



ISSN: 0067-2904

Detection of Cadmium and Chromium in some Facial Cosmetics

Muhammed Nafea Ali AL- Azzawi, Hamsa Tariq Adbl-Razzaq AL- Hilifi

Department of Biology, College of Science, University of Baghdad, Baghdad, Iraq.

Abstract

This study was done to compare among 120 new and used cosmetic brands to determine the heavy metals concentrations (Cadmium, Chromium) in (face foundation, powder and blushers). Sixty new cosmetic products were bought from local markets in Baghdad city (twenty different brands for each cosmetic products), while sixty used cosmetic products were collected from Iraqi women and they had been stored for a long time. This study proved that not all analyzed cosmetic products containing heavy metals concentrations and all concentrations are under Iraqi acceptable limits except one new blusher product which contained chromium with (28 ppm), but all used cosmetic products have shown better results in concentrations of heavy metals than new products and we found that foundations are the best from all analyzed products, although these have emulsion texture which is difficult to store and easily to contaminate; even though most of these cosmetic products have label of ingredients and brand, or free from production and expiration date, that will not prevent any presence of heavy metals within their chemical structure. Women must avoid using the same brand and store the products for a long period to prevent expose to the same chemical ingredients of these products because of being vulnerable to biodegradation and refraining to buy products without a certain brand or country origin.

Keywords: facial cosmetics, heavy metals, biodegradation.

التحري عن عنصري الكروم والكاديوم في بعض مستحضرات تجميل الوجه

محمد نافع علي العزاوي، همسة طارق عبد الرزاق الحلفي

قسم علوم الحياة، كلية العلوم، جامعة بغداد، بغداد، العراق.

الخلاصة

أجريت هذه الدراسة للمقارنة بين 120 من ماركات مستحضرات التجميل الجديدة والمستخدمة لتحديد تراكيز المعادن الثقيلة (الكاديوم، والكروم) في (أساس الوجه، وياودر الوجه وأحمر الخدود). حيث تم شراء ستين مستحضر جديد من الأسواق المحلية لمدينة بغداد بواقع عشرين ماركة تجارية لكل مستحضر، في حين تم جمع ستين مستحضر مستخدم من النساء العراقيات بواقع عشرين ماركة تجارية مختلفة لكل مستحضر مستخدم والتي تم تخزينها لفترة طويلة. أثبتت الدراسة أن ليس كل منتجات التجميل التي تم تحليلها تحتوي على المعادن الثقيلة وجميع التراكيز كانت تحت الحدود العراقية المقبولة باستثناء منتج واحد من منتجات أحمر الخدود الجديدة التي احتوت على الكروم بتركيز (28 ppm)، كانت مستحضرات التجميل المستخدمة أكثر خلوًا من تراكيز المعادن الثقيلة من مستحضرات التجميل الجديدة، وأن منتجات أساس الوجه كانت هي الأفضل من باقي المستحضرات التي تم تحليلها، على الرغم من أن هذه المنتجات تمتلك القوام مستحلب الذي من الصعب تخزينه وتعرضه سريعاً للتلوث. على الرغم من امتلاك مستحضرات التجميل ملصق الخاص

بأسماء المكونات والعلامة التجارية، وخلو بعضها من تاريخ الإنتاج وتاريخ إنتهاء الصلاحية، فأن هذا لم يمنع من تواجد المعادن الثقيلة بتركيز ضئيلة ضمن تركيبها الكيميائية ولتجنب التعرض المستمر لنفس مكونات مستحضر التجميل الكيميائية، على المرأة الأبتعاد عن استخدام نفس العلامة التجارية وتخزين تلك المستحضرات لفترات طويلة لكونها عرضة للتحلل الحيوي وتجنب شراء المنتجات بدون علامة تجارية معينة وبلد مصنع .

Introduction

Makeup or facial cosmetics can be defined as: a subset of cosmetics which named "Make-up" refers to color products are using to modify users appearance [1].

