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Original article

Assessment of Lead and Iron Concentration in Cosmetics Traded in the AL-Ajilat City Market

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ABSTRACT

This study examined the concentrations of heavy metals, namely lead (Pb) and iron (Fe), in lipsticks, foundations, and face powders to ensure compliance with international safety standards and assess potential health risks. Using atomic absorption spectroscopy (AAS), samples were analyzed for heavy metal content and compared to WHO, FDA, and Health Canada guidelines. Results included that lead levels in lipsticks ranged from 0.03 to 6.15 ppm, with one sample exceeding the WHO limit of 0.01 ppm, raising safety concerns. Iron levels were alarmingly high, with a maximum of 2,566 ppm, well above the WHO guideline of 0.3 ppm. Baseline samples consistently showed low levels of lead at 0.03 ppm, but iron concentrations reached 5,735 ppm, indicating significant safety deviations. Lead concentrations in the face powders ranged from 0.03 to 2.14 ppm, with some exceeding the WHO limit, while iron levels averaged 2,613 ppm, well above acceptable limits. The study concluded that high iron levels in these cosmetic products pose health risks, stressing the need for stricter regulatory oversight and quality control in the cosmetics industry.

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INTRODUCTION

Cosmetic products, such as lipstick, foundation, and face powder, are widely used by individuals across various age groups and demographics. These products often come into direct contact with the skin, which raises concerns about the potential for heavy metal contamination. Heavy metals like lead (Pb) and iron (Fe) are of particular interest due to their potential health risks, even at low concentrations. The prolonged use of cosmetics containing these metals can lead to their accumulation in the body, potentially causing toxic effects. This study aims to quantify the concentrations of lead and iron in selected cosmetic products and to compare these values with international safety standards set by organizations such as the World Health Organization (WHO), the U.S. Food and Drug Administration (FDA), and Health Canada.

Several studies have reported the presence of heavy metals, particularly lead, in various brands of lipsticks. A study by Al-Saleh and colleagues analyzed lead concentrations in lipsticks sold in the Saudi Arabian market and found that many products exceeded the permissible limits set by international health organizations [1]. These findings have raised

concerns about the safety of these products, particularly when used over long periods. Research conducted by Adepoju-Bello et al, at Heavy Metal Contamination in Foundations in Nigeria focused on the presence of lead and other heavy metals in face foundations [2]. Their findings indicated that some foundations contained heavy metal concentrations that were significantly higher than the recommended limits. The study emphasized the need for stringent regulatory measures to ensure consumer safety. While A study by Chauhan et al, investigated the levels of lead and iron in various face powders available in the Indian market.

The research highlighted that some face powders contained iron levels much higher than the safety limits, posing potential health risks due to prolonged exposure. The study called for increased awareness and monitoring of heavy metal content in cosmetic products [3]. A comprehensive review discussed the global issue of heavy metal contamination in cosmetic products, emphasizing the need for uniform international regulations [4]. The review included data from multiple countries and compared the levels of lead and iron in cosmetics against various international safety standards and a study by Kalla et al, focused on the regulatory frameworks governing the permissible levels of heavy metals in cosmetics [5]. Therefore, this study aims to evaluate the concentrations of lead and iron in cosmetics sold in the markets of AL-Ajilat city.

METHODS

Sample collection

Five samples from three types of cosmetic products, namely lipstick, foundation, and face powder, were collected from a local shop in the Municipality of Ajilat in 2023. All products had an expiration date extending to 2025, as detailed in Table 1.

Table 1. Types of Samples Used in the Study

Product Type	**Lipstick**	**Foundation**	Face Powder
Sample 1	A1 The Balamjour	B1 Inglot	C1 Inglot
Sample 2	A2 Flomar	B2 Long Wear	C2 Flomar
Sample 3	A3 Kiss Me	B3 Farfasha	C3 Rude
Sample 4	A4 Naked10	B4 Loreal	C4 Final Touch
Sample 5	A5 Romantic	B5 Fit Me	C5 Fit Me

Sample digestion

The samples were prepared and digested at the Advanced Libyan Center for Chemical Analysis Laboratories Tajoura, following the method outlined by the U.S. Environmental Protection Agency (US EPA) [7]. Approximately 1.36-1.5 g of each sample was accurately weighed and placed in a beaker. Following this, 10 mL of concentrated nitric acid (HNO_3) was added, and the beaker was covered with a watch glass.

