ASSESSMENT OF HEAVY METALS IN COSMETIC POWDERS AND AWARENESS OF CONSUMER ON PRODUCT LABELS IN ISLAMABAD PAKISTAN

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ABSTRACT

Cosmetics are synthetic products that have been used for beautification purposes by humans for many years. Heavy metal contamination of these products, can be a reason behind serious organ damage and neural degeneration. The study was conducted in order to determine the health hazards of Cr, Pb, and Hg in internationally and locally manufactured face and talcum powders and consumer awareness on it. The permissible limits determined by the American Food and Drug Association and European authorities for heavy metals contamination are used as standard. It was found that most of the internationally and locally manufactured cosmetic products do not follow these regulations. Hence, cosmetic products are made under poor surveillance causing serious health issues among consumers. Hazard quotient is determined in order to understand the health risk that each metal hold. Most of the products manufactured in developed and developing countries have Hazard quotient values higher than the maximum Hazard quotient value determined by the authorities. Consumers are mostly ignorant of the hazards associated with the products they purchase and are unaware of the health risks associated with that product. This leads to long-term irreversible health conditions.

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LIST OF ABBRIVATIONS

AAS: Atomic Absorption Spectrophotometer

AF: Adherence Factor

BW: Body Weight

CNS: Central Nervous System

ED: Exposure Duration

RfD: Reference Dose

Pb: Lead

Hg: Mercury

Cr: Chromium

FDA: American Food and Drug Association

ADD: Average Daily Dose

SA: Surface Area

HQ: Hazard quotient

MTDI: Maximum tolerable daily intake

CHAPTER 1

INTRODUCTION

A cosmetic is a synthetic substance that is used by millions of consumers on the various body parts for the purpose of changing the outlook of the person (M.G. Volpe, M. Nazzaro, R. Coppola, F. Rapuano, & R.P. Aquino, 2012). Cosmetics can be used on the epidermal layer, face, eyes, neck, underarms, and hands and also on external genitals parts of both males and females (Sani, Gaya, & Abubakar, 2016). The purpose of applying cosmetics can vary from person to person. Some may use it for the purpose of cleaning while some may use it for changing body odors whereas; mostly cosmetics are used to change the outer look (Sani, Gaya, & Abubakar, 2016). Some use these synthetic products to enhance their appearance while, others may use it as a way to cover their imperfections. Also, people use perfumes to subside their body odors. Cosmetics come in multiple physical states and in thousands of varieties and qualities. These cosmetics are a product of several elements that may be harmful to human beings. While the human skin provides a wall for the reasons of protection, the harmful chemicals and metals in the cosmetics often get absorbed by the skin or can enter the human body through the oral cavity and mucous membranes (M.G. Volpe, M. Nazzaro, R. Coppola, F. Rapuano, & R.P. Aquino, 2012). The products contain elements such as; oils, surfactants and heavy metals. In a study conducted by Health Canada, all cosmetic products contain nickel and 90% of the products contain both beryllium and lead and on average all cosmetic products contain 4 harmful metals (Orisakwe & Otaraku, 2013). The purpose of using these products is to ensure that the cosmetics are long-lasting, waterproof and effective. However, despite the positive instant results of these products, continuous use can cause serious damage to both physical health and to the skin of human

beings. The effects of these substances can be observed by irritation, sensitization and acne break on the face and back of the consumer (M.G. Volpe, M. Nazzaro, R. Coppola, F. Rapuano, & R.P. Aquino, 2012).

A research conducted on the local cosmetics produced in Nigeria showed that these products contained very high and damaging quantity of trace metals in them (Orisakwe & Otaraku, 2013). Also, another study conducted in Africa concluded that women in Africa use creams and different types of bleaches to lighten up their skin tone. A study showed that in Nigeria 85% of the cosmetic products tested showed a positive result on a high level of chromium, zinc, iron, and nickel. Out of these sample groups, the increased level of lead was found to be ranging from 6.1 to 45.9 ppm. When tested for the level of iron in these local sample products, the highest level was found to be 261275.6 mg kg-1 and the lowest level was found to be 72.9 mg kg-1 (Sani, Gaya, & Abubakar, 2016). Due to the continuous use of these harmful products on the skin under humid conditions resulted in much serious skin related problems in the women of Africa (Orisakwe & Otaraku, 2013).

Metals are found everywhere around us mixed with air, water, soil and are mostly absorbed by the plant as a food source ultimately becoming a part of our food chain. Even though, these metals are intoxicating in high amounts but cannot be completely eliminated from human food sources. Some are even beneficial for the human body in a certain amount. The struggle to understand the relation of metals to the human body started very early when a man became the victim of abdominal colic during metal extraction (Palpandi & Kesavan, 2012). It was found that humans can be disposed to the consumption of metals through diet, medication or through breathing (Adal & Tarabar, 2013). The absorption of salt metals through the skin can vary from person to person depending on their physical parameters (Lilley, Florence, & Stauber, 1988). However, it was concluded that heavy metals, whose density if five times heavier than water (Eltegani, Ali, & Y. Hammad, 2013) are very harmful to humans regardless of the means of their contact or consumption. Some of these heavy metals include; zinc, iron, lead arsenic, cobalt, chromium, gold, silver, and mercury. A study conducted by Mosby, Glanze, & Anderson, 1996, found out that even the essential metals used in cosmetics are harmful if used in higher concentrations.

1.1. Heavy metals in cosmetics

The raw materials used in cosmetic industries are composed of both desirable and undesirable metals. There are laws and regulations prohibiting the usage of these harmful metals in some countries. However, most of the countries lack these regulations leading to a high amount of hazardous metals being used in the manufacturing of cosmetics. The metals which are part of cosmetics and are harmful to consumers are; mercury (Hg), lead (Pb), nickel (Ni). Other than these trace metals, there are few other, metals which are an essential part of cosmetics but can be toxic when used in excess amount. Iron (Fe), zinc (Zn), and copper (Cu) are some of those essential metals. The presence of heavy metals in a cosmetic product can be a result of two things. Firstly, it may be a result of poor purification after the extraction of the raw materials. Secondly, it could be done intentionally to require a desirable effect.

1.1.1. Mercury

Mercury, commonly known as quicksilver, can be found in deposits throughout the world. Under room temperature, it is found to be liquid. Mercury salts such as; mercurous oxide and mercurous chloride are forbidden to use in cosmetics because of their harmful effects. Mercury and mercury salts are used for the production of skin-lightening creams. Such products can be destructive if are consumed (Eltegani, Ali, & Y. Hammad, 2013). A study conducted by Murphy et.al showed that the average coefficients of variation of mercury in six face products were 74.4% (Murphy, et al., 2015). The amount of mercury present in these products was discovered to be more than 600 ppm which is when compared to the above sample is abundant. The above-mentioned facts and previous literature on cosmetics depict that, in Pakistan, mercury is the most abundant heavy metal used in the cosmetic industry.

Since the boom of cosmetics, compound mercury has been a major element in the formation of cosmetics. Organic and inorganic mercury are two forms that are used in cosmetics. Inorganic mercury is used in skin lightening products whereas, organic mercury is used in eyeshadows due to its preservative properties (al-Saleh & al-Doush, 1997). However, when the human body is exposed to mercury consistently, it results in serious,

long-term neurological degeneration and kidney complications. Inorganic mercury (ammoniated mercury) gets absorbed by the skin during bleaching resulting in accumulation of the excess amount of mercury which can lead to poisoning. Furthermore, neurotoxicity, weakness, allergic reactions, memory loss, hearing impairments, and death are few or many health hazards associated with mercury (Cain, Disch, Twaroski, Reindl, & Case, 2008).

Application of cosmetics around the mouth and hand-to-mouth can cause the product to enter the oral cavity causing the harmful mercury to enter the body of the consumer. Once the mercury is consumed, the only pathway for the excretion of it is through feces or urination. If the consumption of mercury is continuous and consistent, it starts accumulating in the kidneys with can cause serious kidney problems such as; tubular necrosis and nephrotic syndrome (Chan, 2011). Apart from these physical effects, mercury can source serious harm to the central nervous system (CNS). Although inorganic mercury can hardly pass through the blood-brain barrier, the excess amount of it being present in the bloodstream can increase the chances of its solubility and results in it passing through the barrier (M.G. Volpe, M. Nazzaro, R. Coppola, F. Rapuano, & R.P. Aquino, 2012). The presence of mercury or mercury salts in the central nervous system can cause neurotoxicity. Although the amount of mercury present in bloodstream can become normal in a few days, blood tests or urine test is the primary source of mercury test.