The cosmetic molecules able to enter the humans via different exposure routes, when cosmetics directly applied to the skin with their ingredients; they can cross the cutaneous barrier to reach the systemic circulation. Another route of exposure by contact with the mucous membranes or by ingestion (as with lipstick) and by inhalation (cosmetic formula as aerosols: perfumes or deodorants); finally, with varnish application [2, 3]. These days everybody is using cosmetics which contain cleansing products like shampoos, bath and shower products, also deodorants and makeup products [4]. A list of ingredients must be on the product except the impurities and raw materials which used in the industry; additional materials and solvents carrier for perfume and aromatic composition [5]. There are many factors make the product expose to degrade its activity and quality when opened like (oxygen, sunlight, microbes or any factor which the product exposed to it during storage and use); make change to their characteristics, Also air and contaminants, through product's filling; storage and use. So to reduce contamination and degradation; airless packaging can use; this helps manufactures to minimize the preservatives use to make the product more organic. Airless packaging makes the consumer uses the product for final drop [6]. The female can observe the first step of changes in the product's physico- chemical characters like (odor and fragrance changes, color wilt, staining, sedimentation and separation but degradation of active complexes with their concentrations in the product's form and classification of the toxic byproducts estimation by physical monitoring (like photo byproduct of bezophenone classified as 2, 4-dimethyl-lanisole [7]. the product's biodegradation and rising of infection risk to consumers [8]. Heavy metals could be found in cosmetics as impurities [9]. Cosmetics are the serious source of heavy metal releasing to the environment because of daily use and put on the weak areas of facial skin (like lips and pre ocular areas) where absorption is high but the skin doesn't allow the chemical materials in cosmetics to pass through [10]. Their toxicity built on some factors like (dose, exposure route, chemical species, sex, genetics and nutritional case of exposed individuals). Some metallic elements known to promote multiple organ damage even with lower levels of exposure; considered systemic toxicants; they are known as human carcinogens and because of their higher toxicity degree classified among the preference metals in public health significance these are (arsenic, cadmium, chromium, lead and mercury) [11]. Presence of cadmium in a lot of cosmetic products especially lipsticks and face powder; it's used as a pigment to give color in cosmetic industry, because of its dark yellow color to orange [12], while chromium present in cosmetics as impurities [10]. By a moisture skin, heavy metals can be absorbed through dermal contact [13]. Cd isn't essential heavy metal, highly toxic, its well identified for its adverse effects on the cells enzymatic system, oxidative system and till deficiency of nutrition took place in plants [14], his metal gets accumulated in plants and concentrates in food chain, finally, reaches to human body [15, 16]. The Cd effects on cells are well known while its toxicity mechanism is not realized till now [17]. Chromium is an essential nutrient wanted for fat and normal sugar metabolism, deficiency of dietary Cr is linked with cardiovascular disease and first maturity [18], Cr+6 are ranked as group 1 human carcinogenic characters by the International Agency for the Research on Cancer [19]. Cr health effects: large quantity can cause nose redness; nose bleeding, stomach, kidneys and liver problems and contact with its compounds resulting skin ulcers; irritation and Death [20], for these reasons and for human health maintenance this study is came for detection of these heavy metals in cosmetic products.

Materials and Methods

Collection of New brands samples (non- used)

Samples of the most popular brands of cosmetics were purchased from the various shops from local markets of Baghdad (Baghdad Al-Jadeeda market, Palestine Street, Al-Sharjah market, Al-Mansour

and Al-Karada Dakhel). Total twenty different brands of each cosmetic product were taken for laboratory analysis including (face powder, face foundation and blusher).

Collection of old used samples

The same number of samples for same types of cosmetics was collected from Iraqi women who had been used for a period of time. The storage period ranged between from few months to several years because most of these products had no expiry date, so, most of women used them for a long time without care.

Samples numbering

Each type of cosmetic product had been given a brief name with sequence from (1-20) for new products while (21- 40) for used products:

1. Blusher: Bl₁- Bl₄₀.
2. Face powder: Po₁-Po₄₀.
3. Face foundation: FO₁-FO₄₀.

Heavy metals analysis

Blushers and face powder Digestion

The method had been followed for the wet digestion of the collected powder samples. Accurately weighed powder samples (1g) were placed in digestion flasks and concentrated nitric acid (67 %) 10 ml was added. The digestion flasks were heated (70° to 80 C°) on a hot plate for 30 minutes. After cooling, 5 mL of H₂O₂ was added in the flasks and heated vigorously till the white fumes appeared and mixture volume reduced to 2-3 ml. Finally, the contents were diluted up to desire volume by adding de-ionized water, and then the samples were filtered by using wathman filter paper No.42, the concentration of heavy metals was determined by atomic absorption spectrometer [21].

