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Health Hazard Posed by some Heavy Metals in Matte "Paint" Lipstick

Isaac Asusheyi Bello[1], Idorenyin Effiong Umoren[1], Vincent Chijioke Ugboaja[2]

Department of Chemistry, Ahmadu Bello University, Zaria
National Water Research Institute, Kaduna

ABSTRACT

The levels of toxic and heavy metals in 15 matte lipsticks from 5 different brands (three colours (pink, purple and red) each) were assessed. The matte lipsticks samples were bought from Samaru market in Zaria, Kaduna State, Nigeria, after a poll had been conducted on female students of the Ahmadu Bello University main campus, Zaria, to discover commonly used lipstick types and colours. The lipsticks samples were analyzed for lead, cadmium, chromium, magnesium, zinc and iron. All the samples contained; lead, within the range, 85.20±0.02 ppm – 148.48±0.03 ppm, iron, 30.64±0.05 ppm – 488.16±0.04 ppm, zinc, 3.20±0.12 ppm – 90.80±0.16 ppm and magnesium, 134.88±0.04 – 991.44±0.04 ppm. The metals had average concentration of 120.9 ppm, 216.9 ppm, 25.73 ppm and 510.0 ppm for lead, iron, zinc, and magnesium respectively. Out of the analyzed sample, 6.67% contained chromium (1.36±0.14 ppm) with an average concentration of 0.091 ppm and 46.67% contained cadmium (0.08±0.01 ppm – 0.40±0.02 ppm) with an average concentration of 0.091 ppm. The results also showed that lead and cadmium in *Beyond Beauty* (purple), *IMAN* (purple, red and pink), *Romantic* (purple, red and pink), chromium in *Beyond Beauty* (purple), iron in all the samples except *Romantic* (purple), magnesium in *Beyond Beauty* (red and pink), *Jully Rose* (red), *First Class* (red and pink), *IMAN* (purple and pink) were higher than the permissible limit in food as determined by WHO. The safety of cosmetics, especially lipsticks, should be assessed regularly not only for the presence of hazardous contents, but also by comparing estimated exposures with health-based standards.

Keywords: Heavy metals, Toxic metals, Lipstick, Cosmetic safety.

INTRODUCTION

Cosmetics are beauty products used to improve or alter the appearance. The cosmetics industry is one of the most successful industries in the world. Every day, many new cosmetics products are produced and are improved upon in comparison to previous ones. Examples of cosmetics includes lipsticks, body lotions, face powders, body deodorants, bubble bath products, baby products, bath oils, bath salts, and other types of products. The demand for these products is high in both developing and developed countries (Bennet and Bennet, 1993). Cosmetics are applied directly, to the surface of human skin which acts as protective barrier, although certain ingredients may penetrate it (Loretz *et al*. 2005). Cosmetics are mixtures of surfactants, oils and other ingredients and are designed to be long-lasting, stable and safe for human use (Sani *et al*, 2016). It is generally believed that even with the regulation of many cosmetic products, there are still health concerns regarding the presence of harmful chemicals within these products. Besides colour additives, cosmetics and the ingredients used in making them are not subjected to the Food and Drug Administration (FDA) regulation prior to being released into the market. The only time the FDA will take action against cosmetic companies, is when they are found to violate the Federal Food Drug and Cosmetic Act (FD & C ACT), and Fair Packaging and Labeling Act (FPLA), after they release a product into the market (Peter and Viraraghavan, 2005). It is difficult to keep track of the safety level of every product with the sheer volume of new products released into the market every year and some of these products may be contaminated with carcinogenic substances (Peter and Viraraghavan, 2005). The limits of acceptability for heavy metals contamination vary with the subpopulation of interest (for example, children are more susceptible to heavy metal toxicity than adults) (CDC. 2013). Assessing the level absorption of a single component in a cosmetic product via the skin is complex and it depends on many factors which include: the concentration of the component of interest in the product, the amount of the product applied on the body, the contact time of the component with the skin and the presence of emollients and other components that aid or enhances the penetration of the component of interest in the cosmetic product into the skin.

