Article

Status of some metals contained in imported nail polish and lipsticks on the Ghanaian market

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Received 27 June 2015; Accepted 5 August 2015; Published online 1 December 2015

Abstract

Imported cosmetic products (i.e. nail polishes and lipsticks) were purchased on the open market in an urban market in Accra and analyzed for the presence of metals including cadmium, cobalt, lead, nickel, chromium and manganese. While the concentrations of nickel were below detectable limits in all the samples, the concentration of lead in the lipstick samples exceeded the allowable limits as prescribed by the Health Canada Draft Guidelines on Heavy Metals in cosmetics. The lead in the nail polish and lipstick samples also exceeded the Ghana Standard Authority limits on lead in cosmetics.

Keywords metals; nail polish; lipstick; Health Canada Draft Guidelines.

Proceedings of the International Academy of Ecology and Environmental Sciences
ISSN 2220-8860
URL: http://www.iaees.org/publications/journals/piaees/online-version.asp
RSS: http://www.iaees.org/publications/journals/piaees/rss.xml
E-mail: piaees@iaees.org
Editor-in-Chief: WenJun Zhang
Publisher: International Academy of Ecology and Environmental Sciences

1 Introduction

The demand for cosmetic products ranging from creams, beauty soaps, talcum and face powder, lotions, shampoos, hair oils, hair dyes, hair colors, perfumes, lipsticks, shaving creams, body lotions, nail vanish and polish, etc. has increased in recent times, resulting in massive production by the cosmetic industry. This demand has been attributed to the beauty consciousness of people of all socio-economic standings (Chauhan et al., 2010). Cosmetics may contain several raw materials and pigments which contain lead and cadmium, because of the persistent nature of these metals as well as their natural occurrence in rocks, water and soil (Beatrice et al., 2014). Many thousands of ingredients in cosmetics are linked to many diseases like cancer, birth defects, developmental and reproductive harm (Hussain et al., 2013). Cadmium has been used in cosmetic product due to its characteristic color pigment (Godt et al., 2006). There have been a lot of studies in the past on the determinations of metals concentrations in various cosmetic products. Chauhan et al., 2010 determined the levels of lead and cadmium in cosmetic products; Nnorom et al. 2005, also determined the

presence of heavy metals in lipsticks, eyeliners, eye pencils marketed in Nigeria. Oluremi and Oluyemi (2014) studied the heavy metals concentrations in lipsticks and nail polish recording lead and cadmium concentration ranging between below detection limit to 42.14 µg/g and 5.90 µg/g-8.12 µg/g respectively. In Ghana, there is a relatively little attention paid to exposure to toxic heavy metals as a result of using cosmetics for the Ghanaian population, as compared to exposure to heavy metals from food, water, medicinal plants and the environment (Amartey et al., 2011). It is in the light of these that Amartey et al. (2011) investigated the exposure to heavy metals by Ghanaian university students through dermal contact. In addition, oftentimes with the importation of majority of cosmetics products, there could be laxity in systems that regulate such importation, thereby creating the possibility of exposing consumers of products to harmful ingredients which may be present (Amartey et al., 2011). The present study aims at investigating metal concentration levels of lead, cadmium, chromium, nickel, cobalt, manganese in fourteen (14) imported brands of nail polishes and lead, cadmium and chromium in six (6) imported brands of lip sticks on the Ghanaian market.

2 Methodology

Nail polishes and lip stick samples were purchased from shops in Madina, Accra-Ghana. They were of different brands, colors, and volumes. Some of the products originated from China and the United States, while with the other brands analyzed, the origins were not stated on the product labels. A summary of the external characteristics of the nail polish sampled and analyzed is described in Table 1.

Table 1 Summary of the external characteristics of nail polish sampled.

Sample code	Color	Origin	Volume
1	Light brown	United States	30ml
2	Pink	United States	15ml
3	Light green	China	18ml
4	Black	Not Known	12ml
5	Violet	Not Known	16ml
6	Cream	United States	13.3ml
7	Purple	Not Known	18ml
8	Cream	United States	14ml
9	Reddish brown	Not Known	18ml
10	Pink	Not Known	17ml
11	Yellowish brown	United States	3.5ml
12	Pink	Not Known	17ml
13	Red	Not Known	20ml
14	Light brown	Not Known	16ml

The samples were transported to the laboratories of the Nuclear Chemistry and Environmental Research Centre of the Ghana Atomic Energy Commission, Kwabenya-Accra for laboratory analysis.

