ISSN: 0067-2904

Detection of Cadmium and Chromium in some Facial Cosmetics

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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 foe 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 والكادميوم في بعض مستحضرات تجميل الوجه

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الخلاصة

أجريت هذه الدراسة للمقارنة بين 120 من ماركات مستحضرات التجميل الجديدة والمستخدمة لتحديد تراكيز المعادن الثقيلة (الكادميوم، والكروم) في (أساس الوجه، وباودر 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 خلواً من تراكيز المعادن الثقيلة من مستحضرات التجميل الجديدة، وأن منتجات أساس الوجه كانت هي الافضل 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 أمتلاك مستحضرات التجميل ملصق الخاص

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بأسماء المكونات والعلامة التجارية، وخلو بعضها من تاريخ الأنتاج وتاريخ إنتهاء الصلاحية، فأن هذا لم يمنع من تواجد المعادن الثقيلة بتراكيز ضئيلة ضمن تركيبها الكيميائية ولتجنب التعرض المستمر لنفس مكونات مستحضر التجميل الكيميائية، على المرأة الأبتعاد عن أستخدام 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: Bl_1- Bl_{40}.
2. Face powder: Po_1-Po_{40}.
3. Face foundation: FO_1-FO_{40}.

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

Bl.$_{10}$	ROMANTIC BEAUTY	0.007	0.3	**Bl.$_{30}$**	ADS	0.014	0.261
Bl.$_{11}$	ROMANTIC BEAUTY	0.001	0.303	**Bl.$_{31}$**	MISS ROSE	0.015	0.209
Bl.$_{12}$	Random	0.008	0.43	**Bl.$_{32}$**	ADS	0.003	0.213
Bl.$_{13}$	IMPALA	0.004	0.458	**Bl.$_{33}$**	PASHA	0.012	24.71
Bl.$_{14}$	SARA ROSE	0.002	0.342	**Bl.$_{34}$**	ADS	0.007	0.102
Bl.$_{15}$	Ruby Rose	0.01	0.366	**Bl.$_{35}$**	PASTEL JOUES	0.008	0.13
Bl.$_{16}$	Random (unbranded)	0.023	0.423	**Bl.$_{36}$**	EVER BEAUTY	0.009	ND
Bl.$_{17}$	PASTEL JOUES	0.009	0.477	**Bl.$_{37}$**	Lancom	0.009	0.063
Bl.$_{18}$	Beilizi	0.012	0.573	**Bl.$_{38}$**	Flormar	ND	ND
Bl.$_{19}$	LUDAMEI	0.004	0.543	**Bl.$_{39}$**	DALI	0.003	ND
Bl.$_{20}$	CHARM MAX	0.013	0.435	**Bl.$_{40}$**	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
Po.$_{1}$	Revlon (Al-Shaheera)	0.014	0.625	**Po.$_{21}$**	May fail	0.007	2.439
Po.$_{2}$	Flormar	0.03	0.829	**Po.$_{22}$**	Neutrogena	0.006	0.033
Po.$_{3}$	Nada	0.014	0.962	**Po.$_{23}$**	Summer cake	0.005	0.074
Po.$_{4}$	Bijan	0.465	1.198	**Po.$_{24}$**	Flormar	0.008	0.052
Po.$_{5}$	Kidley Crown	0.027	1.434	**Po.$_{25}$**	POND,S (White beauty)	0.02	0.056
Po.$_{6}$	MAX FACTOR	0.029	1.78	**Po.$_{26}$**	CHANEL PARIS	1.259	0.08
Po.$_{7}$	Snial (FASHION ROSE)	0.037	2.34	**Po.$_{27}$**	Beauty	0.506	0.096
Po.$_{8}$	SUMMER CAKE	0.028	3.136	**Po.$_{28}$**	Flormar	ND	0.084
Po.$_{9}$	Colleen	0.025	4.069	**Po.$_{29}$**	jordana	0.011	0.096
Po.$_{10}$	AINUO	0.036	4.641	**Po.$_{30}$**	YARDLEY	0.014	0.101
Po.$_{11}$	Naturagena	0.026	5.051	**Po.$_{31}$**	PASHA	0.015	0.171
Po.$_{12}$	Random	0.015	5.396	**Po.$_{32}$**	Flormar	0.003	0.156
Po.$_{13}$	SEVEN GRIL (green tea)	0.02	5.456	**Po.$_{33}$**	Malva	0.012	0.133
Po.$_{14}$	VUB	0.01	5.512	**Po.$_{34}$**	GOSH	0.007	0.162
Po.$_{15}$	Kiss beauty	0.027	5.546	**Po.$_{35}$**	NITRO CANADA	0.008	0.184
Po.$_{16}$	Random	0.07	5.562	**Po.$_{36}$**	Random (deleted brand)	0.009	0.197
Po.$_{17}$	M.A.C.	0.024	5.569	**Po.$_{37}$**	Random (deleted brand)	0.009	0.297
Po.$_{18}$	Queen	0.029	5.585	**Po.$_{38}$**	Might	ND	0.23
Po.$_{19}$	XXL	0.028	5.598	**Po.$_{39}$**	Random (deleted brand)	0.003	0.256
Po.$_{20}$	EVER BEAUTY	0.017	5.667	**Po.$_{40}$**	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 orang 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 it 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.

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