*Corresponding Author: lobell_ng@yahoo.com; 08053465344

Given this complexity, and the lack of well-conducted dermal absorption studies that incorporates these factors, determination of heavy or toxic metal levels in cosmetics based on human health risk alone is a huge challenge (Peter and Viraraghavan, 2005; Oyedeji *et al*. 2011). Oral exposure can occur for cosmetics used around the mouth, (lipsticks for example) and also from hand-to-mouth contact after being exposed to cosmetics containing heavy or toxic metals (Sainio *et al*. 2000).

Matte lipsticks have very deep colours and are specifically designed to stay for a longer time on the lips which implies longer time for absorption or ingestion to take place.

In view of the above, it is pertinent that an assessment of matte lipstick as used by female students be carried out with a view to ascertain the danger posed by the levels of these metals in matte lipstick.

MATERIALS AND METHOD

All reagents used were of analytical grade. Varian instrument AA24FS was used to carry out AAS on the samples. The analyses were carried out in triplicates.

Sample collection

Three different colours (red, pink and purple) of five brands of lipstick, *Jully Rose*, *First Class*, *Beyond Beauty*, *Romantic* and *IMAN* were bought from Samaru market in Zaria, Kaduna State, Nigeria. The tested products were representative of those used by female students in the Ahmadu Bello University main campus in Zaria.

Digestion procedure

Each of the lipsticks samples (0.5 g) were weighed using an analytical balance. A pipette was used to take 7.5 mL of Nitric acid (HNO_3) and 2.5 mL of Hydrochloric acid (HCl) and respectively added to the beakers containing the samples. The samples were heated on a hot plate in a fume cupboard until they were dissolved as far as possible. After cooling, they were filtered to remove material that did not completely dissolve. These were mainly waxy material floating on the top of the digested samples. The digested sample solutions were then diluted to 40mL using distilled water.

RESULTS

Lipstick product information

Fifteen (15) lipsticks samples were tested in triplicates for the presence of heavy or toxic metals. Three colours each (red, pink and purple) were selected from 5 brands which are *Jully Rose*, *First Class*, *Beyond Beauty*, *Romantic*, and *IMAN*.

Metal Concentrations in lipsticks products

All the tested metals were detected in almost all examined lipsticks samples and increasing in this order; Mg > Fe >Pb> Zn > Cd > Cr. The results are given in table 1.

Lead, iron, zinc, and magnesium were detected in all the lipsticks samples with an average concentration of 120.9 ppm (maximum 148.48±0.03 ppm, minimum 85.20±0.02 ppm) for Lead; 216.9 ppm (maximum 488.16±0.04 ppm, minimum 30.64±0.05 ppm) for iron; 25.73 ppm (maximum 90.80±0.16 ppm, minimum 3.20±0.12 ppm) for zinc; 510.0 ppm (maximum 991.44±0.04 ppm, minimum 134.88±0.04 ppm) for magnesium. Chromium and cadmium were detected in 6.67% and 46.67% of the samples respectively. Chromium had an average concentration of 0.091 ppm (maximum 1.36±0.14 ppm, minimum 1.36±0.14 ppm) and cadmium had an average concentration of 0.091 ppm (maximum 1.36±0.14 ppm, minimum 0.08±0.01 ppm) (Table 2). Chromium and cadmium both had the lowest average concentrations which was similar (0.091 ppm). Chromium was detected in only one colour of one brand, that is, *Beyond Beauty* (purple) brand of lipstick with a concentration of 1.36±0.14 ppm, while cadmium was detected in 7 samples (*Beyond Beauty* (purple), *IMAN* (red, pink, purple), and *Romantic* (red, pink, purple) with concentrations 0.08±0.10 ppm, 0.32±0.02 ppm, 0.16±0.06 ppm, 0.08±0.03 ppm, 0.24±0.04 ppm, 0.08±0.01 ppm and 0.40±0.02 ppm respectively (Table 1)

