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Health Risk Assessment of Some Toxic Metals for Skin Whitening Creams in Iraqi Markets

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Abstract

White skin has long been considered the standard of beauty; however, women who use skin-whitening creams may be unaware that these products contain toxic metals, posing significant health risks to consumers. Therefore, this research aimed to detect the concentration of some toxic metals in thirty whitening creams by flame atomic absorption spectroscopy and to evaluate the carcinogenic and non-carcinogenic risks for all tested samples. The results showed that the average concentrations for all samples were in the order Cd < Co < Cr < Ni < Hg < Pb. All samples exhibited elevated concentrations of Hg, reaching levels up to ten times higher than the permissible limits set by the World Health Organization (WHO) and three times according to the Europe Union (Eu), and Canada. Non−carcinogenic risk results for the current study showed that the hazard quotient (HQ) and hazard index (HI), for all samples were <1. While, carcinogenic risks for Cd, Cr, Ni, and Pb were within the permissible limits, which indicates no harmful health effects, and consumers are safer using the product, but daily exposure can lead to accumulation that may cause cancer.

Keywords: Carcinogenic risk, Hazard index, Hazard quotient, Heavy Toxic Metals, Whitening Creams.

تقييم المخاطر الصحية لبعض المعادن السامة في كريمات تبييض البشرة في الأسواق العراقية

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الخلاصة

لطالما اعتُبرت البشرة البيضاء معياراً للجمال؛ ومع ذلك، قد لا تدرك النساء اللواتي يستخدمن كريمات تفتيح البشرة أن هذه المنتجات تحتوي على معادن سامة، مما يشكل مخاطر صحية كبيرة على المستهلكين. لذا يهدف هذا البحث إلى الكشف عن تراكيز بعض المعادن السامة في ثلاثين كريم تبييض بواسطة الامتصاص الذري اللهبي و لإجراء تقييم للمخاطر المسببة للسرطان وغير المسببة للسرطان لجميع النماذج المدروسة . اظهرت

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النتائج بان متوسط التراكيز لجميع عينات كريم التبييض كان بالترتيب Cd < Co < Cr < Ni < Hg < Pb . كما أظهرت جميع العينات تراكيز عالية من الزئبق تصل إلى عشرة أضعاف الحد المسموح به حسب منظمة الصحة العالمية وثلاث مرات حسب الاتحاد الأوروبي وكندا .أظهرت نتائج المخاطر غير المسرطنة للدراسة الحالية أن حاصل الخطر (HQ) ومؤشر الخطر (HI) لجميع العينات كان أقل من 1. بينما كانت المخاطر المسرطنة لـ Cd, Cr, Ni ضمن الحدود المسموح بها ,مما يشير إلى عدم وجود آثار صحية ضارة، وأن المستهلكين أكثر أمانًا عند استخدام المنتج، لكن التعرض اليومي يمكن أن يؤدي إلى تراكم قد يسبب السرطان.

1. Introduction

Skin whitening creams provide two benefits: they can brighten skin color by removing or reducing the amount of existing melanin, and they can inhibit the formation of new melanin [1, 2]. The presence of spots on the skin is a source of concern for many people, and these spots are caused by skin disorders or the existence of an excessive amount of melanin produced by melanocytes responsible for the pigmentation of the skin. Spots may occur for various reasons, including excessive exposure to solar radiation, aging, weak hormones during pregnancy, or ingesting certain drugs [3,4]. Skin whitening products contain heavy metals such as mercury that can be absorbed through the skin and cause deleterious effects on the body [5, 6]. Mercury is utilized by manufacturers due to its ability to rapidly lighten skin tone. However, this metal accumulates in the human body, especially in the kidney, liver, and brain, which in turn causes adverse effects on health [7, 8]. White and bright skin has been the standard of beauty in the Middle East; humans have looked after their appearance and beauty since ancient times, using clay tree leaves and natural pigments. Therefore, women and men use products to brighten the skin and eliminate dark spots quickly; this encourages many manufacturers to use concentrations that do not match the specifications to meet customers' needs. Many new products are released into the market every season, and it is hard to keep track of the safety of every product. Some products may carry carcinogenic contaminants [9, 10]. Several studies analysed many types of whitening creams from different countries, and they found that they contained high concentrations of mercury and heavy metals like Pb, Cd, and trace elements. These studies indicated that samples for Hg and Pb content exceeded the World Health Organization (WHO) permissible limits among the toxic heavy metals, and arsenic was found appreciably well below. In contrast, Cd exceeded the permissible limit in all samples [11, 12]. A recent assessment by the WHO reported that Hg in skin-lightening creams commonly used in African nations and Asia is potentially dangerous as they have serious side effects [13, 14]. As a result of the increasing spread of diseases that result from metal poisoning [15-17], this study aims to examine the concentration of some toxic metals present in whitening creams and conduct a health risk assessment. Creams are considered one of the primary sources of metals entering the body through direct contact with the skin. The competitive pressure among companies to deliver results quickly has led them to create whitening creams containing toxic metals at concentrations that exceed internationally accepted limits.