2.1 Sample digestion

Wet digestion method was employed in this study. 0.2 grams each of the samples were weighed into Teflon beakers. Six ml of concentrated H_2SO_4 and HF mixture (2:1) were added to the samples. The samples were placed into a digestion carousel and digested for 25 minutes using an ETHOS 900 microwave acid digester.

Once the digestion was complete, the samples were cooled and the solution made up to 20 ml in a volumetric flask with double distilled water.

2.2 Instrumentation

A Varian AA240FS flame atomic absorption spectrometer was used for the determination of metals in the cosmetic samples. The analytical condition is described in Table 2.

Table 2 Analytical conditions of the Varian AA240FS used for the determination.

	Cd	Co	Pb	Ni	Cr	Mn
Wavelength	228.8	240.7	244.8	232	357.9	403.1
Slit width	0.5	0.2	0.2	0.2	0.2	0.2
Background Correction	No	No	Yes	Yes	No	No
Lamp current	4	7	5	7	7	5

The air-acetylene flame was used for the determinations of cadmium, nickel, lead, cobalt and manganese while air acetylene and nitrous oxide flame was used for the determination of chromium.

2.3 Analysis

Standard solutions were prepared in three different concentrations for each metal separately to obtain calibration curve for quantitative analysis.

2.4 QA/QC Procedures

All glassware were thoroughly cleaned with detergents and 10% nitric acid, and rinsed thoroughly with distilled water before being used for the analysis. All chemicals used for the analysis were of analytical grade and purchased from MERCK chemicals. The distilled water used was ultra pure.

3 Results and Discussion

A summary of the results is shown in Table 3 and Table 4. Manganese recorded the highest mean concentration of 10.09 mg/kg in the nail polish samples while nickel concentrations in the nail polish samples recorded were below detectable limits. Lead on the other hand recorded the highest mean concentration of 12.28 mg/kg in the lipstick samples. The mean heavy metal concentrations in the nail polish samples were in the order of Mn> Pb>Co>Cr>Cd. On the other hand, the mean heavy metal concentrations in the lipstick samples were in the order of Pb>Cd>Cr.

3.1 Pb and Cd

The concentration of lead in the nail polishes ranged between 4.15-8.55 mg/kg, with a mean concentration of 6.48 mg/kg. On the other hand, the concentration of lead in the lipstick samples ranged from 10.9 mg/kg to 15.25 mg/kg. Similarly, the concentrations of cadmium in the lipstick and nail polish ranged between 0.8 mg/kg to 1.65 mg/kg and 1.4 mg/kg to 2.8 mg/kg respectively. Cadmium is an important component of the coloring pigments used in cosmetic products. The concentrations of cadmium were below the allowable limits of 3.0 mg/kg, as prescribed by the Health Canadian Draft Guidance on Heavy metals in cosmetics, 2011. The concentrations of lead in the nail polish were below the allowable limits of 10mg/kg based on the Canadian limits in cosmetic products. However lead concentrations in the lipstick products analyzed exceeded the

Canadian limits in all the samples. The concentrations of lead in both the nail polish and lipstick products sampled and analysed also exceeded the Ghana Standard Board, guideline for lead in cosmetic products which is 1 mg/kg.

Table 3 Data on heavy metals in nail polish samples.

Sample code	Pb(mg/kg)	Cd(mg/kg)	Ni(mg/kg)	Co(mg/kg)	Cr(mg/kg)	Mn(mg/kg)
AB	8.55	1.95	<0.01	8.6	<0.006	19.35
AG	6.75	1.45	<0.01	6.5	<0.006	7.55
AN	5.7	2.1	<0.01	7.4	<0.006	8.35
BC	5.6	1.95	<0.01	6.35	0.75	8.65
CB	6.45	2.45	<0.01	7.55	8.29	8.7
JD	4.15	2.4	<0.01	5.85	<0.006	8.8
KB	6.65	2.75	<0.01	6.2	<0.006	9.25
NC	8.4	2.3	<0.01	5.25	<0.006	10.45
NYC	6.55	2.25	<0.01	4.8	<0.006	9.6
RL	6.1	1.4	<0.01	5.1	6.9	8.65
SH	6.75	2.25	<0.01	3.3	<0.006	8.35
SHC	7.8	2.8	<0.01	6.4	<0.006	8.1
TL	5.65	2.5	<0.01	8.3	<0.006	10.55
YX	5.55	2.6	<0.01	8.1	<0.006	14.85
Mean Conc.	6.48	2.23	-	6.41	5.31	10.09
Std. Dev.	1.19	0.43	-	1.5	4.01	3.21

Table 4 Data on heavy metals in lipstick samples.

