Levels of Cadmium, Lead, Nickel and Chromium in Some Cosmetics Marketed in Kano - Nigeria

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Abstract

The study is on determination of the levels of Cadmium, Lead, Nickel and Chromium in selected cosmetics marketed in Kano city. Ten different brands of facial cosmetics, labelled 1 – 10, in the form of Bronze, Eye shadow primer, Cream eyeliner, Concealer, Contour and Highlighter, Foundation, marketed in Kano were randomly purchased from Sabon - gari and Rimi markets in the metropolis. Each sample label contained the manufacture's country of origin. Samples were stored at room temperature. With the mean concentration of Cd as 90.333 µg/g and a range of 34 µg/g to 199 µg/g, the highest concentration of 199 µg/g was in sample 7 while the lowest concentration of 34 µg/g was in sample 4. The mean concentration of lead was 16.924µg/g, a range of 5.767 µg/g to 31.867 µg/g with the highest of 31.867 µg/g in sample 1 and the lowest of 5.767µg/g in sample 6. The nickel concentration varied from 25.667 to 189.733µg/g with a mean of 79.074µg/g. The highest concentration of 189.733µg/g was in sample 10 and the lowest of 25.667µg/g was in sample 2. The concentration of chromium ranged from 9.867 to 71.6µg/g. The highest concentration of 71.6µg/g was in sample 5 while the lowest concentration of 9.867µg/g was in sample 1. In comparison with the available international standards, as there are no national guidelines on metals in cosmetics in Nigeria. All the samples analyzed exceeds the maximum permissible limits with the exception of samples 6 and 10 which have only lead (Pb) concentration within the permissible limit of 10 µg/g.

Keywords: *Heavy metals, cosmetics, Kano, Nigeria.*

I. INTRODUCTION

Cosmetics have been used for beautification as they have impact on history, fashion, culture and lives of people. The use of cosmetics is widespread among females, though an increasing number of males use cosmetics to enhance their facial appearances [1]. Cosmetics are substances placed in contact with external parts human body (including epidermis, hair system, nails, lips and external genital organs) or applied to the teeth and the mucous membranes of the oral cavity for cleaning, perfuming, protecting, changing their appearance, correcting body odours and keeping the surfaces in good condition [2, 3]. They are mixtures of surfactants, oils and other ingredients required to be effective, long- lasting, stable and safe to human use. The various forms of cosmetics include lipstick and lip Gloss; powder, and rouge; mascara, eye liner and eye shadow; and nail polish [4].The toxicity of these ingredients in various cosmetics is evaluated by a self-policing industry safety committee - the Cosmetic Ingredient Review (CIR). In recent time, make up has become an integral part of event planning as more and more makeup artists opened up shops. Excessive use of makeup can be detrimental to the skin and general health of the user. The chemicals found in concealer, foundation, highlighter, bronze and cream eyeliners cause serious health problems.

Heavy metals such as lead, mercury, arsenic and cadmium are known to have negative impacts on human health. For example, Pb even at a very low level and causes abnormal behaviour in humans including anaemia, colic, neuropathy, sterility and coma. Mercury compounds cause fatal damage of human nervous system. Lead has been known to be toxic since ancient times. It is a widespread contaminant in soils and its poisoning is one of the prevalent public health problems in many parts of the world. It was the first metal to be linked with failures in reproduction as it can easily cross the placenta. It affects the brain, causes hyperactivity and deficiency in the fine motor functions, thus resulting in brain damage. The nervous systems of children are especially sensitive to Pb leading to retard [5]. Cd and its compounds are carcinogenic. Organotin are as toxic as cyanides. Therefore, the regulatory agencies have set certain standards for the maximum limit of heavy metals in cosmetics. Acceptable limits for heavy metals vary according to the subpopulation of interest. Assessment of dermal absorption by a single component in a cosmetic product is complex and depends on factors such as the concentration in the product, the amount of

product applied, the length of time left on the skin and the presence of emollients and penetration enhancers in the cosmetic product. Given this complexity and the lack of well-conducted dermal absorption studies incorporating these factors, determination of heavy metal limits in cosmetics based on human health risk alone is a challenge [6, 7]. The toxicity of Pb 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 [8, 9]. Lead has been described as the most severe environmental contaminant to in human civilization [10]. Pb impairs the renal, homopoietic and nervous system and reports of various surveys suggest that the metal is related to deficiency in cognitive functioning [11, 12, 13].

