

# Determination and Safety Assessment of Lead and Cadmium in Eye Shadows Purchased in Local Market in Tehran

Zahra Mousavi<sup>1</sup>, Parisa Ziarati<sup>2\*</sup> and Azita Shariatdoost<sup>3</sup>

<sup>1</sup>Pharmacology and Toxicology Department, Pharmaceutical Sciences Branch, Islamic Azad University, Tehran- Iran

<sup>2</sup>Medicinal Chemistry Department, Pharmaceutical Sciences Branch, Islamic Azad University, Tehran-Iran

<sup>3</sup>Chemistry Department, Pharmaceutical Sciences Branch, Islamic Azad University, Tehran- Iran

## Abstract

Powdered eye shadows are the most used eye cosmetics in Iran. 120 samples of 15 brands of pressed powder eye shadows in main seven colors: pink, white, violet, brown, golden, green and blue made from different countries were randomly purchased for analysis but a single brand may contain several colors which have been analyzed. Data was collected on the cost, brand, and color of product and batch number of the products that was sampled. The samples were analyzed according to standardized international protocols by wet digestion method (Using HNO<sub>3</sub>, HClO<sub>4</sub>, H<sub>2</sub>O<sub>2</sub>) analyzed by Atomic Absorption Spectrophotometer. Lead and cadmium detected in all colors in wide range of concentrations. The brown and golden colors in all brands have the highest concentrations of lead, while blue and green colors have the lowest Lead content and the golden and blue color have the highest and lowest concentration of cadmium respectively. Estimating the safety assessment of cosmetic products such as eye shadows is a complex issue. The concentration of cadmium shows significant differences of this heavy metal in the color main groups ( $p < 0.005$ ). This result reveals that the type of pigment used in eye shadows contributes to its heavy metal content. As toxic metals especially lead can rise to accumulate in body over time and repetitive metal-containing product application and probably lead to significant exposure levels, We recommended the major quality controls for the cosmetics products due to long contact with the skin of eyelids.

**Keywords:** Eye shadows; Lead; Cadmium; Safety assessment

## Introduction

Iran, then Saudi Arabia has the highest consumption of cosmetics in the Middle East. Powdered eye shadows are the most used eye cosmetics and extremely applied. As precedent studies showed that the lead absorbed through skin results negligible [1,2] in Iran assessing and determining heavy metals in this most purchased eye cosmetic products is scanty. Eye shadows are available as pencils, anhydrous creams, emulsions, sticks and pressed powder and are pigmented make-up products [3,4]. Eye shadows with a variety of colors are a common cosmetic. Color is important Dyes and pigments used as ingredients in cosmetics are regulated as color additives by the FDA and must undergo pre-market approval by the agency before they may be used in any cosmetics [5,6]. Eye shadow, a cosmetic commonly used by women and children has been reported to contain toxic metals [7,8]. As the skin of eyelid is the most susceptible to eczemas, irritant and allergic contact dermatitis [9,10]. The toxicity of lead at high levels of exposure is well known but a major concern of today is the possibility that continual exposure to relatively low levels of lead may entail adverse health effects [5]. The use of leaded eye cosmetics have been observed to be strongly correlated with elevated blood lead levels [10-12]. The symptoms of acute lead poisoning are headache, irritability, abdominal pain and various symptoms related to the nervous system [12]. Absorption of cadmium through the skin is low and would be of concern only in situations where concentrated solutions would be in contact with the skin for several hours or longer. The aim of this survey was to assess the public Health risk from certain brands of powder eye shadows sold at local markets in Tehran. To investigate that some brands of cosmetic products sold at Iranian stores were non-complaint with the cosmetic products Group Standard 2006 under the Hazardous Substances in this study on the presence of total and Leachable Lead and Cadmium in randomly selected eye shadows focused.

## Material and Method

### Sampling method

120 samples of 15 brands of pressed powder eye shadows in main seven colors: pink, White, violet, brown, golden, green and blue made from different countries were randomly purchased for analysis but a single brand may contain several colors which have been analyzed. The samples were purchased randomly from cosmetic stores in Tehran in 2012. They are very popular and most of them are imported. Eye shadows were mostly imported from 4 different countries (England, Korea, China, and Turkey) and we compare them with Iranian eye shadows.