2. Materials and Methods

Quantitative analysis of toxic metals was conducted using the flame atomic absorption A. A 350 NOV Analytic Jena (Germany, 2012). The samples (skin-whitening creams) were collected from various retail shops, pharmacies, and beauty stores in the Iraqi markets. Thirty skin-whitening creams were analysed to determine toxic metal levels (Cd, Cr, Ni, Pb, Hg, and Co). The samples were manufactured in different countries (Pakistan, Syria, China, Emirati, Iraq, Korea, Japan, France, Jordan, Switzerland, and Iran). About 2.5–3 g of sample was taken and placed in a ceramic crucible, then an amount of 10 mL of hydrogen peroxide (30%) was added to it and heated at a temperature of 120°C for an hour (until the samples dried); after that, it was transferred to the oven to be burned at a temperature of 800 °C for an hour to remove all carbon compounds. The sample was taken out and left to cool, after which a mixture of 68%

nitric acid and 36% hydrochloric acid was added to the sample and placed on the hotplate at 100°C for 45 minutes. After that, it was left to cool again, finally transported to a volumetric flask (25 mL), and completed with distilled water. Thus, the samples were prepared for measurement using the flame atomic absorption technique. The flame is made of acetylene air, and hollow cathode lamps provide the radiation source. Burner height and gas flow rates were adjusted to get the best absorbance signal for each element. The slit width utilized to isolate wavelength was one nm. The absorbance of each element was measured individually [5, 18]. The recovery analysis in this study indicated that the recovery percentage exceeded 95%.

3. Results and Discussion

The calculations in the current study included models of human health risks for carcinogenic and non-carcinogenic types issued by the United States Environmental Protection Agency (USEPA). To assess the potential health risks to consumers, this study utilized the threshold values established by the USEPA [19, 20]. Currently, there is no consensus on the maximum permissible levels for non-carcinogenic and carcinogenic risk in Iraq. The carcinogenic risk associated with dermal absorption from cream application is evaluated using the equations presented in Table 1, which assess the skin's contact with the cream. Based on chronic daily intake (CDI) in (mg/kg/day), where the constants: exposed skin area (SA), adherence factor (AF), dermal absorption fraction (ABS), exposure frequency (EF), exposure duration (ED), unit conversion factor (CF), body weight (BW), and average time (AT) issued by USEPA [19, 20]. Cancer Slope Factor (CSF) [21] and CDI are used to find carcinogenic risk. CSF is defined as the risk caused by a lifetime average of 1 mg/kg-day of a carcinogen chemical, which is contaminant-specific. The permissible limits for CR are 1×10^{-6} and $< 1\times10^{-4}$ for single and multi-carcinogenic elements. Cancer risks below 10^{-6} were deemed insignificant to human health. Values between 1×10^{-6} and 1×10^{-4} indicate a probable carcinogenic impact on humans. Levels exceeding 1×10^{-4} suggest increased cancer risk for humans [19,20].