Nnorom *et al*. [14] found out that the range of the geometric average for the various cosmetics is: Fe, 97-256µg/g; Ni, 8-13µg/g; Pb, 87-123µg/g; and Zn, 88-101µg/g, Cr and Cd were 40µg/g and about 1µg/g. The result indicates that these cosmetics are relatively safer to use when compared to the lead-based *kwalli (*kajal*)* eye make-up commonly available in Nigeria.

Orish and Jonathan [15] reported that the levels of lead, cadmium, nickel, chromium and mercury have been assessed in 28 body creams and lotions, 10 powders, 3 soaps, 5 eye make-ups, and 4 lipsticks widely available in Nigerian markets. The increases over suggested or mandated levels of lead in these creams and lotions ranged from 6.1 to 45.9 and from 1.2 to 9.2mg/kg when compared with cosmetic Ingredient review expert panel 2007 and German safe maximum permissible limit of lead in cosmetics, respectively. About 61% of the body cosmetics, the lotions, and the creams contained detectable levels of nickel ranging from 1.1 to 6.4-9.2mg/kg. Chromium and mercury were undetected in 100% of the cosmetic products.

Umar and Caleb [16] investigated Pb, Cd, Ni and Cr in Hair, Body, Hand/leg/nail, Soap, Facial, Mouth, and Special treatment products in FCT Abuja with a mean concentration in the order of Cd>Ni>Pb>Cr. Some samples showed the highest concentration of Pb and Cd with the mean values of 61.86µgg^{-1} and 29.05µgg^{-1}. The highest concentration of Cr and Ni with the respective mean values of 6.29µgg^{-1} and 29.39µgg^{-1} was found. The distribution of metals among these classes were; Hair: Cd>Ni>Pb>Cr;Body:Cd>Ni>Pb>Cr; Hand/leg/nail: d>Ni>Pb>Cr; Soap: Cd>Ni>Pb>Cr; Facial: Cd>Pb>Ni>Cr; Mouth: Ni>Cd>Pb>Cr; and Special treatment: Cd>Ni>Pb>Cr.

Commonly used Cosmetic products may be classified into various types as:

1. Decorative products e g: make-up
2. Nail care products e.g.: polish
3. Skin care products e.g.: moisturizers
4. Soaps and bath additives e.g.: bubble bath
5. Oral hygiene products e.g.: toothpaste and mouthwash
6. Shaving products e.g.: foams, after shave
7. Sun protection e.g.: sunscreen creams and lotions
8. Hair care products e.g.: shampoo and dyes
9. Fragrances e.g.: perfumes
10. Deodorants and antiperspirants
11. Foot care products e.g.: antifungicides
12. Baby care products e.g.: baby salve, baby oil, baby powder

The aim of this research was to determine the concentrations of Cd, Pb, Ni and Cr in cosmetic products from Rimi and Sabon gari markets, Kano state, Nigeria in Foundations, Concealers, Highlighter, Gel Eyeliners, Bronzers and Eye shadow primer, compare the levels of heavy metals concentration with the international standards.

II. METHOD

During preparation of reagents chemicals of analytical grade purity were used. All glass wares were washed with 1M nitric acid and rinsed with de-ionized water before drying in the oven.

A. Sampling

Ten different brands of facial cosmetics in the form of Bronze, Eye shadow primer, Cream eyeliner, Concealer, Contour and Highlighter, Foundation, marketed in Kano were randomly sampled and purchased from Sabon gari and Rimi markets in Kano metropolis, Nigeria. Every sample label contained the manufacture country of origin. Samples were stored at room temperature.

