The North African Journal of Scientific Publishing (NAJSP)
مجلة شمال إفريقيا للنشر العلمي (NAJSP)
EISSN: 2959-4820
Volume 1, Issue 4, October-December 2023, Page No: 1-7
Website: https://najsp.com/index.php/home/index
SJIFactor 2023: 3.733 ISI 2023: 0.383

Determination of Mercury in Some Cosmetics Offered in the Iraqi Market

Hussein A. Ibrahim [1*], Hana Sh. Mahmood [2]
[1, 2] Department of Chemistry, College of Science, Mosul University, Iraq

*Corresponding author: hussein.21scp31@student.uomosul.edu.iq

Received: August 01, 2023	Accepted: September 18, 2023	Published: October 01, 2023

Abstract:
Mercury was estimated in twenty facial cosmetics, including five lipsticks of different origins and in various colors, and twenty facial cosmetics, including eyeliner, eyeliner, lip liner, and others, from different origins. As 2 grams of each preparation was taken, an acid digestion process was carried out using nitric acid with a concentration of (69%) and heating to 90 degrees, and an oxidation step was performed after cooling using one millilitre of hydrogen peroxide with a concentration of (30%), then the resulting solution was filtered and the remaining volume was completed with empty water of ions in a 10 ml volumetric vial. Mercury was measured with a flame atomic absorption device at a wavelength of 253.7 nanometers. The relative standard deviations, RSD%, ranged from 0.74 to 3.73%, and the relative error, %Error, ranged from -3.06 to 1.06%. The results showed the presence of mercury in all samples under study, with concentrations ranging between 0.070 and 0.510 µg/mL, which is within the safe limit set by the WHO. The global level is 1 microgram/ml.

Keywords: Atomic, Absorption, Mercury, Cosmetics, Toxic.

Cite this article as: H. A. Ibrahim, H. Sh. Mahmood, "Determination of Mercury in Some Cosmetics Offered in the Iraqi Market," *The North African Journal of Scientific Publishing (NAJSP),* vol. 1, no. 4, pp. 1–7, October-December 2023.

تقدير الزئبق في بعض مستحضرات التجميل المطروحة في الأسواق العراقية

حسين علي ابراهيم [1*]، هناء شكر محمود [2]
[1،2] قسم الكيمياء، كلية العلوم، جامعة الموصل، العراق

الملخص
تم تقُدير الزئبق بعشرين مستحضر تجميل للوجه، منها خمسة أحمر شفاه من أصول مختلفة وبألوان مختلفة، وعشرين مستحضر تجميل للوجه منها الكحل والكحل ومحدد الشفاه وغيرها من أصول مختلفة. حيث تم أخذ 2 جرام من كل مستحضر، وتم إجراء عملية هضم الحمض باستخدام حامض النيتريك بتركيز (69%) والتسخين إلى 90 درجة، وتم إجراء خطوة الأكسدة بعد التبريد باستخدام مليلتر واحد من بيروكسيد الهيدروجين بتركيز (30%)، ثم يتم ترشيح المحلول الناتج ويتم استكمال الحجم المتبقي بماء فارغ من الأيونات في قارورة حجمية سعة 10 مل. تم قياس الزئبق بجهاز امتصاص ذري لهب عند طول موجي قدره 253.7 نانومتر. وتراوحت الانحرافات المعيارية النسبية، *RSD*%، من 0.74 إلى 3.73%، وتراوح الخطأ النسبي، *Error* %، من -3.06 إلى 1.06%. وأظهرت النتائج وجود الزئبق

في جميع العينات قيد الدراسة، بتراكيز تتراوح بين 0.070 و0.510 ميكروغرام/مل، وهو ضمن الحد الآمن الذي حددته منظمة الصحة العالمية. المستوى العالمي هو 1 ميكروجرام/مل.

الكلمات المفتاحية: الذري، الامتصاص، الزئبق، مستحضرات التجميل، السمية.