The concentrations of lead, based on the brand, increases in this order: *Romantic* > *IMAN* > *First Class* > *Jully Rose* > *Beyond Beauty*. The levels of zinc (90.80±0.16 ppm) and lead (148.48±0.03 ppm) were highest in *Romantic* (pink), and lowest in *Beyond Beauty* (purple) (3.20±0.12 ppm and 85.20±0.02 ppm respectively). *Jully Rose* (red) had the highest concentration of magnesium (991.44±0.04 ppm), and *Romantic* (pink) had the lowest (134.88±0.04 ppm). The concentration of iron was highest in *Romantic* (red) (488.16±0.04 ppm) and lowest in *Romantic* (purple); 30.64±0.05 ppm. *Romantic* (purple) had the highest concentration of cadmium (0.40±0.02 ppm) while *Romantic* (pink) had the lowest (0.08±0.01) although *IMAN* (purple) and *Beyond Beauty* (purple) had similar concentrations; (0.08±0.03 ppm and 0.08±0.10 ppm respectively). The summary of statistics of the metal analysis is given in table 2.

Table 1: Concentrations of toxic metals in Lipsticks samples (ppm±SD)

Brands	Colours	Cr	Pb	Cd	Fe	Zn	Mg
Beyond Beauty	Purple	1.36±0.14	85.20±0.02	0.08±0.10	134.16±0.10	3.20±0.12	229.52±0.02
Beyond Beauty	Red	0.00±0.00	92.80±0.05	0.00±0.00	145.60±0.02	14.64±0.02	618.88±0.42
Beyond Beauty	Pink	0.00±0.00	96.56±0.06	0.00±0.00	96.24±0.06	12.64±0.02	680.48±0.05
Jully Rose	Purple	0.00±0.00	108.08±0.05	0.00±0.00	351.20±0.05	12.96±0.05	511.12±0.18
Jully Rose	Red	0.00±0.00	118.00±0.02	0.00±0.00	277.28±0.15	19.76±0.13	991.44±0.04
Jully Rose	Pink	0.00±0.00	120.64±0.03	0.00±0.00	233.84±0.18	73.52±0.04	328.08±0.09
First Class	Purple	0.00±0.00	127.28±0.02	0.00±0.00	282.32±0.00	11.84±0.02	256.56±0.05
First Class	Red	0.00±0.00	126.72±0.03	0.00±0.00	241.04±0.07	10.88±0.01	907.04±0.05
First Class	Pink	0.00±0.00	120.88±0.03	0.00±0.00	195.28±0.14	49.84±0.06	717.52±0.02
IMAN	Purple	0.00±0.00	131.52±0.01	0.08±0.03	173.04±0.02	35.28±0.06	672.32±0.23
IMAN	Red	0.00±0.00	131.68±0.03	0.32±0.02	281.60±0.02	4.08±0.02	215.28±0.04
IMAN	Pink	0.00±0.00	126.32±0.05	0.16±0.06	167.52±0.06	36.32±0.02	791.04±0.20
Romantic	Purple	0.00±0.00	140.56±0.04	0.40±0.02	30.64±0.05	3.68±0.10	306.320.01
Romantic	Red	0.00±0.00	138.40±0.03	0.24±0.04	488.16±0.04	6.48±0.03	289.52±0.04
Romantic	Pink	0.00±0.00	148.48±0.03	0.08±0.01	156.16±0.08	90.80±0.16	134.88±0.04

Table 2: Summary of statistics of metal analysis

Parameter	Cr	Pb	Cd	Fe	Zn	Mg
Number of samples	15	15	15	15	15	15
Number of samples with detectable metal	1	15	7	15	15	15
% of samples with detectable metal	6.67%	100%	46.67%	100%	100%	100%
Minimum concentration detected (ppm)	1.36±0.14	85.20±0.02	0.08±0.01	30.64±0.05	3.20±0.12	134.88±0.04
Maximum concentration detected (ppm)	1.36±0.14	148.48±0.03	0.40±0.02	488.16±0.04	90.80±0.16	991.44±0.04
Average concentration (ppm)	0.091	120.9	0.091	216.9	25.73	510.0

Table 3: Permissible limit of metals in food

Metals	Concentrations
Pb	0.01 ppm (WHO, 1989)
Cd	0.003 ppm (WHO, 1989)
Mg	595.3 ppm (Sehecie and Dragojevic, 2005)
Cr	1 ppm (Choi, 2011)
Zn	100 ppm (USDA, 2003)
Fe	36.2 ppm (Gopalani *et al.* 2007)