B. Sample Preparation

1.00g was weighed from each sample using a well calibrated sensitive balance .To each sample 15mL of nitric acid (HNO_3), 5mL hydrogen peroxide (H_2O_2), and 5mL hydrochloric acid (HCl) were added sequentially using a graduated pipette. The vessels were closed tightly and left for 15 min to ensure complete reaction .The samples were then heated at 150^{0}C in a fume hood for an hour until no more brown fumes were observed. The samples were allowed to cool and 20mL of de-ionized water was added. The aliquot was then filtered through filter paper into a 100mL volumetric flask and diluted to the mark with de ionized water.

3.4 Samples of Various Brand of Facial Cosmetics Purchased from Sabon gari and Rimi Markets

SN	SAMPLE	MARKET PURCHASED	IMPORTED FROM
1	Contour and highlighter	Sabon gari	PRC

2	Eye shadow primer	Sabon gari	US
3	Minister skin beauty	Rimi	ND
4	ADS Gel eyeliner	Sabon gari	ND
5	Foundation	Rimi	ND
6	Bronze	Sabon gari	US
7	ADS mesmerizing eyeliner	Sabon gari	ND
8	Bronze	Rimi	ND
9	Concealer	Rimi	ND
10	ISS Concealer	Sabon gari	ND

KEY:
P.R.C = Peoples Republic of China
U.S.A = United State of America
ND = Not Indicated

C. Sample Analysis

The most frequently used analytical method for the analysis of heavy metal contamination in most cosmetic products is atomic absorption spectroscopy (AAS) was applied.. The instrument was auto zeroed using the blank (ultra-pure water) after which the standard was aspirated into the flame from the lowest to the highest concentration. The corresponding absorbance was obtained by the instrument and graph of absorbance against concentration was plotted. The samples were analyzed in triplicate with the concentration of metals been displaced in parts per million (ppm) by the instrument after extrapolation from the standard curve.

III. RESULTS AND DISCUSSION

A. Result

The concentrations of heavy metals were determined using Atomic Absorption Spectrophotometer and the result is presented below with table 4.1.

Table 4.1 Concentration of Heavy Metals (µg/g) in Cosmetic Samples.

SN	Cd	Pb	Ni	Cr
1	67.00±5.196	31.867±2.54	35.93±4.45	9.87±2.14
2	155.00±0.58	15.93±2.54	25.667±4.45	8.63±2.14
3	76.33±5.77	14.33±2.31	33.36±4.45	8.63±2.14
4	34.00±5.20	14.47±2.54	48.73±4.39	12.57±2.14
5	40.00±5.20	10.133±2.	51.28±4.3	71.60±8.3
		48	9	8
6	61.00±5.20	5.77±2.54	66.63±4.45	4.93±2.14
7	199.00±5.20	18.83±2.48	82.03±4.45	27.13±17.09
8	79.67±5.77	23.17±2.54	97.43±4.45	23.47±2.19
9	122.33±52.54	27.53±2.48	120.53±4.45	19.73±2.14
10	67.00±5.20	7.23±2.54	189.73±4.45	28.37±2.14

Values are expressed as a mean standard deviation (SD) n=3

Table 4.2: Comparison of the Mean Concentration of the Heavy Metals with Some International Standards (µg/g).