Introduction

Cosmetics contain mercury, which is highly toxic, especially after prolonged and repeated use [1] The World Health Organization considers mercury to be one of the top ten chemicals or groups of chemicals with the greatest risk to public health. Mercury exists in various forms: elemental (or metallic), organic and inorganic [2]. It exists in the form of organic compounds (such as methylmercury and ethyl mercury) and inorganic compounds (such as mercuric chloride, sulfate or nitrate) [3,4]. Mercury is widely used in the manufacture of batteries, in the chemical industry, such as pesticides, and is also found in cosmetics [5]. Mercury can affect the central nervous system by crossing the placenta and reaching the fetal brain [6]. Topical mercury preparations are absorbed through the skin into the bloodstream and accumulate mainly in the liver. The amount absorbed varies depending on the chemical form of mercury and other components of the preparation [7]. The use of cosmetics can be harmful if it is excessive, as it forms lines or black spots called hyperpigmentation. Pigmentation [8]. Mercury levels in some cosmetics and body moisturizing products may be minimal and may not exceed 0.003 parts per million [9]. Studies have been conducted to evaluate heavy metals in the urine of women who use a certain type of skin care product for a period of time. 45 days in New York and Hong Kong showed a high concentration of mercury in urine. This was done by comparing them with a group of residents of the same city who did not use these products over a period of 45 days before the experimental analysis [10]. Another study showed that Some skin-lightening creams searched for mercury and recorded levels ranging from 0.01 to 2.3 parts per million. It was found that 60% of the samples analyzed had mercury levels higher than 1 part per million, which is the safe limit set by the World Health Organization [11]. Mercury can be estimated using atomic fluorescence spectrometry, which is one of the methods of fluorescence spectroscopy (also known as fluorometry or spectrofluorometry), as well as it can be estimated using electrical methods [12]. It can be estimated using flame atomic absorption spectrum. The aim of this study is to estimate mercury in 20 cosmetics using an atomic absorption spectrophotometer.

I. Apparatus

1- Atomic absorption spectrophotometer- GBC 933 plus – Australia; with hallow cathode Lampe and air-acetylene flam. the conditions of measurements are as listed in

Table (1): Operating conditions for the flame atomic absorption device.

The conditions of measurements	Heavy metals
	Hg
Wavelength (nm)	253.7
Lamp current (mA)	3.0
The intensity of the column (mA)	0.5
Burner height	10.0

2- Balances: Keren-Swaziland
3- Hearts: Hot plate -JX-1010B-Turkey
4- Thermometer Mercury thermometer-Britain
5- Water bath: karal kolb –German

II. Materials and Methods

1- information on Lipstick brand, symbol, and origin are listed in Table (2).

Table (2): The information of Lipstick used in the study.

Sample	Cosmetic	Brand	color	No.	Origin
L1	Lipstick	Golden-sbouhh	red	04	China
L2	Lipstick	Pretty by flormer	red	10	Turkey
L3	Lipstick	Diamond beauty	red	9	China
L4	Lipstick	NOTE	Brown	313	France

Sample	Cosmetic	Brand	color	No.	Origin
L5	Lipstick	ZD	Pink	02	China
L6	Lipstick	NOTE	Red deep	308	France
L7	Lipstick	3Q	Pink dark	807	China
L8	Lipstick	Habibib beauty	Burgundy	07	China
L9	Lipstick	Golp	Pink	08	China
L10	Lipstick	Tester	Pink	510	England

2- information of eyebrow and lip-pencil and eyeliner and contour lip brand, symbol, and origin are listed in Table (3).

Table (3): The information of eyebrow and lip-pencil and eyeliner and contour lip used in the study.

Sample	Cosmetic	Brand	color	Origin
E1	Eyebrow	Former	Black	Turkey
E2	Eyebrow	Levelbeauty	Black	China
E3	Eyeliner	Smoothing	Black	China
E4	Eyebrow	XP	Black	Turkey
E5	Lippencil	Pretty	Pink	France
E6	Eyeliner	Fabfasha	Black	China
E7	Contour lip	Topface	brown	Turkey
E8	Eyeliner	Former	Brown	Turkey
E9	Contour lip	Hudabeauty	gray	China
E10	Eyeliner	Original bell	White	German

3- practical part Mercury ion solution HgCl2 (100 µg/ml)

A standard solution of mercury ions (Hg^{+2}) with a concentration of 100 ppm and a volume of 100 ml of mercury chloride salt (HgCl2), molecular weight (271.52 g/mol) was prepared by dissolving 0.01353 g of salt in 100 ml of ion-free water in a volumetric vial.

4- Prepare a calibration curve for mercury

Diluted solutions were prepared with concentrations ranging between (3 and 13 micrograms/ml), then the absorption was measured with a flame atomic absorption spectrophotometer and at appropriate operational conditions for mercury. Figure (1) shows the calibration curve for mercury, as the linearity was good and the value of R^2 was $R^2 = 0.980$, and the curve follows. Beer's law in the chosen range of estimation and the molar absorption coefficient was $\varepsilon = 434.432$ litre. $mol^{-1}.cm^{-1}$.