The beaker was then heated in an oven at approximately 95°C for a duration of 10-15 minutes. After this initial heating, an additional 5 mL of concentrated nitric acid was introduced, and the solution was left in the oven until brown fumes were observed emanating from the mixture. Another 5 mL of concentrated nitric acid was added until the evolution of brown fumes ceased.

The solution was kept in the oven for an extended period of two hours, during which the volume was reduced to approximately 5 mL. Once cooled, 2 mL of deionized water and 3 mL of 30% hydrogen peroxide were added. The mixture was covered and allowed to react for 10 minutes. This addition of hydrogen peroxide was repeated until the reaction was deemed complete, resulting in a total of 8 mL of hydrogen peroxide being added. After letting the solution cool again, 10 mL of concentrated hydrochloric acid (HCl) was added to the beaker. The mixture was cooled once more and then filtered into a 50 mL volumetric flask using Whatman filter paper No. 41. Finally, the volume of the solution was adjusted with deionized water to achieve the desired concentration.

Measurement process

The concentrations of lead (Pb) and iron (Fe) were determined at the Libyan Petroleum Institute laboratories using an Inductively Coupled Plasma Optical Emission Spectrometer (ICP-OES).

A standard calibration curve was created using primary standard solutions of lead and iron at concentrations of 0.1, 1, 5, and 10 ppm. Deionized water was used to make the volume up to 100 mL, and the absorbance of the samples was measured at a wavelength of 220.35 nm for lead and 259.940 nm for iron.
A blank solution was prepared following the same digestion method, but without the sample. The concentrations of the sample solutions were measured under the same conditions as the standard solutions. Each measurement was conducted three times, and the average readings were recorded for accuracy.

Data analysis
Descriptive statistics such as frequency (%), mean and standard deviation were used to present the characteristics of the samples as appropriate. The results of the study and its characteristics were compared with the standard numbers of the analyses.

RESULTS
Results of the lipstick sample analysis are presented in table 2, which shows the concentrations of lead (Pb) and iron (Fe) in the tested lipstick samples.
The lipstick samples were analyzed to determine their heavy metal content, specifically lead (Pb) and iron (Fe). According to the results shown in Table 2, the average lead concentration was 1.25 ppm, with the highest value recorded for sample A2 (6.15 ppm) and the lowest values for the remaining samples (0.03 ppm). Notably, all lead levels in the lipstick samples were within the permissible limit set by the World Health Organization (WHO), which is 0.01 ppm.
However, the average concentration of iron in the lipstick samples was found to be 299 ppm, with the highest concentration observed in sample A2 (2566 ppm) and the lowest in sample A5 (20 ppm). These values are significantly higher than the WHO recommendation of 0.3 ppm, indicating potential health risks. When compared to international standards, such as those set by the FDA and Health Canada, the iron content in these samples is excessively elevated, raising concerns about their safety and compliance with global safety guidelines.

Table 2. Lipstick Sample Analysis

Sample No & Type	Pb (ppm)	Fe (ppm)	Quality
A1 (The balamjour)	0.03	60	Good
A2 (Flomar)	6.15	2566	Moderate
A3 (KISS ME)	0.03	54	Good
A4(NAKED10)	0.03	296	Good
A5(ROMANTIC)	0.03	20	Good
X	1.25	599	Moderate
STD	2.74	1105	Moderate
WHO	0.01	0.3	Recommended
FDA	< 20 ppm	-	Acceptable
Health Canada	< 10 ppm	-	Acceptable

The results of the foundation sample analysis are presented in Table 3, which details the concentrations of lead (Pb) and iron (Fe) in the tested foundation samples.

Table 3. Foundation Sample Analysis

Sample No & Type	Pb (ppm)	Fe (ppm)	Quality
B1 (INGLOT)	0.03	1514	Moderate
B2 (LONG WEAR)	0.03	2721	Moderate
B3 (FARFASHA	0.03	650	Moderate
B4 (LOREAL)	0.03	2353	Moderate
B5 (FIT ME)	0.03	5735	Poor
X	0.3	2124	Poor
STD	0.0	2261	Standard
WHO	0.01	0.3	Recommended
FDA	< 20 ppm	-	Acceptable
Health Canada	< 10 ppm	-	Acceptable

The foundation samples were analyzed to determine their content of heavy metals, specifically lead (Pb) and iron (Fe). According to the results shown in Table 3, the lead concentration for all samples was consistently 0.03 ppm. This level is below the permissible limits set by the World Health Organization (WHO) and the U.S. Food and Drug Administration (FDA).

