American Journal of Environmental Engineering and Science
2014; 1(1): 50-54
Published online October 20, 2014 (http://www.aascit.org/journal/ajees)

American Association for Science and Technology

Keywords
Analysis,
Detection,
Heavy Metals,
Spectrophotometer,
and Characterization

Received: September 07, 2014
Revised: September 24, 2014
Accepted: September 25, 2014

Statistical analysis of skin lightening and medicated soaps in other to assess the level of mercury, lead, cadmium and chromium by the use of AAS

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Citation
Uche Eunice Ekpunobi, Arinze Stanley Madumelu, Chinedu Prince Ofoegbu, Adaora Stellamarris Ogbuagu, Pauline Uche Ofora, Emmanuel Chukwudalu Ohaekenyem. Statistical Analysis of Skin Lightening and Medicated Soaps in other to Assess the Level of Mercury, Lead, Cadmium and Chromium by the Use of AAS. *American Journal of Environmental Engineering and Science.* Vol. 1, No. 1, 2014, pp. 50-54.

Abstract
In this research, twenty brands of soaps from different companies were analyzed based on their soap characterization and four different heavy metal content of mercury (Hg), lead (Pd), chromium (Cr), and cadmium (Cd) using Atomic Adsorption Spectrophotometer. The aim was to find out if the soaps contained any of these heavy metals and if so, what quantity and in what quantities is acceptable for health purposes. Out of the twenty different soaps analyzed (labeled A - T), mercury was present in all the soaps which were above the standard permissible limit of 0.2mg/l, cadmium and lead was only present in samples labeled J, M, Nr and P in a very little amount but lead was highly detected in sample S which was above the permissible limit of 0.1mg/l and 1.0mg/l respectively. While chromium was detected only in sample P in a very little amount below the standard limit of 0.1mg/l. From the statistical analysis of the multiple comparisons calculated, the significant difference between the standard and the sample, shows that samples I, K, J and F have the least significant difference while samples P, O, R, H and S have the highest significant difference. These results makes samples I, K, F and G the best quality out of the twenty samples analyzed.

1. Introduction

The main anthropogenic sources of heavy metals are through industrial processes like mining, foundries, smelters, combustion of fossil fuel, gasoline and waste incinerators. Environmental exposure to high concentration of heavy metals has been linked with various cancers and kidney damage (Cacar, 2003). The possibility of skin allergy to contact dermatitis may increase due to the presence of heavy metals in cosmetics. Since the heavy metals toxicity has been exemplified the problem of environmental pollution, it is necessary to know about the all possible sources of heavy metals. Apart from these numerous consumer products like cosmetics, soap and toiletries have been reported as a source of heavy exposure to human being (Amit

et al, 2010). There is a growing concern about the physiological and behavioral effects of environmental trace metals in human population. The toxicity of exposure to high levels of these heavy metals is well known but a major concern today is the possibility that continual exposure to relatively low levels may entail adverse health effects (Bergback et al, 1992). Heavy metals are dangerous because they tend to bioaccumulate. Lead for instance impairs the renal, homopoietic and nervous system and report of various surveys suggest that lead (Pb) is casually related to deficiency in cognitive functioning (Kollar, 2004). Concentration of lead and cadmium were estimated from samples of most popular brands of cosmetics, like soap, facial cream, shampoos, shaving cream. The result showed highest concentration of lead in soap samples (Amit et al, 2010). Ladizinski et al (2011), reported a widespread use of toxic skin lightening compounds. The presence of cadmium has also been reported in various lipsticks (Amit et al, 2010). High level of mercury was detected in some cosmetics recently studied (Ekpunobi et al, 2014). In this research, twenty brands of soaps from different companies were analyzed based on their soap characterization and four different heavy metal content of mercury (Hg), lead(Pd), chromium(Cr),and cadmium(Cd) using Atomic Adsorption Spectrophotometer.

2. Materials and Methods

2.1. Sampling Method

Sampling of the twenty(20) soap samples were done by random purchase of the samples from cosmetics shops and supermarkets in Awka, Anambra State of Nigeria. The samples were grouped into two as follows;

I	Medicated soaps	
	Sample A	Crusader
	Sample B	Tura
	Sample C	Septol
	Sample D	Mekako
	Sample E	Eden
II	Skin lightening soaps	
	Sample F	Valderma
	Sample G	Nivea
	Sample H	Idole
	Sample I	Irish spring
	Sample J	Dove
	Sample K	Pears
	Sample L	Fair and white
	Sample M	Rhome
	Sample N	Fashion fair
	Sample O	Secret transparent complex
	Sample P	Olay
	Sample Q	Extract papaya
	Sample R	Classic white
	Sample S	Fair lady
	Sample T	Bioclair

2.2. Determination of Moisture Content

MB35 Halogen analyzer was used to determine the moisture contents of the soap samples. Aluminium foil was placed on the moisture analyzer and the analyzer was tarred in order to zero the weight of the aluminium foil. One (1)gram of the shredded soap sample was poured onto the moisture analyzer, then covered by the foil. The moisture analyzer was allowed to take and display the readings of the moisture contents (Haut, 2009).

