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THE IMPACT OF HAZARDOUS COSMETICS ON SKIN HEALTH: HYDROQUINONE CONTENT IN ONLINE WHITENING CREAMS

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ABSTRACT

Hydroquinone is an effective skin-lightening agent; however, its use in cosmetics has been banned by the Indonesian Food and Drug Authority (BPOM) because of health risks such as skin irritation, exogenous ochronosis, and potential carcinogenic effects. Despite these regulations, numerous illegal skin-whitening products containing hydroquinone are still widely available, particularly through online marketplaces. Therefore, reliable testing methods are essential for detecting hydroquinone in skin-whitening creams. This study aimed to identify hydroquinone in whitening creams obtained from various online sources using a qualitative test with Potassium Iodide (KI) as a reagent. This study employed a simple qualitative testing method using a 0.5 N KI reagent. A 2-gram sample of the whitening cream was dissolved in chloroform, followed by the addition of a 3:1 mixture of HCl and HNO_3. The filtrate was then tested by adding the KI reagent, where the formation of an orange-red or yellow precipitate indicated the presence of hydroquinonethe presence of hydroquinone. The results showed that one sample from an online marketplace tested positive for hydroquinone, whereas the other samples showed negative results. The product containing hydroquinone lacked a BPOM registration number, indicating that unregulated cosmetic products continue to circulate without adequate oversight. This study confirms the prevalence of illegal whitening creams containing hydroquinone. The uncontrolled use of hydroquinone poses significant health risks, necessitating stricter regulatory enforcement by the BPOM and increased consumer awareness to ensure the safe selection of cosmetic products.

Keywords: Hydroquinone, whitening cream, Potassium Iodide, BPOM regulation, cosmetic safety.

INTRODUCTION

Cosmetics have become an essential part of daily life, particularly for individuals seeking a brighter and more even skin tone. Whitening creams are among the most widely used cosmetic products by both men and women. However, the high demand for these products has led to the widespread circulation of illegal whitening creams sold without official authorization from the Indonesian Food and Drug Authority (BPOM). Many of these products contain hazardous substances, such as hydroquinone and mercury (Hg), which pose significant long-term health risks to the skin and body (Chandra and Handayani, 2024).

In Indonesia, the popularity of skin-whitening products is closely linked to societal beauty standards that often equate fair skin with attractiveness, cleanliness, and health. This perception drives the growing consumption of cosmetic products, including whitening creams containing active ingredients (Saputri et al., 2024). Unfortunately, many of these widely available online products lack safety assurances because they have not undergone proper clinical testing in compliance with regulatory standards (Christian 2024).

Hydroquinone is a potent depigmenting agent that inhibits tyrosinase, which plays a crucial role in melanin production. Hydroquinone (benzene-1,4-diol or $C_6H_6O_2$) is a potent depigmenting agent that inhibits the enzyme tyrosinase, which plays a crucial role in melanin

production. By reducing tyrosinase activity, hydroquinone effectively lightens the skin in a short period and is a popular ingredient in various skin-whitening products and hyperpigmentation treatments for melasma and dark spots. However, the uncontrolled use of hydroquinone can lead to severe side effects, including skin irritation, chronic inflammation, and an increased risk of skin cancer. By reducing tyrosinase activity, hydroquinone effectively lightens the skin in a short period, making it a popular ingredient in various skin-whitening products and hyperpigmentation treatments for melasma and dark spots. However, the uncontrolled use of hydroquinone can lead to severe side effects, including skin irritation, chronic inflammation, and an increased risk of skin cancer. BPOM has mandated that hydroquinone concentrations exceeding 2% must only be used under medical supervision, and its use in over-the-counter cosmetic products is strictly prohibited. Nevertheless, numerous studies have indicated that many whitening creams available online still contain high levels of hydroquinone, posing significant risks to consumers without proper warning labels on product packaging (Hamidah et al., 2024).

