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Quantitative Analysis of Heavy Metals in Body Lotions Collected from Local Markets of Bangladesh.

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Abstract: *Low concentration of elements such as iron, nickel, copper, manganese, zinc etc. which is considered as nutrients. These nutrients play an important role for growing the living beings especially animals and plants. But when the concentrations of these elements are exceeded the tolerable range then these is considered as heavy metals. Cosmetic is common things that is use both male and female in modern civilization. Body lotion is one of the essential item of cosmetic which may be contaminated with heavy metals either adulteration by hazardous chemicals or occur from the source of raw materials. The running experiments have been accomplished with the determination of the concentrations of heavy metals viz. aluminium (Al), chromium (Cr), manganese (Mn), iron (Fe), Nickel (Ni), Copper (Cu), Zinc (Zn), Lead (Pb), Cadmium (Cd), Arsenic (As) and Mercury (Hg) in various branded body lotions. A total of 37 samples have been analyzed by using Atomic Absorption Spectrophotometer (AAS). The experiments have shown that Al was found in the range of (BDL – 4484.64) ppm followed by (BDL – 2.22) ppm for chromium, (BDL – 0.45) ppm for Mn, (0.01 – 51.50) ppm for Fe, (BDL – 1.26) ppm for Ni, (0.06 – 0.78) ppm for Cu, (BDL – 5363.50) ppm for Zn, (BDL – 4.17) ppm for Pb, BDL for Cd, (0.05 – 0.19) ppm for As and (BDL – 0.27) ppm for Hg. All of the metals, zinc have represented the highest concentration in sample $X_{24.}$ This sample (X_{24}) was also contained the highest concentration of another seven metals such as Al, Cr, Mn, Fe, Ni, Cu and Pb.*

Keywords: *Heavy metals, Body lotion, Bangladesh, Local Market.*

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I. Introduction

Cosmetics are very popular products contribute to develop various external organs of human body including eyes, nails, hair, skin, teeth etc. Some of these products mainly cream and lotion improve the complexion. Though people basically women are used different types of cosmetics as beautifying agent but most of them know nothing about the bad effects of these products due to contamination with heavy metals. A total of 23 metals like chromium, cadmium, antimony, bismuth, arsenic, gold, iron, manganese, cerium, gallium, copper, zinc, platinum, cobalt, nickel, lead, tellurium, tin, vanadium, silver uranium, thallium and mercury are assumed toxic metals out of thirty five elements [1]. It is necessary to mention that small amount of metals are more beneficial to human body. Reversely, when these metals are exceeded their acceptable limits then they are definitely considered as heavy metals. Body lotion is one kind of cosmetics which is applied to the body about millions of users to prevent dryness of the skin. This body lotion may be contaminated by heavy metals occurred from different sources either man made or natural sources. Heavy metals exist in the environment because of unlimited utilization of them in different industries. As a result, environmental pollution is increased day by day in the world. Heavy metals are not biodegradable having long biological half-lives [2]. Aluminum compound can be used in cosmetic items in a poor quantity. Excess amount of aluminum can cause to produce neurotoxicity. It may also responsible for reducing male reproduction capacity. Lead is very toxic elements [3], [4] and harmful to human health. It damages kidney as well as liable to cardiovascular disease and autoimmune disorder [5]. Besides, lead can be entered the body by inhalation and ingestion of lead-dust. Skin is also absorbed directly less than 1% of lead [6]. Chromium plays an important role to arise difficult disease like cell damage, cancer, skin diseases etc [7]. Tannery industries are the main culprit for the chromium contamination in environment. Arsenic is naturally occurred in the environment. Other sources of arsenic are considered from medical and industrial sectors [8]. This metal is accountable for brain damage, gastrointestinal diseases and liver disease [9]. Cadmium is very dangerous toxic metal which is liable for lung disease, heart disease, kidney disease and liver disease. Waste water, industrial effluent and unlimited use of fertilizer in agricultural sectors are the main sources of cadmium. Though iron has nutrients value but excess quantity may cause stomach pain, constipation and diarrhea. On the other hand, allergic skin reaction can be appeared in human body due to over doses of nickel [10], [11], [12]. Besides, nickel may cause nose cancer, prostate cancer and lung cancer [9].