For non-carcinogenic risk, the hazard quotient (HQ) was calculated using CDI and reference dose (RfD) dermal in (mg/kg-day). HQ value indicates no harmful health effects if $HQ < 1$, while $HQ \geq 1$ denotes potentially harmful health consequences. HQ is defined as "The ratio of the potential exposure to a chemical and the level at which no negative effects are expected (calculated using the exposure divided by the suitable chronic or acute value)," and the hazard index (HI) as "The sum of HQ for toxics which affects the same target organ or organ system ."The HI value represents the cumulative non-carcinogenic effects of several elements. $HI < 1$ indicates that consumers are safer to use the product [19,20].

Table 1: Risk assessments

Exposure pathway	Formula for calculation	Risk assessment
Dermal contact	$CDI_{dermal}=\frac{CS\times SA\times AF\times ABS\times EF\times ED\times CF}{BW\times AT}$	Non−carcinogenic risk; $HQ= CDI_{dermal}/RfD_{dermal}$
		Carcinogenic risk = CDI X CSF
Metal	RfD dermal (mg/kg-day)	CSF dermal (mg/kg-day)
Cd	$1x10^{-5}$	6.1
Cr	$6x10^{-5}$	20
Ni	5.4×10^{-3}	42.5
Pb	5.25×10^{-4}	8.5×10^{-3}
Cd	$1x10^{-5}$	----
Cr	$6x10^{-5}$	----
Exposure factor	Unit	Currently recommended values by U.S. EPA
Exposure-point concentration (CS)	mg/kg	Concentration of analyte
Exposed skin area (SA)	cm^2	6,032
Adherence factor (AF)	$mg.cm^{-2}$	0.07
Dermal absorption fraction (ABS)	---------	0.001
Exposure frequency (EF)	Days/year	350
Exposure duration (ED)	Year	26
Units conversion factor (CF)	$mg. Kg^{-1}$	10^{-6}
Body weight (BW)	kg	80
Average time (AT)	Days	9,490 (ED X 365 days) for non-carcinogenic
		25,550 (Lifetime: 70 years X 365) for carcinogenic

The heavy metals concentrations (Cd, Cr, Ni, Pb, Hg, and Co) in whitening cream samples are shown in Table 2 and compared to the permitted limits for these metals according to WHO, Europe Union (EU), and Canada [22] in Table 3.

