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Measurement of the concentration of lead and cadmium in some cosmetics sold in the markets of Nalut city

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Abstract:
Cosmetics are a mixture of chemical compounds derived from natural or artificial sources, and they do not contain environmental pollutants such as heavy metals, which may pose health risk when exposed to them. Due to the scarcity of local studies on this topic, in addition to the known toxicity of lead (Pb) and cadmium (CD) Especially with daily use, this research was conducted to determine the concentration of these two ingredients in facial cosmetics (lipstick, eyeshadow, eyeliner).
30 samples were collected from the markets of Nalut City, and selected based on color, price, country of origin, and source of production. The samples were sent to the Delta Scientific Laboratory for analysis using the Atomic Absorber-Graphite Furnace (GF-AAS).
The results of the analysis showed trace concentrations of lead and cadmium in all samples, and were within the limits allowed according to the guidelines of the U.S. FDA, The World Health Organization (WHO), and Health Canada, and there were significant relation between cosmetic type, price and manufacture of lipstick and eyeshadow and lead concentration ,whereas no relation between source of kohl production and lead and cadmium concentration.
Key words: cosmetics ,Heavy metals ,Lead ,cadmium.

Introduction:

Cosmetics have been used since ancient times, as they were made from natural materials that are used to protect the skin and improve its appearance. With industrial advancements, these products have turned into complex chemical compounds that rely primarily on petrochemicals. (Attard & Attard, 2022)

According to the U.S. Food and Drug Administration (FDA), more than 12,500 chemicals are used in the cosmetics industry, and only 20% of them are considered safe by the Cosmetics Review Committee (CIR), and some studies suggest that the human body may absorb up to 5 kilograms of hazardous substances per year from cosmetics. Among these substances, heavy metals such as lead (Pb) have been detected, mercury (Hg), cadmium (Cd), arsenic (As) and nickel (Ni) in many of these products (Mohiuddin, 2019)

Heavy metals are common natural ingredients in soil, rocks, and water, so their presence in cosmetics is not surprising, and studies show that these minerals may leach into preparations as unintentional impurities from raw materials or may be deliberately and illegally added as colorants, fragrances, or preservatives to extend the life of the product (Mohammed, Ahmed, & Oraibi, 2023)

In 2009, the Italian Ministry of Health issued a decision to withdraw several cosmetics intended for children from the market after analyses showed that they contained heavy metals in high concentrations; these products included eyeliner and lipstick, which were made in China under an American brand (Noorabdul, 2017)

Studies have confirmed that heavy metals pose a risk to human health, as they are dangerous and unsafe even when exposed to them in low doses and for short periods, due to their ability to accumulate in the body over time (Alnuqaydan, 2024)

On the other hand, the location of cosmetic use adds a dangerous dimension to the problem: although the skin acts as a defensive barrier to prevent certain metals from entering the internal tissues, the use of products on the lips, eyes, or mucous membranes increases the risk of exposure to these metals. (23) (Ghaderpoori *et al.*, 2020)

Lead and cadmium are among the most common contaminants in cosmetics .Lead containing tin is used to stabilize color and produce red in some cosmetics, while cadmium is added as a yellow - orange pigment for its color properties (Raza-Naqvi *et al*., 2022)

Despite these potential health risks, cosmetics are not subject to FDA approval before they are put on the market. Only products are required to be safe according to the directions on the label. But cosmetic companies are not obligated to share their safety data or submit their product formulations to the FDA, which means companies can add whatever they want to the products we use every day and label them "safe." (Noorabdul, 2017)

Based on the above, the aim of this study was to determine the concentration of lead and cadmium elements that are not authorized in some of the commonly used cosmetics available in the markets of Nalut city.

Material and Methods :

30 samples of cosmetics were purchased from six specialist stores in Nalut based on a vendor survey to identify the most popular products, and the sample consisted of 10 types of lipsticks, 12 samples of eyeshadow and 8 samples of eyeliner. Samples of lipsticks and eyeshadows were selected according to the criteria of color, price category and country of manufacture, while samples of eyeliner were selected based on the source of their production (local or imported).