Usually nickel is naturally found in the earth. Low graded jewelleries, alloy industries, stainless steel industries, tobacco industries may be exposed nickel to the environment. Manganese may be toxic when high quantity is present in human body. Excess amount of manganese can be damaged the liver. Furthermore, high doses of copper are responsible for kidney and liver disease [9]. Nevertheless, mercury is a very dangerous metal which is naturally arisen in environment from coal, petroleum, volcanoes, forest fires etc. Other sources of mercury include pulp and paper industries, incineration of hazardous medical and municipal waste. A large number of difficult diseases like cardiovascular and neurological problems, renal disorder, reduction of fertility, pulmonary diseases can be appeared in human health as deadly effect of mercury. Moreover, memory loss, insomnia, kidney disease and thyroid problem must be arisen as bad effect of mercury [9]. It was observed that workers of an industry are suffer from dizziness and headache due to bad effect of heavy metals especially chromium and lead. Various branded of herbal and synthetic body lotions are available in the local market of Bangladesh. Some of these are locally manufacturing products and also considered as low quality cosmetic products. At present, high quality imported herbal products are very popular to the people of Bangladesh. World Health Organization (WHO) is suggested to control the concentration of heavy metals in safety level. The present study was aimed to assess the heavy metals concentration in a cosmetic item such as body lotion from local markets of Bangladesh.

II. Materials and Method

Sample collection: Thirty seven samples of nineteen brands including both herbal and synthetic body lotions originated from eight countries named USA, England, Malaysia, UAE, Bangladesh, Thailand, India and Mexico were bought from retail shops of Bangladesh. These collected samples were labeled in accordance with their manufacturer's name, batch number, ingredients, manufacturing date, brand name, date of expire, origin and color.

Reagents and chemicals: Required standard solutions (Sigma Aldrich, 1000ppm stock solutions) of Al, Cr, Mn, Fe, Ni, Cu, Zn, As, Pb, Cd and Hg were purchased for calibration. Reagents like Sulfuric acid, Hydrochloric acid, Nitric acid (Scharlau, Spain), Potassium permanganate, Sodium hydroxide, Potassium iodide, Sodium borohydride, Hydroxylamine hydrochloride, L-ascorbic acid (AnalaR grade) were collected from scientific goods supplier for sample preparation.

Preparation of working standard solutions: These solutions of heavy metals were prepared from stock solutions (1000ppm). For this reason 0.0, 0.5, 0.1, 0.2 and 0.5 ppm working standards were prepared by applying serial dilution method.

Preparation of samples: Standard method was followed for the preparation of samples. Weighed 5g of each collected sample in an evaporating dish and dried in an oven at 100±5 °C for about 3 hours. Then the dried sample was ignited in a muffle furnace at 550°C temperature for perfect necessary time to obtain white colored ash which is free from carbon. Normally (6 – 8) hours were required for complete ignition. Then the ash was kept to cool absolutely and added a poor amount of deionized water. About 25ml of 1M Nitric acid was contacted with this sample and then warmed up on a hot plate for 5 minutes. The solution was filtered into a 100ml volumetric flask using Whatman filter paper (No. 42). Each sample was diluted to the mark with deionized water.

Only for Mercury analysis: Weighed 0.5g sample in 50ml Falcon tube. The sample was mixed with 2ml of concentrated Sulfuric acid and 2ml of Nitric acid. Then it was heated at 80°C temperature on a water bath for 1hour and thirty minutes. The sample was allowed to cool at room temperature and contacted with 7ml of Potassium permanganate as well as 5ml of 3% Hydrochloric acid. The total mixture was heated again at 95°C for about 2 hours. Let to cool and added 3ml of Hydroxylamine hydrochloride. Finally, the sample was diluted to 50ml with deionized water.

