

Analysis of Mercury (Hg) Levels in Unregistered Facial Whitening Creams Sold in Traditional Markets in Kudus City Using Atomic Absorption Spectrophotometry

Kadar Ismah*, Yanulia Handayani, Febbi Febriyanti, Dessy Erliani Mugita Sari

Institut Teknologi Kesehatan Cendekia Utama Kudus, Indonesia

*Corresponding Author: kadarismah@gmail.com

Abstract. Mercury (Hg) is a hazardous substance prohibited in cosmetics because it can cause adverse health effects with prolonged exposure. Unregistered skin-lightening creams carry the risk of containing hazardous substances because they do not undergo safety and quality control procedures before being distributed. This study aims to identify the presence of and determine the levels of mercury in unapproved skin-lightening creams circulating in traditional markets in Kudus City. This study employed a laboratory experimental method with a quantitative descriptive approach. The study sample consisted of 10 skin-lightening creams labeled A–J, selected through purposive sampling. Qualitative analysis was performed using chemical reactions with 0.5 N KI, 2 N NaOH, 6 N HCl, and 10% K₂CrO₄ reagents, while quantitative analysis was conducted using Atomic Absorption Spectrophotometry (AAS) at a wavelength of 253.7 nm. The results of the qualitative tests showed a positive KI reaction in samples D, F, G, H, I, and J; a positive NaOH reaction in samples A–F; a negative HCl reaction in all samples; and a positive K₂CrO₄ reaction in all samples. The AAS analysis results showed that all samples contained mercury at levels ranging from 327.82 to 388,371.21 µg/kg. Based on these results, all of the facial whitening creams studied contained mercury and did not meet cosmetic safety requirements.

Keywords: Atomic Absorption Spectrophotometry, Cosmetics Without Marketing Authorization, Mercury, Skin-Lightening Creams

INTRODUCTION

Cosmetics are among the products widely used by the public to support hygiene, health, and appearance, including products used for facial skin care (Sende *et al.*, 2020). The use of cosmetics to brighten the skin is on the rise due to people's desire to have a brighter and clearer complexion (Bamidele *et al.*, 2023). Rising demand for skin-lightening products has led to a wide variety of skin-lightening creams being readily available on the market, including products that lack marketing authorization (Padi *et al.*, 2024). Cosmetic products without marketing authorization require attention because their safety and quality cannot be verified through official oversight processes (Rahmawati *et al.*, 2024).

One of the hazardous substances to watch out for in skin-whitening products is mercury (Hg) (Bastiansz *et al.*, 2022). Mercury may be used illegally in skin-lightening products because it can lighten the skin in a relatively short period of time. This lightening effect is related to mercury's ability to inhibit the activity of the enzyme tyrosinase, which plays a role in the formation of melanin in the skin (Chen *et al.*, 2020). Repeated use of products containing mercury can increase the risk of mercury exposure for users (Qudus *et al.*, 2021).

Exposure to mercury from the use of skin-lightening products can pose a health risk if it occurs continuously (Bastiansz *et al.*, 2022). Mercury that enters the body may be linked to disorders in various organ systems, including the nervous system and the kidneys (Karsanto *et al.*, 2024). Mercury exposure through skin-lightening products has also been linked to elevated mercury levels in the biomarkers of users of these products (Bastiansz *et al.*, 2022). The presence of mercury in skin-lightening cosmetic products is one of the issues that needs to be addressed in public health protection (Lewis, 2023).

Research on mercury in cosmetics is still being conducted in various regions because the mercury content in skin-lightening products can vary by product and region of distribution (Bastiansz *et al.*, 2022). A study by Padi *et al.* (2024) reported the presence of mercury in unapproved facial whitening creams not authorized by the Indonesian Food and Drug Administration (BPOM) circulating in the Wonosari Market. A study by Samaniyah *et al.* (2025) also analyzed the mercury levels in skin-lightening creams available in Banda Aceh using atomic absorption spectrophotometry. A study by Oktavia *et al.* (2025) reported the presence of mercury in skin-lightening creams available on the market in 45 cities in Manado, as determined through analysis using atomic absorption

spectrophotometry.