Cosmetic samples were sent to Delta Scientific Technical Services for analysis .The company used the Graphite Furnace Atomic Absorption Spectrometer.

The data were statistically analyzed using SPSS (Statistical Package For The Social Science) version (26) to analyze the data and know the results, where the significance level (P-Value) was used to find the relationship between the type of cosmetics, its price, color, country of manufacture, and the source of its production with the concentration of lead and cadmium elements.

Results Regarding Lead and Cadmium Analysis in Cosmetics

Table 1. Information on the Cosmetics Samples Studied

Price Category	Sample Code	genre	Price	Color	Country of manufacture
Low Price	L1	Lipstick	4 LD	red	China
	L2	Lipstick	5 LD	pink	China
	L3	Lipstick	5 LD	purple	China
	L4	Lipstick	4 LD	brown	China
	L5	Lipstick	5 LD	orange	China
Expensive Price	L6	Lipstick	35 LD	red	America
	L7	Lipstick	35 LD	pink	America
	L8	Lipstick	35 LD	purple	America
	L9	Lipstick	52 LD	brown	Korea
	L10	Lipstick	52 LD	orange	Korea
	E1	Eyeshadow	10 LD	brown	China
	E2	Eyeshadow	10 LD	White	China

Low	E3	Eyeshadow	18 LD	purple	China
Price	E4	Eyeshadow	18 LD	blue	China
	E5	Eyeshadow	15 LD	pink	China
	E6	Eyeshadow	15 LD	golden	China
	E7	Eyeshadow	80 LD	White	France
	E8	Eyeshadow	80 LD	purple	France
Expensive	E9	Eyeshadow	65 LD	golden	Italy
Price	E10	Eyeshadow	65 LD	pink	Italy
	E11	Eyeshadow	54 LD	blue	Britain
	E12	Eyeshadow	54 LD	brown	Britain
-	A1	Khol	6 LD	black	Pakistan
-	A2	Khol	5 LD	black	Libya
-	A3	Khol	15 LD	black	Libya
-	A4	Khol	20 LD	black	Libya
-	A5	Khol	2 LD	black	China
-	A6	Khol	10 LD	black	China
-	A7	Khol	15 LD	black	Germany
-	A8	Khol	25 LD	black	Germany

The table shows the samples collected in this study, which included three types of cosmetics: lipstick, eyeshadow, and eyeliner.

Samples have been categorized according to price category (low and expensive), type, color, and country of manufacture. The data shows that lipstick samples fall into two price categories: low-priced (4-5 LYD) and included only products of Chinese origin, and expensive (35-52 LYD) and included American and Korean products. Their colors were red, pink, purple, brown, and orange. As for eyeshadow, it also included two categories: cheap samples (10-18 LYD) from China, while expensive samples (54-80 LYD) belonged to European countries such as France, Italy, and Britain. Its colors varied between white, gold, blue, purple, brown, and pink. As for kohl, its prices ranged from 2 to 25 LYD, and the samples included both local and imported products, as Libya represented a local source of kohl, while the imported samples included countries such as China, Pakistan, and Germany, and all samples were in black.

Table 2. Lead concentration in cosmetic samples

Sample Type	Sample Code	First Result	Second Result	Third Result	Mean ± standard deviation (mg/kg)
Lipstick	L1	1.830	1.480	1.650	0.175±1.655
	L2	2.080	1.870	1.930	0.15±1.93
	L3	1.520	1.680	1.600	0.08±1.60

