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Heavy Metals in Selected Skin Lighting Creams and Medicated Soaps

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***Abstract* – Heavy metals toxicity to humans can result from long term exposure to consumer products such as the cosmetics and toiletries. In this work, the levels of toxic metals in different cosmetics products sold at local shops in Anyigba, Kogi State, Nigeria were assessed. The cosmetics analysed includes five skin lightening creams and five medicated soaps. These cosmetics were analyzed for heavy metals (Cd, Pb, Cr and Hg) after digestion with concentrated acids; HNO_3: H_2SO_4 in the ratio of 2:1. The concentrations of the selected toxic heavy metals were determined in triplicate using FS 240 Varian Flame Atomic Absorption Spectrophotometer. All the samples analysed for chromium contained a detectable amount of the metal with a concentration ranging from 0.0020 to 0.0190ppm. Samples A (Dettol), B (Fashion fair), C (Septol), D (Tura) and I (Fashion fair) contained a detectable amount of chromium with concentration ranging from 0.0003 to 0.0027ppm, while the concentration of chromium in samples F (Fair and White), G (Neurotone), H (Hot Movate) and J (Clear tone) is below the detection limit. Also, samples B (Fashion Fair), D (Tura), F (Fair and White), G (Neurotone) and H (Hot movate) contains a detectable amount of lead with concentration range of 0.0063 to 0.0521ppm, while the concentration of lead in samples A (Detol), C (Septol), E (Crusader), I (Fashion fair) and J (clear tone) is below detection limit. All samples analysed for mercury contained a detectable amount of mercury ranging from 0.0030 to 3.7022ppm. It is obvious from the present study that the use of some cosmetic products exposes users to low concentrations of toxic heavy metals which could constitute potential health risks due to accumulate in the biological systems over time.**

***Keywords* – Skin Lighting Creams, Medicated Soap, Cosmetics Heavy Metals.**

I. INTRODUCTION

Cosmetics is defined as any article intended to be rubbed, poured, sprinkled or sprayed on, or introduced into or otherwise applied to the human body or any part thereof for cleansing, beautifying, promoting attractiveness, or altering the appearance, and includes any article intended for use as a component of cosmetics[1]. Cosmetic products are regulated for health and safety. There are concerns regarding the presence of harmful chemicals, including heavy metals, in these products. There have not been many studies in the presences of heavy metals in cosmetics in Nigeria. It may also considered to be any substance or preparation intended to be placed in contact with the various external parts of the human body (epidermis, hair system, nails, lips and external genital organs) or applied to the teeth and the mucous membranes of the oval cavity with a view exclusively or mainly for the purpose of cleaning, perfuming, protecting, changing their appearance, correcting body odours and keeping the surface in good condition [2, 3].

These cosmetic products include; care creams, talcum and face powders, lipsticks, Kajal, sindoor, eye make-ups and mouthwashes [4]. Apart from the demand of availability of cosmetic products in markets, the health awareness draws the attention of researchers and clinicians [5] to find the adverse effects regarding heavy metal contamination [6, 7]. Some cosmetics are benign; others can cause or are supposed to cause harmful effects such as cancer, allergic reactions, mutation, respiratory problems as well as development and reproductive problems [8]. For instance, an increase level of cadmium has been reported to cause inhibition of DNA mismatches. Zinc has been reported to cause the same signs of illness as does lead, and can easily be mistakenly diagnosed as lead poisoning [9]. Heavy metal poisoning takes place in the form of various diseases when ingested or inhaled [6].

The appearance of spots on the skin is a source of concern for may people, especially women. 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. This may occur for a variety of reasons; including excessive exposure to solar radiation, aging, weak hormones during pregnancy or by ingestion of certain drugs [10]. The disorder can be reduced through the use of whitening products, although the most serious case require medical assistance. These products contain various chemicals such as Kojic Depalmitate (KDP), which works as a whitening agent on the skin based on different mechanisms [11]. Unfortunately, some of the skin whitening products contains heavy metals such as mercury which can be absorbed through the skin and can cause deleterious effects in the body [12, 13].