Face foundation Digestion

These type of cosmetics at the formula of semisolid structure were dried by using Muffle-furnace oven at 660° C for 3 hours to convert for solid formulations, 1 g of the ashed powdered sample was taken in a beaker 100 ml, 10 ml of concentrated nitric acid (67%) was added and kept at room temperature for 24 h in a fume hood. Perchloric acid (4 ml) was added to the sample and concentrated on a hot plate at 60°C until a suspension of approximately 1 ml was left in the flask. The residue was cooled, diluted with deionized water up to 50 ml and filtered through Whatman filter paper no. 42 [22].

Results and Discussion

The results of cadmium concentrations ranged between 0.001- 0.036 ppm in new blushers and ND- 1.259 ppm in used blushers respectively as it shows in Table-1, 0.465- 0.01 and ND- 0.024 ppm in new and used face powder respectively as in Table-2 while in new and used foundations are ranged between ND- 0.13 ppm and ND- 0.011 ppm respectively as in Table-3; but chromium concentrations ranged between 0.222-28, ND- 24 ppm in new and used blushers as in Table-1; but 5.667- 0.625, 0.033- 0.297 ppm in new and used face powders as in Table-2; while 0.123- 0.447 ppm and ND- 0.271 ppm in new and used foundations respectively as it shows in and Table-3.

Table 1- Concentrations of Cd and Cr in new and used blushers.

New sample No.	Bran's name	Cd	Cr	Used sample No.	Bran's name	Cd	Cr
Bl ₁	ARTDECO (Al-Shaheera)	0.006	0.449	Bl ₂₁	PAPPIN	0.007	0.435
Bl ₂	Flormar	0.008	0.505	Bl ₂₂	ADS	0.006	5.972
Bl ₃	LADY GUAGUA	0.012	0.611	Bl ₂₃	BONJOUR PARIS-	0.005	3.247
Bl ₄	ADS	0.036	0.664	Bl ₂₄	Jordana	0.008	0.217
Bl ₅	MARKAT MEKYACH	0.007	28	Bl ₂₅	Maysah	0.02	4.341
Bl ₆	Kiss beauty	0.007	0.348	Bl ₂₆	POURJOIS-PARIS-	1.259	0.3
Bl ₇	ROMANTIC BEAUTY	0.002	0.222	Bl ₂₇	BEAUTIFUL	0.506	0.461
Bl ₈	3XL	0.014	0.26	Bl ₂₈	3XL	ND	0.198
Bl ₉	USHAS	0.01	0.272	Bl ₂₉	Random (deleted brand)	0.011	0.191

Bl₁₀	ROMANTIC BEAUTY	0.007	0.3	Bl₃₀	ADS	0.014	0.261
Bl₁₁	ROMANTIC BEAUTY	0.001	0.303	Bl₃₁	MISS ROSE	0.015	0.209
Bl₁₂	Random	0.008	0.43	Bl₃₂	ADS	0.003	0.213
Bl₁₃	IMPALA	0.004	0.458	Bl₃₃	PASHA	0.012	24.71
Bl₁₄	SARA ROSE	0.002	0.342	Bl₃₄	ADS	0.007	0.102
Bl₁₅	Ruby Rose	0.01	0.366	Bl₃₅	PASTEL JOUES	0.008	0.13
Bl₁₆	Random (unbranded)	0.023	0.423	Bl₃₆	EVER BEAUTY	0.009	ND
Bl₁₇	PASTEL JOUES	0.009	0.477	Bl₃₇	Lancom	0.009	0.063
Bl₁₈	Beilizi	0.012	0.573	Bl₃₈	Flormar	ND	ND
Bl₁₉	LUDAMEI	0.004	0.543	Bl₃₉	DALI	0.003	ND
Bl₂₀	CHARM MAX	0.013	0.435	Bl₄₀	BANOOS	0.021	ND

***Bl**: brief name for Blushers.

Table 2- Concentrations of Cd and Cr in new and used face powders.