2.3. Heavy Metal Determination

A Fs 240 Varian Atomic Absorption Spectrophotometer was used for the heavy metal analysis. The heavy metals analysed were Lead (Pb), Cadmium (Cd), Chromium (Cr), andMercury (Hg). The method used was according to the United States Environmental Protection Agency Method 1631 Revision E (EPA, 2002; EPA,2001; Oyelakin *et al.*, 2010).

1000ppm of each of the metals was prepared and used as standard solutions. Sixty five (65)ml of concentrated acid (HNO_3) and 20ml of concentrated sulphuric acid (H_2SO_4) was mixed (aqua regia). Two (2)grams each of the shredded soap samples was digested by pouring into a round bottom flask followed by addition of 20ml of the acid mixture. The round bottom flask was corked and heated on a hot plate inside a fume cupboard until solution becomes clear. The digest was diluted with 250ml of distill water, filtered and 100ml of the filtered solution was then used for the Atomic Absorption Spectrophotometer (AAS). The results from the AAS was read and recorded.

2.4. 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.

3. Results and Discussion

3.1. Moisture Content Result

The result of the moisture content determination was recorded in Table 1. The results were compared with the International Standard Organisation (ISO) standard.

From the result, the % moisture content indicated that the medicated and skin lightening soap categories analysed falls are in the range 5-20 which is below the maximum permissible limit of 30mg/l. The result also showed that sample B has the highest percentage (%) moisture content of 25% followed by sample, 20%, samples O and P, 15% each, samples D, E, F, I, J, M, N, R, S,10% each and then 5% for samples A, C, H, K, L, Q, and T. The moisture content enables the manufacturer to easily bind and stamp the soap while those with low moisture hardly wear in water because of its little physical hardness in hydrating water.

Table 1. *Results of the moisture content determination*

S/N	Sample	Moisture content Value (%)
1	A	5
2	B	25
3	C	5
4	D	10
5	E	10
6	F	10
7	G	20
8	H	5
9	I	10
10	J	10
11	K	5
12	L	5
13	M	10
14	N	10
15	O	15
16	P	15
17	Q	5
18	R	10
19	S	10
20	T	5
	ISO	30

3.2. Heavy Metal Result

In Table 2 is shown the results of the concentrations of the various heavy metals analysed from the samples.

Table 2. *Results of the concentrations of lead (Pb), Cadmium (Cd),Chromium (Cr), and Mercury (Hg) in various samples studied.*

S/N	Sample Type	Sample	Conc. Lead mg/l	Conc. Cadmium mg/l	Conc. Chromium mg/l	Conc. Mercury mg/l
1	Medicated	A	0.000	0.000	0.000	0.500
2	"	B	0.000	0.000	0.000	0.500
3	"	C	0.000	0.000	0.000	0.500
4	"	D	0.000	0.000	0.000	0.500
5	"	E	0.000	0.000	0.000	0.400
6	Skin Lightening	F	0.000	0.000	0.000	0.300
7	"	G	0.000	0.000	0.000	0.700
8	"	H	0.000	0.000	0.000	0.600
9	"	I	0.000	0.000	0.000	0.500
10	"	J	0.000	0.000	0.000	0.400
11	"	K	0.000	0.000	0.000	0.400
12	"	L	0.000	0.000	0.000	0.400
13	"	M	0.500	0.083	0.000	0.600
14	"	N	1.370	0.016	0.000	0.500
15	"	O	0.000	0.000	0.000	0.600
16	"	P	0.150	0.144	0.046	0.600
17	"	Q	0.000	0.000	0.000	0.500
18	"	R	0.060	0.000	0.000	0.500
19	"	S	7.390	0.000	0.000	0.500
20	"	T	0.000	0.000	0.000	0.600
	ISO		1.000	0.100	0.100	0.200

The analysis also revealed that there was also some detectable trace of lead only in skin lightening soaps which implies that the medicated soaps analyzed were free from lead.