### Estimation of Cd, Pb

All glassware and plastic containers used were washed with liquid soap, rinsed with water, soaked in 10% volume/volume nitric acid for 24hrs, cleaned thoroughly with distilled water and dried in such a manner to ensure that any contamination does not occur. Blanks and samples were also processed and analyzed simultaneously. All the chemicals used were of Analytical Grade (AR). For heavy metal analyses 2 gram of each sample was weighed on electronic balance

**\*Corresponding author:** Parisa Ziarati, Islamic Azad University, Pharmaceutical Sciences Branch (IAUPS), Faculty of Pharmacy, Toxicogenomics lab. No 99, Tehran-Iran, Tel: +98-21-22600037; Fax: +98-21-22633986; E-mail: [parziarati@yahoo.com](mailto:parziarati@yahoo.com)

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(Shimadzu LIBROR AEX 200G). The samples were analyzed according to standardized international protocols by wet digestion method, Using HNO<sub>3</sub> and HClO<sub>4</sub> and H<sub>2</sub>O<sub>2</sub> (3:1:1), analyzed by a Flame Emission Spectrophotometer Model AA-6200 (Shimadzu, Japan) using an air-acetylene flame for heavy metals in research Analytical Laboratory in Pharmaceutical Sciences Branch, Islamic Azad University, using at least five standard solutions for each metal. All necessary precautions were taken to avoid any possible contamination of the sample as per the AOAC guidelines.

## Results

The concentrations of 2 metals (lead and Cadmium) were determined in 120 samples from 15 different brands of Iranian and imported powdered eye shadows. Results were determined as mean  $\pm$  SD of dry weight from three replicates in each test.

All the eye shadows monitored in this study contained detectable contents of lead and cadmium. Table 1 shows the mean content of Pb and Cd (mg/kg DW) in 120 studied samples.

Mean Cd(mg/kg) $\pm$ SD	Mean Pb(mg/kg) $\pm$ SD	Color	Origin country	Brand
4.321 $\pm$ 0.062	13.002 $\pm$ 0.122	White	China	1-a
4.095 $\pm$ 0.108	81.821 $\pm$ 0.731	Golden	China	2-a
10.946 $\pm$ 0.124	83.922 $\pm$ 0.894	Golden	China	3-a
5.172 $\pm$ 0.087	32.906 $\pm$ 0.116	White	China	4-a
3.110 $\pm$ 0.063	53.452 $\pm$ 0.139	Violet	China	5-a
3.580 $\pm$ 0.058	16.048 $\pm$ 0.075	Pink	China	6-a
4.392 $\pm$ 0.097	27.998 $\pm$ 0.063	Pink	China	7-a
4.115 $\pm$ 0.056	60.846 $\pm$ 0.204	Violet	China	8-a
3.081 $\pm$ 0.044	32.856 $\pm$ 0.081	Brown	China	9-a
3.909 $\pm$ 0.058	55.739 $\pm$ 0.158	Brown	China	10-a
10.229 $\pm$ 0.122	123.690 $\pm$ 0.952	Brown	China	11-a
5.043 $\pm$ 0.166	98.790 $\pm$ 0.783	Brown	China	12-a
3.181 $\pm$ 0.054	13.873 $\pm$ 0.068	White	China	13-b
3.434 $\pm$ 0.089	13.547 $\pm$ 0.067	Pink	China	14-b
2.103 $\pm$ 0.044	133.111 $\pm$ 0.991	Brown	China	15-b
3.025 $\pm$ 0.063	20.700 $\pm$ 0.085	Pink	China	16-b
3.774 $\pm$ 0.094	18.706 $\pm$ 0.066	Pink	China	17-b
2.020 $\pm$ 0.059	34.045 $\pm$ 0.101	Blue	China	18-b
1.890 $\pm$ 0.047	45.493 $\pm$ 0.156	Golden	China	19-b
6.051 $\pm$ 0.067	32.963 $\pm$ 0.058	Green	China	20-b
4.117 $\pm$ 0.111	35.119 $\pm$ 0.094	White	China	21-b
2.006 $\pm$ 0.129	20.556 $\pm$ 0.123	Blue	China	22-b
3.951 $\pm$ 0.111	48.314 $\pm$ 0.188	Violet	China	23-b
2.143 $\pm$ 0.123	18.843 $\pm$ 0.051	Blue	China	24-b
3.711 $\pm$ 0.057	21.051 $\pm$ 0.085	White	China	25-c
2.141 $\pm$ 0.071	30.115 $\pm$ 0.111	Pink	China	26-c
5.421 $\pm$ 0.115	85.009 $\pm$ 0.201	Brown	China	27-c
4.569 $\pm$ 0.1236	45.636 $\pm$ 0.123	Golden	China	28-c
5.354 $\pm$ 0.168	36.016 $\pm$ 0.056	White	China	29-c
2.616 $\pm$ 0.054	13.236 $\pm$ 0.138	Pink	China	30-c
2.567 $\pm$ 0.041	19.003 $\pm$ 0.067	Pink	China	31-c
4.449 $\pm$ 0.056	80.110 $\pm$ 0.144	Brown	China	32-c
2.046 $\pm$ 0.089	40.544 $\pm$ 0.076	Pink	China	33-c
3.832 $\pm$ 0.098	52.883 $\pm$ 0.154	Violet	China	34-c
3.711 $\pm$ 0.047	21.051 $\pm$ 0.117	Pink	China	35-c
2.141 $\pm$ 0.115	30.115 $\pm$ 0.058	Golden	China	36-c
2.102 $\pm$ 0.086	20.759 $\pm$ 0.133	Blue	China	37-d
8.593 $\pm$ 0.168	55.052 $\pm$ 0.116	Golden	China	38-d
2.856 $\pm$ 0.041	26.090 $\pm$ 0.094	Pink	China	39-d

