

# Estimation of mercury and hydroquinone content in skin whitening creams and the potential risks to the health of women in Lahore, Pakistan

Syeda Hajira Shah, Iram Anjum, Tanveer Majeed

Department of Biotechnology, Kinnaird College for Women, Lahore, Pakistan.

## Abstract

Women in Pakistan are obsessed with the concept of glowing whitish complexion. Fairness creams contain very high amount of mercury and hydroquinone. These act by inhibiting the tyrosinase enzyme responsible for melanin production. The study is conducted with aim to detect the prevalence of skin bleaching in Lahore and determine the levels of hydroquinone and mercury in some locally manufactured brands of skin whitening creams. In first part of study the prevalence of skin bleaching in Lahore was estimated. In second part samples of locally manufactured skin whitening creams were purchased. Physiochemical analysis was done. Percent hydroquinone content was determined by U.V. Spectrophotometer, while the concentration of Mercury was analyzed using Flame Atomic Absorption Spectrophotometer. Prevalence of skin bleaching was estimated to be ~50% in target population. The major motivating factors driving women towards this practice are personal satisfaction and confidence, getting better jobs and good marriage proposals. The practice has resulted in higher prevalence of skin disorders among young females; common being acne, uneven skin tone, facial hairs and scars. All samples were of acidic pH. Hydroquinone content was detected to be in range of 0.000064-0.039%. Mercury content was determined to be in range of 3.6-240 ppm. We should feel free to be confident in the complexion provided by nature and stop the use of any skin whitening product, as in long term they will only make our complexion much worse.

## Key words

White complexion, obsession, skin whitening creams, skin disorders, hydroquinone, mercury.

## Introduction

Epidermal layer consists of melanin pigment that provides color to skin and protects a person against harmful U.V. radiations. Melanin is synthesized by two enzymes, phenylalanine hydroxylase and tyrosinase. These through series of reactions, either produce eumelanine a brown black pigment that provides color to hair and skin or pheomelanine a red pigment that provides color to hair and lips.<sup>1</sup>

The personal liking for white skin can be traced far back to 475-221 BC where white color was considered a symbol of beauty, innocence and represented higher social status. For this reason women in ancient Chinese Era used to swallow crushed pearls and intake arsenic powder.<sup>2</sup> In sub-continent the preference for milky white complexion started with successive invasions of Aryans, Mughals and British. They were much fair than local population. As all three invaders had white complexion and were powerful so it increased the perception of white as sign of power, superiority and richness.<sup>3</sup>

The concept has been captured by manufacturers of SWCs which through their advertisements portray fair skin as the necessity for happy and

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## Address for correspondence

Tanveer Majeed  
Department of Biotechnology,  
Kinnaird College for Women, Lahore, Pakistan.  
Email: tanveer.majeed@kinnaird.edu.pk

successful life and resulted in the domination of skin lightening products in Asian skincare market with 60 percent of sales.<sup>4</sup> For this reason a number of fairness cream brands can be observed in markets. Most of these brands do not have any manufacturing or expiry date mentioned. The labeling sometimes is also incomplete. One can never imagine about the number and type of ingredients present in them. These might contain up to 10,000 ingredients in them, common being steroids, arbutin, ascorbic acid, hydroquinone, and kojic acid. They also contain high levels of toxic metals like mercury in them.<sup>5</sup>

Mercury is a heavy metal used in thermometers and as preservative in some medicines and vaccines. In 1992 FDA had set its safe limit to be 1µg/g in cosmetics.<sup>6</sup> The metal is added because it is a competitive inhibitor of tyrosinase. It competes copper and attacks cysteine in active site of tyrosinase leading to inactivation of enzyme.<sup>7</sup>

The half-life of mercury is estimated to be 42-60 days in body. It gets absorbed in body through sweat glands, hair follicles, sebaceous glands, and when hands come in contact with mouth. It gets accumulated in liver and kidney, leading to organ damage.<sup>8</sup> Exposure to placental cells causes its accumulation in placental membrane and lowers the membrane fluidity. This may either lead to fetal abortion or impaired development and growth and such children are unable to solve mental problems in their later life.<sup>9</sup> Signs of mercury toxicity include metallic taste, increased thirst, abdominal pain and bloody diarrhea, skin problems, insomnia, fatigue etc. Excessive amount of mercury also gets deposited in dermal layer of skin which on exposure to U.V. rays reoxidises and cause further pigmentation and premature aging.<sup>10</sup>