Analysis of samples: All of the digested samples of body lotion were analyzed for the quantification of heavy metals using Atomic Absorption Spectrophotometer (Mode- iCE 3000, Thermo Scientific, USA). It is noticeable that, Flame Atomic Absorption Spectrometry (FAAS) technique was applied for the determination of Lead, Cadmium, Chromium, Copper, Zinc, Aluminum, Nickel, Manganese and Iron. But Hydride Generation Evaporation (VGA 100) was utilized for Arsenic and Mercury. Air and acetylene were used as fuel sources for analysis of metals except aluminum, chromium and mercury. For aluminum and chromium, nitrous oxide and acetylene were used as fuel sources. Nevertheless, Cold Vapor Atomic Absorption Spectrometry (CV-AAS) was followed during Mercury analysis. Hollow cathode lamp of each metal was utilized as radiation source in AAS. The working condition of AAS was shown in Table-2 during analysis.

III. Result and Discussion

The concentrations of heavy metals were shown in Table-1. The present experiment disclosed that aluminum, chromium, manganese, iron, nickel, copper, zinc, arsenic, lead, cadmium and mercury were found in 72.97%, 5.40%, 13.51%, 100%, 2.70%, 100%, 86.50%, 100%, 18.92%, 0.00% and 29.72 of total samples

respectively. Among these samples, the highest concentration (as 4484.64 ppm) of aluminum was found in sample X_{24} and the lowest concentration (as 1.0 pppm) of the same metal was obtained from X_{22}. But 10 samples named X_4, X_6, X_8, X_{13}, X_{18}, X_{19}, X_{20}, X_{25}, X_{27} and X_{34} were shown the concentration of aluminum in Below Detection Limit. Chromium was also found in only two samples viz. X_{24} and X_{29}. According to European Union law one sample was exceeded (2.22 ppm) permissible limit (1.0 ppm). Manganese was obtained from five samples. The detected concentrations of manganese were 0.04 ppm for X_4, 0.26 ppm for X_{12}, 0.45 ppm for X_{24}, 0.05 ppm for X_{28} and 0.09 ppm for X_{32}. The lowest concentration (0.01 ppm) of iron was found in X_{10} and the highest one was also found in X_{24}. It was observed that two samples named X_{24} (51.50 ppm) and X_{32} (10.55 ppm) were crossed the acceptable limit of 10 ppm [13]. Nickel was identified and also quantified in just one sample like X_{24} as the concentration of 1.26 ppm. But this value was not above the standard range (Health Canada 2009). Copper was found in the range of (0.06 – 0.78)ppm. X_{10} and X_{24} were shown the concentration of copper as 0.06 ppm and 0.78 ppm respectively. The concentration of zinc was detected in five samples i.e. X_3, X_6, X_{13}, X_{20} and X_{28} as below detection limit. X_{24} was shown the highest concentration of zinc as 5363.50 ppm. Arsenic was found in the range of (0.05 – 0.19)ppm. According to Food and Drug Administration (FDA) suggestions all of the samples were not exceeded acceptable level (3.0 ppm) of arsenic (Health Canada 2009). Seven samples like X_7, X_9, X_{11}, X_{21}, X_{24}, X_{29} and X_{35} have shown the concentration of lead as 0.34 ppm, 0.20 ppm, 0.24 ppm, 0.34 ppm, 4.17 ppm 0.09 ppm and 0.37 ppm respectively. It was mentioned that thirty samples out of 37 were shown below detection limit of lead. On the other hand, the concentration of mercury was found as 0.01 ppm for X_4, X_5, X_{18}, X_{21}, X_{29}, X_{32} & X_{33}, followed by 0.02 ppm for X_6, 0.08 ppm for X_{26}, 0.03 ppm for X_{28} and 0.27 ppm for X_{35}. It was observed that the concentration of lead and mercury were obtained in the range of (BDL – 4.17)ppm and (BDL – 0.27)ppm respectively. These acquired ranges were not crossed the permissible limit as 10 ppm for lead and as 1.0 ppm for mercury in accordance with World Health Organization (WHO). Furthermore, cadmium was obtained in all of the samples as below detection limit. It is important to mention that, the highest concentrations of eight metals like aluminum, chromium, manganese, iron, nickel, copper, zinc and lead were found in only one sample named X_{24} out of 37. The order of average concentration of heavy metals in body lotions as follows [Table-1 & Figure-1]:

Zn > Al > Fe > Cu > Pb > As > Cr > Ni > Mn > Hg > Cd

IV. Conclusion

The current experiment was indicated that cosmetic like body lotion which is widely used in the world may be injurious to the human health. But it should be referred that all of the branded body lotions are not manufactured with hazardous chemicals. A large number of high quality cosmetic products both medicated and synthetic are available in the market that may beneficial for human health as because not contaminated with any toxic substance. But some of the cosmetic products having low quality can be imposed very adverse effect to the human body as well as environment. So, it is more essential to take awareness of the people as regards not to use contaminated cosmetics and everybody must be careful to reduce the environmental pollution with heavy metals.