The term heavy metal refers to any metallic chemical element that has a relative high density greater than $58km^3$ and it is toxic or poisonous at low concentration. They are dangerous because they tend to bio-accumulate or increase in concentration in biological cells overtime [14]. Heavy metals have been used as instruments of murder and were sprayed by the British in World War I. [15]. The threat of any contaminant to human health is a function of its concentration in the body. In recent times, attention had been focused on cosmetics, disinfectants heavy metals in the human systems without any information on their levels [16, 17, 9, 18].

The human nails is permeable than skin and the composition consists 10%-30% of water. The nails absorb the pigment in the polishes and so could enhance easy passage of metal in vapourized form or in solution) [19]. The metals in lipstick enroot the mouth and swallowed during eating, while some get to the body through the skin pores, metals in nail polishes reached the body through the

porous keratinized nails. The amount that is actually absorbed from the digestive trait can vary widely; depending on the chemical form of the metal, the age and nutritional status of the individual. Once a metal is absorbed, it distributes in tissues and organs. Exposure to heavy metals and metalloids at relatively low levels can cause adverse effects.

In a study in 2001, the Sainio et al., found in contact dermatitis, that in 88 eye shadow colours from 49 different products, 75% of the eye shadow colours contained >5 ppm of at least one of the following: lead, cobalt, mikel, chromium, and arsenic, and 100% contained >1 ppm of at least one of the above substances [20]. Similarly, the United States Food and Drug Administration also found lead in all the samples of lipstick that it tested, with levels ranging from 0.09 to 3.06ppm [21].

A recent assessment by WHO in 2010, reported that mercury in skin lightening creams and soaps that are commonly used in Asian and Central African nations is potentially dangerous as they have serious side effects and can be fatal. Mercury present in fairness creams can cause anxiety, depression, nerve damage, reduces skin resistance to infections, cause seizures, numbness and even memory loss [22].

In 2013, Liu et al. discovered that most of the tested lip products (32) contained high concentrations of titanium and aluminum. All examined products had detectable manganese [23]. Lead was detected in 75% samples tested. Approximately half (47%) of the samples contained lead at concentrations higher than the FDA- recommended Maximum level of 0.1ppm for lead in candy likely to be consumed frequently by small children. Chromium and Nickel were found in almost all samples. Highest concentration of chromium was 9.72ppm and Nikel was 9.73ppm.

The present study attempts to measure the concentration of heavy metals context available in different skin lightening creams and medicated soaps and compare it with internationally acceptable limits and high-lighting. The possible health implications of its prolonged use as the acceptable limits for heavy metals vary according to the sub population of interest e.g. children are more susceptible to heavy metal's toxicity than adults.

II. Experimental

Reagents: Analytical grade reagents were used. Distilled and deionised was used.

Apparatus: Glassware was soaked in 20% nitric acid for twenty-four hours and then rinsed with deionised water before use.

Methods

Digestion of Medicated Soaps: Two grams (2g) each of the shredded soap samples were digested by pouring it into a flat bottom flask followed by addition of 20ml of the acid mixture. The flat bottom flask was corked and heated on a hot plate inside a fume cupboard until solution became cleared. The digest was diluted with 250ml of distilled water, filtered and 100ml of the filtered solution was used for the Atomic Absorption Spectrophotometer (AAS) analysis. The result was read and recorded according to US Environmental Protection Agency Method 1631 Revision E) [24].

Digestion of Skin Lightening Creams: All samples were digested using the sample method [25] the creams were emptied into a clean beaker and transferred to a homogenizer for 10mins. 5ml of each sample was carefully measured and transferred into flat bottom flask and 25ml of the mixed acid (2:1, HNO_3: $HCLO_4$) was added to each sample. This was placed on the hot plate inside the fume cupboard until solution became cleared. On completion of digestion, the digested samples were allowed to cool to room temperature and made up to 250ml with distilled water. It was then filtered using a watman filter paper. 100ml filtrate was used for AAS analysis.