Table 2: Concentrations of heavy metals in whitening cream samples

Sample NO.	Country of origin	Cd µg/g ±SD	Cr µg/g ±SD	Ni µg/g ±SD	Pb µg/g ±SD	Hg µg/g ±SD	Co µg/g ±SD
1	Syria	0.505±0.13	0.918±0.13	1.855±0.14	5.332±0.90	6.502±1.22	0.422±0.12
2	Pakistan	0.313±0.09	1.001±0.20	1.533±0.16	6.088±0.98	10.524±1.91	0.705±0.12
3	Pakistan	0.419±0.13	0.973±0.13	0.931±0.03	5.466±0.99	7.509±1.56	0.591±0.14
4	Pakistan	0.209±0.08	0.989±0.11	2.098±0.13	5.911±0.84	9.833±1.44	0.722±0.20
5	Pakistan	0.321±0.09	1.144±0.14	2.055±0.15	8.110±1.13	5.903±0.55	0.904±0.19
6	Pakistan	0.817±0.12	1.055±0.15	2.243±0.23	6.011±0.23	9.770±1.05	0.821±0.15
7	China	0.324±0.03	1.208±0.13	3.098±0.22	6.351±0.80	6.621±1.05	0.866±0.11
8	Emirati	0.623±0.15	1.632±0.14	2.644±0.19	6.441±1.03	5.099±0.66	0.908±0.13
9	China	0.551±0.11	0.977±0.13	2.904±0.18	5.099±0.82	6.500±0.95	0.928±0.16
10	China	0.352±0.04	0.991±0.16	1.998±0.12	7.910±1.91	11.098±1.95	0.499±0.10
11	Iraq	0.411±0.10	1.899±0.15	1.886±0.16	9.077±1.57	6.698±1.01	0.491±0.09
12	Emirati	0.298±0.05	1.854±0.16	2.099±0.17	9.011±1.83	7.033±1.53	0.598±0.15
13	Pakistan	0.394±0.08	2.021±0.24	3.071±0.25	8.632±1.54	8.099±1.77	0.855±0.16
14	Iraq	0.701±0.18	1.721±0.18	2.709±0.21	8.918±1.75	7.632±1.06	0.964±0.17
15	China	0.745±0.17	1.604±0.19	2.603±0.26	9.933±1.65	5.799±0.93	0.988±0.16
16	Pakistan	0.805±0.17	2.550±0.19	3.056±0.30	8.311±1.70	6.922±0.82	0.793±0.13
17	Iraq	0.509±0.12	2.001±0.18	2.774±0.13	8.883±1.86	7.904±1.33	0.963±0.14
18	China	0.487±0.13	1.891±0.16	2.611±0.22	8.991±1.45	8.788±1.45	0.977±0.13
19	Emirati	0.699±0.15	2.208±0.17	2.933±0.27	9.854±1.87	8.031±1.30	0.872±0.17
20	Korea	0.491±0.03	1.055±0.13	2.865±0.29	9.930±1.63	8.955±1.41	0.933±0.11
21	Korea	0.907±0.13	1.409±0.11	3.132±0.31	7.998±1.05	5.871±0.35	0.980±0.14
22	Iraq	0.397±0.07	1.771±0.12	3.300±0.34	9.909±1.01	6.902±0.57	0.766±0.10
23	Korea	0.488±0.04	0.995±0.08	3.001±0.32	8.665±1.05	7.957±1.42	0.990±0.21
24	Korea	0.791±0.13	1.379±0.10	2.909±0.13	9.552±1.11	7.895±1.34	0.854±0.15
25	Japan	0.651±0.11	1.422±0.11	2.991±0.21	8.775±1.21	8.936±1.33	0.881±0.13
26	France	0.772±0.13	1.701±0.12	3.109±0.29	8.937±1.09	9.022±1.53	0.898±0.10
27	Jordan	0.832±0.10	2.018±0.20	3.076±0.28	9.011±1.35	8.966±1.22	0.989±0.20
28	Switzerland	0.911±0.12	1.905±0.23	2.033±0.25	9.004±1.75	8.899±1.38	0.698±0.12
29	Iran	0.544±0.03	2.009±0.19	2.124±0.20	8.076±1.11	9.377±1.44	0.916±0.18
30	France	0.690±0.12	2.108±0.18	2.802±0.19	9.009±1.02	6.910±0.75	0.971±0.19
Mean		0.565	1.547	2.548	8.107	7.865	0.825
Maximum		0.911	2.550	3.300	9.933	11.098	0.990
Minimum		0.209	0.918	0.931	5.099	5.099	0.422

Table 3: Maximum limits of permissible concentrations for heavy metals in cream products

Metal	International standards (PPM)		
	WHO	EU	Canada
Cd	0.3	0.5	3
Cr	NA	1	NA
Ni	NA	NA	NA
Pb	10	0.5	10
Hg	1	3	3
Co	NA	NA	NA

NA: Not Available; WHO: World Health Organization; Eu: Europe Union; PPM: Parts Per Million; Cadmium (Cd); Chromium (Cr); Nickel (Ni); Lead (Pb); Mercury (Hg); Cobalt (Co).

The results of the current study showed that the Cd concentrations in all samples of whitening creams were higher than the permissible limit according to the values specified by the WHO, except for samples NO. 4 and 12. However, compared to the EU, the results showed that samples NO. 1, 6, 8, 14-19, 20, and 24-30 are higher than the specified values. As for comparing to the permissible limits in Canada, all samples are confirmed. This study also showed that Cr concentrations in all samples were higher than the permissible level, according to the EU, except for samples 1, 3, 4, 9, 10, and 23. While Pb concentration in the studied samples was consistent with the permissible limits according to the WHO and Canada, all samples were higher than the permitted limits in the EU. All samples showed high concentrations of Hg, up to ten times the permissible limit according to the WHO and three times according to the EU and Canada.