The average concentration of iron in the foundation samples was found to be 2124 ppm, with the highest concentration observed in sample B5 (5735 ppm) and the lowest in sample B3 (650 ppm). These levels significantly exceed the WHO's recommended maximum limit of 0.3 ppm for iron in cosmetic products**.** The results of the face powder sample analysis are presented in Table 4, which details the concentrations of lead (Pb) and iron (Fe) in the tested face powder samples.

Table 4: Results of Face Powder Sample Analysis

Sample No & Type	Pb (ppm)	Fe (ppm)	Quality
C1 (INGLOT)	0.03	1648	Moderate
C2 (FLOMAR)	0.03	7182	Poor
C3 (RUDE)	1.70	3105	Poor
C4 (FINAL TOUCH)	1.83	1146	Poor
C5 (FIT ME)	2.14	812	Poor
X	1.15	2779	Moderate
STD	1.03	2613	Standard
WHO	0.01	0.3	Recommended
FDA	< 20 ppm	-	Acceptable
Health Canada	< 10 ppm	-	Acceptable

The face powder samples were analyzed to determine their heavy metal content, specifically lead (Pb) and iron (Fe). According to the results shown in Table 4, the average lead concentration was 1.15 ppm, with the highest value recorded for sample C5 (2.14 ppm) and the lowest values (0.03 ppm) observed in samples C1 and C2. Although these lead levels exceed the World Health Organization's (WHO) recommended limit of 0.01 ppm, they remain within the broader permissible limits set by the FDA and Health Canada. The average concentration of iron in the face powder samples was found to be 2613 ppm, with the highest concentration observed in sample C2 (7182 ppm) and the lowest in sample C5 (812 ppm). These values significantly exceed the WHO's recommended limit of 0.3 ppm, raising concerns about their safety.

DISCUSSION

The analysis of heavy metals in cosmetic products, specifically lipstick, foundation, and face powder, reveals concerning levels of lead (Pb) and iron (Fe) in some samples, raising significant questions about product safety and compliance with international standards.

Previous studies have generally reported lead concentrations in cosmetic products such as lipstick within acceptable limits set by global health organizations, including the World Health Organization (WHO), the U.S. Food and Drug Administration (FDA), and Health Canada. For example, research published in the Journal of Hazardous Materials found lead levels in commercial lipsticks ranging from 0.01 to 1.5 ppm, with most products well within safety thresholds [7].

The current study aligns with these findings, showing lead concentrations in most lipstick samples at 0.03 ppm, which is below the WHO's recommended maximum limit of 0.01 ppm. However, an alarming deviation was found in sample A2, with a lead concentration of 6.15 ppm, far exceeding international safety standards and indicating potential non-compliance and significant health risks. Similarly, the foundation samples showed consistently low lead levels of 0.03 ppm, well within the safe limits defined by WHO and FDA guidelines. This is consistent with earlier studies, such as the one by Sainio et al, which reported that lead concentrations in foundation products typically fall below regulatory thresholds [8]. However, in the case of face powder, while some samples showed low lead concentrations (0.03 ppm), others, particularly samples C3, C4, and C5, presented higher levels ranging from 1.70 to 2.14 ppm. These concentrations exceed the WHO's recommended limit of 0.01 ppm, presenting a potential health risk, especially with long-term exposure, as lead is a cumulative toxin.

The iron concentrations found in this study contrast starkly with previous research. While lead is a well-known toxicant, iron's role as a potential contaminant in cosmetics is less clear but still concerning. Prior studies have typically reported iron levels in lipsticks ranging from 50 to 500 ppm. For instance, Karakaya et al. Found iron concentrations in lipsticks within this range, with the highest levels significantly lower than those found in the current study [9]. The current analysis revealed iron concentrations as high as 2566 ppm in lipstick sample A2, greatly exceeding the WHO's

recommended limit of 0.3 ppm. These elevated levels suggest possible contamination during manufacturing or the use of iron-based pigments, posing potential health risks to consumers.

The foundation samples also exhibited troubling iron levels. With an average concentration of 2124 ppm and a peak at 5735 ppm in sample B5, the findings far exceed the WHO's guideline of 0.3 ppm. Such high concentrations suggest significant deviations from safe formulation practices and highlight the potential for iron-based contamination. The face powder samples presented similarly concerning results, with an average iron concentration of 2613 ppm and a peak of 7182 ppm in sample C2. These levels are alarmingly high and suggest a severe breach of international safety standards. Although iron is not typically considered as toxic as lead, such excessive exposure, especially through inhalation of fine powders, could lead to respiratory issues and other systemic effects.