1.1.2. Lead

Lead is a poisonous heavy metal. It is found almost in all parts of our atmosphere. Mostly it is a byproduct of chemical reactions. Most of the lead comes from fossil fuels and is a byproduct during the manufacturing of sulfuric acid, phosphoric acid and pipes (Eltegani, Ali, & Y. Hammad, 2013). A research conducted on lipsticks purchased in Nigeria to find the content of chromium found out that, most of the sample contained lead below the permitted quantity. The highest amount of lead contamination in lipsticks found in Nigeria was 6 ppm (Olalekan, Adedoyin, & Odubo, 2018). According to the research done in this study, the results show that none of the regulations were followed internationally. A study conducted in Khyber Pakhtunkhwa on locally manufactured cosmetics showed that the amount of lead concentration varied from 1.74–1071 ppm (Ulllah , et al., 2013). The highest

amount of lead was recorded in a sample of Surma and the lowest amount of lead contamination was recorded in a locally manufactured face cream (Ulllah , et al., 2013).

Lead can cause serious biological effects on kidneys and brain. Excess amounts of lead in the body can be fatal. If the lead crosses the blood-brain barrier, it can cause damage to neurons affecting their growth. Lead enters the body through breathing, eating or through skin absorption. When mixed in cosmetics and used in the form of cream over the skin, the lead gets absorbed by the skin, the absorption rate can vary from person to person, lipid solubility and on their skin type (M.G. Volpe, M. Nazzaro, R. Coppola, F. Rapuano, & R.P. Aquino, 2012). This is the reason why the lead should be forbidden to use in cosmetics.

1.1.3. Chromium

Chromium is another heavy metal that is almost found everywhere in the environment. It is mostly found in cosmetics and is considered toxic when present in a high amount of concentration. Chromium causes problems to many organs in the body including kidneys, liver and also blood cells. It causes renal and liver failure. The carcinogenicity of chromate dust is considered to be cancerous. In many people, chromium caused allergic reactions. During the last few decades, consumer demand has increased for cosmetic products. It has become a norm, especially in females, to apply cosmetics daily (Safavi, et al., 2019). With excess use, many health conditions have also been reported due to cosmetic use in the last few years. Several reports suggest the toxic effect of chromium and consider chromium a huge factor responsible for liver and blood toxicity, allergic reactions and lung cancer (Maina, Bovenzi, Adami, & Crosera, 2009). Chromium has a strong binding property which makes it easier to absorb into the skin. Sweating and damaged skin enhances the absorption of chromium into the skin.

These metals are harmful to both male and female consumers. It is believed that females in developed countries are more at risk considering their high usage and demand for cosmetics. A study conducted on 150 different types of cosmetic products revealed that eye shadows and face powders (cosmetics with solid filler content) contained a hive amount of chromium contaminations. The eye shadows used for the study contained the amount of chromium up to 15000 ppm which, was 2% of the product (Hepp, Mindak,

Gasper, Thompson, & Barrows , 2014). The comparison of both findings shows that chromium contamination can be as low as 0.30 to highest of 15000 ppm (Hepp, Mindak, Gasper, Thompson, & Barrows , 2014).

The study by Safavi et al., demonstrates the highest level of chromium present in eye shadows found in China, Italy, and the USA were 197.2 ppm and the lowest concentration of chromium in these products was 1.2 ppm (Safavi, et al., 2019). It is suggested that products which require green pigmentation (green eye shadow shimmers) are more concentrated in chromium (Hepp, Mindak, Gasper, Thompson, & Barrows , 2014) whereas, pearly pigments are not contaminated due to black iron oxide present in them (Safavi, et al., 2019).

It is also observed that continuous and consistent exposure to these heavy metals not only causes external problems but, also alters the female hormonal system by acting as endocrine disrupters (Orisakwe & Otaraku, 2013). The toxicity of heavy metals can be degenerative and destructive for the central nervous system. It causes damage to the lungs, livers, kidneys and other vital organs in the consumer's body. Also, heavy metals are considered to be involved in neurological and muscular degeneration under long-term exposer (Eltegani, Ali, & Y. Hammad, 2013).

This study was built on the knowledge that, heavy metals in cosmetics are hazardous to human health and consumers are mostly unaware of the elements used in cosmetics products and their harmful effects. Hence, this study tries to assess the number of heavy metals present in the imported and local cosmetics products. The study also focuses on the consumer's knowledge about the elements used in the cosmetics they are using.

1.2. Objectives of the study

The objectives of the study are to,

(i) To quantify the heavy metals concentrations in the face and body cosmetic powders.
(ii) To evaluate the consumer awareness on cosmetic labels.
(iii) To assess the non-carcinogenic chronic health risk due to exposure to heavy metals in cosmetics.

CHAPTER 2

METHODOLOGY

2.1. Study Area

Samples of cosmetics products for the assessment of heavy metals were taken from the market of Islamabad, Pakistan. Both nationally and internationally manufactured cosmetics were chosen. The samples of Face powders and Talcum powders those were of imported brands were taken from the posh markets of Islamabad and Local brands were taken from the local markets located in sectors of Islamabad, Pakistan. Islamabad is the capital city of Pakistan and is federally administered as part of the Islamabad Capital Territory Latitude and longitude coordinates are 33.738045, 73.084488**.**

2.2. Sampling

The cosmetic products were chosen by randomized sampling. The samples of commonly used cosmetics were chosen and purchased from the local markets of Islamabad, Pakistan. These local markets contain cosmetics from developed/developing countries as well as locally manufactured national companies. In this study, 40 cosmetic samples were used which included both imported and local brands. The sample for the study was consisted of, 10 different locally manufactured brands for each talcum powder and face powders and, 10 different internationally manufactured brands for both talcum powders and face powders, present in the markets of Islamabad.

The chosen products are the most frequently and commonly used cosmetics and almost contains all the local and imported brands available in Islamabad, Pakistan. Each category of cosmetic product (face powder and talcum powder) is consisting of 10 different qualities and price ranges, making it possible to cover many brands. The sample products are shown in the tables below.

Table 1: Imported face powders purchased for the heavy metal assessment.

Brand Name	Coding	Type
Maybelline	FP1	Imported
Essence	FP2	Imported
Sweet Touch	FP3	Imported
Flormar	FP4	Imported
Diana of London	FP5	Imported
Lentheric	FP6	Imported
Queen Collection	FP7	Imported
Rimmel	FP8	Imported
Max Factor	FP9	Imported
Loreal Paris	FP10	Imported

Note. FP=Face Powder

Table 2: The imported talcum powder purchased for the heavy metal assessment.

Brand Name	Coding	Type
Fenjal	Talc 1	Imported
Bhaesaj	Talc 2	Imported
Johnsons Baby	Talc 3	Imported
Romano	Talc 4	Imported
Ponds	Talc 5	Imported
Yardley	Talc 6	Imported
Bela Ann	Talc 7	Imported
Enchanter	Talc 8	Imported
Rasai	Talc 9	Imported
Black Suede	Talc 10	Imported

Note. Talc=Talcum powder

Table 3: The locally manufactured face powders purchased for the heavy metal assessment.

Brand Name	Coding	Type
QIBAO	FP1	Local
Party Queen	FP2	Local
OYLY	FP3	Local
YOFU	FP4	Local
VOGUE	FP5	Local

Brand Name	Coding	Type
Rose Leaf	FP6	Local
Tanako	FP7	Local
Loreal Paris	FP8	Local
Tailaimei	FP9	Local
YAYE	FP10	Local

Table 4: The locally manufactured talcum powders purchased for the assessment of the heavy metal.

Brand Name	Coding	Type
Touch Me	Talc 1	Local
Medicam Valentine	Talc 2	Local
Black Beauty	Talc 3	Local
Viceroy	Talc 4	Local
Blue Diamond	Talc 5	Local
Medora	Talc 6	Local
Black Cat	Talc 7	Local
Charming	Talc 8	Local
Broche	Talc 9	Local
Tibet	Talc 10	Local

2.3. Chemical reagents

Nitric acid, 65%, and per hydroxide 30% was used for the purpose of digestion of samples. Double distilled water was used for the preparation of the solutions. Other than that, the heavy metals (samples) were diluted and concentrated with each required step using standard methods.