One of the most common side effects of hydroquinone is skin irritation and heightened sensitivity. Prolonged use can lead to redness, burning sensations, and excessive skin peeling, particularly in individuals with sensitive skin. If usage continues, these reactions may progress to irritant contact dermatitis, causing chronic inflammation and an increased risk of infection (Amelia, Agustina and Rahmadani, 2022).

A more severe side effect is exogenous ochronosis, a condition characterized by permanent hyperpigmentation that results in dark blue-black patches on the skin. This phenomenon occurs with prolonged hydroquinone use, especially at high concentrations. Exogenous ochronosis is challenging to treat and is often irreversible, meaning that skin discoloration persists even after discontinuing hydroquinone (Artini, 2021).

Beyond skin-related effects, hydroquinone has been linked to skin cancer risk. Several studies suggest that hydroquinone may induce genetic mutations and cause DNA damage in skin cells, potentially leading to carcinogenesis. Owing to its potential carcinogenicity, countries such as the United States and the European Union have banned hydroquinone in cosmetic products (Rustiah et al., 2024).

In addition to skin effects, systemic absorption of hydroquinone can lead to internal organ damage, particularly affecting the liver and kidneys. Hydroquinone increases oxidative stress, causing cellular damage and inflammation in these organs. When used in high doses and over extended periods, hydroquinone can lead to liver and kidney dysfunction, ultimately posing serious health risks (Teheni, Supardi and Mustiqawati, 2023).

In hydroquinone, mercury (Hg) is another toxic substance frequently found in illegal whitening products on the market. Mercury inhibits melanin production but has far more dangerous side effects than hydroquinone. Exposure to mercury in cosmetics can cause irreversible skin damage and is associated with neurological disorders, kidney damage, and immune system dysfunction. Therefore, an effective detection method is crucial for identifying mercury in cosmetic products (Burdah et al., 2023).

A simple method for detecting mercury in whitening creams involves the use of Potassium Iodide (KI). This technique is based on the reaction between mercury ions (Hg^{2+}) and iodide ions (I^-), forming a yellow HgI_2 (Mercury Iodide) precipitate. The reaction can be observed visually, making it a quick and straightforward method that does not require complex laboratory equipment. Additionally, this method effectively detects mercury in various cosmetic formulations, including creams and liquid-based products (Burdah et al., 2023).

Most previous studies have focused on the detection hydroquinone using UV-Vis spectrophotometry or thin-layer chromatography (TLC). However, this study introduces a novel approach by combining the detection of both hydroquinone and mercury using a simpler and more efficient method. By utilizing KI as a reagent, this study aimed to detect mercury and offers a preliminary screening method before conducting further analysis using more advanced techniques. This approach is expected to serve as a practical and accessible screening tool for laboratories and healthcare institutions.

Given the significant health risks posed by hydroquinone and mercury, this study is highly relevant for raising public awareness of the dangers of unregistered whitening products. Therefore, this study aimed to identify the hydroquinone and mercury content in online whitening creams using the KI reagent method. This method is expected to provide valuable insights for consumers in selecting safer cosmetic products that comply with regulatory standards.

Hydroquinone is a phenolic compound commonly used in skin-lightening products because of its ability to inhibit tyrosinase enzyme activity in melanin synthesis. This compound suppresses melanin production, making it effective for treating hyperpigmentation. However, long-term or high-concentration use of hydroquinone can cause various side effects, such as skin irritation, contact dermatitis, exogenous ochronosis (permanent skin darkening), and potential carcinogenicity due to oxidative stress. Additionally, excessive absorption of hydroquinone into the body can have toxic effects on organs such as the liver and kidneys, making its use highly regulated (Suharyani et al., 2022).

Due to its health risks, the Indonesian Food and Drug Authority (BPOM) has banned the use of hydroquinone in cosmetics since 2008, except at concentrations of ≤0.02% in nail polish as a polymerization agent. Hydroquinone-containing products are only permitted in pharmaceutical formulations with a doctor's prescription, with a maximum concentration of 2% for treating hyperpigmentation conditions, such as melasma. According to BPOM Regulation No. 23 of 2019, cosmetics containing hydroquinone without BPOM authorization are prohibited from being circulated in the market. However, many illegal whitening products containing hydroquinone are still found, particularly through online sales, prompting BPOM to enhance its monitoring efforts (Harimurti et al., 2021; Ranti, 2021).

