Determination of Amount of Mercury in Some Selected Skin-Lightening Creams Sold in the Ghanaian Market

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***Abstract*: In this study, fifty (50) samples of skin-lightening creams were analyzed for total mercury by Cold Vapour Atomic Absorption Spectrophometry using an automatic mercury analyzer. The concentration of mercury in the creams ranged from 0.001 to 0.549 µg/g. All creams sampled for mercury had concentrations less than the US Food and Drugs Administration's acceptable limit of 1 µg/g. The low amounts of mercury detected in the samples analyzed do not pose any potential risk to consumers of these skin-lightening creams.**

Keywords— Mercury, skin- lightening, automatic mercury analyzer, creams, Food and Drug Board, High liquid Performance Chromatography.

I. INTRODUCTION

Many Ghanaian women love to keep their skin toned and beautiful but unfortunately most of them end up indulging in skin care products that bleach the skin and eventually pose potential risk to their health. Most of these bleaching products contain different kinds of chemicals that may be harmful and affect the health of the women. Examples of chemicals in these products include mercury, hydroquinone, Kojic acid, Kojic acid dipalmitate, Azleic acid, Arbutin, Bearberry, Vitamin C, Magnesium ascorbyl phosphate, Calcium ascorbate, and L-ascorbic acid. The most commonly used skin-lightening agents are known to contain mercury. The skin colour of the individual or people is determined by the amount of melanin produced. Looking at the five hundred years of human history, humans have constantly labeled and stereotyped each other on the basis of skin colour. In most African and Asian communities, fairness is branded as beauty, grace and high social status. The darker skin is seen as being of lowest social value whereas the lighter skin is regarded as being of highest social value. This perception encourages most women to indulge in skin care products that lighten the skin.

Studies have shown that the percentages of women using such products regularly in Senegal, Mali, Togo, South Africa and Nigeria are 27%, 25%, 59%, 35%, 77%, respectively (UNEP, 2008). Many women use these products for long periods, sometimes for as long as 20 years.

Mercury is a very toxic element but its uses have been found in many areas including use for religious, cultural and ritualistic purposes. Mercury has also been used in some traditional medicines (such as certain Traditional Asian remedies), as a preservative in some vaccines, pharmaceuticals, skin-lightening creams, paints, jewelry and soaps (Cole et al.1930; Turk and Baker, 1968). The application of mercurial preparations to the skin has been practiced for centuries. (Cole et al. 1930; Turk and Baker, 1968). Mercury is a highly volatile element with a long atmospheric half-life. As result of these physical properties, it is ubiquitous in the environment and exposure is not an isolated concern but rather a global threat to human health. In recent years, research has revealed that even frequent exposure to very low concentrations of mercury has the ability to cause long-lasting neurological and kidney impairment (Hudson et al. 1985, Zalups et al. 2000). Human health risks from mercury exposure have been widely documented, and include neurological effects, impaired fetal and infant growth, and possible contributions to cardiovascular disease (Grandjeanet al. 2005, Mergler et al. 2007, Karagas et al. 2012).

Mercury-based bleaching creams contain ammoniated mercury as a bleaching agent. Some of These creams may contain up to more than 2.5% mercury which can be harmful to our health, thus resulting in mercury poisoning, especially chronic mercury poisoning may be resulted. Mercury use in cosmetic products can have adverse effects including skin rashes like dermatitis and acne venenata, discolouring and scarring like post inflammatory dyschromia and can reduce skin's resistance to bacterial and mycotic skin disorders (Weldon et al 2000 and Soo et al 2003).

Direct and prolonged exposure through the skin during repeated applications can cause damage to the brain, nervous system and kidneys.

Cosmetics preparations containing Mercury has been in existence for many years as skin bleaching agents (Al-Saleh and Al-Doush, 1997). Toning creams containing mercury in the form of inorganic mercury are mainly used by dark skinned people mostly in developing countries notably in Africa and Asia to lighten their skin tone. This has been reported to be probably due to the inhibition of the production of the skin pigment known as melanin, resulting in a lighter skin tone. (Marzulli and Brown, 1972; Barr et al., 1973; Bourgeois et al., 1986; Katzung, 1995). Bleaching preparations containing

Mercury have resulted in the accumulation of mercury in the body after absorption through the skin especially in the kidney where it is mainly accumulated in the tubular region, giving rise to the occurrence of severe reactions (Marzulli and Brown, 1972; Barr et al., 1973; Berlin, 1979; Bourgeois et al., 1986). The United States Food and Drugs Administration (US FDA) in 1992 established the maximum acceptable limit of mercury in cosmetics to be 1 µg g-1. A clinical investigation of Kenyan women with damaged kidneys revealed that they suffered from a higher incidence of nephritic syndrome, which was attributed to the use of creams containing mercury (Barr et al., 1973).