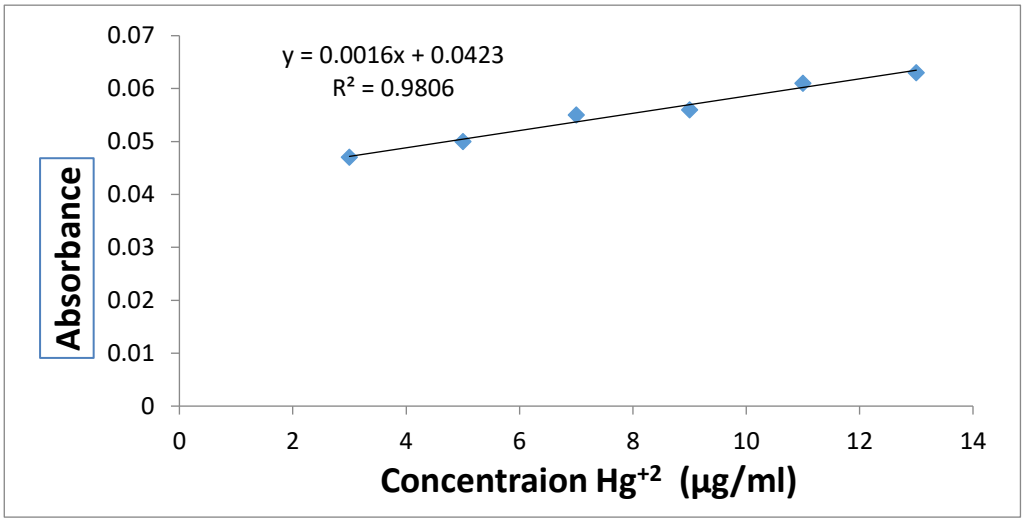

Figure (1): Calibration curve for mercury.

5- **Accuracy and compatibility of the mercury ion calibration curve**

The accuracy and agreement of the calibration curve of the mercury chloride solution was studied by taking specific concentrations that fall on the calibration curve and repeating the measurement with a flame atomic absorption spectrophotometer three times for each concentration. Then the values of the relative error% and the relative standard deviation RSD% were calculated.

Table (4): Accuracy and precision in the calibration curve for a solution of mercury ions.

Hg(µg/ml)-Taken	-Hg (µg/ml) Found	Error%	RSD%
7	7.27	3.85	4.56
11	11.16	1.45	2.11

It can be seen from Table (4) that the relative standard deviation RSD% of the mercury calibration curve ranges from 2.11 to 4.56, and the relative error% ranges from 1.45 to 3.85.

III. Digestion and sample preparation

2 grams of each preparation was taken and an acid digestion process was carried out using 10 millilitres of nitric acid at a concentration of (69%) and heated to 90 degrees and an oxidation step was performed after cooling using one millilitre of hydrogen peroxide at a concentration of (30%), then filtering the resulting solution and completing the remaining volume with deionized water in a 10 ml volumetric vial. The results below show the recovery values of the samples under study.

Table (5): Mercury concentration in lipstick and facial cosmetics.

Sample-facial cosmetic	Concentration (µg/ml)
E_1	0.376
E_2	0.363
E_3	0.319
E_4	0.453
E_5	0.829
E_6	0.325
E_7	0.280
E_8	0.446
E_9	0.510
E_{10}	0.478
Sample-Lipstick	Concentration (µg/ml)
L_1	0.140
L_2	0.459
L_3	0.108
L_4	0.197
L_5	0.070
L_6	0.076
L_7	0.185
L_9	0.082
L_{10}	0.248

It is clear from Table (5) that the highest concentration of mercury is in samples E5 and E9, relative to the rest of the preparations under study, but in general, the concentration of mercury is lower than the limit permitted by the World Health Organization, which is 1 microgram/ml [13].

Figure (2) shows a graph showing the concentration of mercury in lipstick samples. The mercury content shows the highest content in sample L2, but it is still in the acceptable range according to the permissible percentage of the World Health Organization, which is 1 microgram/ml.