This study aimed to determine the quantities of six heavy metals in 30 skin whitening cream samples, as whitening creams often contain several potentially harmful heavy metals. The average concentrations of studied metals for all whitening cream samples were in the order Cd < Co < Cr < Ni < Hg < Pb (0.56 < 0.82 < 1.54 < 2.54 < 7.86 < 8.10; µg/g), respectively, as shown in Table 2. The concentrations of analyzed metals (Cd, Cr, Ni, Pb, Hg, and Co) were in the range of (0.20-0.91, 0.91-2.5, 0.93-3.30, 5.09- 9.93, 5.09-11.09, and 0.42-0.99); µg/g), respectively, as seen in table 2. All these metals were compared with the permissible limits of WHO, EU, and Canada.
Various studies have reported different levels of metal content in cosmetics, typically showing a trend of Pb > Cd > Cr > Hg. For whitening creams Pb > Cr > Ni > Cu >As [24] .
The scientific literature suggests that a nickel value of less than 5 mg/kg is considered a "good manufacturing practice." [25]. The concentrations of Ni for all whitening creams in the current study were < 5 mg/kg.

The displacement of essential elements in biomolecules by toxic metals through electrophilic substitution results in disrupted bodily functions. Lead exposure was nine times higher through damaged skin than through healthy skin, and skin cleaning with liquid soap did not reduce Pb skin absorption. Low Pb concentrations, for instance, may function as a selective blocker of calcium channels that depend on voltage and limit the reabsorption of small organic molecules on renal mitochondria [23]. The current study showed that Pb concentration in all samples were many times higher compared to the permitted limits in the EU. Recently, a study showed that in many types of cosmetics, Co concentration was higher than the recommended level, while Pb concentration was within the range recommended by US-FDA. As yet, there are no international limits for Co concentration in cosmetic products, but extended exposure to Co through the skin leads to irritation. Symptoms appear when the concentration of Co is ≤ 10 ppm [26].

Despite being banned in many countries, numerous brands of skin-whitening products containing mercury levels exceeding the permissible limit are still sold to accelerate the whitening effect. The concentration of mercury for this study in all samples is very high, and previous studies in other countries have also proved this [8,14]. Mercury salts are used in cosmetics because of their ability to suppress the synthesis of melanin, resulting in skin whitening. Cd is most widely known for its colour pigment properties and Cr used as colour additive in products of cosmetics [23].

All studies conducted in Iraq on whitening creams were limited to calculating the concentrations of toxic metals and comparing them to the internationally permissible limits. Therefore, the current research is characterized by assessment of health risk based on the concentrations of toxic metals in addition to comparing these concentrations with the

permissible limits of WHO, EU and Canada. There are very few studies conducted on whitening creams products in Iraq, one of these conducted on 17 samples of whitening creams available in Iraqi markets (7 European and 10 Asian), it showed that 53% of the products contained Pb higher than the limit permitted by the FDA, as the contamination percent in European products was 14% and 84% in Asian products [24]. In another study that assessed the mercury levels in 12 whitening cream products, it was noted that the concentration of Hg was more than the permissible limit compared to the WHO [25].

Non−carcinogenic risk results for the current study showed that HQ and HI for all samples were less than one, as shown in Table 4. Due to the unavailability of dermal CSF for the Hg, and Co, carcinogenic risk was calculated only for (Cd, Cr, Ni, and Pb) metals and presented in Table 5. All results for CR were within the permissible limits.