Sampling Method

Sampling of five (5) medicated soap and five (5) skin lightening creams was done by random purchase of these samples from cosmetic shops and supermarkets in Anyigba, Kogi State, Nigeria.

I. Medicated Soaps	
Sample A	Dettol
Sample B	Fashion fair
Sample C	Septol
Sample D	Tural
Sample E	Crusader.
II. Skin Lightening Soaps	
Sample F	Fair and white
Sample G	Neutrotone
Sample H	Hot movate
Sample I	Fashion fair
Sample J	Clear tone

Preparation of Standard Solution

Standard solutions of lead, cadmium, chromium and mercury were prepared from 1000ppm standard stock solution of GFS Fishers' AAS Reference Standard. These stock solutions were serially diluted to given concentrations of; 0, 0.05, 0.1, 0.15ppm for mercury standards while 0, 2, 4 and 6ppm for lead, 0, 0.1, 0.2, 0.3, 0.5ppm for cadmium and 0, 0.5, 1.0 and 1.5ppm for chromium standards.

Statistical Analysis

Statistical analysis of the multiple comparisons was calculated showing the significant difference between the standard and the sample at the 95% confidence interval.

III. Result and Discussion

Results

Table 1. Results of the concentrations of lead (Pb), Cadmium (Cd), Chromium (Cr), and Mercury (Hg) in medicated soap samples studied.

S/N	Samples ID	Samples name	Pb	Cr	Cd	Hg
1	A	Dettol	-0.0521	0.0157	0.0022	0.0037
2	B	Fashion fair	0.0198	0.0105	0.0014	-
3	C	Septol	-0.0052	0.0190	0.0010	-
4	D	Tura	0.0125	0.0118	0.0003	-
5	E	Crusader	-0.0386	0.0131	0.0027	3.7022

Table 2. Results of the concentrations (ppm) of lead (Pb), Cadmium (Cd), Chromium (Cr), and Mercury (Hg) in skin lightening cream samples studied.

S/N	Samples ID	Samples name	Pb	Cr	Cd	Hg
1	F	Fair & White	0.0344	0.0020	-0.0049	-
2	G	Neutrotone	0.0521	0.0105	-0.0016	0.0451
3	H	Hot movate	0.0063	0.0059	-0.0020	-
4	I	Fashion fair	-0.0271	0.0183	0.0004	0.4982
5	K	Clear tone	-0.0928	0.0059	-0.0004	-

Table 3. Statistical analysis of multiple comparisons at 95% Confidence Interval of the concentration of Cadmium (Cd) in the samples.

S/N	Sample ID	Mean	Standard Deviation	Mean Difference	Sig. Values	95%		Q Values
						Lower Bound	Upper Bound	
1	A	0.0022	0.0001	0.2978	<0.01	0.1521	0.4435	6.048
2	B	0.0014	0.0003	0.2986	<0.01	0.1529	0.4443	6.065
3	C	0.0011	0.0002	0.2989	<0.01	0.1532	0.4447	6.071
4	D	0.0003	0.0002	0.2997	<0.01	0.1539	0.4454	6.086
5	E	0.0027	0.0002	0.2973	<0.01	0.1516	0.4430	6.038
6	F	-0.0049	0.0003	0.3049	<0.01	0.1591	0.4406	6.192
7	G	-0.0016	0.0001	0.3016	<0.01	0.1559	0.4473	6.125
8	H	-0.0021	0.0001	0.3020	<0.01	0.1563	0.4477	6.134
9	I	0.0004	0.0001	0.2996	<0.01	0.1539	0.4453	6.085
10	J	-0.0004	0.0002	0.3004	<0.01	0.1547	0.4461	6.101

Table 4. Statistical analysis of multiple comparisons at 95% Confidence Interval of the concentration of Chromium (Cr) in the samples.