2.4. Sample digestion

Acid digestion was used for the analyses of heavy metals present in the sample cosmetics. The apparatus used for the sample digestion were rinsed by using distilled water and later let dry in an oven for half an hour. The apparatuses were rinsed thoroughly to remove the elements that might be present on their surface. An amount of 0.2g of each cosmetic powder was taken with the help of electronic balance. All the samples were then

put separately in a beaker of 100 ml volume and mixed with 4ml of nitric acid (HNO3). The solution was then let to dissolve properly. Once the solution was ready, it was transferred to a hot plate at a temperature of 80 degrees to evaporate the nitric acid and later let cool down. Afterward, the final product was mixed with 30% of H202 and to dissolve properly and kept on the hot plate at a temperature of 80 degrees to oxidize the organic matter of residues. The solution was let to cool down. When the samples were completely cooled down, they again turn into powder forms which were mixed with 15ml of distilled water. The mixture is mixed thoroughly, filtered and stored in plastic bottles to analyze later (Ulllah , et al., 2013).

2.5. Heavy metal analysis

After acid digestion, Atomic Absorption Spectrophotometer (AAS) was used for the analysis of heavy metals containments present in the samples of the face and talcum powder (Ulllah , et al., 2013).

Heavy mental containments are present in cosmetic regardless of the quality of the product. These metals are hazardous for consumers' health and hence a standard amount guideline should be followed (FDA, 2019). The results were compared to the amount of the standard given by the American Food and Drug Association. The standard amount of the heavy metals determined by FDA is,

- Mercury1 ppm
- Chromium 50 ppm
- Lead 20 ppm

2.6. Health risk assessment

The main path of the heavy metals in powders entering the human body is through the oral cavity. However, the amount being consumed may be curial for the wellbeing of the consumers. The continuous exposure of the body to heavy metals causes serious health problems. The dose was calculated using Equation (US Environmental Protection Agency, 1989)

$$ADD = \frac{C \times SA \times AF \times ABS \times EF \times ED}{BW \times AT}$$

where C is the contaminant concentration (mg kg−1), SA is the surface area (24 cm^2) (Bremmer, Prud'homme de Lodder, & van Engelen, 2006), AF is the adherence factor (6.9 mg cm2−1event−1) (Murphy, et al., 2015), ABS is the absorption factor (0.001) (Murphy, et al., 2015), ED is the exposure duration (30 years) (Murphy, et al., 2015), EF is the exposure frequency (730 events year−1) (YB, MP, PA, & N, 2012), BW is the body weight (60 kg), and AT is the average time (10950days).

The recommended value for the dermal adherence factor and absorption factor of skin whiteners in the study of Murphy et al was used in estimating the ADD of exposure to heavy metals (Murphy, et al., 2015). The recommended value for the surface area of eyes was adapted from the study from Bremmer (Bremmer, Prud'homme de Lodder, & van Engelen, 2006). There were no dermal route exposure RFDS or slope factors available; however, the United States Environmental Protection Agency stated that hazardous risks associated with dermal exposure of heavy metals can be evaluated using an oral reference dose slope factor, respectively.

The RfD for mercury is not allowed above 1ppm

The RfD for chromium is 0.003 mg kg−1 day−1.

The RfD for lead is 10ug/g in Canadian regularity limits and is not available from the Integrated Risk Information System (IRIS) (Environmental Protection Agency & Integrated Risk Information System, 2014)

$$HQ = ADD/RfD$$

In the above equation, ADD is the everyday contact amount of metals through absorption (mg/kg/day) and RfD is the reference oral dose. RfD for mercury and chromium is 0.08 µg/kg/day (Environmental Protection Agency & Integrated Risk Information System, 2014) and 0.003 mg/kg/day (Environmental Protection Agency & Integrated Risk Information System, 2014), respectively whereas the RfD for lead is not available from

Integrated Risk Information System (IRIS) the United States Environmental Protection Agency. The RfD indicates the maximum acceptable amount that is not hazardous to consumers. To find the adverse health effects in a person's life, the threshold of RfD value is used. If an RfD value is higher compared to ADD, it is indicated that there would not be any adverse health effects; otherwise, if the RfD value is lower than the ADD, it is likely that the exposure pathway will cause adverse human health effects. HQ < 1 specifies no negative health effects whereas HQ > 1 specifies likely negative health effects (Zakaria & Ho, 2015).

CHAPTER 3

RESULTS AND DISCUSSIONS

3.1. Heavy metal analysis

The cosmetic products used for the study were selected randomly, analyzed and interpreted by AAS. The local products were selected from the local markets of Islamabad and the imported products were selected from some of the branded shops. The total number of products used for the study were 40 (n=40) out of which, 20 were face powders and 20 were talcum powder. The group of each product contained, 10 nationally manufactured products and 10 internationally manufactured products. By paralleling the results with the reported results and the ones with the international standards given some of the values were very high and some of them were low as compared

The descriptive analysis of heavy metals present in both imported and locally manufactured face powders and talcum powders. The total number of samples used for the study is N=40. Each group of cosmetics is further divided into two subgroups depending on the manufacturing. The descriptive analysis given in *table 3.1* shows that, the mean value of chromium in the tested samples is 0.630 ppm, mercury 31.955 ppm and lead is observed to be 7.142 ppm. The minimum value of chromium observed in the samples is 0.4 ppm whereas, the maximum value is 0.63 ppm. Both the values are less compared to the standard value of 50 ppm (FDA, 2019). Mercury is the heavy metal present in high quantity (max=41.24 ppm, min=26.76 ppm). Moreover, lead is recorded as the second most contaminating metal present in the samples, compared to all three with a mean value of 7.142 ppm.

Table 5 shows the mean values, t-values and significance value of heavy metal contamination in imported and local products with respect to standard values set by America Food and Drug association.

Table 5: One sample t-test of heavy metals present in Imported and local cosmetics with the standard values. (N=40)

	Product Type	**N**	**Mean**	**t**	**Sig.**
Chromium	Imported	20	0.455	-7.533	0.000
	Local	20	0.806	-7.533	
Mercury	Imported	20	26.853	-3.125	0.004
	Local	20	37.058	-3.125	
Lead	Imported	20	4.973	-8.891	0.000
	Local	20	9.312	-8.891	

The results show that, the mean difference between imported and locally manufactured cosmetics products, chromium is present more in locally products (0.806 ppm) as compared to imported products (0.455 ppm). The trend continues with both mercury and lead. The contamination of mercury is more in local products (37.058 ppm) as compared to imported products (26.853 ppm). The mean value of lead in local product was observed to be 9.312 ppm whereas, the mean value in imported products is 4.973 ppm.

3.1.1. Chromium in imported face powders

Chromium Oxide Greens is used for pigmentation in hair coloring and cleansing products. The suggested amount of chromium in cosmetics is 50 ppm, determined by the FDA (U.S Food and Drug Association, 2019). It was found that, imported cosmetics were below the concentration. The lowest amount present in imported cosmetics was 0.30 whereas, 0.113 ppm was the lowest amount in locally manufactured products. Moreover, 1.025 ppm was the highest recorded amount of chromium in local products; whereas, 0.685 ppm was the highest in imported brands.

This analysis shows that chromium in imported face powers is used in very low quantities but still present in these products. As these heavy metals can affect if used daily, their amount in cosmetics should be checked strictly and cautiously.