In Ghana little work has been undertaken to determine the levels of mercury in toning creams (Voegborlo et al., 2008) even though concerns have been expressed about the wide spread of the negative effect of the skin lightening creams on the skin.

Mercury has acute and chronic side effects. The Ghana Standards Authority allows a maximum of 1µgg^{-1} for mercury. Despite the side effects of mercury, skin lightening creams containing these harmful chemicals are still sold to the public by retailers and dealers.

Considering the toxic effect of mercury, it is important to control their exposure to humans. This can only be achieved if their levels in skin lightening creams are known.

The objectives of this research is to determine levels of mercury in some selected skin lightening creams sold on the Ghanaian market and compare levels with standards and to determine if Ghanaian women are at risk.

II. MATERIALS AND METHODS

Fifty bleaching creams were obtained randomly from cosmetic shops in the city of Kumasi and Accra. Automatic Mercury Analyzer Model HG-5000 (Sanso Seisakusho Co., Ltd, Japan), equipped with mercury lamp operated at a wavelength of 253.7nm was used for mercury determination. The signals were obtained on a computer.

Digestion apparatus was thick walled long neck 50ml volumetric flask and a Clifton hot plate with a temperature range of 150-350^{0}C. Mercury standard solution (1000 mg/L) was prepared by dissolving 0.0677g of $HgCl_2$ in the acid mixture HNO_3:H_2SO_4:$HClO_4$, (2:10:2) in a 50ml digestion flask with heating on a hot plate at temperature of 200^{0}C for 30 minutes. The clear solution was cooled and diluted to 50ml with water. Blank solutions were also prepared alongside and bulked together for use as diluents. The working solutions were freshly prepared by diluting an appropriate aliquot of the stock solution through intermediate solutions using blank solution. Stannous chloride solution (10% v/v) was prepared by dissolving 10g of the salt in 100ml of 1M HCl. The solution was aerated with nitrogen gas at 50ml per minute for 30 minutes to expel any elemental mercury from it.

A. Digestion of Samples for Mercury Analysis

Fifty skin-lightening creams samples were obtained from local markets in the city of Accra and Kumasi. The samples were digested for total mercury determination by a modified version of an open flask procedure developed at the National Institute for Minamata Disease (NIMD) Japan (Akagi and Nishimura, 1991). Approximately 0.5g of each cream was weighed accurately into a 50ml volumetric digestion flask and 1ml of deionized water was added. A 5ml mixture of nitric acid and perchloric acid (1:1) was added and swirled. The mixture was heated at 200^{0}C for 30 minutes to obtain a clear solution.

The solution was allowed to cool and made up to volume with double distilled water. A blank and standard solution digest using 0,25, 50 and 100µl of 1µg ml^{-1} standard Hg solution were subjected to the same treatment. The concentrations of the standard solution digest obtained were 0.5,1 and 2µg ml^{-1}.

The accuracy and precision of the method were determined by analysis of procedural blanks and calibrations standards, triplicate sub-samples, spiked sub-samples and analysis of certified reference materials from the National Research Council of Canada.

B. Determination of Mercury

Determination of mercury in all the digests were carried out by cold vapour atomic absorption spectrophotometry using an Automatic Mercury Analyzer Model HG-5000 (Sanso Seisakusho Co., Ltd, Japan) developed at National Institute for Minamata Disease (NIMD) in Japan. The analyzer consist of an air circulation pump, a reaction vessel, Tin(II) chloride dispenser, an acidic gas trap and a four wave stock-cock with tygon tubes to which is attached a ball valve. The operations of the ball valve and the air circulation pump are controlled by a microprocessor. During the determination a known volume of the sample solution normally 5ml is introduced into the reaction vessel using a micropipette (1-5ml). The reaction vessel is immediately stoppered tightly and 0.5ml of 10% (w/v) tin (II) chloride in 1M HCl was added from a dispenser for the reduction reaction. During this time, air is circulated through the four–way stop-cock to allow the mercury vapour to come to equilibrium and the acidic gases produced by the reaction also swept into the sodium hydroxide solution. After 30sec the four-way stop-cock is rotated through 90^0 and the mercury vapour is swept into the absorption cell. Peak heights were analyzed and used for computations.