Sample no.	Bran's name	Cd	Cr	Sample no.	Bran's name	Cd	Cr
Po₁	Revlon (Al-Shaheera)	0.014	0.625	Po₂₁	May fail	0.007	2.439
Po₂	Flormar	0.03	0.829	Po₂₂	Neutrogena	0.006	0.033
Po₃	Nada	0.014	0.962	Po₂₃	Summer cake	0.005	0.074
Po₄	Bijan	0.465	1.198	Po₂₄	Flormar	0.008	0.052
Po₅	Kidley Crown	0.027	1.434	Po₂₅	POND,S (White beauty)	0.02	0.056
Po₆	MAX FACTOR	0.029	1.78	Po₂₆	CHANEL PARIS	1.259	0.08
Po₇	Snial (FASHION ROSE)	0.037	2.34	Po₂₇	Beauty	0.506	0.096
Po₈	SUMMER CAKE	0.028	3.136	Po₂₈	Flormar	ND	0.084
Po₉	Colleen	0.025	4.069	Po₂₉	jordana	0.011	0.096
Po₁₀	AINUO	0.036	4.641	Po₃₀	YARDLEY	0.014	0.101
Po₁₁	Naturagena	0.026	5.051	Po₃₁	PASHA	0.015	0.171
Po₁₂	Random	0.015	5.396	Po₃₂	Flormar	0.003	0.156
Po₁₃	SEVEN GRIL (green tea)	0.02	5.456	Po₃₃	Malva	0.012	0.133
Po₁₄	VUB	0.01	5.512	Po₃₄	GOSH	0.007	0.162
Po₁₅	Kiss beauty	0.027	5.546	Po₃₅	NITRO CANADA	0.008	0.184
Po₁₆	Random	0.07	5.562	Po₃₆	Random (deleted brand)	0.009	0.197
Po₁₇	M.A.C.	0.024	5.569	Po₃₇	Random (deleted brand)	0.009	0.297
Po₁₈	Queen	0.029	5.585	Po₃₈	Might	ND	0.23
Po₁₉	XXL	0.028	5.598	Po₃₉	Random (deleted brand)	0.003	0.256
Po₂₀	EVER BEAUTY	0.017	5.667	Po₄₀	MAXFACTOR	0.021	0.28

***Po**: brief name for face powder.

Table 3- Concentrations of Cd and Cr in new and used foundations.

New sample no.	Bran's name	Cd	Cr	Used Sample no.	Bran's name	Cd	Cr
FO _{.1}	ARTDECO (Al-Shaheera)	0.013	0.123	FO _{.21}	Max factor	0.003	ND
FO _{.2}	M.n (menow)	ND	0.143	FO _{.22}	Flormar	0.001	0.001
FO _{.3}	NITRO CANADA	ND	0.172	FO _{.23}	jordana	0.004	0.01
FO _{.4}	True match (LOPEAL)	ND	0.201	FO _{.24}	Flormar	0.004	0.024
FO _{.5}	BB (EVER BEUTY)	ND	0.209	FO _{.25}	Might	0.004	0.045
FO _{.6}	MALEK SALOON (Nitro Canada)	ND	0.198	FO _{.26}	Golden Rose	0.005	0.078
FO _{.7}	BB (MAKAT MEKYACH)	ND	0.244	FO _{.27}	DREAM WOMEN (green tea)	0.001	0.073
FO _{.8}	MAKAT MEKYACH	ND	0.258	FO _{.28}	GOSH (BB)	0.001	0.067
FO _{.9}	NITRO CANADA	ND	0.275	FO _{.29}	LOREAL PARIS	0.005	0.092
FO _{.10}	Seven Gril (BB)	ND	0.349	FO _{.30}	MAKAT MAKYACH	0.004	0.103
FO _{.11}	Seven Gril	ND	0.357	FO _{.31}	MAX FACTOR	ND	0.115
FO _{.12}	Random	ND	0.328	FO _{.32}	PASHA	0.003	0.149
FO _{.13}	ADS (BB)	ND	0.344	FO _{.33}	ADS	0.007	0.151
FO _{.14}	EVER BEAUTY (stick foundation)	ND	0.364	FO _{.34}	EVER bilENA	0.002	0.156
FO _{.15}	Olive (Romantic beauty)	ND	0.393	FO _{.35}	MISS ROSE	0.011	0.203
FO _{.16}	Random (unbranded)	ND	0.382	FO _{.36}	Random*	0.002	0.278
FO _{.17}	Yalanni (BB)	ND	0.399	FO _{.37}	May fair	0.005	0.19
FO _{.18}	Flormar	ND	0.445	FO _{.38}	ARCAaL Paris	0.009	0.217
FO _{.19}	SNAKE (ADS)	0.001	0.435	FO _{.39}	Might	0.009	0.24
FO _{.20}	Flormar	0.002	0.447	FO _{.40}	DALI	0.003	0.271

*FO: brief name for face foundation.