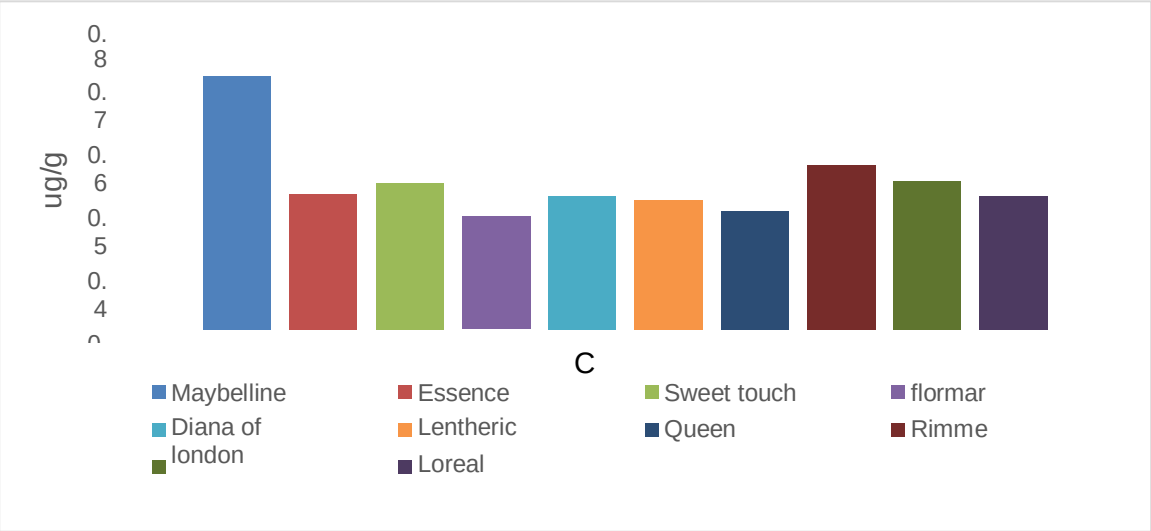

Figure 1: Concentration of chromium in imported face powders.

3.1.2. Chromium contents in local face powders

The internationally permissible limit of Cr in face powders is 50ppm (FDA, 2019). The analyzed results were very low ranging from 0.49 - 1.005 ppm in local face powders. The amount of chromium in both national and international product used for this study were checked and found under the international standards. Furthermore, it is also seen that the

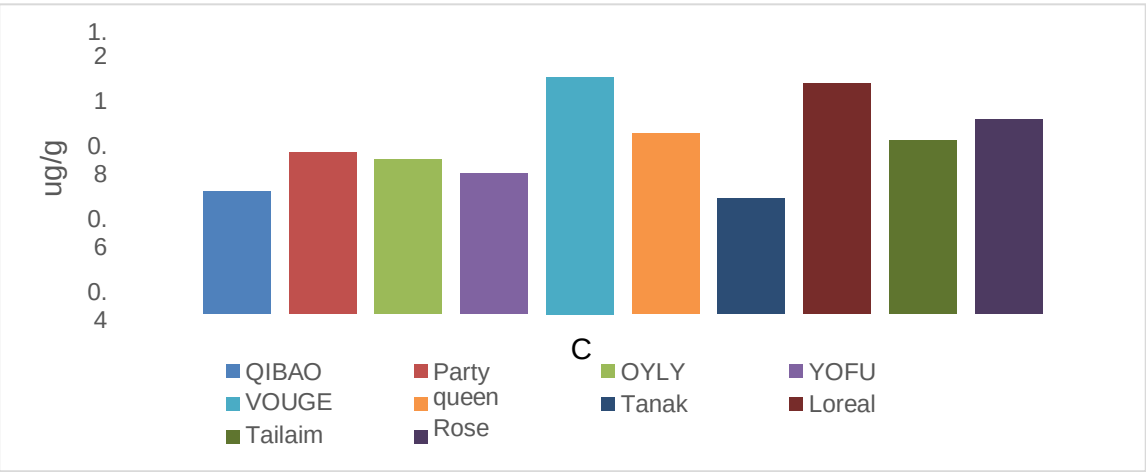

Figure 2: Concentration of chromium local face powder

amount varies among the local products; i.e., 0.52 ppm in QIBAO, 1.005 ppm in VOUGE and 0.975 ppm in Loreal Paris.

3.1.3. Mercury in imported face powders

Mercury as heavy metal is potentially a dangerous metal if used in cosmetics and in some countries, it is banned and, in others, as per regulations, it is not allowed more than 1 ppm. In United States, the maximum amount of mercury that may be present in drugs, foods and cosmetics 1 ppm (FDA, 2019). In Pakistan, there are no such regulations against these heavy metal concentrations so we follow protocols of FDA. The results show a significant amount of mercury present in internationally manufactured face powders. As shown in *figure 3*, the values of mercury are ranging from 18.49-75.2 ppm.

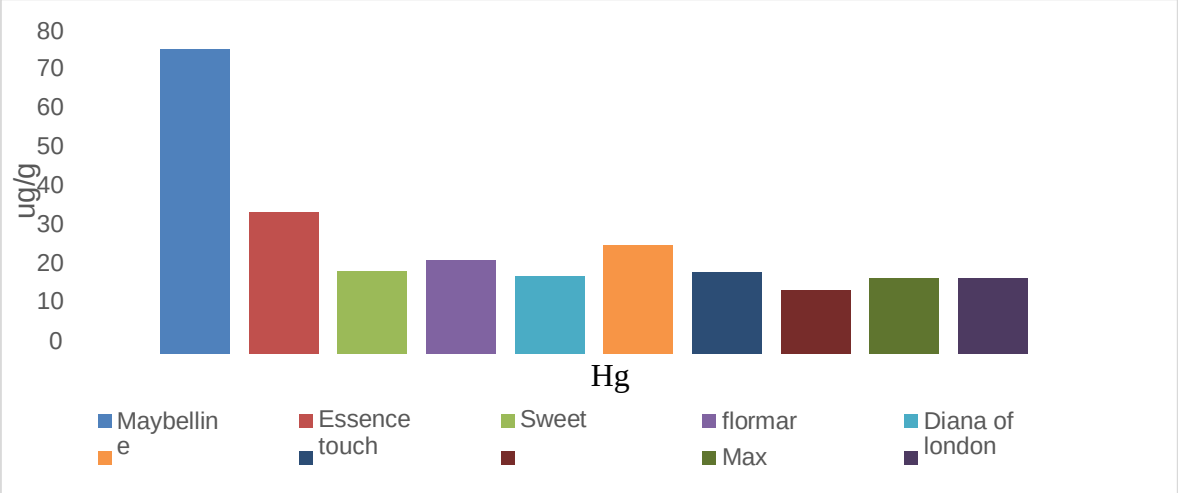

Figure 3: Concentration of mercury in imported face powders

3.1.4. Mercury in local face powders

As shown in the figure 4, all the products contain a heavy amount of mercury present in them as ranging from 26.22-40.97 ppm which is very high as compare to the permissible limit. In comparison to this study, a spectrometric analysis of mercury content present in skin products showed that, 3.3% of these products purchased in United states contain mercury above 1000 ppm (R.Hamann, et al., 2013). Furthermore, out of 549 tested skin lightening products 6 % were contaminated with more than 1000 ppm of mercury and 45% of these

mercury-containing products had an excess contamination of up to 10,000 ppm (R.Hamann, et al., 2013).

The amount of mercury varies highly among different brands of Pakistan ranging from lowest of 26.22 ppm to 40.97. When, compared to the international brands, the amount of mercury is highest in Maybelline: 75.2 ppm. Mercury is considered among the most hazardous heavy metals and must not be present in any food or cosmetic products. The local products manufactured in Pakistan are made under no supervision making consumers prone to health risks.

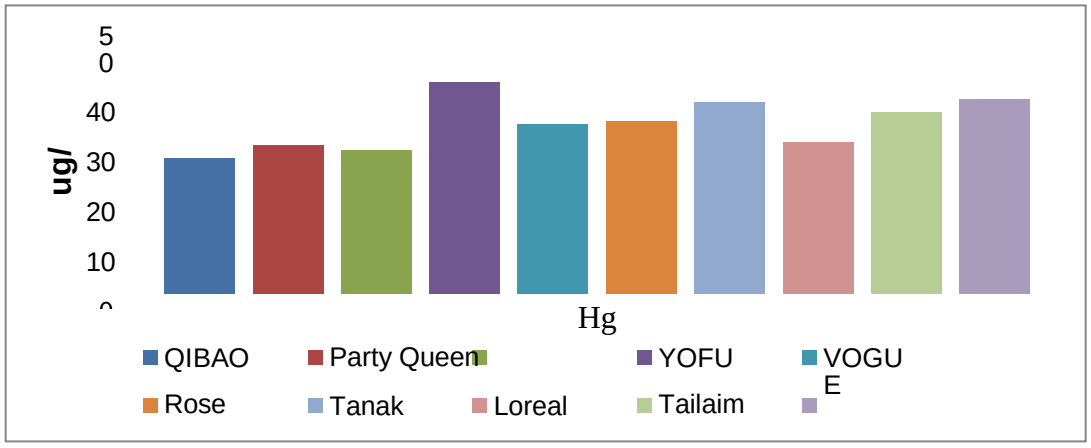

Figure 4: Concentration of mercury in local face powders

3.1.5. Lead in Imported face powder

Lead is found on earth's surface mixed in air, rocks, soil, water and sediments. In cosmetic products, lead is always found as a contamination due to its presence in water, soil and air. It is never used intentionally in any cosmetic products (Olalekan, Adedoyin, & Odubo, 2018). The lead concentration amount in the cosmetics samples tested in this study ranged from <LOQ (below limit of detection) to 2.52 -5.58 ppm in imported face powders. Nevertheless, all the samples confined lead below the limit of international standards. The determined permissible limit for Pb as an impurity in beautifying products is 10 ppm (FDA, 2019), but according to European Parliament Regulation No. 1223/2009, Pb is not permitted as an impurity in any cosmetic.