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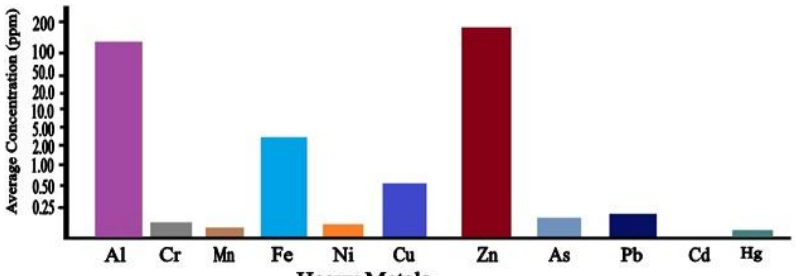

Figure-1: Average concentration of heavy metals

Table-1: Concentration of heavy metals in body lotion

Brands	Sample ID	Origin	Concentration of heavy metals (ppm)										
			Al	Cr	Mn	Fe	Ni	Cu	Zn	As	Pb	Cd	Hg
A	X_1	Bangladesh	25.67	BDL	BDL	0.35	BDL	0.14	0.35	0.06	BDL	BDL	BDL
	X_2	Thailand	10.88	BDL	BDL	0.48	BDL	0.18	0.25	0.10	BDL	BDL	BDL
	X_3	India	4.77	BDL	BDL	0.38	BDL	0.27	BDL	0.08	BDL	BDL	BDL
	X_4	Mexico	BDL	BDL	0.04	0.50	BDL	0.12	0.59	0.17	BDL	BDL	0.01
	X_5	India	11.97	BDL	BDL	0.78	BDL	0.29	4.37	0.16	BDL	BDL	0.01
	X_6	Bangladesh	BDL	BDL	BDL	0.42	BDL	0.16	BDL	0.10	BDL	BDL	0.02
	X_7	Thailand	57.41	BDL	BDL	0.70	BDL	0.27	0.32	0.08	0.34	BDL	BDL
	X_8	Bangladesh	BDL	BDL	BDL	0.15	BDL	0.12	0.30	0.15	BDL	BDL	BDL
	X_9	India	4.06	BDL	BDL	0.54	BDL	0.20	0.45	0.10	0.20	BDL	BDL
	X_{10}	UAE	1.56	BDL	BDL	0.01	BDL	0.06	0.06	0.12	BDL	BDL	BDL
B	X_{11}	Bangladesh	36.49	BDL	BDL	1.32	BDL	0.36	0.36	0.15	0.24	BDL	BDL
	X_{12}	Bangladesh	36.64	BDL	0.26	1.89	BDL	0.22	0.45	0.12	BDL	BDL	BDL
	X_{13}	Thailand	BDL	BDL	BDL	0.05	BDL	0.12	BDL	0.19	BDL	BDL	BDL
C	X_{14}	India	2.12	BDL	BDL	0.51	BDL	0.26	0.40	0.11	BDL	BDL	BDL
	X_{15}	India	272.11	BDL	BDL	2.87	BDL	0.31	0.70	0.05	BDL	BDL	BDL
D	X_{16}	Bangladesh	26.64	BDL	BDL	0.01	BDL	0.22	1.43	0.12	BDL	BDL	BDL
E	X_{17}	Bangladesh	16.64	BDL	BDL	0.45	BDL	0.12	178.67	0.08	BDL	BDL	BDL
	X_{18}	USA	BDL	BDL	BDL	0.13	BDL	0.14	0.15	0.16	BDL	BDL	0.01
F	X_{19}	USA	BDL	BDL	BDL	0.24	BDL	0.16	0.05	0.09	BDL	BDL	BDL
	X_{20}	USA	BDL	BDL	BDL	0.18	BDL	0.25	BDL	0.08	BDL	BDL	BDL
G	X_{21}	India	2.47	BDL	BDL	1.55	BDL	0.25	0.47	0.12	0.34	BDL	0.01
	X_{22}	India	1.00	BDL	BDL	0.70	BDL	0.08	0.63	0.18	BDL	BDL	BDL
H	X_{23}	India	9.42	BDL	BDL	1.28	BDL	0.17	0.25	0.09	BDL	BDL	BDL
I	X_{24}	India	4484.64	2.22	0.45	51.50	1.26	0.78	5363.50	0.12	4.17	BDL	BDL
J	X_{25}	Thailand	BDL	BDL	BDL	0.07	BDL	0.17	1.30	0.05	BDL	BDL	BDL
K	X_{26}	Thailand	42.92	BDL	BDL	3.43	BDL	0.21	0.32	0.16	BDL	BDL	0.08
L	X_{27}	Thailand	BDL	BDL	BDL	0.24	BDL	0.11	0.43	0.13	BDL	BDL	BDL
M	X_{28}	USA	10.13	BDL	0.05	2.35	BDL	0.14	BDL	0.11	BDL	BDL	0.03
N	X_{29}	UAE	2.46	0.37	BDL	3.50	BDL	0.16	0.19	0.12	0.09	BDL	0.01
	X_{30}	UAE	18.24	BDL	BDL	0.72	BDL	0.21	65.26	0.13	BDL	BDL	BDL
	X_{31}	USA	4.63	BDL	BDL	0.55	BDL	0.10	1.89	0.07	BDL	BDL	BDL
O	X_{32}	USA	24.10	BDL	0.09	10.55	BDL	0.17	0.90	0.11	BDL	BDL	0.01
P	X_{33}	USA	5.22	BDL	BDL	0.38	BDL	0.12	0.20	0.09	BDL	BDL	0.01
Q	X_{34}	England	BDL	BDL	BDL	0.10	BDL	0.13	0.04	0.10	BDL	BDL	BDL
	X_{35}	England	3.81	BDL	BDL	0.30	BDL	0.16	58.96	0.12	0.37	BDL	0.27
R	X_{36}	England	1.26	BDL	BDL	0.43	BDL	0.23	0.63	0.07	BDL	BDL	BDL
S	X_{37}	Malaysia	18.08	BDL	BDL	2.18	BDL	0.32	0.60	0.10	BDL	BDL	BDL
		Average	**138.79**	**0.07**	**0.02**	**2.48**	**0.03**	**0.20**	**153.63**	**0.11**	**0.16**	**0.00**	**0.01**