	L4	0.960	1.050	1.010	0.05±1.01
	L5	1.050	1.560	1.310	0.25±1.31
	L6	2.230	2.600	2.420	0.19±2.42
	L7	2.400	3.900	3.150	0.75±3.15
	L8	2.150	1.950	2.050	0.10±2.05
	L9	2.160	2.230	2.200	0.03±2.20
	L10	4.370	4.460	4.420	0.04±4.42
Overall average	**N=10**	-	-	-	**2.172±0.990**
Eyeshadow	E1	<0.01	<0.01	<0.01	0±<0.01
	E2	<0.01	<0.01	<0.01	0±<0.01
	E3	<0.01	<0.01	<0.01	0±<0.01
	E4	0.24	0.24	0.24	0±0.24
	E5	<0.01	<0.01	<0.01	0±<0.01
	E6	<0.01	<0.01	<0.01	0±<0.01
	E7	<0.01	<0.01	<0.01	0±<0.01
	E8	<0.01	<0.01	<0.01	0±<0.01
	E9	1.560	1.600	1.580	0.02±1.58
	E10	1.650	2.090	1.870	0.22±1.87
	E11	1.780	1.250	1.520	0.27±1.52
	E12	1.780	1.730	1.760	0.03±1.76
Overall average	**N=12**	-	-	-	**0.580±0.820**
Kohl	A1	<0.01	<0.01	<0.01	0±<0.01
	A2	<0.01	<0.01	<0.01	0±>0.01
	A3	0.04	0.07	0.06	0.02±0.06
	A4	0.08	0.12	0.10	0.02±0.10
	A5	<0.01	<0.01	<0.01	0±<0.01
	A6	0.22	0.35	0.29	0.07±0.29
	A7	0.12	0.16	0.14	0.02±0.14
	A8	<0.01	<0.01	<0.01	0±<0.01
Overall average	**N=8**	-	-	-	**0.0737±0.102**

The table shows the concentrations of lead measured in 30 samples of cosmetics, divided into three categories: 10 samples of lipstick, 12 samples of eyeshadow, and 8 samples of eyeliner, for each sample the analysis was performed three times to ensure the accuracy of the results.

A clear disparity in lead concentrations was observed between the categories, with the lipstick samples recording the highest values with an overall average of 2,172±0.990 with the highest concentration recorded in the sample (L10). As for the eyeshadows, most of the samples showed concentrations Below the detection limit of 0.01< except for samples E4, E9, E10, E11 and E12 whose concentrations ranged from 0.24 to 1.87 with an overall average of 0.580±0.820 indicates low concentrations in most samples. As for the kohl samples, the lead concentrations were significantly reduced, with most of the results appearing below the detection limit, with only trace values recorded in the A6 and A7 samples, and the overall average of this category was 0.0737±0.102, which is much lower than the rest of the categories.

Table 3. Cadmium Concentration in Cosmetic Samples

Sample Type	Sample Code	First Result	Second Result	Third Result	Mean ± standard deviation (mg/kg)
Lipstick	L1	<0.005	<0.005	<0.005	0±<0.005
	L2	<0.005	<0.005	<0.005	0±<0.005
	L3	<0.005	<0.005	<0.005	0±<0.005
	L4	<0.005	<0.005	<0.005	0±<0.005
	L5	<0.005	<0.005	<0.005	0±<0.005

	L6	<0.005	<0.005	<0.005	0±<0.005
	L7	<0.005	<0.005	<0.005	0±<0.005
	L8	<0.005	<0.005	<0.005	0±<0.005
	L9	<0.005	<0.005	<0.005	0±<0.005
	L10	<0.005	<0.005	<0.005	0±<0.005
Overall average	**N=10**	-	-	-	**0±<0.005**
Eyeshadow	E1	<0.005	<0.005	<0.005	0±<0.005
	E2	<0.005	<0.005	<0.005	0±<0.005
	E3	<0.005	<0.005	<0.005	0±<0.005
	E4	0.24	0.24	0.24	0±0.24
	E5	<0.005	<0.005	<0.005	0±<0.005
	E6	<0.005	<0.005	<0.005	0±<0.005
	E7	<0.005	<0.005	<0.005	0±<0.005
	E8	<0.005	<0.005	<0.005	0±<0.005
	E9	<0.005	<0.005	<0.005	0±<0.005
	E10	<0.005	<0.005	<0.005	0±<0.005
	E11	<0.005	<0.005	<0.005	0±<0.005
	E12	<0.005	<0.005	<0.005	0±<0.005
Overall average	**N=12**	-	-	-	**0.020±0**
Kohl	A1	<0.005	<0.005	<0.005	0±<0.005
	A2	00.7	00.7	00.7	0±0.07
	A3	<0.005	<0.005	<0.005	0±<0.005
	A4	<0.005	<0.005	<0.005	0±<0.005
	A5	<0.005	<0.005	<0.005	0±<0.005
	A6	0.01	0.01	0.01	0±0.01
	A7	0.001	0.001	0.001	0±0.001
	A8	0.006	0.01	0.008	0.008±0.002
Overall average	**N=8**	-	-	-	**0.01113±0.024**