All these cosmetic products with high contamination of Pb, whether applied once or number of times per day, possibly will lead to human contact to Pb (Łodyga-Chruścińska et al., 2018)

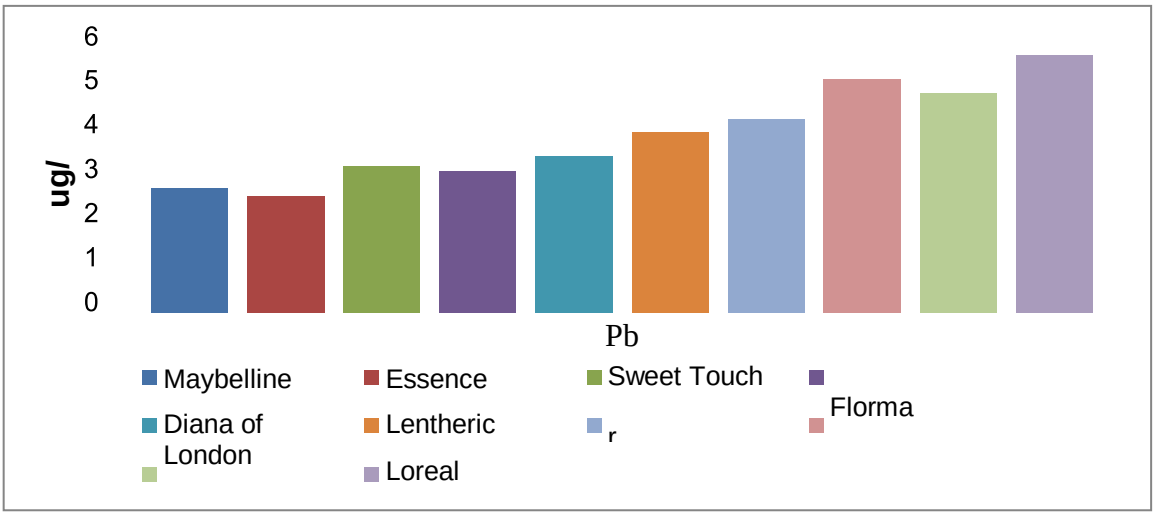

Figure 5: Concentration of lead in imported face powders

3.1.6. Lead in local face powder

Lead acetate is used as a color additive in hair dyes but in very low amount. It is a white crystalline substance and is a byproduct of litharge oxide with acetic acid (Hepp, Mindak, Gasper, Thompson, & Barrows , 2014) The highest value lead in rose leaf, a local product which is manufactured locally by unauthorized companies in Pakistan, contains 9.05 ppm. As per European regulations lead is not allowed at all and as per US EPA, it should not exceed more than 10 ppm (FDA, 2019). When compared with imported products, the amount of lead in locally manufactured cosmetics is high indicating, the authorities are not very cautious about health-hazardous that can be faced by people due to consuming these products (Ulllah , et al., 2013).

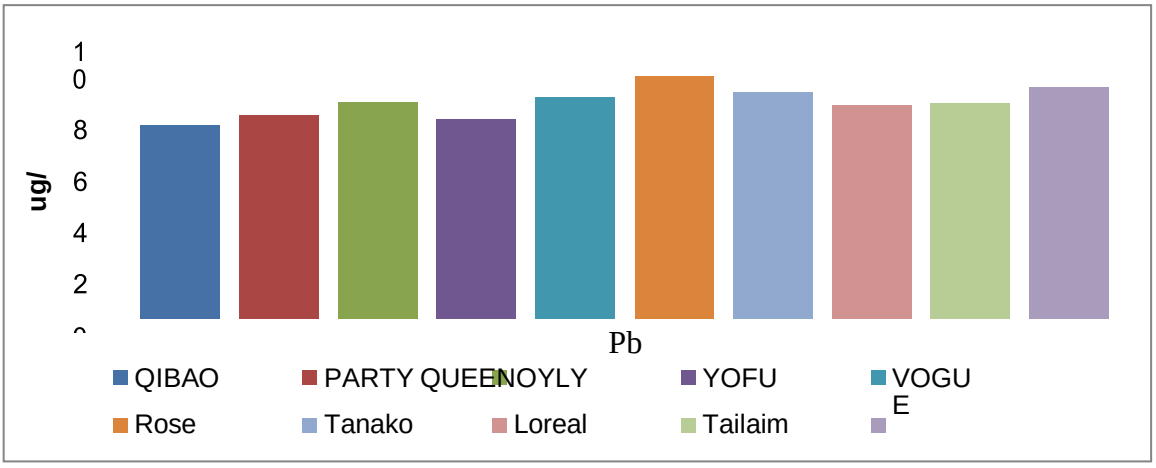

Figure 6:Concentration of lead in local face powders

3.1.7. Chromium in imported talcum powder

Talc is found in the form of minerals and is highly contaminated with heavy metals. It has physicochemical properties such as softness, good gloss, heat removal, lubrication, moisture permeability and used in the manufacture of cosmetic products. (Wang, Lin, Lin, & Yuan, 2018)Chromium concentrations present in these products are very low ranging from 0.34 – 0.65 ppm which by the regulations is not hazardous. According to American regulations by Food and Drug, the maximum amount of trace chromium that can be present in cosmetics is 50 ppm (FDA, 2019). Any amount exceeding this quantity is hazardous for human health and cause serious health issues. The highest amount of chromium present in imported talcum powder was recorded as 0.65 ppm whereas, the lowest recorded was 0.3ppm.

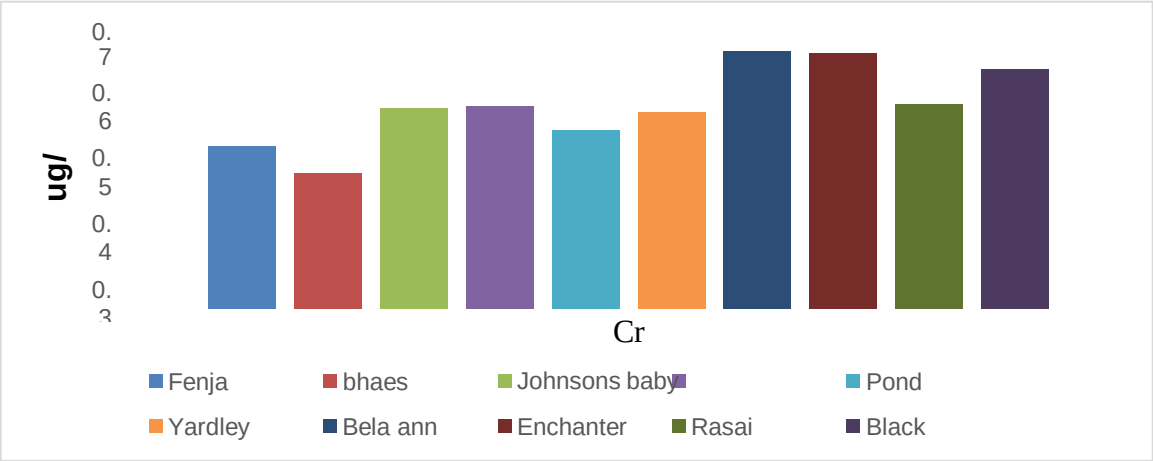

Figure 7: Concentration of chromium in imported talcum powders

3.1.8. Chromium in local talcum powder

Ranging from 0.113 – 1.025 ppm, local talcum powder manufacturers do not add excessive amount of chromium in these unbranded products which, are not manufactured under proper rules and regulations. As the standard amount for chromium is 50 ppm (FDA, 2019), and 1.025 ppm is less comparatively but it is fairly high when compared to imported talcum products (0.65 ppm). Another study conducted in Khyber Pakhtunkha showed that, the amount of chromium present in locally manufactured cosmetics ranged to 0.774 ppm

(Ulllah , et al., 2013). Though the amount is less, it is still present in all the products which cannot be ignored considering the health hazards that it can cause.