DISCUSSION

This research studied some heavy and/or toxic metals content in matte lipsticks. The results suggest potential public health concerns. However, based on the review, metals in cosmetics products are not currently regulated. Although metal concentrations in lipstick products have been reported by studies both in the U.S. and in other countries (Al-Saleh *et al*. 2009; Hepp *et al*. 2009; Gondal *et al*. 2010; Al-Saleh and Al-Enazi, 2011; Solidum and Peji, 2011; Adepoju-Bello *et al*. 2012; Brandao *et al*. 2012; Gunduz and Akman, 2013).

Lipsticks are seen as a risk of direct ingestion of toxic metals to the body. Following such observations, there is an increasing need to investigate the concentrations of toxic metals in lipsticks. Interpreting how reported concentrations of metals in lipsticks may be related to potential health risk is challenging. However, permissive limit of metals for food is used for this study (Table 3). It has therefore been found that lead, in the entire tested samples, is higher than the WHO permissible limit of 0.01 ppm. Cadmium was detected in 7 lipsticks samples and their concentrations in those samples were higher than WHO permissible limit of 0.003 ppm. Chromium was detected in only one lipstick sample (*Beyond Beauty* (Purple)) which was also higher than the WHO permissible limit of 1 ppm (Choi, 2011). Magnesium was detected in all the lipsticks samples, 7 samples which are *Beyond Beauty* (Red and Pink), *Jully Rose* (Red), *First Class* (Red and Pink), *IMAN* (Purple and Pink) were higher than the WHO permissible limit of 595.3 ppm reported by Sehecie and Dragojevic, 2005. Iron was detected in all the

lipsticks samples in which all the concentrations were higher than the permissible limit of 36.2 ppm reported by Gopalani *et al*; 2007. Zinc was detected in all the lipsticks samples, the concentrations were moderate and below the WHO permissible limit of 100 ppm (USDA, 2003).

Cadmium and its compounds are known human carcinogens (IARC, 1993). Inhalation exposure to cadmium has been associated with lung cancer and respiratory system damage (Smith *et al.* 1976; Thun *et al*. 1985; Chan *et al*. 1988; Davison *et al.* 1988; Stayner *et al*. 1992; Nawrot *et al.* 2006), and chronic oral exposure may lead to kidney and bone damage (Nogawa *et al*. 1990; Akesson *et al*. 2005). Animal studies indicate that young animals might absorb more cadmium than adults and be more susceptible to bone impairments (Ogoshi *et al.* 1989). Animal studies on rats and mice also found that feeding them with a high level of cadmium (1 – 20mg/kg/day) during pregnancy resulted in low birth weight. It also affected skeleton development, and produced behavioural and learning problems (ATSDR, 2008a). Almost half (46.67%) of the lipstick samples tested positive for cadmium, which suggests that the level of cadmium contamination is high. In a similar study conducted in Kano metropolis of Nigeria, Cd was found to be present in lipstick at an average concentration of 0.89±0.58 ppm which was higher than what was observed in this study (0.40±0.02 ppm) (Sani *et al*., 2016).

Chromium has a few adverse effects on humans, such as lung cancer and stomach cancers through inhaling or ingesting it in excess (ATSDR 2008b). Chromium was absent in 93.3% of the samples, it was only found in one sample (*Beyond Beauty* (Purple)) at a concentration of 1.36±0.14 ppm which seems not too high. However, high total estimated intake of chromium from using several lip products and the potential for additional exposure from other sources suggests that chromium intake from lip products should be a priority for additional research. A similar study conducted in Northern Nigeria found Cr to be present in lipstick at 0.016±0.023 (Sani *et al*., 2016) which was lower than what was observed in this study even though we found Cr be present only in one sample.