The table shows the results of the analysis of cadmium concentrations in 30 samples of cosmetics, divided into three categories: lipstick (10 samples), eyeshadow (12 samples), and eyeliner (8 samples). Three measurements were taken for each sample to enhance the credibility of the results. All lipstick samples (L1-L10) recorded values below the detection limit (0.005<) with an overall average of 0±<0.005 in the eyeshadow category, the vast majority recorded concentrations below the detection limit, while the sample recorded E4 A concentration of 0.020. Five samples recorded undetectable concentrations, while A2 (0.07), A6 (0.01), A7 (0.001), and A8 (0.008) showed

negligible values. The overall average cadmium concentration in this category was 0.01113±0.024, the highest compared to the other two groups.

Table 4. Relationship between the type of cosmetic and its concentration of lead and cadmium

Sample Type	Lead concentration (mg/kg)	Cadmium concentration(mg/kg)
Lipstick	2.172	<0.005
Eyeshadow	0.580	0.020
Kohl	0.0737	0.01113
P-value	0.000	0.570

The previous table shows the analysis of lead and cadmium elements in the samples of lipstick, eyeshadow, and eyeliner by type, the lipstick samples recorded the highest average concentration of lead with an average of 2.172, while the eyeshadow samples recorded the highest average concentration of cadmium with an average of 0.020. Statistical analyses showed that there is a significant relationship between the sample type and the average concentration of lead, as the value of P It reached 0.000, which is less than the significant value of 0.05, and confirms that there is no significant relationship between the sample type and the average cadmium concentration, as the P value reached 0.570, which is not statistically significant at the significance level of 0.05.

Table 5. The Relationship between Lipstick Color, Eyeshadow and Lead and Cadmium Concentration in Them

Sample Type	Sample Color	Lead concentration (mg/kg)	Cadmium concentration(mg/kg)
Lipstick	red	2.026	<0.005
	pink	2.54	<0.005
	purple	1.825	<0.005
	brown	1.605	<0.005
	orange	2.865	<0.005
P-value		**0.758**	**-**
Eyeshadow	brown	0.88	<0.005
	White	<0.01	<0.005
	purple	<0.01	<0.005
	blue	0.76	0.12
	pink	0.935	<0.005
	Gold	0.79	<0.005
P-value		**0.926**	**0.360**

The previous table shows the analysis of the elements of lead and cadmium in the lipstick and eyeshadow samples by color, in the lipstick all colors recorded cadmium concentrations below the detection limit (<0.005) while the lead concentrations varied, where orange recorded the highest value (2.865) while the brown color was the lowest concentration (1.605), while in the eyeshadow samples, the pink samples recorded the highest lead concentration (0.935) while the white and purple samples were below the detection limit (<0.01)). For cadmium, blue had the highest measurable concentration (0.12). Statistically, the analysis of P-values showed that all values were greater than the significance value of 0.05, i.e., there was no statistically significant relationship between the color of the samples in the lipstick, the eye shadow, and the concentration of lead and cadmium in them.