Table-4 shows significant differences in Cd concentrations between new and use products of blushers and face powders ($p < 0.05$) but there are no significant differences between new and used foundation products; while there are no significant differences between all new cosmetic products analyzed in this study in Cd concentrations in comparison with used products which recorded significant differences ($p < 0.05$) due to LSD values 0.0399 and 0.0662 respectively; Cadmium is present in all new products except 80% from new foundations as it shows in table 5 but 5% from (used blushers and foundations with 20% form used face powders don't have any detection limit.

Table 4- Effect of Makeup type and sequence in Cd.

Makeup type	Sequence		LSD value
	New	Used	
Blusher	0.0097 ±0.002	0.1012 ±0.069	0.0478 *
Powder	0.0485 ±0.022	0.0101 ±0.002	0.0162 *
Foundations	0.0065 ±0.003	0.0043 ±0.0006	0.0035 NS
LSD value	0.0399 NS	0.0662 *	---
* (P<0.05), NS: Non-significant.			

Table 5- Distribution of sample study according to test of Cd.

Makeup type	New			Used		
	Yes	No	%	Yes	No	%
Blusher	20	0	0.00	19	1	5.00
Powder	20	0	0.00	16	4	20.00
Foundations	4	16	80.00	19	1	5.00
Chi-square	---	---	13.20 **	---	---	8.187 **
** (P<0.01)						

There are no significant differences between new and used products of blushers and foundations in chromium concentration but there are highly significant differences are recorded ($P < 0.01$) between new and used face powder products due to LSD value 1.139; Chromium recorded highly significant differences ($P < 0.01$) between all new and used products analyzed in this study as it shows in table 6; all new brands had Cr concentrations in comparison with used products which only the used face powders had 5% didn't have any detection limit and Table-7 shows that:

Table 6- Distribution of sample study according to test of Cr.

Makeup type	Sequence		LSD value
	New	Used	
Blusher	1.80 ±1.37	2.33 ±1.25	0.668 NS
Powder	3.79 ±0.44	0.131 ±0.02	1.139 **
Foundations	0.303 ±0.02	0.133 ±0.02	0.182 NS
LSD value	1.396 **	1.074 **	---
** (P<0.01), NS: Non-significant.			

Table 7- Distribution of sample study according to test of Cr.

Makeup type	New			Used		
	Yes	No	%	Yes	No	%
Blusher	20	0	0.00	20	0	0.00
Powder	20	0	0.00	19	1	5.00
Foundations	20	0	0.00	20	0	0.00
Chi-square	---	---	0.00 NS	---	---	1.035 NS
* (P<0.05).						

All brands analyzed by this study on Cd concentrations are under the acceptable limits for heavy metals in cosmetics 20 ppm according to speciation of Iraqi specification no. 1159 [23] for blushers; no.1654 [24] for face powders and no.2079 [25] face foundations. Chromium concentrations in face powders and foundations are under the Iraqi acceptable limits of 20ppm; except one brand from new blusher (Bl.5) recorded above the acceptable limit. All heavy metals were found in cosmetics as impurities in many cases, they weren't add to them on purpose, in result the consumer doesn't find them on the product's labels [26]. The responsible for taking care of these impurities and removing them are the manufactures but time in money; for this purpose, the guidelines were attributed [27].

