (Alvarado *et al.,* 2014). Feizi *et al.* (2019) carried out a study of composition of makeup products grades in markets of Iran, mean concentrations of Pb and Cd were 41.86 and 53.42 μg/g, respectively. Concentrations of lead were higher than those of Cd in lipsticks, while for eye pencil, Cd showed higher concentrations. The overall results indicated that in all brands and colors of lipsticks, only 33 % of the samples had Pb content less than the FDA limit, and among lipstick samples, 44 % had Cd concentration less than the FDA limit of 3 μg/g, however, in 100 % of the eye pencil samples, the concentration of Cd was higher than the recommended value of 3 μg/g. Finally, in South Africa, Brandao (2012) found that lead levels in lipsticks, lip gloss and foundation ranged from non-detected to 73.1 ± 5.2 μg/g , 4.7 to 11.7 ± 2.8 μg/g and 7.8 to 32.9 ± 1.4 μg/g, respectively. Therefore, in most samples, lead concentrations are higher than the USFDA maximum allowable concentration of 0.10 μg/g in candy and cosmetics. In lipsticks alone, only 25 % of 40 samples met the requirement. Therefore, the continued use of cosmetic products in which the concentration of lead exceeds the maximum allowable level may pose a health hazard to the female population in the long term. Eventually, we can conclude that the lead concentration in lipsticks distributed in the first world countries where the security regulations are highly qualified is lower than the one in those distributed in the developing countries.

According to what the FDA quotes word-for-word: "In our strict rules and regulations in terms of health that focuses on the large amounts of heavy metals in cosmetics, for instance the Lead (Pb), which must be contained in every lipstick that is imported and exported internationally, should be in the range of 0 to 10 ppm each one. If it exceeds the prescribed range, the product will have to be commercially withdrawn, to avoid any type of harm to consumers" (Llahuilla, 2017). Based on this parameter, the results obtained from the 5 samples that were tested and the references that were consulted we can conclude that the values ranged on every part per million "ppm" comply with the acceptance and quality levels imposed by the FDA. Nevertheless, the lead amount found in the samples contains dyes used in the industry to provide gloss quality, color durability and stability; colorants provide the main active ingredients or compounds responsible for the color, in addition to some salts, which can contain unwanted substances called contaminants, being the lead one of the most common. These compounds even if they are within the permitted limits, can cause toxic and/or cumulative effects in people who use it frequently (Cobar *et al.,* 2006; Gioffre, 2021). In the same way, if there is a concentration above the established limits it causes damage to the nervous, reproductive, bone and carcinogenic systems. For this reason, some controversy has been triggered because lipsticks are used continuously and could generate an accumulation of lead in the body and end up in poisoning being the reason why analytical techniques should be taken into consideration to be able to identify the content of lead (Gallegos *et al.,* 2005).

Most of the colorants used in lipsticks are composed of lead acetate ($Pb(C_2H_3O_2)_2$), which is an organic salt, and it is considered organic in nature can be absorbed through the skin, therefore, it represents a greater risk to health (Laguna & Ricaldi, 2017). This compound is marked by the FDA as a contaminating substance that enters into a promulgated classification of "Non-certifiable compound" and must fulfill the requirements of identity, specifications, restrictions and labeling to be considered and used in the product manufacturing at its demand (Medrano, 2019).

The regulation known as "NOM -141-SSA1/SCFI-2012" for the labeling of prepackaged cosmetic products states that the names of the ingredients in those products that have a lack of space due to their size may appear on a secondary container, if any, on an attached printed flyer or on a flag label but lipsticks do not comply with this regulation because the presentation of this product in department stores doesn´t have any secondary container, label, sun protector factor, expiration date, precautionary legend and batch number (Diario Oficial de la Federación, 2012). In this way, consumers are not aware of the product´s composition and thus the damage that can be caused by its regular use.

## Conclusions

Along this research, the concentration of lead in lipsticks was analyzed as it is a cosmetic product that is frequently used by a large percentage of the population. Furthermore, the presence of lead in lipsticks was determined through a flame atomic absorption spectroscopy while testing 5 different brands of lipstick. All samples show the presence of lead in a range between

1.1775 ppm to 1.8242 ppm and even they fulfill the concentration limit established by the FDA, there are potential health risks if they are used regularly. In conclusion, it is suggested to make a change in the regulation to forbid the use of compounds that contain potentially toxic metals, like lead acetate, in beauty products so user´s health is not committed to risk. The use of alternative, sustainable and innocuous components must be a priority for companies, governments and the healthcare sector.

Given the health risks of exposure to heavy metals and in order to increase community awareness about the harmful effects of cosmetics, it is necessary to monitor the concentration of these toxic elements in these products and encourage the manufactures to meet the FDA standards.

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