Table 4: Hazard quotient and hazard index of heavy metals in whitening cream samples

Sample NO.	HQ Cd	HQ Cr	HQ Ni	HQ Pb	HQ Hg	HQ Co	HI
1	2.556E-04	7.743E-05	1.739E-06	5.140E-05	1.567E-03	1.335E-07	1.953E-03
2	1.584E-04	8.444E-05	1.437E-06	5.869E-05	2.536E-03	2.230E-07	2.840E-03
3	2.121E-04	8.207E-05	8.726E-07	5.269E-05	1.810E-03	1.869E-07	2.158E-03
4	1.058E-04	8.342E-05	1.966E-06	5.698E-05	2.370E-03	2.284E-07	2.618E-03
5	1.625E-04	9.650E-05	1.926E-06	7.818E-05	1.423E-03	2.860E-07	1.762E-03
6	4.135E-04	8.899E-05	2.102E-06	5.795E-05	2.355E-03	2.597E-07	2.917E-03
7	1.640E-04	1.019E-04	2.904E-06	6.122E-05	1.596E-03	2.739E-07	1.926E-03
8	3.153E-04	1.377E-04	2.478E-06	6.209E-05	1.229E-03	2.872E-07	1.747E-03
9	2.789E-04	8.241E-05	2.722E-06	4.916E-05	1.567E-03	2.935E-07	1.980E-03
10	1.782E-04	8.359E-05	1.873E-06	7.625E-05	2.675E-03	1.578E-07	3.015E-03
11	2.080E-04	1.602E-04	1.768E-06	8.750E-05	1.614E-03	1.553E-07	2.072E-03
12	1.508E-04	1.564E-04	1.967E-06	8.687E-05	1.695E-03	1.892E-07	2.091E-03
13	1.994E-04	1.705E-04	2.878E-06	8.321E-05	1.952E-03	2.705E-07	2.408E-03
14	3.548E-04	1.452E-04	2.539E-06	8.597E-05	1.839E-03	3.049E-07	2.428E-03
15	3.771E-04	1.353E-04	2.440E-06	9.576E-05	1.398E-03	3.125E-07	2.008E-03
16	4.074E-04	2.151E-04	2.864E-06	8.012E-05	1.668E-03	2.508E-07	2.374E-03
17	2.576E-04	1.688E-04	2.600E-06	8.563E-05	1.905E-03	3.046E-07	2.420E-03
18	2.465E-04	1.595E-04	2.447E-06	8.667E-05	2.118E-03	3.090E-07	2.613E-03
19	3.538E-04	1.862E-04	2.749E-06	9.499E-05	1.936E-03	2.758E-07	2.574E-03
20	2.485E-04	8.899E-05	2.685E-06	9.573E-05	2.158E-03	2.951E-07	2.594E-03
21	4.590E-04	1.189E-04	2.935E-06	7.710E-05	1.415E-03	3.100E-07	2.073E-03
22	2.009E-04	1.494E-04	3.093E-06	9.552E-05	1.663E-03	2.423E-07	2.113E-03
23	2.470E-04	8.393E-05	2.813E-06	8.353E-05	1.918E-03	3.132E-07	2.335E-03
24	4.003E-04	1.163E-04	2.726E-06	9.208E-05	1.903E-03	2.701E-07	2.514E-03
25	3.295E-04	1.199E-04	2.803E-06	8.459E-05	2.154E-03	2.787E-07	2.691E-03
26	3.907E-04	1.435E-04	2.914E-06	8.615E-05	2.174E-03	2.841E-07	2.798E-03
27	4.211E-04	1.702E-04	2.883E-06	8.687E-05	2.161E-03	3.128E-07	2.842E-03
28	4.611E-04	1.607E-04	1.905E-06	8.680E-05	2.145E-03	2.208E-07	2.855E-03
29	2.753E-04	1.695E-04	1.991E-06	7.785E-05	2.260E-03	2.897E-07	2.785E-03
30	3.492E-04	1.778E-04	2.626E-06	8.685E-05	1.665E-03	3.071E-07	2.282E-03

Table 5: Carcinogenic risk assessment for heavy metals in whitening cream samples