Based on these issues, this study was conducted to identify the presence of mercury in unlicensed skin-lightening creams circulating in traditional markets in Kudus City. This study also aimed to determine the mercury levels in positive samples using atomic absorption spectrophotometry. The results of this study are expected to provide scientific information regarding the presence and levels of mercury in unapproved skin-lightening creams and to serve as a source of information for the public in selecting and using safe cosmetic products.

METHODS

Time and Location of the Study

This study is a laboratory-based experimental study involving both qualitative and quantitative analyses. Qualitative analysis was performed using a color reaction method to detect the presence of mercury (Hg), followed by quantitative analysis using Atomic Absorption Spectrophotometry (AAS) to determine the mercury concentration in the samples. The study was conducted from May to June 2026 at the Pharmaceutical Chemistry Laboratory of the Cendekia Utama Kudus Institute of Health Technology and the Integrated Laboratory of Diponegoro University in Semarang.

Research Sample

The study population consisted of unregistered skin-lightening creams available in traditional markets in Kudus City. Samples were selected using purposive sampling based on the following criteria: the creams were sold over the counter, were relatively inexpensive, claimed to provide rapid skin-lightening effects, and lacked marketing authorization. A total of 10 samples of facial whitening creams were obtained from traditional markets in Kudus City and coded as A, B, C, D, E, F, G, H, I, and J. The products' registration status was verified through the BPOM Check system based on the product name or notification number on the packaging.

Tools and Materials

The equipment used included a Shimadzu AA-7800 Series Atomic Absorption Spectrophotometer with Flame and Graphite Furnace, beakers, measuring cups, stirring rods, funnels, Erlenmeyer flasks, filter paper, volumetric flasks, test tubes, test tube racks, an analytical balance, dropper pipettes, and a hot plate. The materials used include nitric acid (HNO_3), distilled water, 0.5 N potassium iodide (KI), 2 N sodium hydroxide (NaOH), 6 N hydrochloric acid (HCl), 10% potassium chromate (K_2CrO_4), a mercury standard solution, and samples of facial whitening cream.

Sample Preparation

Sample preparation was performed using the wet digestion method. A 0.5 g sample was weighed and placed in a ground glass stoppered Erlenmeyer flask, then 7 mL of concentrated HNO_3 was added. The mixture was heated on a hot plate at a temperature of approximately 60 °C for about 3 hours until a digestion solution was obtained. After cooling and standing, the solution was filtered using Whatman No. 40 filter paper. The filtrate was then diluted with distilled water to a volume of 50 mL in a volumetric flask (Padi *et al.*, 2024).

Qualitative Analysis

1. KI Reagent
1 mL of the sample solution was placed in a test tube, and 2 drops of 0.5 N KI were slowly added. The appearance of an orange color indicates a positive result for mercury (Maulina *et al.*, 2021).
2. NaOH Reagent
Add two drops of 2 N NaOH to 1 mL of the sample, the formation of a yellow color indicates a positive result for mercury (Purnomo *et al.*, 2024).
3. HCl Reagent
Add 2–3 drops of 6 N HCl slowly along the wall of the test tube to 1 mL of the sample solution. The formation of a white color indicates a positive result for mercury (Padi *et al.*, 2024).
4. K_2CrO_4 Reagent
Add 2–3 drops of K_2CrO_4 reagent to 1 mL of the sample solution. The formation of a yellow-orange color indicates a positive result for mercury (Nuradi *et al.*, 2024).

Quantitative Analysis

Preparation of a mercury standard solution

A 1000 ppm ($\mu\text{g/mL}$) mercury (Hg) stock solution was diluted by transferring 10 mL of the stock solution into a 100 mL volumetric flask, then adding distilled water up to the mark to obtain a 100 ppm ($\mu\text{g/mL}$) standard solution. A total of 10 mL of the 100 ppm standard solution was pipetted into a 100 mL volumetric flask and diluted with distilled water to the mark to obtain a 10 ppm solution. This solution is then further diluted by transferring 10 mL of the 10 ppm standard solution into a 100 mL volumetric flask and adding demineralized water up to the mark to obtain a 1 ppm ($\mu\text{g/mL}$) or 1000 ppb ($\mu\text{g/L}$) mercury standard solution (Samaniyah *et al.*, 2025).