Hydroquinone is a benzene derivative used as a

stabilizer in paints and oils. It is used as a bleaching agent in fairness creams and acts as a competitive inhibitor for tyrosinase. It inhibits the enzyme due to its structural similarity with melanogenic precursor of tyrosinase and leads to inhibition by binding with histidine in the active site.<sup>11</sup> According to World Health Organization 1.5-2% of compound in creams is safe to use, but the levels above this limit are said to be toxic and associated with adverse health conditions. Its use in skin-whitening cosmetic products has been banned by the EU, USA and several African and Asian countries due to different safety problems such as ochronosis, irritation, allergy and its carcinogenic property particularly over long-term use.<sup>12</sup>

Half-life of compound is estimated to be 9-18 minutes. Long term exposure can also lead to thyroid disorder, liver damage and neurological problems. It indirectly causes DNA damage or mutation, as it leads to thinning of skin and thus making us even more sensitive to U.V. radiation.<sup>13</sup> According to Occupational Safety & Health Administration, it has been categorized as a mutagen and a carcinogen because it causes breaks in single strands of DNA, and inhibition of DNA/RNA synthesis.<sup>14</sup> In bone marrow and liver hydroquinone converts into its metabolites i.e. p-benzoquinone and glutathione conjugates that lead to DNA damage and mutation and are main cancer causing agents. Neurological effects include headache, nausea, vomiting, dizziness, muscle twitching; these occur because hydroquinone peels off the outer protective layer and therefore has a negative effect on underlying nerves.<sup>15</sup>

Therefore, the study is conducted with aim to evaluate the prevalence of health issues regarding skin complications occurring among women using skin whitening creams. Fairness creams may contain concentration of hydroquinone and mercury, higher than that

recommended by FDA. Analyzing the concentration of these two in different local brands of skin whitening creams will be beneficial in generating awareness among people regarding the harmful side effects of using low profile skin whitening creams.

## **Methods**

### **Study Design**

#### ***Questionnaire Development and Contents***

Self-administered questionnaires were distributed to the 140 women respondents and 20 dermatologists of the study to estimate the behavior of skin lightening users and gather the information related to the practice of skin lightening, the knowledge, and also the perception about having white skin. The determines the sociodemographic background of respondents, the skin lightening practice by the respondents, the consumer behavior and preference in skin lightening product selection, the health symptoms reported from the skin lightening products used, and the knowledge and perception of respondents towards skin lightening products. 12 locally manufactured skin whitening creams were purchased to analysis mercury and hydroquinone content in them.

#### ***Sampling Procedure***

The study was carried out in Kinnaird college for women Lahore, one of the public universities in Pakistan. While recruiting the respondents, the inclusion criteria implied were female students, aged from 18 to 25 and studying in the college on the period when the data is taken.. As for the reason why the study only focuses on female students, it is because in Pakistan women generally have higher rates of skin lightening practice than men.

As for the ethical clearance, the study protocol and questionnaire was approved by the Ethical Committee of Kinnaird college for Women Lahore.

#### ***pH analysis***

To determine the pH of SWCs, 1g of each sample was weighed and 0.05M sulphuric acid was added. pH probe was rinsed and dipped in sample solution. Reading was recorded. pH of 0.05M sulphuric acid was recorded and values were subtracted.

#### ***Hydroquinone analysis***

For standard, 250ppm of stock hydroquinone solution was prepared. To obtain a standard curve the stock solution was diluted to obtain dilutions of 2 ppm, 4ppm, 6ppm, 8ppm, 10ppm and 12ppm.

1g of each sample was weighed. 20cm<sup>3</sup> of 0.05M sulphuric acid was added and solutions placed in water bath to obtain a clear digest. Then transferred to 25cm<sup>3</sup> conical flask and made up to volume with 0.05M sulphuric acid. Later they were filtered and the first 5cm<sup>3</sup> of filtrate was discarded and additional 5cm<sup>3</sup> of 0.05M sulphuric acid was added to rinse the filter paper so as to remove any retained sample. The absorbance was taken at wavelength of 302nm and mean of best two replicas was recorded.

#### ***Mercury analysis***

Dilutions for standard Hg solutions along with their absorbance were provided by Environmental Sciences Department of Lahore College for Women University, Lahore.