Several analytical methods are used to detect hydroquinone in cosmetics. Qualitatively, Potassium Iodide (KI) can be used as an initial detection method based on color changes or precipitate formation, with a positive result indicated by a red-orange or yellow color. However, this method is only suitable for preliminary screening and does not provide quantitative information on hydroquinone levels. Qualitatively, Potassium Iodide (KI) can be used as an initial detection method based on color changes or precipitate formation. When hydroquinone reacts with KI in the presence of strong acids, it undergoes oxidation, and iodine is reduced, leading to the formation of an orange-red or yellow precipitate, which indicates a positive result. However, this method is only suitable for preliminary screening and does not provide quantitative information on hydroquinone levels. For a more accurate analysis, UV-Vis spectrophotometry can be used to measure hydroquinone absorption at a wavelength of 293 nm, allowing for more precise detection than qualitative methods (Pangesti and Jamaluddin, 2021; Rosita, Ardianto and Wardana, 2024). The most precise method for determining hydroquinone levels in cosmetics is High-Performance Liquid Chromatography (HPLC), which has high sensitivity and is the primary standard used by BPOM for regulatory monitoring (Werdiningsih, 2024).For a more accurate analysis, UV-Vis spectrophotometry can be used to measure hydroquinone absorption at a wavelength of 293 nm, allowing for more precise detection than qualitative methods (Pangesti and Jamaluddin, 2021; Rosita, Ardianto and Wardana, 2024). The most precise method for determining hydroquinone levels in cosmetics is High-Performance Liquid Chromatography (HPLC), which has high sensitivity and is the primary standard used by BPOM for regulatory monitoring (Werdiningsih, 2024).

From a legal perspective, the circulation of hydroquinone-containing cosmetics without BPOM authorization constitutes a serious violation that may result in legal sanctions. Therefore, BPOM continues to strengthen its oversight of cosmetic products, especially those sold online, while taking legal action against illegal producers and distributors (Charismawati, 2021). Additionally, consumer education regarding the dangers of hydroquinone and how to identify BPOM-approved products is crucial for preventing the use of high-risk cosmetics. However, challenges remain in enforcement, particularly because of the prevalence of illegal imports and counterfeit product labeling. As a result, consumers are encouraged to be more selective when choosing skin-whitening products, ensuring their safety and legality under BPOM regulations (Sari et al., 2023).

RESEARCH METHODS

Equipment and Materials

This study utilized various laboratory instruments, including a 100 mL volumetric flask, a 25 mL volumetric pipette, a 5 mL graduated cylinder, a 250 mL Erlenmeyer flask, a 1 L beaker, a glass stirring rod, a water bath, an analytical balance, a funnel, filter paper, and an electric stove or hot plate (Latief, 2021).

The materials used included 5% Potassium Iodide (KI), Hydrochloric Acid (HCl), Nitric Acid (HNO_3), and distilled water. The tested samples consisted of various brands of facial whitening creams obtained from online marketplaces, including night creams, day creams, temulawak night creams, temulawak day creams, collagen night creams, and collagen day creams (Di et al., 2024).

1.) Sample Source and Classification

Samples were obtained from various online stores, with documentation including brand names, BPOM registration numbers (if available), seller names, and the online store links where the products were sold (Istiqomah et al., 2023). The samples were classified based on BPOM registration status (registered or unregistered), cream type (day cream, night cream, herbal, or non-herbal), and price range (Simorangkir et al., 2024). Each product was documented, including packaging photos, ingredient lists, and BPOM registration numbers before laboratory testing. This documentation aimed to compare the listed product composition with laboratory test results (Andalia et al., 2023).