[28] concluded that the amounts of heavy metals in cosmetic products can be considered "technically avoidable" but many cosmetics didn't match with the impurities legislation; this leads to necessary to know the differences about the metal level between safe cosmetic product and technically avoidable. Expensive cosmetics are not necessary to be "safe" about the problem of heavy metals; the consumers must be notified about the general harmful effects of cosmetics, without any attention to the product's cost [29]. Metal absorption efficiency through the skin is also affecting by the application site of cosmetic product [30], Some of these metals can cause different long- health effects, like cancer; hormonal disruptors and organs damage (highly toxic) like: As, Cd, Hg and Pb, while others caused skin sensitization like Co, Cr and Ni [31, 32]. All these cosmetics must be nontoxic, nonirritant and safe because of the daily use by consumers who don't have a sufficient awareness about these products and their side effects on health [33]. These cosmetics applied on healthy skin (essentially the face), nail or hair but they caused allergy dermatitis when applied on damaged skin [34]. Women are putting cosmetics every day without knowledge on eyes, face and lips, this might be small amounts but via the cosmetics; the exposure is increased and accumulated [28] and constantly use of them make these levels behind acceptable limits [12]. This multiple using of cosmetics involving heavy metals consider as supplementary source for toxic chemicals and metals [35]. This metal widely used in face powders and lipsticks because of its dark yellow to orange in pigment and other industries [36]. To get the color ranging between orange to specially black; selenium is added with increasing quantities to Cd sulfide which is used for getting yellow color only and to get light green mixture; so pigments are one of the most important sources of Cd in cosmetic products [37]. Cadmium and Cadmium compounds are highly toxic to human health (carcinogenic, mutagenic and toxic to reproduction) and to the environment also; they had been banned and restricted in standards for Eco- labels from many products like cosmetics, toys, plastics and building materials[38], an increasing Cd levels can cause DNA mismatches inhibition [39]. Eating tiny Cd levels for a long- period of time can result in metal promotion in the kidneys; which potential damage, chronic Cd effects involve bones fragile and going to break easily and its absorption via the skin isn't considerable route for Cd; the slow release may result in harmful effect in human body [28]. Skin absorbs Cd slowly (0.5%), this metal for oral exposure is (0.09 mg/ Kg) to 3ppm given by USP [40]. The ability of Cr(VI) to permeate the skin in dermal absorption larger than Cr(II); this due to higher solubility [41]. Ions Cr (III) incapable to penetration biological membranes and communication with dermal and epithelial tissues; while compounds of Cr (VI) are quickly intake by the system of anion transport; then reducing to Cr (III) which pass via the skin [42]. The most common sensitive area of skin is (face); because of the huge and numerous numbers of products used on face (especially women); facial skin has thinner barrier with large density of nerve endings [43]; especially the area of nasolabial fold was recorded as the most sensitive part from the facial areas; secondly: the malar eminence, chin, forehead and finally the upper lip [44, 45];the women have the highest hormonal differences which cause inflammatory sensitivity [46, 47]. The skin which it's a complex organ; provided a barrier as attachment point between the inside and outside biological environment; stratum corneum is the outer skin layer which it is hard to penetrate [48]. the final cosmetic formula grantee the long- period of stability (up to 3 years) of active ingredients compounds which may have effect on the fate of the active ones [49].

Conclusion

As long as our face is our wealth and the cosmetics considered an additional source of heavy metals; Iraqi women must take careful when choosing, buying and using them to avoid the resulting effects; whenever put makeup for a longer period the exposure was more; this includes Since the relationship between facial cosmetics application and their quantity, exposure time is an extrusive relationship; this makes women more contact with heavy metals content in the cosmetic product. Changing the brands avoid women the continuous exposure to the same ingredients. The consumer must pay attention to the type and quality of cosmetic product and how to buy cosmetic products from markets and through the internet and the origin country which manufacture them to make sure about their contents.

References

1. Burlando, B. and Verotta, L. **2010**. *Herbal principles in cosmetics*. CRC Press. Taylor and Francis Group, LLC .
2. Wormuth, M., Scheringer, M., Vollweider, M. and Hurgert, K. **2006**. What are the sources of exposure to eight frequently used phthalic acid esters in European? *Risk Anal.* **26**(3): 803- 824.