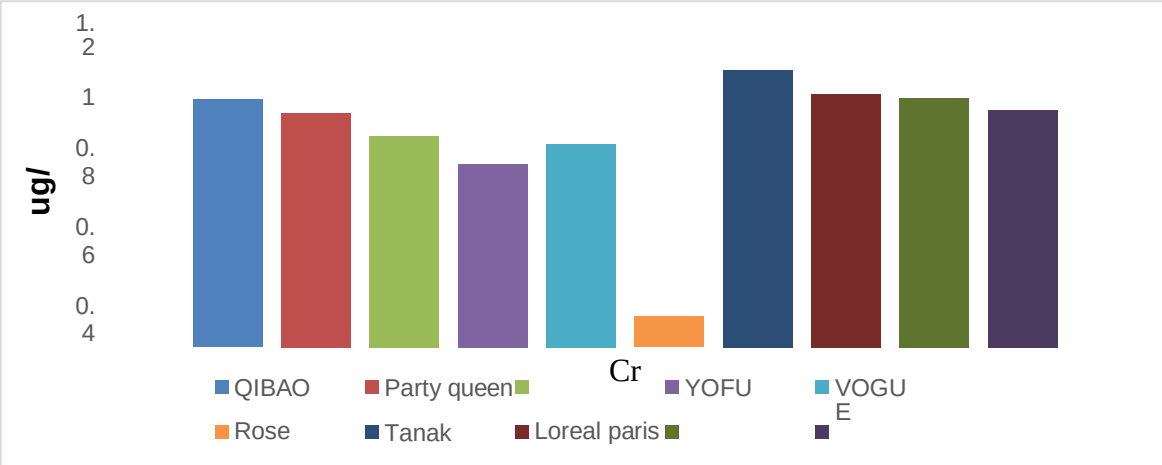

Figure 8: Concentration of chromium in local talcum powders

3.1.9. Mercury in imported talcum powder

Mercury is also one of the dangerous heavy metals present in the environment. The usage of mercury in cosmetics is prohibited by many health regulations and authorities all over the world in both developed and developing countries (U.S Food and Drug Association, 2019). Talc, also known as living stone, is a major raw material used in the manufacture of many face and body products. It is made up of hydrated magnesium silicate, □2□□3(□□□3)4 and found as a carbonate minerals such as calcite, magnesite, chlorite, etc. (Taylor & Francis, 2011)

The imported samples contained the amount of mercury up to 75.2 ppm and 19.1 ppm as, the minimalist amount. Levels of mercury in talcum powders are also in exceeding limits ranging from 19.1 – 39.80 ppm. When compared with previous literature, out of 581 face creams 41% in 2015 and 16% in 2011 where contaminated with mercury (Murphy, et al., 2015). The highest amount found in 2015 was 6,305 µg/g and whereas in 2011 the amount was found to be 35,000 µg/g (Murphy, et al., 2015). These products are imported and belong to well-known companies. Mercury should not exceed 0.001 ppm and in some countries with strict rules and regulations, it should not be present as it can cause different kinds of cancer in the human body (M.G. Volpe, M. Nazzaro, R. Coppola, F. Rapuano, & R.P. Aquino,

2012).

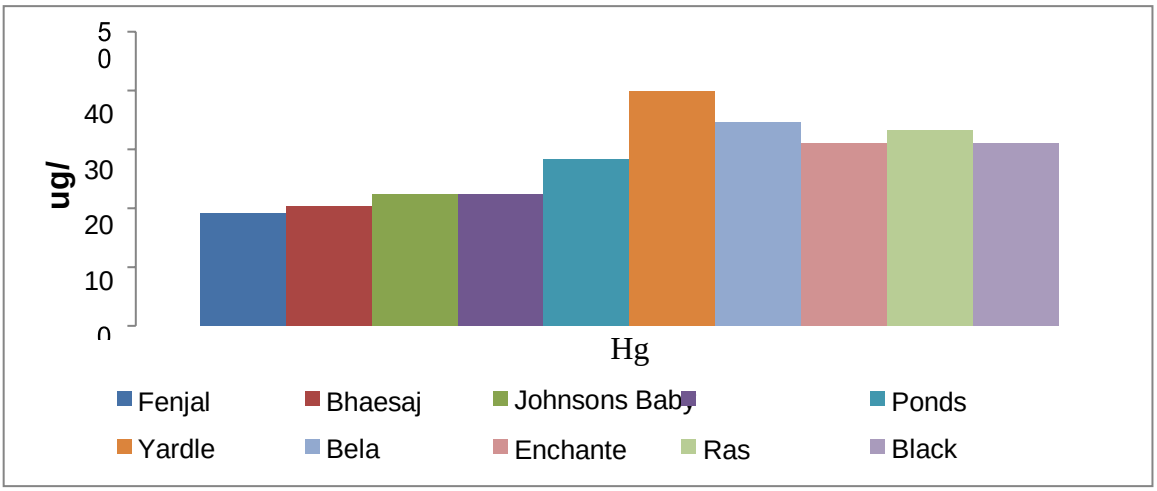

Figure 9: Concentration of mercury in imported talcum powders

3.1.10. Mercury in local talcum powder:

Mercury is found in two forms; organic and inorganic. Due to it melanin suppression properties, iodide and ammoniated mercuric chloride are usually used in skin lightening products. On the other hand, phenyl mercuric salts and thiomersal salts are the only organic mercury are only allowed to use as a preservative (Murphy, et al., 2015).All the products were detected with high concentrations of mercury ranging from 35.29 – 48.5 ppm. Whereas a study conducted on 549 skin lightening products showed, 6.0% of these samples contain mercury above 1000 ppm (R.Hamann, et al., 2013), 45% of mercury contaminated products contain above than 10,000 ppm (R.Hamann, et al., 2013).

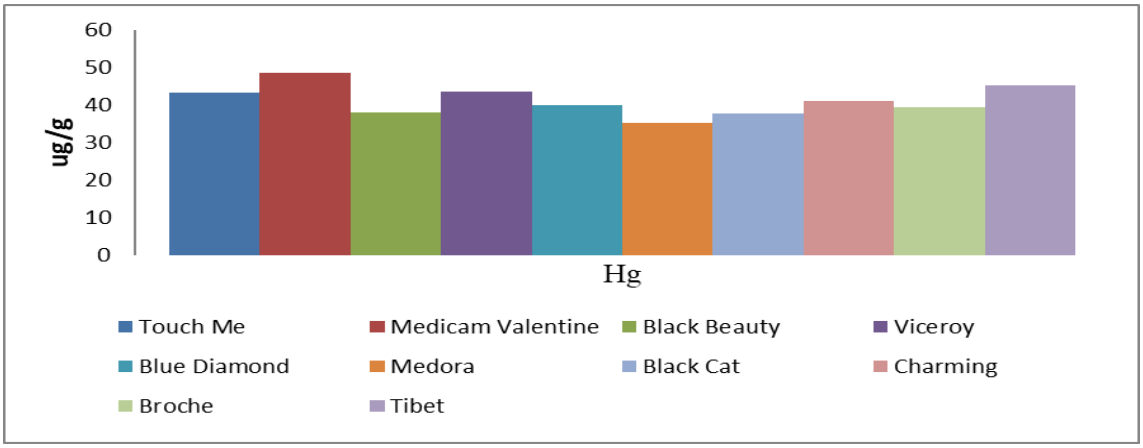

Figure 10: Concentration of mercury in local talcum powders

As compared to these studies, although the samples used in this study contains comparatively less mercury but it still exceeds the permissible amount set by regulations. The maximum amount of mercury that can be present in any cosmetic product, determined by the American authorities is 1ppm (FDA, 2019). These products are manufactured under no proper rules and regulations. Hence the high concentration shows us that these products can be dangerous to use on a daily basis.