Creating a calibration curve

Standard mercury solutions for preparing the calibration curve were prepared by pipetting 0, 0.1, 0.2, and 0.3 mL of a 1000 ppb standard mercury solution into 100 mL volumetric flasks, which were then diluted with distilled water to the mark to obtain standard solutions with concentrations of 0, 1, 2, and 3 $\mu\text{g/L}$. The absorbance of each standard solution was then measured using an Atomic Absorption Spectrophotometer (AAS) at a wavelength of 253.7 nm (Samaniyah *et al.*, 2025).

Testing Using Atomic Absorption Spectrophotometer

The prepared sample solution was analyzed using an atomic absorption spectrophotometer at a wavelength of 253.7 nm. Distilled water to which 1 mL/L of concentrated HNO_3 had been added was used as the blank solution. The blank was first introduced into the atomic absorption spectrophotometer, then the sample solution resulting from the digestion was analyzed, and its absorbance value was recorded (Rahman *et al.*, 2019).

Determination of Mercury Levels

The mercury concentration is determined based on the relationship between the concentration of the standard solution and its absorbance, which yields the linear regression equation $y = bx + a$. The resulting regression equation is used to determine the mercury concentration in the sample solution. The mercury concentration is calculated using the following formula (Oktavia *et al.*, 2025):

$$\text{Hg concentration} = \frac{C \times V \times FP}{w}$$

Notes:

C : Sample concentration from the AAS reading (mg/L)

V : Final volume of the solution (mL)

Fp : Dilution factor

W : Sample weight (g)

RESULTS AND DISCUSSION

BPOM Registration Testing

The results of the examination of 10 samples of facial whitening creams labeled A–J showed that none of the samples were found in the BPOM's cosmetic notification system. This indicates that the samples examined do not have valid notification numbers or have not been officially registered as cosmetics authorized for distribution. Checking registration status is crucial because cosmetic products intended for distribution must undergo a notification process to ensure that administrative, safety, quality, and efficacy requirements have been met (BPOM, 2022).

All Products List

10 ▾

Search...

Filter

Type	Registration Number	Product Name	Registrant
No matching records found.			

Showing 0 to 0 of 0 entries (filtered from a total of 658,792 entries)

Previounya

1

Of: 0

Selanjutnya

Figure 1. Check BPOM Registration

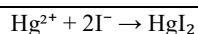
Qualitative Analysis

A qualitative analysis was conducted as an initial step to identify the possible presence of mercury (Hg) in facial whitening creams. The method used was a chemical reaction test involving four reagents: 0.5 N potassium iodide (KI), 2 N sodium hydroxide (NaOH), 6 N hydrochloric acid (HCl), and 10% potassium chromate (K₂CrO₄). Chemical reaction tests can be used as an initial screening method because the presence of the analyte can be indicated by a color change or the formation of a precipitate after the addition of certain reagents (Mustarin *et al.*, 2025). The use of several reagents in this study was intended to increase confidence in the identification results, as each reagent has a different reaction mechanism with respect to mercury ions (Danimayostu *et al.*, 2026).

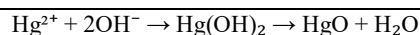
Table 1. Results of the qualitative analysis

Sample	KI 0,5 N	NaOH 2 N	HCl 6 N	K ₂ CrO ₄ 10%
A	Clear yellow	Yellow	Clear yellow	Orange
B	Clear yellow	Yellow	Clear white	Orange
C	Clear yellow	Yellow	Clear yellow	Orange
D	Orange	Yellow	Clear yellow	Orange
E	Clear yellow	Yellow	Clear white	Orange
F	Orange	Yellow	Clear yellow	Orange
G	Orange	Clear yellow	Clear yellow	Orange
H	Orange	Clear yellow	Clear yellow	Orange
I	Orange	Clear yellow	Clear yellow	Orange
J	Orange	Clear yellow	Clear yellow	Orange

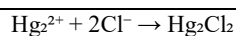
The test results showed that the 0.5 N KI reagent produced a positive result in samples D, F, G, H, I, and J, as indicated by the formation of an orange color, while samples A, B, C, and E exhibited a clear yellow color and were therefore deemed negative. The color change to orange in the KI test occurs because iodide ions (I⁻) react with Hg²⁺ ions to form mercury(II) iodide (HgI₂), which has an orange to reddish-orange color (Padi *et al.*, 2024). The reaction that occurs is as follows (Svehla, 1979):



