

Determination of Lead (Pb) in Kohl cosmetics sold in the south of Algeria



MA. KERDOUN

Faculté de médecine - Université Kasdi Merbah –Ouargla

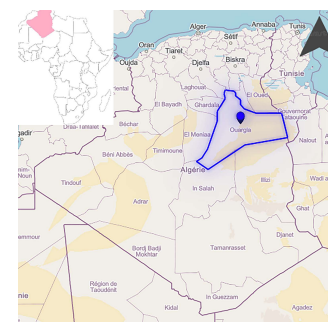
Introduction

Kohl, known as Kajal or Surma, holds a rich historical significance dating back to ancient civilizations. Despite being banned by the Food and Drug Administration (FDA) in the United States [1], it remains widely embraced in regions across Africa [2,3], the Middle East [4,5], and Europe [6,7].

The composition and application methods of kohl contribute to its harmful effects [11]. Mixed with saliva before application, kohl can enter the body orally or through the skin, with absorption rates varying depending on exposure routes [19]. Despite lower dermal absorption rates, contact with kohl has been associated with various pathologies, including severe corneal edema and conjunctival pigmentation abnormalities [20,21]. In Algeria, kohl holds significant cultural and medicinal value, particularly among the Saharan population. Used for aesthetic and therapeutic purposes in both adults and infants, it is often marketed in bulk form, combined with additional ingredients before daily use. An Algerian study conducted in 2015 found significant levels of Pb in all tested kohl products, with concentrations ranging from 100 to 38,000 mg.kg⁻¹ [2]. Based on these discoveries, our study set out to evaluate the Pb levels in kohl products sold in Southern Algerian markets by Absorption Spectroscopy, as a component of a comprehensive investigation into hazardous substances in consumer goods.

Study design and sampling

The present analytical study was carried out in Ouargla city, Algeria, an area renowned for the widespread use of Kohl among adults, infants, and newborns. Situated in the Southeast of Algeria, Ouargla's geographical coordinates are 31° 57' 9.6192" N and 5° 20' 0.6864" E (Fig. 1). Sixteen (N = 16) samples were procured from local markets and categorized into three groups based on their textures: paste (n = 2), powder (n = 7), and stone (n = 7). Purchased samples were also divided into two groups; products originated from local producers (n = 11) and imported brands (n = 5). Each brand's packaging was scrutinized, and a sampling sheet was completed, documenting pertinent information such as composition and provenance. The integrity and waterproofing of the purchased packets were visually inspected before analysis.



Sample analysis

For microwave digestion, each sample weighing 0.5 g was carefully measured into the digestion reactor. Subsequently, 4 mL of concentrated nitric acid (69 %), 2 mL of sulfuric acid (98 %), and 2 mL of hydrogen peroxide (60 %) were added to the samples. The digestion process for all samples followed a specific protocol: 5 min to reach 130 °C, 10 min to reach 200 °C, and finally 15 min at 200 °C. Upon cooling to ambient temperature, the reactors were opened and subjected to sonication to eliminate any residual nitrous oxide vapors. The resulting solutions were then transferred to plastic flasks and diluted to a final volume of 50 mL with ultrapure water. Subsequently, these solutions underwent analysis using AAS-GF.

Lead analysis Lead concentrations were determined using an atomic absorption spectrometric method with a graphite furnace, by employing the "ContraAA 800D™" automated system of Analytik Jena (®) (Jena, Germany). This apparatus features an atomic absorption spectrometer, a high-efficiency graphite furnace, an automatic sampler and a multi- element lamp. External calibration was applied and the selected wavelengths was 217.05 nm.

Results and discussions

Table 1

Summary of QA/QC for Toxic Element analysis.

Linearity range (mg.kg ⁻¹)	50-250
LOD (mg.kg ⁻¹)	15
R ²	0.994
NIST 2709	
Certified value	18.9 ± 0.5
Measured value	18.3 ± 0.4
Recovery	96.8 %

LOD, Limit of Detection; R², coefficient of determination.