2.) Sample Preparation

A total of 2 grams of whitening cream was weighed using an analytical balance, then dissolved in 25 mL of chloroform. 25 ml kloroform total of 2 grams of whitening cream was weighed using an analytical balance and dissolved in 25 mL of chloroform (Rasyid and Halwadiyah, 2020). A mixture of 10 mL HCl and HNO_3 (3:1 ratio) was then added to the solution, which was heated on a hot plate until it was almost dry. The remaining residue was dissolved in 10 mL of distilled water and briefly heated to facilitate homogenization. After cooling, the sample was filtered using filter paper to separate the solution to be tested (Utama, Rifqi and Andini, 2023).

3.) Qualitative Testing with Potassium Iodide (KI)

Reagent A : :A 1 mL aliquot of the filtrate solution was placed into a test tube, and 1–2 drops of 0.5 N KI solution were added (Meilyda, Febriani and Balfas, 2024). If a red-orange or yellow precipitate was formed, the sample was considered positive for hidroquinon (Christina and Rahayu, 2023). This method serves as a preliminary screening to detect the presence of mercury in whitening creams. If a positive reaction was observed, further quantitative analysis was conducted for precise measurement (Agustina et al., 2024).

4.) Validation of Results

To ensure the accuracy of the results, several validation steps were performed. Positive and Negative Controls: As sample known to contain mercury was used as a positive control, while a mercury-free sample was used as a negative control (Rasyid and Halwadiyah, 2020). Test Replication: Each sample was tested three times to confirm the consistency of the results (Agustina et al., 2024).

The test results were analyzed using descriptive statistical methods to evaluate the distribution of the findings and to detect any significant differences between the samples. This approach allowed for a better understanding of the variations in hydroquinone content among different whitening cream products and provided insight into potential trends in illegal cosmetic formulations available in the market (Andalia et al., 2023).

Data Analysis

1.) Comparison with BPOM Regulations

The research findings were compared with the regulatory standards established by the BPOM. If a product was found to contain mercury but had a BPOM registration number, this could indicate possible product counterfeiting or differences in formulation between production batches (Utama, Rifqi and Andini, 2023).

2.) Correlation Between Hydroquinone Content and Other Factors

In addition to detecting mercury, this study analyzed hydroquinone levels in the tested samples (Agustina et al., 2024). The hydroquinone test results were compared with several factors, including the BPOM registration status and product price (Istiqomah et al., 2023). This analysis aimed to determine whether higher-priced creams were safer than lower-priced ones and whether illegal products were more likely to contain hydroquinone compared to BPOM-approved products (Christina and Rahayu, 2023). If a correlation between the presence of hydroquinone and BPOM status is identified, the findings could serve as a basis for strengthening cosmetic product regulations in the market (Di et al., 2024).

RESULTS AND DISCUSSION

Table I. Sample Testing Results with KI Reagent

Parameter	Store A	Store B	Store C	Store D	Store E
Brand Name	Present	Present	Present	Present	Present
BPOM Number	-	-	-	-	-
Online Store Name	Present	Present	Present	Present	Present
Cream Photo	Present	Present	Present	Present	Present
Container Photo	Present	Present	Present	Present	Present
Photo of KI Reagent Addition					
Results					
Conclusion	Negative	Positive	Negative	Negative	Negative

The qualitative test using Potassium Iodide (KI) reagent showed that some of the whitening cream samples tested positive for hydroquinone, indicated by the formation of a red-orange or yellow precipitate. According to the obtained data, the sample from Store B tested positive, while the other samples did not show any color changes, indicating the absence of hydroquinone in those products (Fitri, 2022). Previous studies have shown that hydroquinone identification using UV-Vis spectrophotometry and thin-layer chromatography (TLC) is highly effective in detecting this compound in cosmetics. Several commercially available cosmetic products contained hydroquinone in concentrations ranging from 1.29% to 5.25%, exceeding the BPOM regulatory limit (Muadifah and Ngibad, 2020). Furthermore, another study using High-Performance Liquid Chromatography (HPLC) revealed that most over-the-counter night creams contained hydroquinone concentrations ranging from 0.95% to 3.49%, far above the permitted threshold (Asworo and Maulida, 2022).