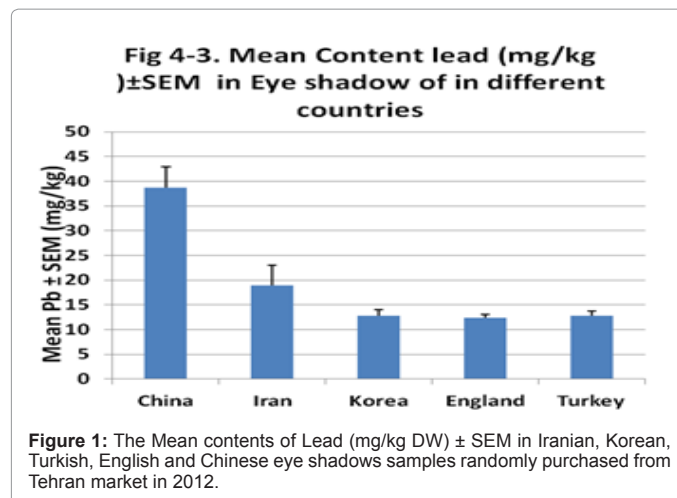
4.846 $\pm$ 0.056	31.31 $\pm$ 0.065	Pink	China	40-d
1.445 $\pm$ 0.068	16.217 $\pm$ 0.147	Brown	China	41-d
1.252 $\pm$ 0.097	13.906 $\pm$ 0.121	Pink	China	42-d
1.414 $\pm$ 0.066	22.375 $\pm$ 0.054	Green	China	43-d
3.054 $\pm$ 0.124	13.938 $\pm$ 0.083	White	Iran	44-e
2.920 $\pm$ 0.098	24.982 $\pm$ 0.118	Brown	Iran	45-e
1.885 $\pm$ 0.029	42.79 $\pm$ 0.067	Golden	Iran	46-e
1.853 $\pm$ 0.054	18.038 $\pm$ 0.094	White	Iran	47-e
1.592 $\pm$ 0.083	0.5986 $\pm$ 0.013	Pink	Iran	48-e
0.623 $\pm$ 0.097	16.452 $\pm$ 0.081	Green	Iran	49-e
2.399 $\pm$ 0.058	20.023 $\pm$ 0.129	Violet	Iran	50-e
1.436 $\pm$ 0.069	14.128 $\pm$ 0.094	Blue	Iran	51-e
1.600 $\pm$ 0.036	60.158 $\pm$ 0.193	Pink	China	52-f
5.492 $\pm$ 0.115	202.058 $\pm$ 0.964	Brown	China	53-f
1.861 $\pm$ 0.069	73.462 $\pm$ 0.233	Golden	China	54-f
3.589 $\pm$ 0.087	79.860 $\pm$ 0.184	Brown	China	55-f
1.316 $\pm$ 0.052	29.632 $\pm$ 0.091	Pink	China	56-f
2.695 $\pm$ 0.094	10.307 $\pm$ 0.059	Blue	China	57-f
1.715 $\pm$ 0.106	10.972 $\pm$ 0.063	Green	China	58-f
1.678 $\pm$ 0.118	12.705 $\pm$ 0.084	Pink	China	59-f
3.672 $\pm$ 0.052	18.681 $\pm$ 0.058	Violet	China	60-f
1.584 $\pm$ 0.095	16.875 $\pm$ 0.113	Golden	China	61-g
1.490 $\pm$ 0.083	37.438 $\pm$ 0.057	Pink	China	62-g
5.669 $\pm$ 0.074	32.085 $\pm$ 0.139	Green	China	63-g
1.601 $\pm$ 0.069	16.074 $\pm$ 0.051	Pink	China	64-g
1.424 $\pm$ 0.067	29.287 $\pm$ 0.116	Brown	China	65-g
2.678 $\pm$ 0.051	27.359 $\pm$ 0.094	Brown	China	66-g
0.654 $\pm$ 0.009	14.795 $\pm$ 0.061	Violet	China	67-h
1.669 $\pm$ 0.008	16.829 $\pm$ 0.133	Golden	China	68-h
0.658 $\pm$ 0.009	8.296 $\pm$ 0.058	Blue	China	69-h
0.719 $\pm$ 0.029	5.205 $\pm$ 0.061	Green	China	70-h
3.016 $\pm$ 0.054	29.256 $\pm$ 0.149	Brown	China	71-h
1.783 $\pm$ 0.074	14.647 $\pm$ 0.127	Pink	China	72-h
1.598 $\pm$ 0.116	23.411 $\pm$ 0.094	Pink	China	73-h
1.192 $\pm$ 0.068	11.855 $\pm$ 0.056	Pink	China	74-h
1.964 $\pm$ 0.093	9.326 $\pm$ 0.088	Green	Korea	75-i
1.698 $\pm$ 0.058	16.240 $\pm$ 0.121	Blue	Korea	76-i
1.760 $\pm$ 0.079	12.578 $\pm$ 0.072	Violet	England	77-j
1.594 $\pm$ 0.074	8.262 $\pm$ 0.061	Blue	England	78-j
3.097 $\pm$ 0.053	11.357 $\pm$ 0.099	Brown	England	79-j
2.668 $\pm$ 0.088	11.767 $\pm$ 0.053	Green	England	80-j
1.295 $\pm$ 0.065	10.557 $\pm$ 0.084	White	England	81-j
0.897 $\pm$ 0.087	8.158 $\pm$ 0.051	Pink	England	82-j
1.702 $\pm$ 0.075	16.808 $\pm$ 0.143	White	England	83-j
1.800 $\pm$ 0.115	15.523 $\pm$ 0.117	Green	England	84-j
2.110 $\pm$ 0.096	13.721 $\pm$ 0.136	Pink	England	85-j
1.689 $\pm$ 0.068	9.429 $\pm$ 0.061	White	Korea	86-k
1.908 $\pm$ 0.051	13.143 $\pm$ 0.093	Pink	Korea	87-k
1.642 $\pm$ 0.079	15.713 $\pm$ 0.051	Brown	Korea	88-k
1.172 $\pm$ 0.052	9.741 $\pm$ 0.135	Violet	Korea	89-k
1.905 $\pm$ 0.067	20.790 $\pm$ 0.121	Golden	Korea	90-k
1.67 $\pm$ 0.086	14.856 $\pm$ 0.092	Blue	Korea	91-k
1.284 $\pm$ 0.066	8.856 $\pm$ 0.053	Green	Korea	92-k
1.295 $\pm$ 0.078	9.0175 $\pm$ 0.122	Brown	Korea	93-k
1.576 $\pm$ 0.091	8.654 $\pm$ 0.054	Brown	Korea	94-k
1.551 $\pm$ 0.075	18.074 $\pm$ 0.149	Green	Korea	95-k
1.287 $\pm$ 0.056	12.772 $\pm$ 0.114	Golden	England	96-L
0.982 $\pm$ 0.008	14.260 $\pm$ 0.086	Brown	England	97-L
1.900 $\pm$ 0.062	12.621 $\pm$ 0.051	Pink	England	98-L
1.185 $\pm$ 0.047	9.826 $\pm$ 0.088	Green	Turkey	99-m
1.094 $\pm$ 0.098	10.558 $\pm$ 0.093	Green	Turkey	100-m