1g of each cream was accurately weighed. 25ml of acid mixture of concentrated nitric acid and

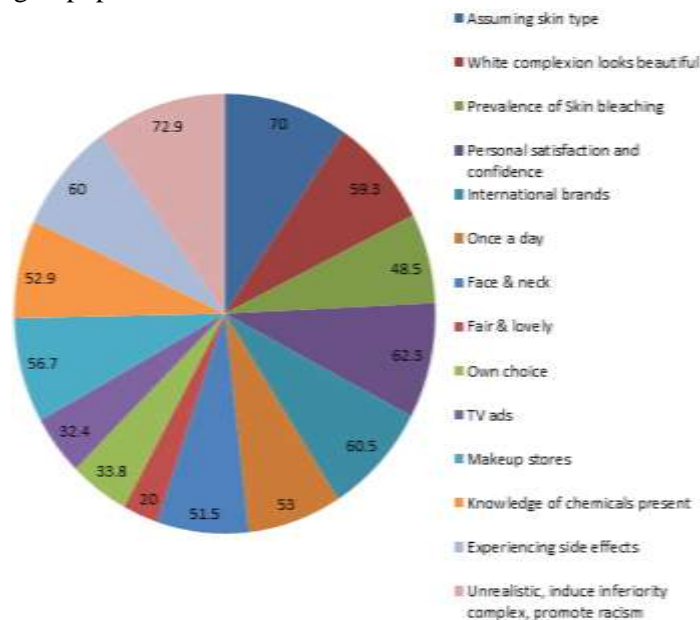
concentrated hydrochloric acid in ratio 3:1 was added to each sample. Samples were vigorously shaken to dissolve the contents. Mixture was heated at 200°C on hot plate in fume hood until there were no more brown fumes produced. The samples were cooled, filtered and marked up to the volume of 50ml with distilled water. Hg concentration was determined by Flame Atomic Absorption Spectrophotometer at wavelength of 253.7nm.

### Results and Discussions

The statistical analysis of data collected by surveying women from various locations of Lahore indicated that target population mainly comprised of unmarried females in age group of 15-25 years. They had varying level of education from primary to post graduate levels. The results as summarized in **Figure 1**, indicate that 70% had just assumed their skin type meaning they have never consulted a dermatologist. Knowing one's own skin type is essential because in summers due to sweating we tend to assume it to be oily while in winters we consider it to be dry. On basis of these assumptions we apply any product found to be suitable. 59.3% of target population consider

white complexion to be beautiful while the prevalence of skin bleaching in selected population of Lahore is found to be 48.5%. The result of study is a bit lower than study carried out by Gul<sup>16</sup> where prevalence of skin bleaching in Karachi was 61% and also lower than the study carried out by Askari<sup>17</sup> according to whom the prevalence of skin bleaching in Lahore is 59%. 62.3% of the respondents use fairness creams for personal satisfaction and confidence and 60.5% prefer international brands of skin whitening creams. 53% of target population applies the product once a day and majority (51.5%) apply them on face and neck only. The most popular brand (20%) is found to be Fair & Lovely.

The products used were purely of their own choice (33.8%) or an inspiration from some TV ad (32.4%). The most popular sites of purchase were the makeup stores with approximately 56.7% women buying their fairness products from there. The ratio between the women having knowledge (52.9%) regarding the chemicals present in fairness products and those admitting lack of their knowledge (47.1%) was nearly the same.



**Figure 1** Public survey data.

**Table 1** Perception regarding White Complexion and Fairness Creams.

<i>Question</i>	<i>Strongly Agree</i>	<i>Agree</i>	<i>Neutral</i>	<i>Disagree</i>	<i>Strongly Disagree</i>
Lighter skin tone is more beautiful?	17.9	29.3	14.3	24.3	14.2
Women with lighter skin tone are more confident and have higher self-esteem?	17.1	30.7	13.6	27.1	11.5
It gives females a younger look?	15	25	15	31.4	13.6
It implies that woman belongs to higher social class?	9.3	24.3	16.4	29.3	20.7
It helps in getting better jobs?	3.6	19.3	27.9	25.7	23.5
Women with lighter tone get good marriage proposals?	35.7	40.7	13.6	5.7	4.3
Men consider women with lighter tone more beautiful?	32.8	45	13.6	5.7	2.9
Do you think the brand name is important for buying a skin whitening product?	37.9	50	8.6	2.1	1.4
Do think application of skin whitening creams can have undesirable side effects?	41.4	43.6	7.1	6.4	1.5

This result was contradictory to the study carried out by Gul16 in Karachi where only 2% of women knew about the chemicals and ingredients present in SWCs. From this we can deduce that some women in Lahore are aware of the health effects caused by fairness products and thus they buy the product after reading the ingredients, if mentioned. 60% of the women interviewed had suffered from adverse effects due to application of skin lightening products. The side effects were inform of blemishes and acne faced by 20% of the women surveyed, irritation faced by 21.4% women and uneven skin tone experienced by 18.6% of the women interviewed. In regard to their opinion on airing of fairness product ads 72.9% women from all age groups and areas of life had a consensus that these ads are unrealistic, show fantasy life, induce inferiority complex among young girls with darker tone, and promote racism & discrimination by showing lighter tone as a key to happy life and successful marriage or career.