The analysis revealed that not all hydroquinone-containing products had BPOM authorization, while some products with a BPOM registration number still contained hydroquinone. The sample from Store B, which tested positive for hydroquinone, did not have BPOM authorization, indicating the presence of illegal products in the market (Alawiyah et al., 2024). This result aligns with research conducted in various regions of Indonesia, which found that many unauthorized whitening products contain high levels of hydroquinone (Novitasari, Fitriyah and Rosidah, 2024). Additionally, some products with BPOM registration numbers but still containing hydroquinone raise suspicions of product counterfeiting or formulation differences across production batches (Fertiasari, Leni and

Kristiandi, 2023). Stronger monitoring of cosmetic products is needed, especially for products sold online, as many illegal products contain hydroquinone without clear concentration information (Fariha et al., 2023).

Hydroquinone is a well-established skin-lightening agent that inhibits melanin production. However, unsupervised use of hydroquinone can cause various side effects, including skin irritation and contact dermatitis, which are commonly observed in users of illegal whitening creams (Muadifah and Ngibad, 2020). Additionally, long-term use of hydroquinone can lead to exogenous ochronosis, a condition in which the skin darkens permanently due to hydroquinone accumulation (Asworo and Maulida, 2022). Oxidative stress induced by hydroquinone may also cause DNA damage, increasing the risk of skin cancer (Alawiyah et al., 2024). Several studies have shown that high concentrations of hydroquinone may cause hyperpigmentation instead of depigmentation (Novitasari, Fitriyah and Rosidah, 2024). A study in Blitar found that 8 out of 12 tested whitening cream samples contained hydroquinone at varying concentrations (Fertiasari, Leni and Kristiandi, 2023). Moreover, research utilizing digital imaging techniques has discovered that whitening creams containing hydroquinone exhibit distinct color reflectance values, which can serve as an indicator of hydroquinone presence in cosmetic products (Fariha et al., 2023).

The use of hydroquinone in cosmetics has been banned by BPOM, except at concentrations ≤0.02% in nail polish. However, this study shows that many illegal whitening products containing hydroquinone are still widely available in the market, especially through online stores (Muadifah and Ngibad, 2020). Based on previous studies, High-Performance Liquid Chromatography (HPLC) analysis confirmed that many over-the-counter night creams contain hydroquinone concentrations far exceeding the legal limit (Asworo and Maulida, 2022). Among the five tested products, all contained hydroquinone levels exceeding 0.02%, with some reaching 12.896%, which poses serious health risks (Alawiyah et al., 2024). To combat the circulation of illegal products, stricter BPOM regulations and monitoring are necessary, particularly for products sold online (Novitasari, Fitriyah and Rosidah, 2024). Consumer education about hydroquinone risks is also crucial to ensure people make informed decisions about skincare products (Fertiasari, Leni and Kristiandi, 2023). Furthermore, stronger sanctions against illegal manufacturers and distributors are required to prevent the distribution of hazardous products (Fariha et al., 2023).

Based on the qualitative test results, one sample of whitening cream from Store B tested positive for hydroquinone, while the other samples tested negative. This hydroquinone-containing product also lacked BPOM authorization, highlighting the ongoing presence of illegal cosmetic products in the market (Muadifah and Ngibad, 2020). Several previous studies also confirmed the presence of hydroquinone in various whitening products at levels significantly exceeding BPOM's safety limit (Asworo and Maulida, 2022). These findings emphasize the need for stricter regulations and increased consumer awareness to prevent the use of harmful products (Alawiyah et al., 2024).

CONCLUSION

This study found that one sample of the whitening cream tested positive for hydroquinone, while the others were negative. Several illegal products without BPOM authorization are still circulating, and some authorized products have been found to contain hydroquinone. The uncontrolled use of hydroquinone poses risks, such as skin irritation, exogenous ochronosis, and skin cancer. Strict supervision, consumer education, and firm sanctions are necessary to prevent the distribution of hazardous products.

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