1.659 ± 0.092	13.469 ± 0.141	Green	Turkey	101-m
2.141 ± 0.053	11.247 ± 0.131	Blue	Turkey	102-m
2.011 ± 0.094	13.146 ± 0.115	Blue	Turkey	103-m
1.986 ± 0.069	15.009 ± 0.091	Blue	Turkey	104-m
4.652 ± 0.113	12.008 ± 0.053	White	Turkey	105-m
1.013 ± 0.087	17.705 ± 0.124	Golden	Turkey	106-m
1.002 ± 0.096	12.946 ± 0.091	Violet	Turkey	107-m
1.046 ± 0.058	9.142 ± 0.126	Brown	Turkey	108-n
0.893 ± 0.007	13.261 ± 0.144	Brown	Turkey	109-n
1.063 ± 0.064	26.327 ± 0.066	Pink	Turkey	110-n
1.003 ± 0.117	8.142 ± 0.101	Pink	Turkey	111-n
1.490 ± 0.084	11.642 ± 0.143	Pink	Turkey	112-n
0.836 ± 0.055	9.141 ± 0.117	Pink	Turkey	113-n
2.368 ± 0.077	16.003 ± 0.055	Brown	Turkey	114-n
2.248 ± 0.099	18.140 ± 0.139	Golden	Turkey	115-o
0.625 ± 0.085	9.862 ± 0.094	Green	Turkey	116-o
1.961 ± 0.094	8.565 ± 0.073	Blue	Turkey	117-o
0.520 ± 0.007	9.962 ± 0.134	Blue	Turkey	118-o
1066 ± 0.023	8.106 ± 0.009	Dark Blue	Turkey	119-o
0.773 ± 0.018	8.001 ± 0.013	Green/ Blue	Turkey	120-o