S/N	Samples ID	Mean	Standard Deviation	Mean Difference	Sig. Values	95%		Q Values
						Lower Bound	Upper Bound	
1	A	0.0157	0.0080	0.9843	<0.01	0.6199	1.349	7.996
2	B	0.0108	0.0076	0.9892	<0.01	0.6248	1.354	8.036
3	C	0.0188	0.0082	0.9812	<0.01	0.6168	1.346	7.971
4	D	0.0117	0.0021	0.9883	<0.01	0.6239	1.353	8.029
5	E	0.0137	0.0131	0.9863	<0.01	0.6219	1.351	8.013
6	F	0.0022	0.0044	0.9978	<0.01	0.6334	1.362	8.106
7	G	0.0109	0.0053	0.9891	<0.01	0.6247	1.353	8.035
8	H	0.0059	0.0025	0.9941	<0.01	0.6297	1.358	8.076
9	I	0.0183	0.0035	0.9817	<0.01	0.6174	1.346	7.976
10	J	0.0057	0.0078	0.9943	<0.01	0.6300	1.359	8.078

Table 5. Statistical analysis of multiple comparisons at 95% Confidence Interval of the concentration of Lead (Pb) in the samples.

S/N	Sample ID	Mean	Standard deviation	Mean difference	Sig. Values	95%		Q Values
						Lower Bound	Upper Bound	
1	A	-0.0523	0.0096	4.052	<0.01	2.595	5.510	8.230
2	B	0.0200	0.0044	3.980	<0.01	2.523	5.437	8.083
3	C	-0.0054	0.0015	4.005	<0.01	2.548	5.463	8.135
4	D	0.0129	0.0125	3.987	<0.01	2.530	5.445	8.098
5	E	-0.0387	0.0036	4.039	<0.01	2.581	5.496	8.203
6	F	0.0345	0.0165	3.966	<0.01	2.508	5.423	8.054
7	G	0.0523	0.0053	3.948	<0.01	2.490	5.405	8.018
8	H	0.0064	0.0061	3.994	<0.01	2.536	5.451	8.111
9	I	-0.0267	0.0106	4.027	<0.01	2.569	5.484	8.178
10	J	-0.0926	0.0059	4.093	<0.01	2.635	5.550	8.312

Table 6. Statistical analysis of multiple comparisons at 95% Confidence Interval of the concentration of Mercury (Hg) in the samples.

S/N	Samples ID	Mean	Standard Deviation	Mean Difference	Sig. Values	95%		Q Values
						Lower Bound	Upper Bound	
1	A	0.0032	0.2630	0.0968	<0.01	0.0419	0.1518	5.0940
2	E	3.7020	1.4490	-3.6020	<0.01	-3.6570	-3.5470	189.490
3	G	0.4958	0.5260	-0.3958	<0.01	-0.4507	-0.3408	20.8210
4	I	0.0454	0.7890	0.0546	<0.05	-0.0003	0.1095	2.8720

Discussion

Table 1 and 2 above shows the concentration of mercury, lead, cadmium and chromium in five soap and five cream samples. The analysis revealed that there was some detectable traces of lead in samples B, D, F, G and H. Lead were detected in appreciable amount in samples B (0.0198ppm), D (0.0125ppm), F (0.0344ppm), G (0.0521ppm) and H (0.0063ppm), which are within the standard permissible limit of 1.00ppm. But, the presence of lead in samples A, C, E, I and J is below detectable limit. Due to the dangerous effect of lead to human health, the presence of lead in cosmetics even in trace amount has also been reported and thus, the European Union (EU) law for cosmetics banned lead and lead compounds in cosmetics since 1976 [26].