SAMPLE	Cd	Pb	Ni	Cr
1	67.00	31.87	35.93	9.87
2	155.00	15.9	25.667	8.63
3	76.33	14.33	33.36	8.63
4	34.00	14.47	48.73	12.57
5	40.00	10.133	51.28	71.60
6	61.00	5.77	66.63	4.93
7	199.00	18.83	82.03	27.13
8	79.67	23.17	97.43	23.47
9	122.33	27.53	120.53	19.73
10	67.00	7.23	189.73	28.37
WHO	0.30	10.00	-	-
USA	3.00	1.00	0.08	0.60
CANADA	3.00	10.00	0.60	-

B. Discussion:

The summary of heavy metals concentration in the cosmetic products sampled is shown in table 3.1 and and fig 3.1.The range of concentration of cadium in all the sampled cosmetics is 34 to 199µg/g.The highest concentration of 199µg/g was found in sample 7 while the lowest concentration of 34µg/g was found in sample 4 and the mean concentration of cadmium is 90.333µg/g.This is similar to the findings of Umar and Caleb [17], reported high amount of cadmium in their sampled cosmetics with mean concentration of 29.05µg/g .

The concentration of lead in this study ranges from 5.767µg/g to 31.867µg/g.The highest concentration of 31.867µg/g was obtained in sample 1 whereas the lowest concentration of 5.767µg/g was found in sample 6.Mean concentration of lead was 16.924µg/g . This is similar to the findings of Nnorom *et al*., [18] with lead concentration of 87 to 123µg/g in their sampled cosmetic products, Similarly Umar and Caleb [19] reported high concentration of lead which is 61.86µg/g .Lead concentration in this study is contrary to the findings of Adepoju *et al*. [20]. They reported

low concentration of lead which is 0.006 to 0.207ppm and 0.12 to 1.11mg/kg respectively.

The concentration of nickel varied from 25.667 to 189.733µg/g with mean concentration of 79.074µg/g.The highest concentration of 189.733µg/g was obtained in sample 10 where as the lowest concentration of 25.667µg/g was found in sample 2. Nnorom *et al.* [21] reported a high concentration of nickel which ranges from 8 to 13µg/g. Similarly, Umar and Caleb [22] reported high concentration of nickel with mean concentration of 26.783µg/g .

The concentration of chromium ranged from 9.867 to 71.6µg/g. The highest concentration of 71.6µg/g was obtained in sample 5 while the lowest concentration of 9.867µg/g was found in sample 1.

In comparison with the available international standards, as there are no national guidelines on metals in cosmetics in Nigeria [23], All the samples analyzed exceeds the maximum permissible limits as shown in table 4.2 with the exception of sample 6 and 10 which have only lead (Pb) concentration within the permissible limit of 10µg/g according to WHO, 1995 [24] and Canada, 2005 [25].

Table 3.3: Mean concentration (µg/g) and Range of Metals in all the Cosmetic

Metal	Mean (µg/g) ± SD	Range
Cd	90.133 ± 52.683	34 – 199
Pb	16.923 ± 8.542	5.767 – 31.867
Ni	75.074 ± 50.391	25.667 – 189.733
Cr	26.783 ± 22.307	9.867 – 71.6

Values are expressed as mean ± standard deviation (SD) n=3

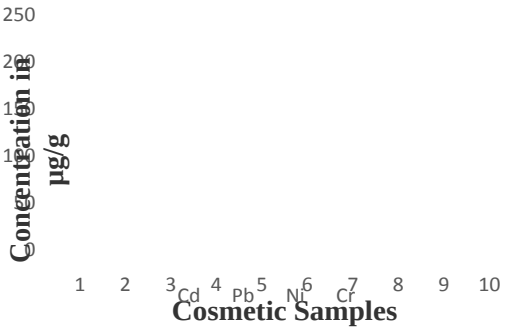

Fig 3.1: Graphical distribution of heavy metals concentration in cosmetic samples.

From Fig 3.1, the concentration of the heavy metals in the cosmetics analyzed in this study is in the order of Cd>Ni>Cr>Pb with mean concentration of 90.133 µg/g, 75.074µg/g, 26.783µg/g, and 16.924µg/g respectively as shown in table 3.3. The presence of cadmium in all the samples analyzed was relatively higher than other metals. Higher concentration of 199 µg/g of cadmium was obtained in sample 7. Nickel is the second metal with relatively high concentration after cadmium in the samples analysed. High concentration of nickel was found in samples 10 with a mean concentration of 189.333 µg/g. The concentrations of lead and chromium were moderate compared to the corresponding concentrations of cadmium and nickel. A high concentration of lead was however obtained in sample 1 with a mean concentration of 31.867 µg/g. The metal whose concentration was the least obtained in all the cosmetic samples analyzed was chromium. However, a relatively high concentration of chromium was obtained in sample 5 with mean concentration of 71.6 µg/g.