Sample NO.	Cd	Cr	Ni	Pb
1	1.559E-08	9.292E-08	3.990E-07	2.294E-10
2	9.663E-09	1.013E-07	3.297E-07	2.619E-10
3	1.294E-08	9.849E-08	2.003E-07	2.351E-10
4	6.452E-09	1.001E-07	4.513E-07	2.543E-10
5	9.910E-09	1.158E-07	4.420E-07	3.489E-10
6	2.522E-08	1.068E-07	4.825E-07	2.586E-10
7	1.000E-08	1.223E-07	6.664E-07	2.732E-10
8	1.923E-08	1.652E-07	5.687E-07	2.771E-10
9	1.701E-08	9.889E-08	6.246E-07	2.194E-10
10	1.087E-08	1.003E-07	4.298E-07	3.403E-10
11	1.269E-08	1.922E-07	4.057E-07	3.905E-10
12	9.200E-09	1.877E-07	4.515E-07	3.876E-10
13	1.216E-08	2.046E-07	6.606E-07	3.713E-10
14	2.164E-08	1.742E-07	5.827E-07	3.836E-10
15	2.300E-08	1.624E-07	5.599E-07	4.273E-10
16	2.485E-08	2.581E-07	6.573E-07	3.575E-10
17	1.571E-08	2.025E-07	5.967E-07	3.821E-10
18	1.503E-08	1.914E-07	5.616E-07	3.868E-10
19	2.158E-08	2.235E-07	6.309E-07	4.239E-10
20	1.516E-08	1.068E-07	6.163E-07	4.272E-10
21	2.800E-08	1.426E-07	6.737E-07	3.441E-10
22	1.226E-08	1.793E-07	7.098E-07	4.263E-10
23	1.507E-08	1.007E-07	6.455E-07	3.728E-10
24	2.442E-08	1.396E-07	6.257E-07	4.109E-10
25	2.010E-08	1.439E-07	6.434E-07	3.775E-10
26	2.383E-08	1.722E-07	6.687E-07	3.845E-10
27	2.569E-08	2.043E-07	6.616E-07	3.876E-10
28	2.813E-08	1.928E-07	4.373E-07	3.873E-10
29	1.679E-08	2.034E-07	4.569E-07	3.474E-10
30	2.130E-08	2.134E-07	6.027E-07	3.876E-10

Previous studies found that the Pb concentration exceeded the maximum level set by the US FDA in 14 skin lightening products in Southern Africa. The hydroquinone (HQ) level was also found to be above the recommended limit of <1%. Meanwhile, the levels of chromium (Cr) and nickel (Ni) were both found to be <1%. The HI for all samples was greater than 1 [27].They found that HQ and HI values for (As, Pb, Ni, Hg, and Cd) were < 1 in all facial cosmetics [28] as well as HQ and HI values were within the permissible limit for Cr, Ni , Pd and Cd in whitening creams [6]. Also the carcinogenic risk estimated for (Ni, Cd, Cr, and Pb) in various cosmetic products was within permissible limits except for Cd, and the concentration of these metals are lower than permissible limit set by WHO [29]. Carcinogenic and non-carcinogenic risk estimated for Pb, Cd, Ni, Cr, and Co were within the safe range for lightening

creams [30]. Another study found that non-carcinogenic assessment was lower than the safe risk limits in traditional cosmetic products for As, Cd, Co, Cr, Cu, and Ni [31, 32].

Conclusion

Based on established guidelines, the concentrations of Cd, Cr, Ni, Pb, Hg, and Co detected in all samples in this study were within acceptable limits for both non-carcinogenic and carcinogenic risk assessments. However, due to the high concentration of the studied metals in most samples, consumers should be aware of the potential health risks from heavy metals. The source of accumulation of toxic metals in the body through the skin is one of the dangerous sources, in addition to their entry into the body through plants that absorb these metals from the soil. It is not easy to eliminate cosmetic products containing mercury because it is a quickly rising sector of the cosmetics business in many countries. Heavy metals cannot be removed from whitening creams after they are manufactured. However, by thoughtfully selecting raw materials with consideration for heavy metal content, we can enhance product quality and protect our beauty. The concerned authorities should also regularly inspect marketed products to detect and ban any toxic products. Also people need to minimize the use of whitening creams to save health. One of the benefits of the current study is raising public awareness of toxic heavy metals that are used in whitening creams. This study recommends monitoring harmful levels of metals in whitening creams in Iraq to verify compliance with defined limits and protect consumer health.

Conflicts of interest

There are no conflicts of interest.

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