3. Chevillotte, G., Ficheux, A. C. **2014**. Exposure method development for risk assessment to cosmetic products using a standard composition. *Food Chem. Toxicol.* **68**: 108- 116.
4. Goossens, A. **2011**. Contact allergic reactions to cosmetics. Hindawi Publishing Corporation. *Journal of Allergy*: 6pp.
5. European Directive 76/ 768/ EEC. **1976**. The approximation on the laws of the member states relating to cosmetic products. *Off. J. Eur. Commun.* **L151**: 169- 200.
6. Harry, E. B. **2000**. *Handbook for bar coding systems*. Van Nostrand Reinhold Company. ISBN 978- 0- 442- 2, pp: 219.
7. Liu, Ys., Ying, GG., Shareef, A. and Kookana, R. S. **2011**. Photostability of the UV filter benzophenone-3 and its effect on the photodegradation of benzotriazole in water. *Environ. Chem.* **8**: 581- 588.
8. Hugbo, P. G., Onyekweli, A. O. and Igwe, I. **2003**. Microbial contamination and preservative capacity of some brands of cosmetic creams. *Trop. J. Pharm.* **2**(1): 229- 234 .
9. Morra, O. Z. **2014**. Levels of selected heavy metals in Aloe Vera skin cosmetics. A thesis school of pure and applied sciences Kenyatta University: 6pp.
10. Corraza, M., Baldo, f., Pagnonoi, A., Miscioscia, R. and Virgili, A. **2009**. Measurement of nickel, cobalt and chromium in toy make-up by atomic absorption spectroscopy. *Acta Derma Venereol.* **89**(2): 130- 133.
11. Tchounwou, P. B., Yedjou, C. G., Patlolla, A. and Sutton, D. **2012**. Heavy metals toxicity and the environment. *EXS* **101**: 133- 164.
12. Godt, J., Scheidig, F., Grosse- Siestrup, C., Esche, V., Beich, A. and Groneberg, D. A. **2006**. The toxicity of cadmium and resulting hazards for human health. *J. of Occup. Med.Toxicol.* **1**(22): 1-6.
13. Omolayo, J. A.; Uzairu, A. and Gimba, C. E. **2010**. Heavy element assessment of some eye shadow products imported into Nigeria from China. *Arch. Appl. Sci. Res.* **2**(5): 76 -84.
14. Irfan, M., Hayat, S., Ahmed, A. and Alyemeni, M. N. **2013**. Solid cadmium enrichment: allocation and plant physiological manifestation. *Saudi J. Biol. Sci.* **20**: 1- 10.
15. Bernard, A. **2008**. Cadmium and its adverse effects on human health. *Indian J. Med. Res.* **128**(4): 64- 557.
16. Mutlu, A., Lee, B. K., Park, G.H., Yu, B.G. And Lee, C.H. **2012**. Long- term concentrations of airborne Cadmium in metropolitan cities in Korea and potential health risk. *Atoms Environ.* **42**: 164 -173.
17. Patrick, L. ND. **2003**. Toxic metals and antioxidants: part II. The role of antioxidant in Arsenic and Cadmium. *Altern. Med. Rev.* **8**(2): 106- 128.
18. Anderson, R. A. **1989**. Essentiality of Chromium in humans. *Sci. Total Environ.* **86** (1-2): 75 -81.
19. International Agency for the Research on Cancer (IARC). **1999**. Monographs for the evaluation of carcinogenic risks to humans, Vol. 72, hormonal contraception and mono menopausal hormonal therapy. Lyon.
20. Gondal, M. A., Seddigi, Z. S., Nasr, M. M. and Gondal, B. **2010**. Spectroscopic detection of hazardous contaminants in lipsticks using laser induced breakdown spectroscopy. *J. Hazardous Materials*, **75**(1- 3): 726- 732.
21. Rehman, G., Bukhari, I. H., Riaz, M., Rassol, N., Khalid, A. and Sattar, U. **2003**. Determination of heavy metals in different brands of talcum powders. *International Journal of Applied and Natural Sciences*, **2**(2): 45- 52.
22. Saeed, M., Muhammad, N. and Zakiullah. **2011**. Assessment of heavy metals of branded Pakistani products. *Trop. J. Res.* **10**(4): 499- 506.
23. Central Organization for standardization and Quality Control. **1988**. Standard Specification No.1159. Rouge (Blusher): 4pp.
24. Central Organization for standardization and Quality Control. **1991**. Standard Specification No.1654. Skin powders: 8pp.
25. Central Organization for standardization and Quality Control. **1998**. Standard Specification No.2079. Skin lotion: 4pp.
26. Ayenimo, J. G., Yusuf, A. M., Adekunle, A. S. and Makinda, O. W. **2010**. Heavy metal exposure from personal care products. *Bull Environ. Contam. Toxicol.* **84**(1): 8- 14.
27. Health Canada. **2011**. Toxic metals found in makeup cosmetics. A report released by Environmental Defense: 23- 26.