Testing using 2 N NaOH as a reagent showed that samples A, B, C, D, E, and F produced a positive result a yellow color while samples G, H, I, and J produced a clear yellow color and were deemed negative. NaOH is a strong base that produces hydroxide ions (OH⁻) and can react with Hg²⁺ ions to form mercury(II) hydroxide, which subsequently transforms into yellow mercury(II) oxide (HgO) (Purnomo *et al.*, 2024). The reaction that occurs is as follows (Svehla, 1979):

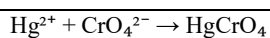


Testing with 6 N HCl yielded negative results for all samples. The absence of a white precipitate indicates that no visually observable mercury chloride compound was formed. HCl can be used to identify mercury(I) ions through the formation of the sparingly soluble mercury(I) chloride (Hg_2Cl_2), via the following reaction (Svehla, 1979):



Negative results for all samples may indicate that the mercury present in the samples is not in the form of mercury(I) ions which produce the precipitate or that its concentration is insufficient to produce a visual response (Dwijayanti & Susanti, 2018).

Testing all samples with a 10% K_2CrO_4 reagent yielded positive results, as indicated by the appearance of a yellow-orange color. Potassium chromate (K_2CrO_4) is an inorganic reagent containing yellow chromate ions (CrO_4^{2-}) that reacts with various metal ions, including heavy metals, to form precipitates or chromate complexes with characteristic colors ranging from yellow to orange (Diuli *et al.*, 2025). The reaction that occurs is as follows (Svehla, 1979):



Quantitative Analysis

Quantitative analysis was performed using an Atomic Absorption Spectrophotometer (AAS) because this method is based on measuring the absorption of radiation by free atoms at specific wavelengths. Atomic Absorption Spectrophotometers (AAS) are widely used in metal analysis because they offer good sensitivity and selectivity for determining the concentration of metallic elements in various matrices (Esati *et al.*, 2023).

Table 2. Standard Absorbance Values for Mercury

Sample	Concentration (ppb)	Absorbance
Standard 1	0	-0,0036
Standard 2	1	0,0173
Standard 3	2	0,0523
Standard 4	3	0,0760

Before measuring the samples, a calibration curve was prepared using standard mercury solutions with concentrations of 1, 2, and 3 $\mu\text{g/L}$, as well as a blank at a concentration of 0 $\mu\text{g/L}$. The calibration curve was used to determine the relationship between mercury concentration and the instrument's response (absorbance), so that the mercury concentration in the samples could be determined based on a linear regression equation (Qudus *et al.*, 2021). The measurement results show that as the concentration of the standard solution increases, the absorbance value also increases, indicating a positive relationship between concentration and absorbance (Bamidele *et al.*, 2023).

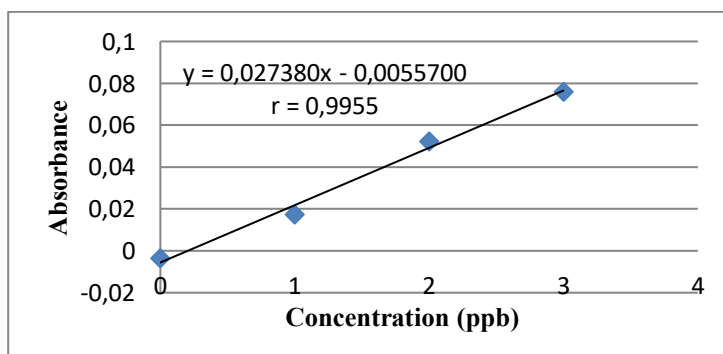


Figure 2. Calibration Curve

Based on the measurement results, the linear regression equation obtained was $y = 0.027380x - 0.005570$, with a correlation coefficient of $r = 0.9955$ and a coefficient of determination of $R^2 = 0.9910$. A correlation coefficient close to 1 indicates that there is a very strong linear relationship

between the standard mercury concentration and the absorbance measured by the instrument (Allison *et al.*, 2022).