SAMPLE CODE	Pb(mg/kg)	Cd(mg/kg)	Cr(mg/kg)
TL	10.9	1.15	<0.001
MA	12.05	0.8	0.9
DL	11.95	0.55	<0.001
JK	12.5	0.8	<0.001
CL	11.05	1.65	<0.001
MR	15.25	1.05	<0.001
Mean Concentration	12.28	1.0	0.9
Standard deviation	1.58	0.38	-

3.2 Ni and Co

Nickel concentrations in the nail polish samples were below the detection limit in all the samples; however the concentration of cobalt ranged from 3.3 mg/kg to 8.6 mg/kg. Orisakwe and Otaraku (2013) detected nickel concentrations in creams and lotions from Nigeria with concentrations, ranging between 1.09 mg/kg to 6.41 mg/kg.

3.3 Cr and Mn

The concentrations of chromium in the nail polish samples ranged from below detectable limits to 8.29 mg/kg. On the other hand, manganese concentrations in the lipstick samples ranged from below detectable limits to 0.9 mg/kg. Nnorom et al. (2005) detected chromium in lipstick samples marketed in Nigeria in the range of 20.5-58.8 mg/kg as shown in Table 5. The toxicity of chromium compounds depends on the oxidation state of the metal. The hexavalent chromium is more toxic than the trivalent form, and it is recognized as a human carcinogen when inhaled (Sahu et al., 2014). A list of data obtained for heavy metals in cosmetics in this study in comparison to other studies obtained from literature is presented in Table 5.

Table 5 Comparison to literature values.

	Pb(mg/kg)	**Cd(mg/kg)**	**Cr(mg/kg)**	**Ni(mg/kg)**	**Reference**
Lipsticks	28.7-252.4 **(87.3)**	0.5-2.4 **(0.9)**	20.5-58.8**(30.4)**	7.0-22.8 **(13.3)**	Nnorom et al., (2005)
Lipsticks	0.27-3760.0	-	-	-	Al-Saleh et al., (2009)
Lipsticks	12.28	1.0	0.9	-	This Study

Table 6 International Limits for some heavy metals in cosmetics.

	Pb	**Cd**	**Cr**	**Ni**	**% nail polishes exceeding limits**			**% lipstick exceeding limits**		
WHO	**10**	**0.3**	**-**	**-**	**Pb-0%**		**Cd-100%**	**Pb-100%**		**Cd-100%**
EU	**0.5**	**0.5**	**1.0**	**-**	**Pb-100%**	**Cd-100%**	**Cr-14%**	**Pb-100%**	**Cd-100%**	**Cr-0%**
US	**1.0**	**0.08**	**-**	**0.6**	**Pb-100%**	**Cd-0%**	**Ni-0%**	**Pb-100%**		**Cd-100%**
GERMANY	**1.0**	**0.1**	**-**	**-**	**Pb-100%**		**Cd-100%**	**Pb-100%**		**Cd-100%**
CANADA	**10**	**3**	**-**	**-**	**Pb-0%**		**Cd-0%**	**Pb-100%**		**Cd-0%**
INDIAN BIS STANDARDS	**20**	**-**	**-**	**-**	**Pb-0%**			**Pb-0%**		

3.4 Comparison of data with International Regulations on limits of heavy metals in various cosmetics products

International standards obtained from literature were obtained from Umar and Caleb (2013) study on cosmetics in Nigeria. The percentage of heavy metals in this study was compared to the limits. All the nail polish and lipstick samples analysed in this study exceeded the Germany limits for cosmetics, while 100% of all the lipstick samples exceeded the Canadian limits of heavy metals in cosmetics as shown in Table 6.

4 Conclusions

In this present study, lead, cadmium, cobalt, chromium, and manganese have been detected in various brands of nail polishes. Lead, cadmium and chromium have also been detected in lipstick samples. From the results, the concentrations of the heavy metals were within the Health Canada Guidance in the nail polish samples. However the concentration of lead in the lipstick samples exceeded the allowable limit in the Health Canada

allowable limits in cosmetics. Extensive and continue use of these lipsticks could release heavy metals slowly and cause harm to users of these products.

Acknowledgement

The authors express their sincere gratitude to the National Nuclear Research Institute for the use of the Atomic Absorption Spectrometer and other facilities for carrying out this research.

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