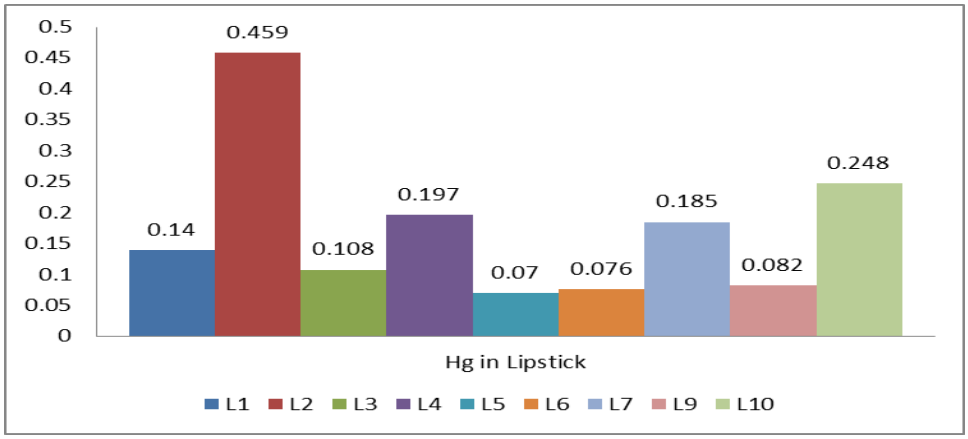

Figure (2): Graph of mercury concentration in lipstick samples.

Figure (3) shows a graph showing the concentration of mercury in lipstick samples. The mercury content is relatively high in all samples. The highest content was in sample E5, but it was still in the acceptable range according to the percentage allowed by the World Health Organization, which is 1 microgram/ml.

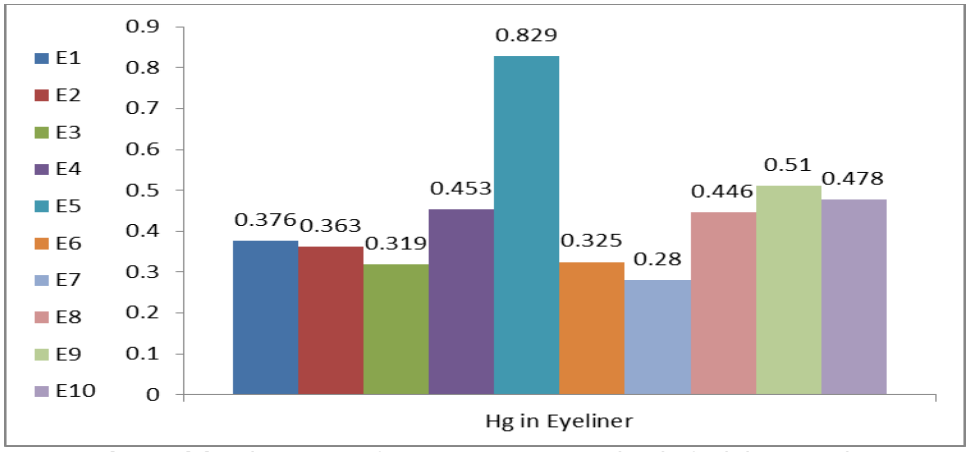

Figure (3): Histogram of mercury concentration in facial cosmetics Samples.

VI. Statistical tests

1- **Accuracy and compatibility of some samples under stud**

The accuracy of the analysis of the selected heavy elements in the selected cosmetics was determined for two concentrations of each product with three replications. The results in Table (6) show that the relative standard deviations (RSD) range from 0.74 to 5.45%, and the relative error (%Error) ranges from -3.06 to 3.7 %.

Table (6): Accuracy and compatibility in the samples under study.

Sample	Taken-Hg (µg/ml)	Found-Hg (µg/ml)	Error %	RSD %
E1	0.376	0.378	0.53	0.74
E5	0.829	0.808	-2.54	3.73
E8	0.446	0.438	-1.8	2.69
L2	0.459	0.445	-3.06	2.34
L3	0.108	0.109	0.92	3.45
L7	0.185	0.187	1.08	1.51

2- **Calculate the P-value**

The P value is the probability value of the data under the null hypothesis
for the purpose of determining the presence or absence of a significant difference between the measured value and its replicates (if the P values are less than 0.05, this indicates the existence of significant differences, and if the P values are greater than or equal to 0.05, this indicates the absence of Significant differences) and the P value was calculated using the statistical program (25, SPSS (Hinton, 2004). Table (7) does not show a significant difference between the concentration of heavy metals in cosmetics and their concentrations in repetition.