C. Apparatus and Equipment

All glassware used were soaked in detergent solution overnight; rinsed and soaked in 10 % (v/v) HNO_3 overnight. They were rinsed with distilled water followed by 0.5 % (w/v) $KMnO_4$ and finally rinsed with distilled water before used. Reversed-phase High performance liquid chromatography was performed at ambient temperatures using a Spectrophysics SP800 solvent delivery system and a Shimadzu SPD-MIA diode-array UV spectrophotometric detector. The analytical column used was stainless steel, 5µm supelco LC-18-DB, 6×250mm. The sample injection volume was 50µl. The mobile phase was methanol and water (10+90 v/v) pumped at a flow-rate of 1.0 ml per minute. The UV detector was operated at 226 nm with a sensitivity of 0.50. A chart speed of 5 mm min-1 was used to record peaks.

D. Reagents

All reagents were of analytical reagent grade (BDH Chemicals Ltd, Poole, England) unless otherwise stated. Double distilled water was used for the preparation of all solutions.

E. Recovery studies

The recovery study was determined by analyzing two samples and adding increasing concentration of mercury. Analytical and matrix recovery studies were performed by spiking samples with 25 and 50µl of 1 µg ml^{-1} standard hg solution. Analytical and matrix spike recoveries of the procedure yielded results between 97% and 104% with coefficient of variation between 4% and 9%. Recoveries was performed by weighing two samples separately and a known amount of standard solution was added and analyzed .Amount present summed with amount obtained gave the percentage recoveries which was within the range of (96-106) %.

III. RESULTS AND DISCUSSION

Table 1. The results for recovery of mercury

Sample	Weight (g)	Amt present (g)	Amt added (g)	Amt Obtained (g)	Amt Recovered(g)	% Recovered
Zarina cream	0.57	0.15	0.47	0.49	0.49	104
Zarina Cream	0.57	0.15	0.39	0.38	0.38	97
Maprovate cream	0.53	0.102	0.42	0.412	0.41	98
Maprovate cream	0.53	0.102	0.34	0.352	0.35	103

Table 2. Shows ranges and mean values of Mercury

Country of origin	Number of samples	Mercury levels, Range(µg/g), Mean(µg/g)
Italy	30	0.006-0.271, 0.0855
Ghana	1	0.076-0.076, 0.076
Thailand	1	0.51-0.51, 0.51
India	1	0.042-0.186, 0.0886
Nigeria	1	0.015-0.015, 0.015
USA	1	0.015-0.015,0.015
Spain	3	0.047-0.047, 0.0687
U.K	4	0.027-0.195, 0.0895
Switzerland	1	0.122-0.122, 0.122
Cote d'voire	1	0.549-0.549, 0.549
France	2	0.062-0.185, 0.1235

Levels of mercury in skin-lightening creams sold on the Ghanaian market were determined using Automatic Mercury Analyzer (Model HG-5000) for mercury. The accuracy of the technique used for mercury determination was determined by analyzing certified reference materials. Precision and accuracy of the procedure were evaluated by repeated analyses of samples and CRM, DORM-2 from the NR. The validity of the method for mercury determination has been proved by the agreement between the measured (mean =4.69µgg^{-1}, n = 5) and the certified (range of 4.38-4.90 µgg^{-1}, mean = 4.64). The results were all within the 95% confidence. Analytical and matrix recovery studies were performed by spiking samples with 25 and 50 µl of 1 µg ml^{-1} standard Hg solution. Analytical and matrix spike recoveries of the procedure yielded results between 97% and 104% with coefficient of variation between 4% and 9%.

A. Recovery Results for Mercury

Mercury concentrations in the creams ranged from (0.006 to 0.549) µgg^{-1}. The results for mercury levels are summarized in Table 2.

Table 3.The amount Mercury in different skin lightening creams from a

Ghanaian market.

Name	Country of origin	Hg(µg/g)
White Mark Cream	Italy	0.114
Skin Maxitoner Cream	Italy	0.271
Fair and Beautiful Cream	Italy	0.09
Biotone Toning Lotion	Ghana	0.076
Nivea Night Whitening Milk	Thailand	0.151
Surfaz Cream	India	0.186
Epiderm Cream	India	0.074
Amiderm Cream	India	0.042
Closol Cream	India	0.059

Table 3.The amount Mercury in different skin lightening creams from a Ghanaian market