Lead were detected in appreciable amount in samples J (0.1mg/l), M (0.3mg/l), P (0.13mg/l) and N (0.13mg/l) which are within the standard permissible limit of 1.0mg/l but it was highly detected in S (7.39mg/l) which is far greater than the permissible limit of 1.0mg/l and tends to be more dangerous to the health. The presence of lead in cosmetics has been also reported and thus , the European Union (EU) law for cosmetics banned lead and lead compounds in cosmetics since 1976 (Amit *et al*, 2010)). Chromium were also detected in appreciable trace amount in sample P, a skin lightening soap (0.046mg/l) which is below the standard of maximum permissible limit of 0.1mg/l. This simply means that there will be no trace of chromium toxic heavy metal since chromium appears in a very low concentration in P and absent in others. Cadmium was only detected in very minute amount in samples M (0.083mg/l), N (0.016mg/l), and P (0.144mg/l). Which were quite below the permissible limit of 0.1mg/l but P is above the limit in a very small amount so tends not to be very harmful but can bio-accumulate in long term use of the soap. Sample G, a skin whitening soap has the highest concentration of mercury (0.70), Followed by Idole, Rhome, Secret, Olay, and Bioclair (0.60mg/l) each, while others are between 0.50-0.30mg/l. The level of mercury concentration regulated in Nigeria requires that soaps carry labels indicating their contents. Of all the soap analysed, only Samples A and D indicated the presence of mercury on their labels.

According to a study carried out on the use of skin lightening soap, (Lightening soap in Kenya) 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 the hair of people who used soaps that contained 5.3×10^{-3}% HgI_2 which correspond to 2.3×10^{-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 (Masazumi *et. al.*, 2001; Oyelakin *et al.*, 2010). This implies that the user of the soap containing mercury below 5.3×10^{-3}% might not experience short term health problems associated with the use of

mercury (Oyelakin *et al.*, 2010). Relating these findings to this project, where the highest level of mercury in soap is found to be 7.0×10^{-1}% which is far above 2.3×10^{-1}%. It is then logical to conclude that these soaps are likely to cause some serious health problems. These soaps 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.

3.3. Statistical Analysis Result

The multiple comparisons were statistically carried out at 95% Confidence Interval. In Table 3 is shown the result of the statistical analysis of multiple comparisons.

Table 3. *Statistical analysis of multiple comparisons at 95% Confidence Interval*

Parameters LSD		**Multiple Comparisons**			**95% Confidence Interval**	
Control	**Samples**	**Mean Difference**	**Std.**	**Sig.**	**Lower**	**Upper**
(X)	**(Y)**	**(X-Y)**	**Error**	**Diff.**	**Bound**	**Bound**
Control	A	4.20000	4.16026	0.318	-4.1844	12.5844
	B	4.06340	3.70136	0.278	-3.3962	11.5230
	C	4.18000	4.16026	0.321	-4.2044	12.5644
	D	3.18000	3.70136	0.395	-4.2796	10.6396
	E	3.88280	3.70136	0.300	-3.5768	11.3424
	F	2.70200	3.70136	0.469	-4.7576	10.1616
	G	3.00920	3.70136	0.421	-4.4504	10.4688
	H	5.18000	3.70136	0.169	-2.2796	12.6396
	I	1.18000	4.16026	0.779	-7.2044	9.5644
	J	4.18000	4.16026	0.321	-4.2044	12.5644
	K	2.14000	4.16026	0.610	-6.2444	10.5244
	L	5.16000	4.16026	0.221	-3.2244	13.5444
	M	5.18000	4.16026	0.220	-3.2044	13.5644
	N	4.18000	4.16026	0.321	-4.2044	12.5644
	O	5.20000	4.16026	0.218	-3.1844	13.5844
	P	5.20000	4.16026	0.218	-3.1844	13.5844
	Q	4.16800	4.70136	0.266	-3.2916	11.6276
	R	5.20000	3.70136	0.167	-2.2596	12.6596
	S	5.16000	3.70136	0.170	-2.2996	12.6196
	T	4.16800	3.70136	0.266	-3.2916	11.6276

From the statistical analysis of the multiple comparisons calculated, the significant difference between the standard and the sample, shows that samples I, K, F and G have the least significant difference while samples P, O, R, H and S have the highest significant difference. These results makes samples I, K, F and G the best quality out of the twenty samples analyzed.

4. Conclusion

The soap 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 run effect of the use of such soaps has the capacity to affect the health of consumer and with greater social cost for Government in terms of health service provision. Soaps which contain mercury below 0.5mg/l might not experience short term health problems associated with the use of mercury. Therefore samples I, J, Fand K have the best quality when compared to other samples.

Skin lightening and medicated soaps have been found containing heavy metals and other qualities which may affect living organisms and cause destabilization to the health. World Health Organization (WHO) and The Environmental Protection Agency (EPA) should implement a law guiding the control of exposure in various soap industry. National Agency for Food and Drugs Administration Control (NAFDAC) should as well protect the public health by checking the amounts of dangerous heavy metals in soaps and regulate a standard for them.

Soap manufacturing industries in Nigeria are required to improve in the area of purification of raw materials used in making soaps or avoid completely the usage of any materials that contains the dangerous heavy metals during soap production. People using skin lightening soaps should help themselves to stop it because those soaps reduce their melanin production thereby expose the body to infectious diseases. It would appear that exposure to elevated levels of carcinogenic metals in the environment can induce cancer in a small number of the most susceptible individuals (Nriagu, 1988).

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