Respondent’s perception regarding lighter tone is presented in **Table 1**. The perception was tapped by 9 questions given in the table. Majority of women 47.2% agreed that lighter tone is more beautiful. This result was in consistence with the prevalence of skin

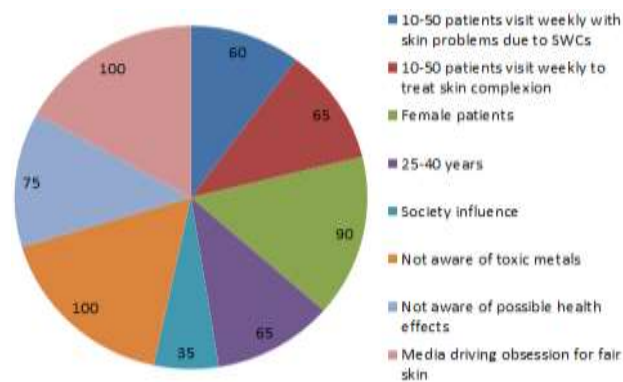
lightening practice among target population which was found to be 48.5%. Women of same ratio 47.8% have also agreed that lighter tone increases confidence and self-esteem among women. On the notion that whether men consider women with lighter tone more beautiful and if lighter complexion helps in getting better marriage proposals, majority have agreed to these factors with the ratio being 77.8% and 76.4% respectively. Most of the women in target population have disagreed with the notions that lighter tone has an influence on age (45%), promotes higher social class (50%) or helps in getting better jobs (49.2%).

In terms of brand loyalty 87.9% respondents agreed on the notion that brand name is an important criterion for purchasing the product regardless of age, marital status, skin tone, skin type, income or class. Though skin lightening practice is prevalent among women in Lahore, 85% respondents have agreed that application of fairness creams can cause undesirable side effects.

**Figure 2**, gives a summarized data for the dermatologists consulted to assess the prevalence of skin lightening practice. According to 60% dermatologists, they attend

**Table 2** Analysis of SWCs.

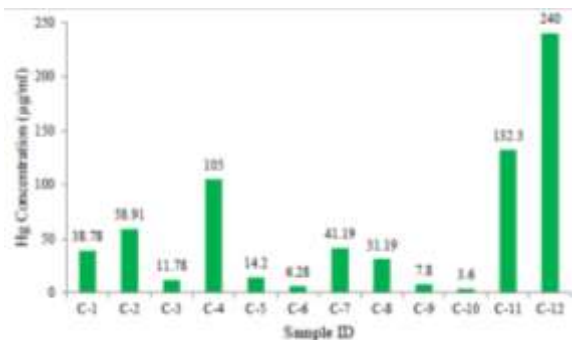
Sample ID	Product Name	Color	pH	Percent Hydroquinone Content	Mercury Content (ppm)
C-1	Face Fresh Beauty Cream	Pink	2.14	0.014	38.78
C-2	Faiza Beauty Cream	White	2.8	0.013	58.91
C-3	Arche Pearl Cream	Peach	No pH as completely oil based	0.014	11.78
C-4	Golden Pearl Beauty Cream	White	2.39	0.026	105
C-5	Skin White Gold Beauty Cream	Peach	3.35	0.026	14.2
C-6	Stillman’s Skin Beach Cream	White	No pH as completely oil based	0.000064	6.28
C-7	Due Beauty Cream	Greenish Blue	3.66	0.013	41.19
C-8	Seven Herbal Ubtan	Goldish Yellow	2.55	0.014	31.19
C-9	Fair & Lovely Advanced Multi Vitamin	Daisy	2.45	0.024	7.8
C-10	Ponds White Beauty	Light Pink	2.44	0.016	3.6
C-11	Brido Whitening Cream	Cream	2.49	0.039	132.3
C-12	Golden Star Beauty Cream	Off White	3.90	0.012	240



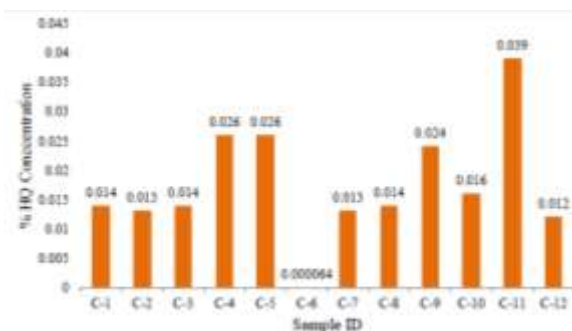
**Figure 2** Dermatologist survey data.