Table 6. The Relationship between the Price of Lipstick and Eyeshadow and the Concentration of Lead and Cadmium in Them

Sample Type	Price Category	Lead concentration (mg/kg)	Cadmium concentration (mg/kg)
Lipstick	Low Price	1.50	<0.005
	Expensive	2.844	<0.005
P-value		**0.020**	**-**
Eyeshadow	Low Price	0.04	0.04
	Expensive	1.121	<0.005
P-value		**0.013**	**0.341**

The previous table shows the concentrations of lead and cadmium in the lipstick and eyeshadow samples by price, for lead, the expensive samples in both lipstick and eyeshadow recorded the highest concentrations (2.844) (1.121) respectively, and for cadmium, no detectable concentrations were recorded in lipstick samples of all price categories (<0.005), while the highest concentrations appeared in low-price eyeshadow samples (0.04). The table also shows the P-value where We find that there is a statistically significant relationship between the sample price and the lead concentration in both the lipstick samples 0.038 and the eyeshadow 0.013 as the values are less than the significant value of 0.05. While there was no relationship between the concentration of cadmium and the sample price in the eyeshadow of 0.341.

Table 7. Relationship between Country of Manufacture and Lead and Cadmium Concentration in Lipsticks and Eyeshadows

Sample Type	Country of Sample Making	Lead concentration(mg/kg)	Cadmium concentration(mg/kg)
Lipstick	Korea	3.31	<0.005
	America	2.53	<0.005
	China	1.5	<0.005
P-value		**0.009**	**-**
Eyeshadow	China	0.04	0.04
	France	<0.01	<0.005
	Italy	1.725	<0.005
	Britain	1.64	<0.005
P-value		**0.000**	**0.412**

The previous table shows the concentrations of lead and cadmium in the lipstick and eyeshadow samples by country of manufacture, where Korean lipstick samples recorded the highest lead concentration (3.31), while Chinese samples were the least contaminated with it (1.5), with cadmium undetectable in all countries of manufacture of this category, while in eyeshadow, Italian samples recorded the highest lead concentration (1.725) while all French samples were below the detection limit (<0.01)), while the presence of cadmium was limited to the Chinese samples only (0.04), the statistical analysis showed a statistically significant relationship between the country of manufacture and the concentration of lead in both lipstick (0.009) and eyeshadow (0.000) as the values were less than the significance value of 0.05.While the country-of-manufacture cadmium concentration is not statistically related to 0.412 eyeshadow.

Table 8. The relationship between the source of kohl production (domestic or imported) and the concentration of lead and cadmium in it

Source of Kohl Production	Lead concentration (mg/kg)	Cadmium concentration (mg/kg)
local	0.053	0.023
Imported	0.086	0.0038
P-value	**0.697**	**0.301**

The previous table shows the concentrations of lead and cadmium in kohl samples Based on the source of production, the imported samples recorded higher concentrations of lead compared to the local samples, as it is clear from the statistical analysis that there is no statistically significant relationship between the average concentration of lead in kohl and its source of production, as the P-value is 0.697 is a value greater than the significance value of 0.05, while the local samples showed higher concentrations of cadmium compared to the imported samples, and we also find that there is no statistically significant relationship between the average concentration of cadmium in kohl and its source of production, as the P-value is 0.301 is greater than the significant value of 0.05.

Discussion:

The results of this study showed that the upper and lower concentrations of lead in lipstick samples were 1.01 – 4.42 mg/kg, with an average of 2.172±0.990, which is close to the results of a study conducted by researchers at the US Food and Drug Administration (Hepp *et al*., 2014) where lead levels in lipstick ranged between 0.13 – 3.4 mg/kg, as well as a study conducted in Iraq (Khazaal *et al*., 2018) where lead concentrations in lipstick were in the range of 0.10 – 4.85ppm, and a study in

Mexico (Montserrat *et al.,* 2023) in which the overall average concentration of lead in lipstick samples was 1.457 ppm.