***BDL:** Below Detection Limit (Fe: <0.01, Ni: <0.02, Cu: <0.05, Zn: <0.05, Cd: <0.003, Cr: <0.04, Al: <0.1, Pb: <0.01, Mn: <0.03, Hg: <0.001, As: <0.01ppm)

Table – 2: Working condition of AAS during analysis of heavy metals in body lotions.

Condition of AAS	**Detected Metals**					
	Aluminum	***Chromium***	***Manganese***	***Iron***	***Nickel***	***Copper***
Flame Type	Nitrous oxide-Acetylene	Nitrous oxide-Acetylene	Air-Acetylene	Air-Acetylene	Air-Acetylene	Air-Acetylene
Fuel Flow (L/min)	4.3	1.4	1.0	0.9	0.9	1.1
Wavelength (nm)	309.3	357.9	279.5	248.3	232	324.8
Hollow Cathode Lamp Current (mA)	10	12	12	15	15	5
Band pass (nm)	0.5	0.5	0.2	0.2	0.2	0.5
	Detected Metals					
	Zinc	***Arsenic***	***Lead***	***Cadmium***	***Mercury***	
Flame Type	Air-Acetylene	Air-Acetylene (Vapor mode)	Air-Acetylene	Air-Acetylene	No heating (Cold vapor)	
Fuel Flow (L/min)	1.2	1.0	1.1	1.2	-	
Wavelength (nm)	213.9	193.7	217	228.8	253.7	
Hollow Cathode Lamp Current (mA)	10	12	10	8	6	
Band pass (nm)	0.2	0.5	0.5	0.5	0.5	

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