10-50 patients on weekly basis suffering from skin problems due to usage of skin whitening creams. 65% of them attend same number of patients per week, visiting them to treat their skin complexion. Majority of these patients are females (according to 90% dermatologists) in the age group of 25-40 years (as reported by 65% dermatologists). According to 35% dermatologists, societal influence is the most

prominent reason influencing people to change their complexion. While according to 30% of them, people want to change their complexion as a result of collective pressure from society, advertisements, job requirements, matrimonial problems and lack of confidence. All dermatologists had consensus on notions that women have no knowledge regarding the presence of toxic metals and chemicals in fairness products and that media is driving and obsession for fair skin. While 75% had consensus on factor that women in our society are not aware of the possible side effects due to these skin lightening products. These responses were contradictory to the ones obtained from female target population, where according to them they do have knowledge regarding the chemicals present and possible health effects occurring due to the usage of such products. Results obtained following analysis of the samples are showed in **Table 2**. All products analyzed are acidic in nature, have levels of



**Figure 3** Concentration of Hg in locally Available SWCs.



**Figure 4** Percent Concentration of HQ in locally available SWCs.

hydroquinone below safe limit while concentrations of mercury present in them are higher than recommended limits.

All the samples tested had pH in acidic range. pH of cosmetics indicates the presence of free fatty acids and bases in them. All creams should have pH as neutral i.e. in range of 7-7.25. This is essential because skin has a pH in range of 3-5. If cosmetics applied will of acidic nature they will irritate the skin while the cosmetics of alkaline nature will make skin dry and rough.<sup>18</sup> So to keep skin smooth and soft, it is essential to use creams and lotions that are of high moisture content and neutral pH. pH could be one of the factors that most of the women in our study faced irritation after applying such products.

In terms of hydroquinone analysis sample C-11 Brido Whitening Creams has the highest percentage of hydroquinone present in it i.e. 0.039%, while sample C-6 Stillman's Skin

Bleach Cream has the lowest percentage of hydroquinone present in it i.e. 0.000064%. But as can be seen all the products contain levels of hydroquinone much lower than the safe limits recommended by FDA and WHO. Studies have not been carried out in Pakistan to assess the levels of hydroquinone in fairness products, so the results were compared with the studies done in other countries. In a study carried out in Kenya Terer and his coworkers<sup>19</sup> reported the levels of hydroquinone in body creams and lotions to be in range of 0.00025-0.03457%. During a study done Southeastern Nigeria Duru and his coworkers<sup>18</sup> found the levels of hydroquinone in fairness products in range of NIL-2.3%.

Results obtained following analysis by FAAS shows that sample C-12 Golden Star Beauty Cream has the highest concentration of mercury present in it i.e. 240ppm, while sample C-10 Ponds White Beauty has the lowest concentration of mercury present in it i.e. 3.6ppm. But as can be seen all the products contain levels of mercury much higher than the safe limits recommended by FDA. Sustainable Development Policy, Islamabad under the supervision of Ali and Khwaja<sup>20</sup> recorded the level of Hg in fairness products manufactured in Pakistan and found them to be in range of <0.05-26500 ppm. According to their study Stillman's Bleach Cream contains 26500 ppm of mercury in it, while the results of this study contradict with their value in which mercury is found to be in concentration of 6.28 ppm in the product.

Overall it can only be said that women should try to feel confident and comfortable in the complexion provided by nature as it is the one best suited for our body. Moreover we as humans should try not to judge a person on basis of their complexion, but rather on basis of intelligence, sincerity, honesty and hard work.

## Conclusion

From the results of this study it can be concluded that women in Lahore are currently indulge in skin lightening practice. This leads to higher prevalence of skin problems like acne, melasma, facial hairs etc., along with other health issues like cancer and Hg poisoning. The major motivating factors for women to practice skin bleaching are personal confidence and self-esteem, getting better jobs and to have good marriage proposals. The hydroquinone content in 12 samples analysed was lower than safe limit while these samples had very high concentration of mercury in them, thus making these creams highly inappropriate for use.

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