Lead is a zootoxic metal and most people and animals receive the largest portion of their daily lead intake via food. Lead was detected in all (100%) the lipstick samples with concentrations higher than U.S. FDA standard of 0.1 ppm for lead in candy frequently consumed by children (U.S. FDA, 2005) and the WHO standard which is 0.01 ppm. This indicates that the concentration of lead in matte lipsticks is high and this implies that excessive swallowing of these products may cause adverse health effect eventually as lead is bioaccumulated in the body. The European Union Cosmetic Directive lists Cadmium, Chromium, and Lead and their compounds as unacceptable constituents of cosmetic products (Salvador and Chisvert, 2007). The toxicity of lead at high concentrations of exposure is well documented but a major concern in recent time is the possibility that continual exposure to even relatively low levels of these toxic metals in cosmetic products may pose potential health risk (Koller *et al*. 2004). Therefore, it is generally accepted that there is no safe level of lead intake (U.S.CDC, 2012) because it is bioaccumulated in the body. Lead was detected in 75% of products in a study in California with an average concentration of 0.36 ± 0.39 ppm, including one sample with 1.32 ppm (Liu *et al*., 2013). The values recorded in our study was significantly higher than this. The reason adduced to these high values could be because our type of lipstick is matte which is designed to stay on for longer than regular lipsticks used in the other study.

Iron and zinc are not of toxicological significance. Iron compounds have an established role as colorants in many cosmetic products. Evidence shows that in addition to its importance as an essential nutrient necessary for oxygen metabolism and mitochondrial function, iron exhibits a functional maturation of the skin (Lansdown, 2001). The level of concentration of iron was higher than the permissible limit (Gopalani *et al*; 2007). If the level of iron becomes toxic, it can lead to multisystem organ failure, coma, convulsions and even death (Manoguerra *et al.* 2005; Chang and Rangan, 2011). The concentration of zinc was moderate and below the permissible limit. If the level of zinc becomes toxic, it can lead to acute adverse effect such as nausea, vomiting, loss of appetite, abdominal cramps, diarrhea and headaches (IMFNB, 2001).

Magnesium is an abundant mineral in the body that contributes to the structural development of bones and is required for synthesis of Deoxyribonucleic Acid (DNA), Ribonucleic Acid (RNA), and the antioxidant, glutathione and it also plays a role in the active transport of calcium and potassium ions across cell membranes, a process that is important to nerve impulse conduction, muscle contraction and normal heart rhythm (Rude, 2012).

Magnesium toxicity increases the risk of impaired renal function or kidney failure because the ability to remove excess magnesium is reduced or lost (IOM, 1997, Barbagallo *et al.* 2009). The permissible limit for magnesium is 595.3mg/kg (Sehecie and Dragojevic, 2005). The concentration of magnesium in some tested lipsticks samples was moderate but 7

samples contained higher concentrations of magnesium. If the level of magnesium becomes toxic, it causes diarrhea that can be accompanied by nausea and abdominal cramping (IOM, 1997).

The digestion method used in this study did not completely dissolve the lip product samples as some waxy material was still floating on the digest. Therefore, the possibility of under-reporting exists for this study. The recent FDA study, which used a more complete digestion method to determine the total lead in lipsticks, reported an average lead content of 1.07 ppm (range: 0.09 – 3.06 ppm) in twenty-two tested lipsticks (Hepp *et al*. 2009), in contrast to an average lead concentration of 120.9 ppm (range: 85.20±0.02 ppm – 148.48±0.03 ppm) for our 15 samples. The differences between the studies may reflect variation in lead content among the specific products tested. Therefore, future studies should endeavour to measure total content to the degree possible.

CONCLUSION

In this study, the levels of chromium, lead, cadmium, iron, zinc and magnesium were determined in 15 lipsticks samples from 5 brands. From the results, the concentration of lead in all the samples was high, and continuous use of these products may cause harmful effects to the consumers over time. Therefore, the need for further studies to evaluate the metal concentrations in other cosmetics needs to be carried out. Extensive use of these products should be avoided until the situation is adequately addressed. The manufacturers should be compelled by law to provide information about the presence and levels of these metals in the final product on the packaging.

RECOMMENDATION

This research was limited to a few toxic and heavy metals in lipsticks. It is therefore recommended that further studies should be carried out to determine the levels of contamination of other toxic metals in lip products and other cosmetics.

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