3.1.11. Lead in imported talcum powder

Analysis of lead showed that, lead is present in all samples in minor amounts from 5.17 – 6.62 ppm. In other studies, the highest amount of lead contamination in lipsticks found in Nigeria was 6 ppm (Olalekan, Adedoyin, & Odubo, 2018) where the highest in Khyber Pakhtunkha on local manufactured cosmetics was found to be1071 ppm (Ulllah , et al., 2013). The amount of lead contamination in this study is less than the standard limit determined by the American Association of Food and Drugs, which is 10 ppm (FDA, 2019). When looked at the amount of lead in the sample products, it is seen that all the talcum powder samples contain lead more than 5 ppm.

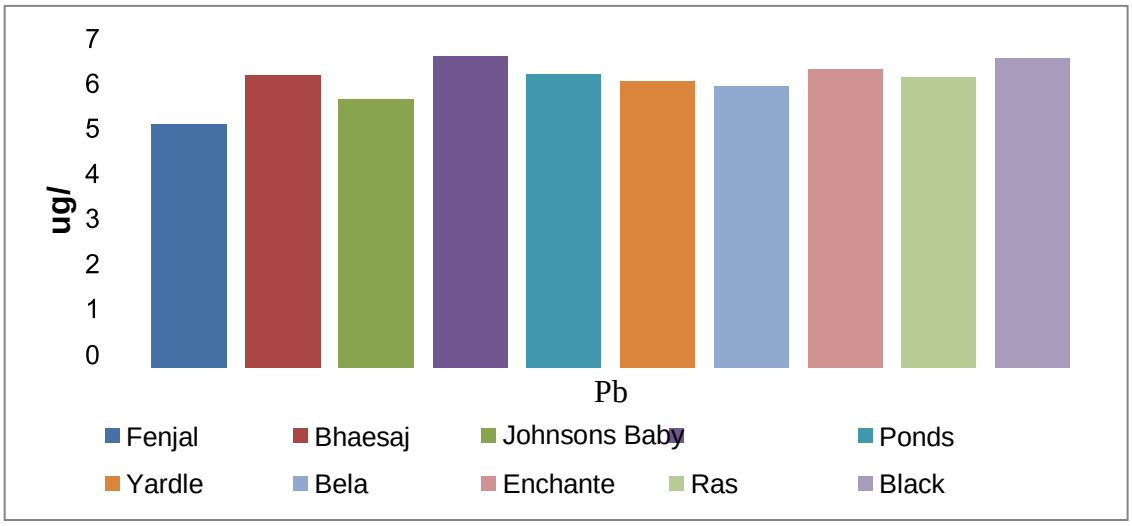

Figure 11: Concentration of lead in imported talcum powders

3.1.12. Lead in local talcum powder

As we can see in the below figure, the products MEDICAM valentine and charming show us a relatively high amount of lead present in these two, i.e.; products 14.02 ppm and 12.23 ppm. Faruruwa and Stephen (2014), conducted a study on talcum powder and recorded significant amount of lead ranging from 15-20 ppm (Faruruwa & Bartholomew, 2014). Orisakew and Otaraku (2013), worked on 7 different brands of face cosmetics and recorded low concentration of lead and cadmium in comparison to other metals investigated (Orisakwe & Otaraku, 2013)

Although all the products contain near to the permissible limits of international standards which is 10ppm (FDA, 2019) but, it is still high and dangerous for the consumer's health. Five out of 10 local products exceed the permissible limit of lead which shows that the local cosmetics manufactured in Pakistan are not reliable and can be very harmful when it comes to the containment of heavy metals in it.

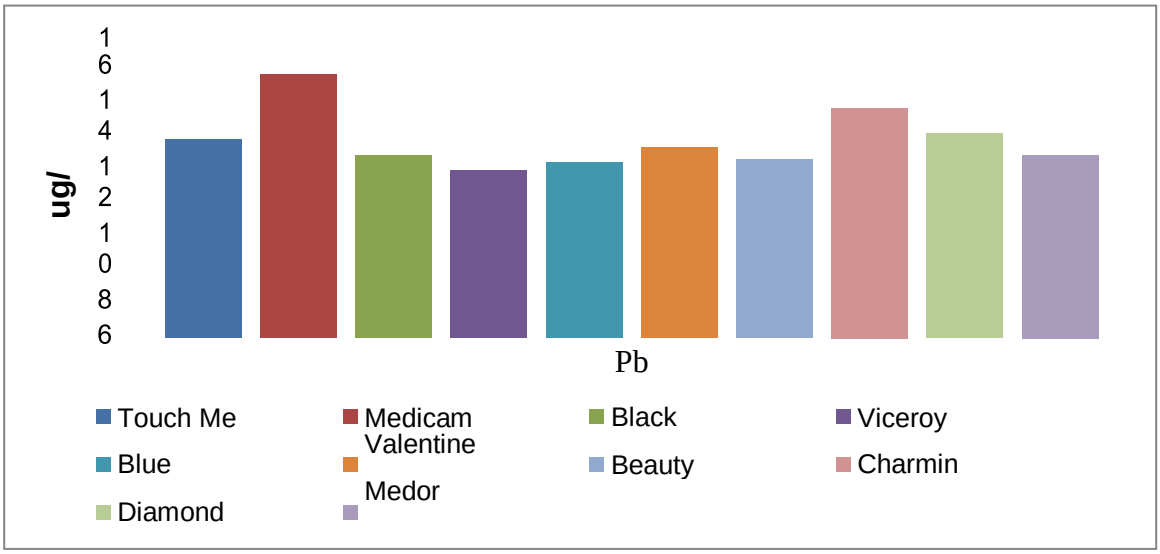

Figure 12: Concentration of lead in local talcum powders

When the samples of local products are compared to imported products, it is seen that all the internationally manufactured brands are considering the standard limits of lead and the containment of lead is less than 10 ppm. Whereas, as compared to the imported brands, local products contain a very much higher amount of lead in it.

3.2. Consumer awareness survey

The study was conducted among randomly selected individuals from the Islamabad city through convenience/random sampling. The participants were interviewed individually, using a structured questionnaire. The whole study was conducted from December to March 2019. Results show that most of them rely on brand names to buy a product and they do not even know what health hazards are associated with it.

Before giving the questionnaires, the participants were briefed about the questionnaire and its importance which enhanced their interest and also helped in generating awareness.

The first part of the questionnaire was about the demographic information of the respondent. The questionnaire contained questions such as "what do you see when buying a cosmetic product?" and "what kind of product do you buy?" The purpose of the survey was to see what type of products consumers prefer and how aware are they about the chemicals being used in the product. The questionnaire also contained suggestive questions regarding the labeling on the product. A survey method was used to determine whether cosmetic labeling and the level of awareness are noticed by Pakistani consumers while shopping. For this purpose, SPSS was used.

Table 6: Demographic information of the respondent

Type	Category	Result
Age	15-35	89%
	35-65	11%
Gender	Male	20%
	Female	80%
	Primary	0%
Education	Secondary	4%
	Under-graduate	46%
	Graduate	50%
Income	20-50 thousand	66%
	50-80 thousand	22%
	100 thousand +	11%
Marital status	Single	75%
	Married	25%

The results of the survey show that, while buying cosmetic products, consumers mostly look at the labels (14.4%), cost (14.2%), expiry (14.6%) and directions (12.6%). This implies that consumers are more concerned about how much the product will cost them rather than what types of metals are present in the product.

Table 7: Current Consumers' product purchase behavior

	Labels on product	**Percentage**
Labels that consumer reads	Labels	14.4%
	Content	7.2%
	Cost	14.2%
	Warning	9.0%
	Content	4.5%
	Expiry date	14.6%
	Chemical composition	2.5%
	Directions	12.6%
	Cautions	5.6%
	Metals	.9%
	Health risks	11.2%
	Consult doctor	3.4%
Total		100.0%

Only 0.9% of the consumers look at the materials that have been used for the preparation of the cosmetic product. The results also show that only 11.2% of the buyers consider the health risks associated with cosmetics which is very less. 91% of the people do not look at the warnings that are written on the products and 96.6 % of people do not consult the advice of the dermatologist/physician before applying the products. It is concluded from the results of the survey that, people in Islamabad are not very aware of the composition of cosmetics and they do not consider the health risks that are associated with the usage of the heavy metal contaminated cosmetics.