The results of this study reveal a significant deviation from international safety standards, particularly regarding iron concentrations. While WHO, FDA, and Health Canada have established stringent guidelines to minimize heavy metal exposure from cosmetics, emphasizing consumer health and product safety, the levels of iron reported in this study far exceed these guidelines. The WHO's recommended maximum of 0.3 ppm for iron was surpassed in all product categories, indicating potential hazards and the need for more rigorous quality control and regulation in cosmetic manufacturing.

While the lead content in foundation samples remains within safe limits, the excessively high iron concentrations pose potential health risks, indicating the need for stricter oversight and adherence to international cosmetic safety guidelines. The same concerns apply to the face powder samples, where both lead and iron concentrations in some instances exceed international safety thresholds. These findings underscore the importance of continuous monitoring, regulatory enforcement, and adherence to global safety standards in the formulation and production of cosmetic products to ensure consumer safety.

CONCLUSION

In conclusion, the study reveals that while the lead content in the foundation samples is within safe limits, the excessively high iron concentrations pose potential health risks, indicating the need for stricter oversight and adherence to international cosmetic safety guidelines. This concern extends to the face powder samples as well, which show varying levels of lead and significantly elevated levels of iron, with some samples exceeding international safety standards. These findings highlight a concerning deviation in heavy metal content, especially iron, compared to previous research and established global safety thresholds. The presence of high levels of iron, and in one instance, lead, suggests potential risks to consumer health and underscores the critical importance of continuous monitoring and strict compliance with regulatory standards in the production of cosmetic products.

Conflict of interest. Nil

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تقييم تركيز الرصاص والحديد في مستحضرات التجميل المتداولة في أسواق مدينة العجيلات

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المستخلص

فحصت هذه الدراسة تركيزات المعادن الثقيلة، وهي الرصاص والحديد، في أحمر الشفاه وكريمات الأساس وبودرة الوجه لضمان الامتثال لمعايير السلامة الدولية وتقييم المخاطر الصحية المحتملة. وباستخدام مطيافية الامتصاص الذري، تم تحليل العينات لمعرفة محتواها من المعادن الثقيلة ومقارنتها بإرشادات منظمة الصحة العالمية وإدارة الغذاء والدواء ووزارة الصحة الكندية. وتضمنت النتائج أن مستويات الرصاص في أحمر الشفاه تتراوح من 0.03 إلى 6.15 جزء في المليون، مع تجاوز إحدى العينات للحد الأقصى لمنظمة الصحة العالمية البالغ 0.01 جزء في المليون، مما أثار مخاوف تتعلق بالسلامة. وكانت مستويات الحديد مرتفعة بشكل مثير للقلق، حيث بلغ الحد الأقصى 2566 جزء في المليون، وهو أعلى بكثير من إرشادات منظمة الصحة العالمية البالغة 0.3 جزء في المليون. وأظهرت العينات الأساسية باستمرار مستويات منخفضة من الرصاص عند 0.03 جزء في المليون، لكن تركيزات الحديد وصلت إلى 5735 جزء في المليون، مما يشير إلى انحرافات كبيرة تتعلق بالسلامة. وتراوحت تركيزات الرصاص في بودرة الوجه من 0.03 إلى 2.14 جزء في المليون، مع تجاوز بعضها للحد الذي حددته منظمة الصحة العالمية، في حين بلغ متوسط مستويات الحديد 2613 جزء في المليون، وهو ما يفوق الحدود المقبولة بكثير. وخلصت الدراسة إلى أن ارتفاع مستويات الحديد في هذه المنتجات التجميلية يشكل مخاطر صحية، مؤكدة على الحاجة إلى رقابة تنظيمية أكثر صرامة ومراقبة الجودة في صناعة مستحضرات التجميل. وتشمل التوصيات تحسين ممارسات المراقبة، وتعديل التركيبات لتقليل محتوى الحديد، ومواصلة التحقيق في مصادر التلوث.

مفاتيح الكلمات. المعادن الثقيلة، منظمة الصحة العالمية، إدارة الغذاء والدواء، عنصر الرصاص، عنصر الحديد.