Chromium were also detected in appreciable trace amount in samples A (0.0157ppm), B (0.0105ppm), C (0.0190ppm), D (0.0118ppm), E (0.013ppm), F (0.0020ppm), G (0.0105ppm), H (0.0059ppm), I (0.0183ppm) and J (0.0059ppm), which are below the maximum standard permissible limit of 0.1ppm. This simply means that there will be no trace of chromium toxicity since chromium appears in trace amount in all the samples analyzed. But long term continuous usage of soaps and creams containing this trace amount of chromium especially sample C, E and I which contain higher concentration of chromium should be avoided to prevent chromium poisoning.

Cadmium was only detected in very minute amount in samples A (0.0022ppm), B (0.0014ppm), C (0.0010ppm), D (0.0003ppm), E (0.0027ppm) and I (0.0004ppm), which were quite below the permissible limit of 0.1ppm.

Sample E, a medicated soap has the highest concentration of mercury (2.7022ppm), followed by sample I (0.4982ppm). While sample G has (0.0451ppm) and sample A (0.0037ppm). Sample E and I are far above the maximum permissible limit of 0.2ppm and are highly dangerous to human health. The level of mercury concentration regulated in Nigeria requires that soaps and creams carry labels indicating their contents. Of all the soap and creams analyzed, only Sample E indicated the presence of mercury on its label.

A study was carried out in Kenya on the use of skin lightening soap, in which some toilet soaps and hair of some users were analyzed for mercury. There was no elevated level of mercury (above 10ppm) found in hair of people who used soaps that contained $5.3x10^{-3}$% HgI_2 which correspond to $2.3x10^{-1}$% of total mercury content and below 10ppm total mercury level according to the researchers, it can be taken as the upper limit of normal hair mercury [27]. This implies that the user of the soap containing mercury below $5.3x10^{-3}$% might not experience short term health problems associated with the use of mercury [27]. Relating these findings to this work, where the highest level of mercury in soap is found to be 3.7022% and that of cream is 0.4982% which are far above $2.3x10^{-1}$%. It is then logical to conclude that these soap and cream are likely to cause some serious health problems like skin cancer. These soap and cream would impose mercury related problems however on the short term, so would not be considered safe especially for individual who use them for skin whitening purposes. This is easy to understand since such person must continue to use them to maintain a fair skin colour. The half-life of mercury in the body is large thus, over a long period of time; there will be accumulation in the body of users which may result to cancer and death. Distribution of mercury-containing creams and soaps is banned in the European Union [28]. A European Union Directive specifies that mercury and mercury compounds are not allowed as ingredients in cosmetics (including soaps, lotions, shampoos, and skin bleaching products).

From the statistical analysis of the multiple comparisons calculated in tables 3, 4 and 5 above, the significant difference between the standard and the sample shows that all the samples A, B, C, D, E, F, G, H, I and J have the same significant difference since the P values are all less than 0.05 and the Q values are higher than 2.960. Therefore, all the samples have the same quality in terms of the concentration of cadmium (Cd), chromium (Cr) and lead (Pb) in them.

Also, from the statistical analysis of the multiple comparisons calculated in table 6 above, the significant difference between the standard and the sample shows that all the samples (A, B, C, D, E, F, G, H, I and J) have the same significant difference since the P values are all less than 0.05 and the Q values are higher than 2.960. But sample I has no significant difference since the Q value is less than 2.960 and the P value is higher than 0.05. Therefore, all the samples have the same quality in terms of the concentration of mercury in them but sample I has the best quality in terms of mercury toxicity than the rest samples.

IV. Conclusion

The soap and cream samples studied showed relatively high level of mercury concentration. It showed that many of the manufacturers have failed to comply with the regulations and the enforcement agencies would need to pear up their actions as to protect the consumers because it has been identified that the long term effect of the use of such soaps and creams has the capacity to affect the health of consumers and with greater social cost for Government in terms of health service provision. Soaps and creams which contain mercury below 0.2ppm may not cause short term health problems associated with the use of mercury. Therefore samples A and G have the best quality when compared to other samples and samples E and I have the least quality. Therefore, sample E and I should be avoided especially long term continuous usage because mercury compounds are readily absorbed through the skin. Products containing mercury can lead to host number of diseases.

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