Table (7): Calculating the P value for some samples under study.

sample	Concentration-Hg (µg/ml)	Reputations	Mean	P-value
E1	0.376	0.378	0.378	0.420
		0.380		
E5	0.829	0.829	0.807	0.411
		0.790		
E8	0.446	0.445	0.438	0.423
		0.420		
L2	0.459	0.450	0.455	0.623
		0.469		
L3	0.108	0.107	0.109	0.184
		0.111		
L7	0.185	0.181	0.187	0.423
		0.194		

3- **t-test**

The method was applied to select some samples (1E, 5E, 8E, L2, 3L, 7L) under the chosen optimal conditions, each concentration repeated three times. The confidence of the proposed method has been tested and listed in Table (8) to calculate t-test.

Table (8): Calculating t-test.

Sample	Taken-Hg (µg/ml) (µ)	Found-Hg (µg/ml) **(x̄)**	N	S	t-test
E1	0.376	0.378	3	0.009750161	0.35
E5	0.829	0.808	3	0.036852145	0.98
E8	0.446	0.438	3	0.014740858	0.93
L2	0.459	0.445	3	0.01328723	2.23
L3	0.108	0.109	3	0.01245675	1.25
L7	0.185	0.187	3	0.00521168	0.664

It is clear from Table (8) that the calculated experimental t values are within the tabulated t values, which gives the method reliability in estimation.

Conclusion

Mercury was estimated in twenty facial cosmetics, including ten lipstick products from different origins and in multiple colors. Ten facial cosmetics that included eyeliner, eyeliner, lip liner, and others from different origins. The results showed the presence of mercury in all samples under study at concentrations ranging between 0.070 and 0.510 micrograms. /ml, which is within the safe limit set by the World Health Organization, which is 1 microgram/ml. Regular, continuous and long-term use of these products leads to mercury entering the human body through the skin barrier, and may lead to

the accumulation of this metal in the human body, especially in the kidneys and liver. The present method provides simple quality control of these products with precision.

References

[1] Al-Saleh, Iman, and Inaam Al-Doush. "Mercury content in skin-lightening creams and potential hazards to the health of Saudi women." *Journal of Toxicology and Environmental Health* 51.2 (1997): 123-130.

[2] Boyd, A. S., Seger, D., Vannucci, S., Langley, M., Abraham, J. L., & King Jr, L. E. (2000). Mercury exposure and cutaneous disease. *Journal of the American Academy of Dermatology*, *43*(1), 81-90.

[3] Clarkson, T. W., & Magos, L. (2006). The toxicology of mercury and its chemical compounds. *Critical reviews in toxicology*, *36*(8), 609-662.

[4] Seńczuk, W. (Ed.). (2005). *Toksykologia współczesna*. Wydawnictwo Lekarskie Pzwl.

[5] Adhani, R. H., & Husaini, H. (2017). Logam berat sekitar manusia. Banjarmasin: Lambung.

[6] Sah, R. C. (2012). *Poisonous Cosmetics: The problem of mercury in skin whitening creams in Nepal*. Sah, Ram Charitra. 2012. Poisonous Cosmetics, the Problem of Mercury in Skin Whitening Creams in Nepal, vi+ 10. Kathmandu: Cephed.

[7] Elhag, D. E., Osman, H. O., & Dahab, A. A. (2015). Investigation of mercury content in cosmetic products by using direct mercury analyzer. *American Journal of PharmTech Research*, *5*(5), 3.

[8] Hayati, N. (2014). Analisis Merkuri Dalam Sediaan Krim “A” Dan “B” (Tidak Terdaftar) Yang Dibeli Melalui Internet (Secara Online). Calyptra, 2(2), 1-12.

[9] Rumondang, I., & Lestari, A. (2012). Monitoring Merkuri Pada Kosmetika Dengan Standar Uji Asean Document ACM THA 05. *Jurnal Kimia dan Kemasan*, *34*(1), 225-230.

[10] Al-Saleh, I. (2016). Potential health consequences of applying mercury-containing skin-lightening creams during pregnancy and lactation periods. *International journal of hygiene and environmental health*, *219*(4-5), 468-474.

[11] Al-Ashban, R. M., Barratt, D. A., & Shah, A. H. (2006). Mercury contents of skin-lightening creams marketed in Saudi Arabia. *Journal of Saudi Chemical Society*, *10*, 383-388.

[12] Li, Y., Zheng, C., Ma, Q., Wu, L., Hu, C., & Hou, X. (2006). Sample matrix-assisted photo-induced chemical vapor generation: a reagent free green analytical method for ultrasensitive detection of mercury in wine or liquor samples. *Journal of Analytical Atomic Spectrometry*, *21*(1), 82-85.

[13] Attard, T., & Attard, E. (2022). Heavy metals in cosmetics.