While cadmium was not detected in any of the lipstick samples in this study, which is consistent with the results of a study conducted at the University of Belgrade in Serbia by (Đogo-Mračević *et al*., 2023) where cadmium was not detected in any of the lipstick samples (BLD), and also a study conducted in Morocco by (Mabrouki *et al*., 2022) where cadmium was not detected in lipstick samples

As for the eyeshadows, the average concentration of lead in them was 0.580±0.820 mg/kg with a range of 0.24 – 1.87 mg/kg, which is close to the results of a study conducted in Iraq (Mahdi and Salman, 2024), where the concentration of lead ranged between 0.02 – 0.374 ppm. As for cadmium, it was detected in only one sample with an average of 0.020±0 and a range of <0.005 – 0.24 mg/kg, which are similar results to an Iraqi study conducted by (Mahdi and Salman, 2024) where the concentration of cadmium in the eyeshadow ranged between <0.02 – 0.023 ppm, and a study conducted by the researcher (Abubaker, 2022) at the University of Nairobi, Kenya, where the average concentration of cadmium in the eyeshadow was 0.08±0.38 ppm.

In Kahl, the average lead concentration was 0.0737 mg/kg with a range of 0.06 – 0.29 mg/kg, which is similar to the results of a local study conducted in Sabha by (Ali, Shaaban, & Belhassan, 2021) where lead concentrations ranged between 0.000004 and 0.02 ppm, and differs from another local study conducted in Benghazi (Rahil *et al*., 2019) where lead concentrations ranged from 0 – 20.25 mg/kg, and a study in Pakistan by (Ullah *et al*., 2017) where the average lead concentration was 692.9±0.022 µg/g, µg/g. The average concentration of cadmium in kohl was 0.01113 mg/kg with a range of 0.001 – 0.07 mg/kg, which is similar to the results of an Iraqi study (Mahdi and Salman, 2024) where the concentration of cadmium in kohl samples ranged between <0.02 – 0.126 ppm, and a study conducted in Pakistan (Ullah *et al*., 2017) where the average concentration of cadmium was 0.422±0.002 µg/g

From the previous results, it is clear that all the values of lead and cadmium in the cosmetic samples were low, and fall within the permissible limits according to the standards approved by the U.S. FDA, THE WORLD HEALTH ORGANIZATION (WHO), Health Canada, as well as the Libyan standard. This is often attributed to the quality of the raw materials from which these products are made, and their subjection to periodic controls and inspections before manufacturing. However, the results do not exclude the possibility that there are other preparations on the market that may be affected by the level of environmental pollution with heavy metals, and although the recorded concentrations were minimal, the continued use of these products raises some concerns, given the possibility of gradual accumulation of minerals in the body and the possible long-term health effects.

Statistical analyses showed that lipstick had the highest concentration of lead (2.172 mg/kg) among the cosmetics studied, with a strong statistical significance (p=0.000) less than 0.05, indicating a significant relationship between the type of product and the concentration of lead. This result is consistent with several studies, including a study conducted in Iran by (Nourmoradi *et al*., 2013) The results showed that the value of (p<0.001), which indicates that there are statistical differences between the concentration of lead and the type of sample, as well as another study conducted in Iran by (Zafarzadeh *et al*., 2018) showed that there are significant differences between the concentration of lead in different products (p=0.013). As for cadmium, the results did not show a statistically significant relationship between its concentration and the type of preparation (p=0.570), which is a value greater than 0.05, which means that there are no significant differences between the types of preparations and the concentration of cadmium. This result contradicts the findings of an Iranian study (Nourmoradi *et al*., 2013) where a statistically significant difference was found between the type of product and the concentration of cadmium (p=0.04), as well as a study conducted in Benghazi by (Rahil *et al*., 2019) where there were clear differences in cadmium concentrations between different cosmetics (p=0.029).