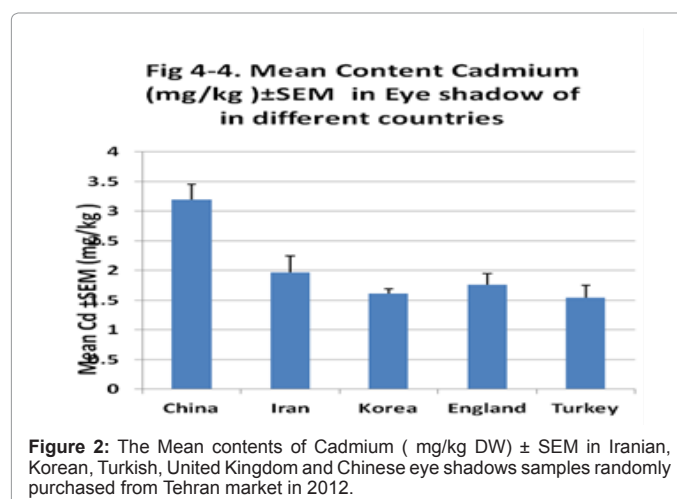
SD: Standard Deviation

**Table 1:** The Mean Content of Lead and Cadmium content in eye shadows samples randomly purchased from Tehran market in 2012.