Name	Country of Origin	Hg(µg/g)
Movate Cream	Italy	0.025
New Age Cream	Italy	0.253
Swiss Formular Cream	Italy	0.045
Claire Dark Cream	Italy	0.101
Skinicles Cream	Italy	0.155
Cream A3 Lotion	Italy	0.01
Skin Solution Cream	Italy	0.061
Clear Spot Cream	Italy	0.135
Maprovate Cream	Italy	0.006
Clear White Cream	Italy	0.132
Bioclaire Cream	Italy	0.088
Clear Essence Cream	Italy	0.108
Lemonvate Cream	Italy	0.065
Fade out Cream	Italy	0.011
Clear and Smooth Cream	Italy	0.073
Skin Success Cream	Italy	0.031
Neo-vate Cream	Italy	0.007
Maxi-clear Cream	Italy	0.139
Visible Difference Cream	Italy	0.011
Caris Cream	Italy	0.037
Clear Dark Spot Cream	Italy	0.145
Oranvate Cream	Italy	0.014
Aloe Vera Cream	Italy	0.187
Clean and Clear Cream	Italy	0.05
Tenovate Cream	Italy	0.011
P&C Cream	Italy	0.127
Natural Lemon Cream	Italy	0.064

Table 3.The amount Mercury in different skin lightening creams from a Ghanaian market

Name	Country of origin	Hg(µg/g)
Betasol Cream	India	0.082
Dove silk Cream	Nigeria	0.015
Jergens Soothing Cream	USA	0.015
Niuma Skin Lightening	spain	0.079
Nivea Intensive Lotion	Spain	0.047
Nivea Smooth Lotion	Spain	0.08
Dermatological E45 Lotion	U.K	0.195
Dove Hydro Fresh Cream	U.K	0.056
Dove Seidige Lotion	U.K	0.027
Zarina Cream	U.K	0.08
Lemonvate Cream (SWISS)	Switzerland	0.122
Diva Maxotone Cream	Cote d'voire	0.549
Akagni Cream.	France	0.062
Fair and White Exclusive	France	0.185

The entire sample had concentration of mercury below the 1.0ugg-1 limit recommended by the United State Food and Drug Administration (USFDA). Out of the fifty samples analyzed, thirty two (64%) of the samples had mercury levels less than 0.1µgg-1. Fifteen (30%) of the samples had levels more than 0.1µg/g but less than 0.2µg/g. New age cream and skin maxitoner cream recorded 0.253 µg/g and 0.271µg/g respectively. Diva maxitone cream recorded the highest level of 0.549µg/g but also within the recommended limit. The concentration of mercury in skin toning creams has been the subject of study in recent years and the mercury content of creams has seriously been reported in Ghana (Voegborlo et al., 2008). In similar study of cream obtained in the Saudi Arabian market, mainly originating from Asia and the Middle East using Inductively Coupled-Plasma Spectrometry (ICP), mercury concentration was 376.58 ppm with a range from 0 to 5650ppm (AI-Saleh AI-Doush, 1997) which was excessively higher than the US FDA permissible limit. Though effects of mercury poisoning on the skin itself have not been reported in relation to the use of mercury containing soap and cream, other toxic effects have been reported. Marzulli and Brown (1972) found that the use of skin creams containing inorganic mercury salts result in substantial absorption and accumulation in the body. Repeated application of these skin toning creams could cause cumulative effect of prolonged low level mercury exposure, which could lead to nephritic syndrome (Giunta et al., 1983; Rosenman et al., 1986; Emwonwe, 1987). Mercury can also be transferred from the mother to the fetus during pregnancy (Kuhnert et al., 1981; Lauwerys et al., 1987). Mercury from soap and cream has been reported to be readily absorbed through the skin and via inhalation (WHO, 1991; AI Sahel et al., 2004). An average of 0.1 mg/l could develop the nephritic syndrome (renal diseases). In another study carried out in Tanzania some women who were not active in artisanal gold mining had up to 0.1 mg/l mercury per liter of urine, and it was concluded that the mercury was derived from bleaching soap and cream containing mercury (Kahatano et al., 1998). A 46 year old woman developed membranous nephropathy following the use of a mercury-containing skin lightening cream. Results of a mercury analysis revealed that the cream contained 1% mercury by weight (Oliveira et al., 1987). Most of the creams analyzed in this study originate mainly from USA, United Kingdom, Cote d'Ivoire and Europe where it is possible that manufacturing regulation concerning skin lighting creams so far as mercury is concerned is being strictly adhered to. The wide range of skin lightening creams on the market as well as their wide use by some women in an attempt to convert their dark skin to fair skin indicate that the blending effect from the use of the creams may be due to other active ingredients other than mercury added to the creams. Though the scope of this study does not include the other blending ingredients in skin lightening cream it can be concluded that there is no potential mercury related health risk from the use of the creams studied.