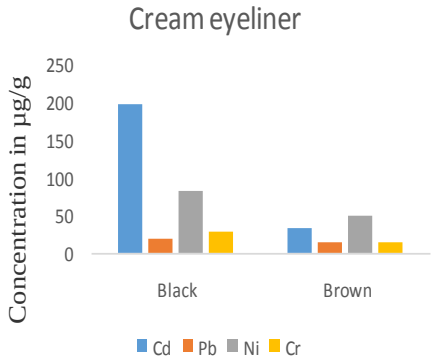

Fig 3.2: Graphical Distribution of heavy metals concentration in black and brown Cream eyeliners

From Fig 3.2 the concentrations of two different eyeliners of the same brand were compared.It shows that the concentrarion of all the heavy metals analysed (Cd, Pb, Ni, Cr) were higher in black cream eyeliner than in brown cream eyeliner with mean concentrations of 199 µg/g Cd, 18.833 µg/g Pb, 82.033 µg/g Ni, 27.133 µg/g Cr and 34 µg/g Cd, 14.467 µg/g Pb, 48.733 µg/g Ni, 13.567 µg/g Cr respectively .

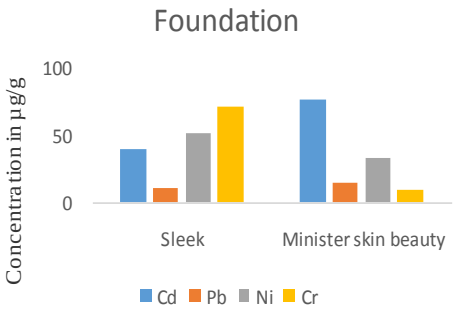

Fig 3.3: Graphical distribution of heavy metals concentration in two different foundation of different brand

The concentration of cadmium and lead were higher in minister skin beauty foundation with mean concentrations of 76.333 µg/g Cd and 14.333 µg/g Pb compared to minister skin beauty foundation with mean concentration of 40 µg/g Cd and 10.133 µg/g. The concentration of nickel and chromium were higher in sleek foundation with mean concentration of 51.276 µg/g Ni and71.6 µg/g Cr than in minister skin beauty foundation with mean concentration of 33.367 µg/g Ni and 8.633 µg/g Cr.

Fig 3.4: Graphical Distribution of heavy metals concentration in Bronze of two different brands

The concentrations of heavy metals in bronze of two different brands were compared. Lead and nickel concentrations are higher in kiss beauty foundation with mean concentration of 23.167 µg/g Pb and 97.433 µg/g Ni. The concentration of cadmium and chromium are higher in bronze L.A pride with mean concentration of 61 µg/g Cd and 4.933 µg/g Cr.

IV. CONCLUSION AND RECOMMENDATION

A. Conclusion

From the results obtained, all the metals analyzed were detected. Cd has the highest concentration and Pb has the least. Heavy metals in the sampled analyzed were above the permissible limits according to WHO, US and CANADA. It is however feared that the excessive use of cosmetic products contaminated with toxic heavy metals may lead to slow release of the metals into the human body tissues and subsequently cause certain health complications.

B. Recommendation

Precaution should be taken on the choice of skin cosmetics to be used. Public enlightment has to be organized on the dangerous effects of extensive use cosmetic products. Guiding principles on heavy metals in cosmetics should be framed and enforced by appropriate authorities in the manufacture of cosmetic products in Nigeria. Also, regulatory monitoring of other heavy metals and chemicals used in the manufacture of cosmetic products which may cause health hazards to consumers should be emphasized.

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