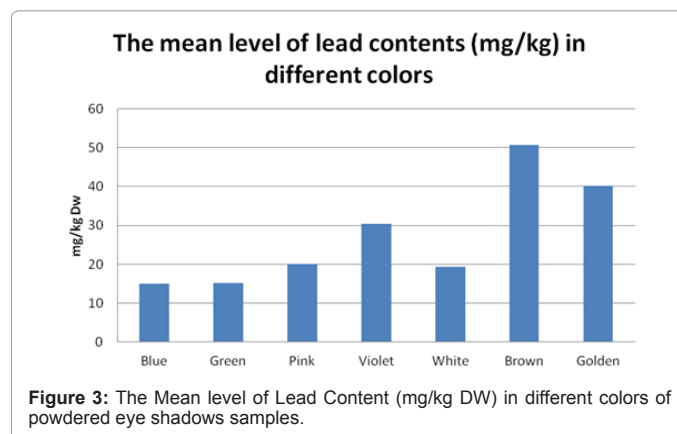
In Kiss & Beauty and Romantic Beauty (Chinese Brands), there is significant difference in the levels of Lead in all the seven main color groups analyzed. The brown and golden colors in all brands have highest concentrations of lead, while blue and green colors have the lowest Lead content and the golden and blue color have the highest and lowest concentration of cadmium respectively. The highest concentration of lead and Cadmium was detected in Chinese eye shadows. The mean content of lead in 66.6 % of 66 Chinese samples monitoring in this study was much higher than 20 mg/kg and the maximum level 202.058 mg/kg of lead belongs to brown color of kiss beauty brand. 37.5%, 8% and 5% of Iranian, Korean and Turkish samples brands monitoring in this research were contaminated to lead respectively. Analysis of variance (ANOVA) was done on each brand of eye shadows to find out if there is significant variation in the concentrations of heavy metals in different colors of each brand. In all brands there is a significant difference in the levels of lead in entire seven main color group analyzed and golden color samples in 13 of 15 monitoring samples had lead contents much higher than the other groups of colors ( $p < 0.01$ ) (Figure 1). This result reveals that the type of pigment used in eye shadows contributes to its heavy metal content. In Iranian brand: My Fair, the mean contents of lead in golden color 42.79 mg/kg, brown color 24.982 mg/kg and violet color 20.023 mg/kg showed the higher lead content than 20 mg/kg which is established as the maximal lead limit in impurities in color additives in the cosmetics for external use, formulated following the good manufacturing practices [2,12] while according to National Iranian permissible level of 10 mg/kg the 96.6% Chinese monitoring samples would be lead contaminated (Figure 2). Cadmium contents in golden group color in 10 of 66 Chinese samples was higher than 10 mg/kg and the highest one related to golden color 10.946mg/kg. The concentration of cadmium shows significant differences of this heavy metal in the color main groups ( $p < 0.005$ ). The 110 of 120 monitoring samples from other 6 main group (blue, green, white, pink, brown and violet) had no cadmium contamination and their concentrations were lower than 5 mg/kg cadmium (Figure 3).



**Figure 1:** The Mean contents of Lead (mg/kg DW) ± SEM in Iranian, Korean, Turkish, English and Chinese eye shadows samples randomly purchased from Tehran market in 2012.



**Figure 2:** The Mean contents of Cadmium ( mg/kg DW) ± SEM in Iranian, Korean, Turkish, United Kingdom and Chinese eye shadows samples randomly purchased from Tehran market in 2012.



**Figure 3:** The Mean level of Lead Content (mg/kg DW) in different colors of powdered eye shadows samples.

## Conclusion

The heavy metal contents in eye shadows may cause harm to consumers. Toxic metals especially lead from eye shadows and other cosmetics like lipstick can rise to accumulate in body over time and repetitive metal-containing product application and probably lead to significant exposure levels. The last author finding on the presence of high lead and cadmium contents in lipsticks samples purchased from Tehran market in Iran, results revealed that 95.91% of Chinese lipstick

samples monitoring had higher level of 20 mg/kg lead [5]. As lead is not an ingredient of lipstick and eye shadow, it might be present as impurities in the color additives. Therefore major quality controls are recommended for cosmetic products like eye shadows. Manufacturers would have to test the raw ingredients before adding them to the final product. The ingredients should not be a not screening of residual of other manufacturing process or be impurities of industrial processor get into products by poor quality controls. The international cooperation between toxicologists and study of safety assessment of these cosmetic products can reduce the risk of toxicity for all consumers around the world. We recommended the major quality controls for the cosmetics products due to long contact with the skin of eyelids.

#### Acknowledgment

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