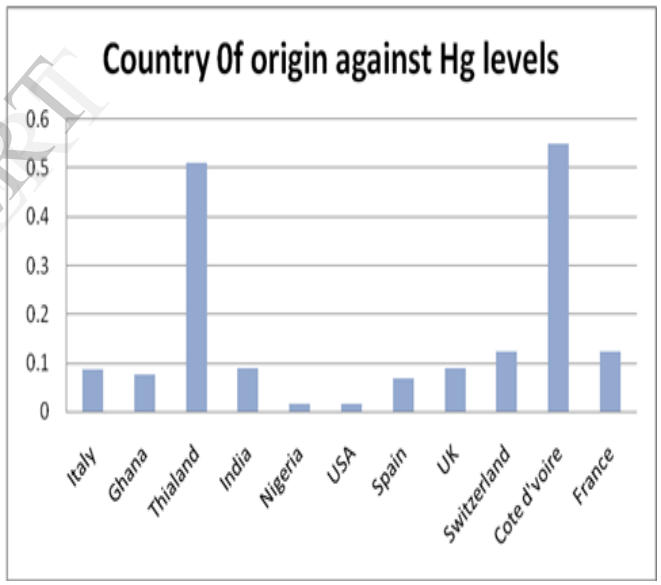

Fig.1.Graph of Country of origin against Mercury levels.

Fig.1. indicates a graph of mean values of mercury levels against Country of origin. Cote d'voire recorded the highest value of 0.549µg/g followed by Thailand which recorded 0.511µg/g. Nigeria and USA recorded the lowest mean values of 0.015µg/g . However, the mean value for all the countries falls below the threshold limit of 1µg/g.

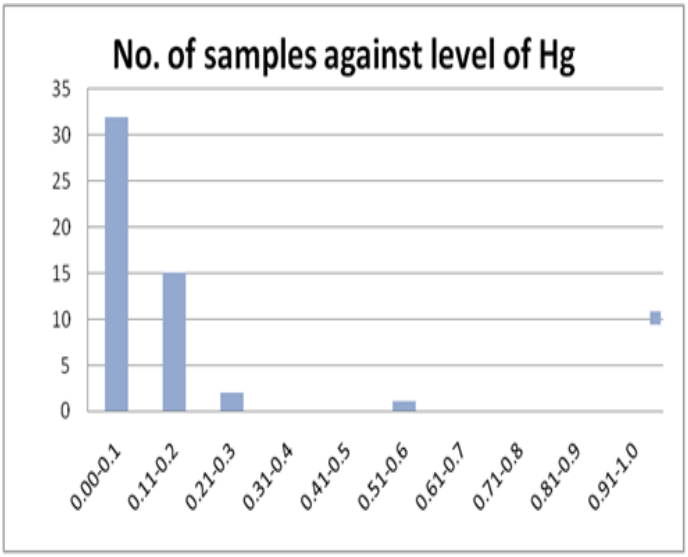

Fig.2.Graph of number of samples against mercury levels (µg/g).

Fig.2. indicates number of samples against mean values of mercury. Thirty two (64%) of the samples recorded mean values from 0.00-0.1µg/g. Fifteen (30%) of the samples recorded mean values from 0.11-0.2µg/g. Two (4%) of the samples recorded mean values from 0.21-0.3µg/g and one sample recorded mean values of 0.51-0.6µg/g. This implies that all the samples analyzed had very low levels of mercury.

IV. CONCLUSION.

It was realized from the study that the total mercury concentration in the sample of creams analyzed ranged from 0.010 to 0.549 $\mu g g^{-1}$ which is below the maximum permissible limit recommended by the United State Food and Drug Administration (USFDA), FAO and WHO.
Though, the amount of mercury was in low quantities. It is feared however that the continuous use of cosmetic products contaminated with mercury may however cause slow release of mercury into the human body and cause harmful effects to the consumers over time. Excessive use of such products should be avoided.

V. RECOMMENDATION.

It can therefore be recommended that, the population should be educated on the implications of using skin toning creams and soaps. This should be targeted at all ages through workshops and seminars that should be organized by Food and Drugs Authority of Ghana, Media and other stake holders. The levels of mercury in toning creams to be sold in the Ghanaian should be investigated by Regulatory authorities before allowed into the country.
Regular analysis and evaluation should be conducted to ascertain the levels of mercury in creams sold in Ghanaian market.

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