Table 2

Characteristics and information mentioned in the packaging of Kohl products marketed in Ouargla city.

	Local samples											Imported samples				
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
Country	Algeria											India	Saudi Arabia	Pakistan	India	Pakistan
Content: weight	(-)											0.4 g	(-)	(-)	(-)	4 g
Expiration date	(-)											(-)	(-)	(+)	(+)	(+)
Precautions of use	(-)											(+)	(-)	(-)	(+)	(+)
Cosmetic uses	(-)											(+)	(-)	(+)	(+)	(+)
Ingredients	(-)											(+)	(-)	(+)	(+)	(+)
Texture	S	P	S	P	S	S	P	P	S	S	S	P	Pa	P	Pa	
Color	G	B	G	B	G	G	B	B	G	G	G	B	B	B	B	
Mention of Lead	(-)											Free from Lead	(-)	Free from lead	Free from lead	Free from lead

(-) : Not mentioned; (+) : Mentioned; P : Power; S : Stone; Pa : Paste; G : Grey; B : Black.

Table 3

Lead content (mg.kg⁻¹) in analyzed Kohl products.

Sample	Location	Pb information	Pb content Mean ± SD	Min	Max	Mean ± SD	p-value
1	Local products	(-)	29,330- 4420	3890	85,570	46,490- 32,240	0.04
2		(-)	20,670- 6480				
3		(-)	61,930- 3570				
4		(-)	3890- 270				
5		(-)	81,910- 2210				
6		(-)	80,260- 2520				
7		(-)	85,570- 2550				
8		(-)	19,340- 6840				
9		(-)	7240- 520				
10		(-)	80,260- 2520				
11		(-)	39,960- 4.6				
12	Imported	(-)	54,320- 3890	<10	54,320	17,130- 24,820	
13		Free from Lead	< 15				
14		Free from Lead	31,340- 5000				
15		Free from Lead	< 15				
16		Free from Lead	< 15				

(-) Not mentioned.

Table 4

Pb content in Kohl items reported in research articles from other countries.

Author	References	Location	N	Analytical method	Results	Pb content (%)
Adam et al. (1997)	[17]	United Kingdom	8	AAS	Presence of Pb in all samples	5.0 - 82.9
Aslam et al. (1996)	[38]	NM	AAS	Presence of Pb in all samples	80 - 90	
Healy et al. (1984)	[39]	Nigeria	17	AAS	Presence of Pb in all samples	-
Badeeb et al. (2008)	[40]	Saudi Arabia	16	AAS	Presence of Pb in all samples	0.01 - 78.0
Goutina et al. (2016)	[35]	Morocco	100	AAS	Presence of Pb in all samples	0.01 - 97.4
McMichael et al. (2018)	[15]	Afghanistan	10	AAS	Presence of Pb in all samples	0.04 - 83
Navarro-Tapia et al. (2021)	[14]	Spain and Germany	12	ICP-MS	Presence of Pb in 6 samples	0.2 - 41.0
Aguiñal et al. (2015)	[16]	Algeria	45	AAS	Presence of Pb in all samples	0.1 - 32.0
Kerdoun et al. (2024)	The present study	Algeria	16	AAS	Presence of Pb in 13 samples	0.1 - 85.6

NM: Not Mentioned; AAS: Atomic Absorption Spectrometry; ICP-MS: Inductively Coupled Plasma-Mass Spectrometry.

Conclusion

The present study revealed that Kohl products marketed in Ouargla city are contaminated with Pb which exposes Kohl-users to chronic Pb poisoning as it can be absorbed by ocular route. It would be strongly recommended to make the general population aware of using contaminated Kohl products and to enforce local regulations which clearly prohibit the incorporation and the contamination of heavy metals in cosmetic products especially those made traditionally. As perspectives, it would be interesting to carry out the dosage of TMEs in subjects exposed through prolonged use of Kohl. The ophthalmic toxicity of mixtures, known as the cocktail effect, of these toxic metals and metalloids is also to be explored through experimental studies.