28. Bocca, B., Pino, A., Alimonti, A. and Forte, G. **2014**. Toxic metals contained in cosmetics: a status report. *Regulatory and pharmacology*, **68**: 447- 467.
29. Faruruwa, M. D. and Bartholomew, S. P. **2014**. Study of heavy metals content in facial cosmetics obtained from open markets and superstores within Kaduna metropolis, Nigeria. *American Journal of Chemistry and Application*, **1**(2): 27- 33.
30. Pratchyapruit, W., Kikuchi, K., Gritiyarngasan, p., Aiba, S. and Tagami, H. **2007**. Functional analysis of the eyelid skin constituting the most soft and smooth area on the face: contribution of its remarkably large superficial coenocytes to the effects water- holding capacity of the stratum corneum. *TOC*. **13**(2): 169- 175.
31. Forte, G., Perucci, F. and Bocca, B. **2008**. Metal allergens of growing significance epidemiology, immunotoxicology, strategies for testing and prevention. *Infammant Allergy Drug Targets*, **7**(3): 145- 162.
32. Thyssen, J., and Menñe, T. **2010**. Metal allergy on exposures, penteration, genetics, prevalence, and clinical implications. *Chem. Res. Toxicol.* **23**(2): 309- 318.
33. Amasa, W., Santiago, D., Mekonen, S. and Ambelu, A. **2012**. Are cosmetics used in developing countries safe? Use and dermal irritation of body care in Jimma town, south western Ethiopia. *Journal of Toxicology*: 8pp.
34. White, I. R. and De Groot. **2001**. *Cosmetics and skin care products*. In: *Contact Dermatitis*. Rycroft, R. J. G.; Menne, T.; Frosch, M. P. and Lepoittevin, J. P. (eds.) 3rd ed. Springer- verlag Berlin in Heidelberg. New York. pp: 394- 509.
35. Borowska, S. and Brozóska, M. M. **2015**. Metals in cosmetics: implications for human health. *J. Appl. Toxicol.* **35**: 551- 572.
36. Godt, J., Scheidig, F., Grosse- Siestrup, C., Esche, V., Beich, A. and Groneberg, D. A. **2006**. The toxicity of cadmium and resulting hazards for human health. *J. of Occup. Med. Toxicol.* **1**(22): 1-6.
37. Lavilla, I., Cabalero, N., Costa, M., de la Calle, I. and Bendicho, C. **2009**. Ultrasound- assisted emulsification of cosmetics products prior to elements analysis by different atomic spectrometric techniques. *Talanta*, **80**: 109- 116.
38. United States Environment Protection Agency (USEPA). **2013**. Survey of Cadmium and Cadmium compounds. Environmental project No. 1471. Washington. DC.
39. Theresa, O. C., Onebunne, O. C., Dorcas, W. A. and Ajani, O. I. **2011**. Potentially toxic metals exposure from body creams sold in lagos. *Nigeria. Researcher*, **3**: 30- 37.
40. Alissa, E. M. and Ferns, G. A. **2011**. Heavy metal poisoning and cardiovascular disease. *J. Toxicol.* 2011: 1- 12pp.
41. Larese, F., Gianpieri, A., Venier, M., Mania, G. and Renzi, N. **2007**. *In vitro percutaneous absorption of metal compounds*. *Toxicol. Lett.* **170**: 49- 56.
42. Guy, R.; Hostýnek, J. J.; Hinz, R. S. and Lorence, C. R. **1999**. *Metals and skin, tropic effects and systemic absorption*. Marcel Dekker. New York: 403 pp.
43. Chew, A. and Maibach, H. **2000**. *Sensitive skin*. In: *Dry skin and moisturizers: chemistry and function*. (Loden, M. and Maibach, H. eds) pp: 429- 440. CRC Press. Boca Raton .
44. Berne, B., Boström, A., Grahnen, A. F. and Tammela, N. **1996**. Adverse effects of cosmetics and toiletries reported to the Swedish medical products agency 1989- 1994. *Contact Dermatitis*, **34**: 359- 362.
45. Marriott, M., Holmes, J., Peters, L., Cooper, K., Rowson, M. and Basketter, D. A. **2005**. The complex problem of sensitive skin. *Contact Dermatitis*, **53**(2): 93- 99.
46. Lee, C. H. and Maibach, H. L. **1995**. The sodium sulfate model: an over view. *Contact Dermatitis* **33**: 1- 7.
47. Farage, M. A. **2005**. Vulvar susceptibility to contact irritants and allergens: a review. *Arch. Gynecol. Obstet.* **272**(2): 167- 172 .
48. Charlene DeHaven, M. D. **2014**. Delivery of cosmetic ingredients to the skin. *Science of Skincare*. LLC: 4pp.
49. Lane, M. E., Hadgraft, J., Oliveira, G., Mohammed, D. and Hirata, K. **2012**. Rational formulation design. *International Journal of Cosmetic Science*, **34**: 496- 501.