When survey about what kind of labels does the consumers thinks should be present on the labels of the cosmetic product, it was found out that, 9.9% of the consumers think the details of heavy metals present in the cosmetic should be written over the product. Moreover,

the presence of minerals and the net quantity of the products was also equally suggested (9.4%).

Table 8: Consumers' desired on label content on cosmetic items

	Labels on product	**Percentage**
Labels should contain	Expiry date	2.8%
	Nutrient content	9.0%
	Ingredients	6.1%
	Mineral content	9.4%
	Manufacture	5.3%
	Drug facts	7.7%
	Usage	7.2%
	Heavy metals	9.9%
	Active ingredients	7.1%
	Directions	6.6%
	Warning	5.6%
	Allergies	7.9%
	Organic/synthetic	6.0%
	Net quantity	9.4%
Total		100.0%

The results show that, even if the number of responses is high on heavy metals, but the number of people suggesting is low. Out of 109 participants, 64 of the participants are aware of the importance of the composition of the product. Only 2.8% of people think that the label should contain the expiry dates over it. People in Islamabad are not well aware of the hazardous effects of heavy metals and their contamination in cosmetics.

3.3. Health risk assessment

The danger of consumption of metal-contaminated powders to human health was categorized by Hazard Quotient (HQ). This is a ratio of determined dose to the reference dose (RD). The population will pose no risk if f the ratio is less than 1 and if the ratio is equal or greater than 1 then the population will experience health risk.

When the HQ of chromium was determined to see if the products can cause health issues or not. The value of HQ for chromium must be under 1 to ensure that the product is safe and does not cause any health issues

Table 9: Hazard quotient (HQ) values for imported and local brands for face powders.

Face powders Imported		**Face powders Local**	
Products	**HQ for chromium**	**Products**	**HQ for chromium**
Maybelline	1	QIBAO	0.6
Essence	0.6	Party queen	1
Sweet touch	0.7	OYLY	1
Flormar	0.3	YOFU	1
Diana of London	0.6	VOGUE	1.8
Lentheric	0.6	Rose leaf	1.4
Queen collection	0.3	Tanako	0.6
Rimmel	0.6	Loreal Paris	1.6
Max factor	0.6	Tailaimei	1.3
Loreal Paris	0.3	YAYE	1.3

HQ < 1 is nonhazardous and HQ > 1 is hazardous (Lim, Ho, & Hamsan, 2017)

Table 10: Hazard quotient (HQ) values for imported and local brands for talcum powders

Talcum powders Imported		**Talcum powders Local**	
Products	**HQ for chromium**	**Products**	**HQ for chromium**
Fenjal	1.6	Touchme VIP	1.6
Bhaesaj	0.3	MEDICAM valentine	1.5
Johnsons baby	1	Black beauty	1.4
Romano	0.6	Viceroy	1.2
Ponds	0.6	Blue diamond	1.3
Yardley	0.6	Medora	2.0
Bela Ann	1	Black cat	1.8
Enchanter	1	Charming	1.7
Rasai	0.6	Broche	1.6
Black suede	1	Tibet	1.6

HQ < 1 is nonhazardous and HQ > 1 is hazardous (Lim, Ho, & Hamsan, 2017)

When the HQ of imported and local face powder was found out, only 1 imported face powder has an HQ of 1. Whereas, eight out of ten locally manufactured face powders had HQ value equal and higher than 1. It shows that eight locally manufactured and 1 imported face powder is hazardous to health. These products, when exposed to the human body can cause serious damage to organs and deteriorate the functions of the muscles

The HQ of chromium in imported and local talcum powders was determined. It can be seen in the above table that, five out of ten imported talcum powders have an HQ of higher than 1. Whereas, all of the samples of local talcum powder have a hazard quotient value of more than 1. These findings indicate that all of the locally manufactured talcum powder is risky and will cause serious health issues when are exposed to the body.

CONCLUSIONS

The results showed that Cr, Hg, and Pb were present in all the samples and most of the samples contained the levels beyond the limits set by the American food and drug association and European regulations.

The mean concentration of mercury and lead in imported and local cosmetic products was found above the permissible limit of the American Food and Drug Association (FDA). Similarly, the amount of chromium is noticeable in these products but, it was found to be present below the permissible level determined by the FDA. Although the amount of chromium was low than the prohibited level, this does not mean that this is not harmful to the health of consumers

The value of HQ for chromium was detected to be above 1 in all local talcum powders indicating health risks from the application of these cosmetic products. Similarly, the HQ value for chromium in half of the imported local face powder was detected to be above 1 indicating their consumption, which arises to human health.

The consumer awareness survey concluded that the majority of people in Islamabad are more concerned about how much the product will cost them rather than the composition of the product. Furthermore, people in Islamabad are not well aware of the health risks associated with the heavy metals present in cosmetic products they use.

RECOMMENDATIONS

1. For effective control and precautions, PCMA (Pakistan Cosmetic Manufacturers and other concerned authorities must shape their own rules and regulations regarding the use of hazardous metals and chemicals in cosmetic manufacturing. Furthermore, the regulatory authorities should make sure the rules are being followed by respective industries.
2. In order to reduce the health risks associated with heavy metals used in cosmetics, the manufacturing industries should use less harmful substitutes. The authorities must ensure safe and harmless cosmetics for Pakistani citizens.
3. For awareness among citizens regarding heavy metals and chemicals used in cosmetic products, the responsible authorities must ensure descriptive details on the packaging of the product. The packaging must highlight the hazardous chemicals used and the associated health risks; which, may cause due to the usage of the product.
4. Further research on contaminant source identification may add value to the primary effort of this undertaken work.

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ASSESSMENT OF HEAVY METALS IN COSMETIC POWDERS AND AWARENESS OF CONSUMER ON PRODUCT LABELS IN ISLAMABAD PAKISTAN

ORIGINALITY REPORT

11%	6%	10%	8%
SIMILARITY INDEX	INTERNET SOURCES	PUBLICATIONS	STUDENT PAPERS

PRIMARY SOURCES

1	**Airin Zakaria, Yu Bin Ho. "Heavy metals contamination in lipsticks and their associated health risks to lipstick consumers", Regulatory Toxicology and Pharmacology, 2015** Publication	Publication
2	www.mdpi.com Internet Source	
3	contaminantsreviews.com Internet Source	
4	Submitted to Universiti Teknologi MARA Student Paper	
5	banglajol.info Internet Source	
6	Jun Wu, Dongping Duan, Jian Lu, Yongming Luo, Xiaohu Wen, Xiaoying Guo, Brian J. Boman. "Inorganic pollution around the Qinghai-Tibet Plateau: An overview of the current observations", Science of The Total Environment, 2016	

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ANNEXURE

Questionnaire

Questionnaire survey
Earth and Environmental sciences
OMAR AFZAL KHAN
MS-EPM 3

Part 1

Name

Age	15-35	35-65
Gender	Male	Female

Education	Primary	Secondary	Tertiary	Graduated
Income/pocket money per month	20-50 thousand	50-80 thousand	100 thousand and plus	
Willing to pay on cosmetics	500 -1000 Rs	1000-3000 Rs	3000-7000 Rs (And above)	
Marital status	Married	Single		
No of children (if married)	1-2	2-4	4-6	6-8

Part 2

What kind of products you buy	**Imported**	**Local**	
What do see when buying a product (tick)	Labels	Active Ingredients	Cost
	Warning	Minerals	Expiry
	Oxides	Directions	Do not use
	Metals	Health risks	Consult doctor first

Do you apply face powders daily?	Yes	No
Do you apply talcum powders daily	Yes	No
Do you clean your skin before applying powder	Yes	No
Have you ever had allergic reaction	Yes	No
Have you ever purchased a local product	Yes	No

Part 3

What kind of labels should be present on cosmetics?	**Expiry**	**Nutrients**	**Ingredients**	**Minerals**
	Made in metals	**Drug facts**	**Usage**	**Heavy**
	Active Ingredients		**Directions**	**Warning**
	Hypoallergic		**Organic**	**Net Quantity**

Do you check labels while buying	Yes	No

Do you consider only brand name while buying	**Yes**	**No**

Health effect labelling while buying a product	Yes	No