Regarding price, it was found that the concentration of lead was highest in the samples of expensive lipsticks with an average of (2.844 mg/kg), with a significant value (p=0.020) less than 0.05, which

indicates that there is a statistically significant relationship between the price of lipstick and the concentration of lead. This result differs from what has been reported in several studies, including a study in the city of Mashhad, Iran by (Alidadi *et al*., 2019) where there was no significant relationship between lead concentration and the price categories of lipstick (p=0.26, 0.39), as well as a Chinese study conducted by (Li et *al*., 2021) did not record any significant statistical correlation between lead concentration and product price (p=0.443). As for eyeshadow, the high-priced samples had the highest concentration of lead (1.121 mg/kg), with a value of (p=0.013) less than 0.05, indicating that there is a significant relationship between lead concentration and the price of eyeshadow, this result is consistent with what was stated in a Polish study by (Pawlaczyk *et al*., 2021) where a clear statistical difference appeared in the concentration of lead between the different price categories of eyeshadow (p<0.05). As for cadmium, the highest concentration was recorded in low-priced eyeshadow samples (0.04 mg/kg), but the value (p=0.341) was greater than 0.05, which means that there was no significant relationship between price and cadmium concentration. This result contradicts what was reported in a Yemeni study (Saleh *et al*., 2020) which reported that there were statistically significant differences (p<0.05) between low-priced and high-priced products

The orange color in the lipstick samples recorded the highest concentration of lead (2.865 mg/kg), but the results of the analysis did not show a statistical significance of the relationship between the color and the concentration of lead (p=0.758) a greater than 0.05, this result is consistent with a Syrian study conducted by (Malka, 2016) where no significant differences were recorded between the different colors of lipstick (p=0.635), and also with an Iranian study conducted by (Nourmoradi *et al*., 2013) which did not observe significant differences (p>0.2). As for cadmium, blue in the eyeshadow recorded the highest measurable concentration (0.12 mg/kg), however, there was no statistically significant relationship between color and cadmium concentration (p=0.360) greater than 0.05, this result is consistent with a Syrian study (Malka, 2016) and a Polish study (Pawlaczyk *et al*., 2021) that did not record significant differences (p=0.606) (p>0.05) respectively

The analysis showed that with regard to the country of manufacture, the highest concentration of lead was recorded in the Korean lipstick samples (3.31 mg/kg) with a value of (p=0.009) less than 0.05, which indicates that there is a statistically significant relationship between the country of manufacture and the concentration of lead, which is consistent with an Iranian study conducted in the city of Ahvaz (Feizi *et al*., 2019), where the results showed that there are statistically significant differences in the concentration of lead between the countries of manufacture in the lipstick samples (p< 0.001). In the eyeshadows, the Italian samples with the highest lead concentration (1.725 mg/kg) with a value of (p=0.000) less than 0.05 were recorded, which also indicates a statistically significant relationship between the country of manufacture and the concentration of lead, in accordance with a Polish study conducted by (Pawlaczyk *et al*., 2021), where the results showed a clear statistical difference between the countries of manufacture in the levels of lead in the eyeshadow (p<0.05).). As for cadmium, it was only detected in Chinese eyeshadow samples (0.04 mg/kg) with a value (p=0.412) greater than 0.05, which means that there is no statistically significant relationship between cadmium concentration and country of manufacture.

Regarding the source of kohl production, the imported samples contained the highest concentration of lead (0.086 mg/kg) compared to the local (0.053 mg/kg), but the statistical analysis showed a value (p=0.697) greater than 0.05, which indicates that there is no statistically significant relationship between the source of kohl and the concentration of lead. This result contradicts what has been reported in several studies, including a study conducted in Algeria by (Kerdoun *et al*., 2024) where the local samples were more contaminated with lead than the imported ones, and the value of (p=0.04) was also conducted by a Moroccan study (Gouitaa *et al*., 2016) that showed that homemade kohl contained higher percentages of lead compared to the imported (p<0.02). Ethmad is likely the material used in local kohl in this study, while galena (lead) was used in other studies that contradicted our findings, which explains the high concentrations of lead in local kohl in these studies.

Conclusion:

The leakage of heavy metals into raw materials used in the manufacture of cosmetics is a health hazard, due to their ability, even when present in low concentrations, to accumulate in the body over time and cause health problems, the results of this study showed that cadmium was not detected in most of the samples, while lead was detected in a number of products in varying concentrations but all remained within the safe limits set by global regulators, indicating that the products in circulation are not completely free of pollution, but does not pose a direct threat within the limits of normal use

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