An r value of 0.9955 indicates a very strong linear relationship between mercury concentration and absorbance. This value is relatively comparable to that reported in the study by Qudus *et al.* (2021), which found an r value of 0.993 in the analysis of mercury in skin-lightening creams. An R^2 value of 0.9910 indicates that approximately 99.10% of the variation in absorbance can be explained by changes in mercury concentration in the linear regression model (Bamidele *et al.*, 2023). It is important to note the difference in meaning between r and R^2 , because r describes the direction and strength of a linear relationship, while R^2 indicates the proportion of variation in the response that can be explained by the model (Stalikas & Sakkas, 2024).

Table 3. Results of atomic absorption spectrophotometry tests

Sample	Hg concentration
A	327,82 $\mu\text{g/kg}$
B	282.359,68 $\mu\text{g/kg}$
C	414,25 $\mu\text{g/kg}$
D	448,46 $\mu\text{g/kg}$
E	388.371,21 $\mu\text{g/kg}$
F	14.927,65 $\mu\text{g/kg}$
G	8.281,98 $\mu\text{g/kg}$
H	216.508,44 $\mu\text{g/kg}$
I	6.223,83 $\mu\text{g/kg}$
J	345.618,68 $\mu\text{g/kg}$

The results of atomic absorption spectrophotometry analysis showed that all samples contained mercury at varying concentrations. Sample E had the highest concentration, at 388,371.21 $\mu\text{g/kg}$, while sample A had the lowest, at 327.82 $\mu\text{g/kg}$. Overall, the mercury concentrations ranged from 327.82 to 388,371.21 $\mu\text{g/kg}$.

Based on BPOM Regulation No. 17 of 2022 concerning Technical Requirements for Cosmetic Ingredients, which stipulates that mercury and its compounds are among the ingredients prohibited for use in cosmetics, the presence of mercury in all samples of skin-lightening creams analyzed in this study indicates that these products do not meet the cosmetic safety requirements in effect in Indonesia, regardless of whether the detected mercury levels are high or low (BPOM RI, 2022). Cosmetics containing more than 1 mg/kg of mercury are considered unacceptable from a safety standpoint and may increase the risk of toxic effects if used continuously (BPOM, 2024).

The mercury contained in skin-lightening creams is generally used in the form of inorganic mercury compounds, such as mercury chloride (HgCl_2) and ammonium mercury, which can produce a skin-lightening effect. This skin-lightening effect is related to mercury's ability to inhibit the activity of the enzyme tyrosinase, which plays a role in melanin production, as a result, melanin production decreases and the skin appears lighter in a relatively short period of time (Triasih, 2025). Repeated use of products containing mercury can increase the amount of mercury absorbed into the body, especially when used over the long term or on skin that is irritated or damaged. Mercury that penetrates the skin can then enter the capillaries in the dermis and be distributed through the bloodstream to various tissues and organs throughout the body (Haryanti *et al.*, 2020).

Mercury is a toxic heavy metal that can bioaccumulate in the body if exposure is continuous (Karim & Amalia, 2025). Repeated exposure through the use of skin-lightening creams can cause mercury to be absorbed through the skin, enter the systemic circulation, and then be distributed and accumulate in certain organs, particularly the kidneys, liver, and nervous system (Ainia, 2025).

Long-term exposure to mercury can cause both localized and systemic health effects (Hasma & Panaungi, 2023). Local effects primarily occur on the skin and may include irritation, a burning sensation, redness, thinning of the skin, peeling, hyperpigmentation, and increased skin sensitivity to sunlight (Dampang *et al.*, 2023). Systemic effects can occur when absorbed mercury enters the bloodstream and accumulates in the body's organs, particularly the kidneys and the nervous system (Hasma & Panaungi, 2023). Kidney disorders may be characterized by proteinuria and decreased kidney function, which, in severe cases, can progress to kidney failure, meanwhile, nervous system

disorders may include tremors, impaired coordination, memory loss, difficulty concentrating, emotional disturbances, and tingling in the extremities (Ainia, 2025).

CONCLUSION

The results of the study showed that all samples of unlicensed facial whitening creams circulating in traditional markets in Kudus City namely, samples A, B, C, D, E, F, G, H, I, and J tested positive for mercury (Hg). Quantitative test results using the Atomic Absorption Spectrophotometry method showed that mercury levels in all samples varied, ranging from 327.82 µg/kg to 388,371.21 µg/kg. Based on these results, all samples of facial whitening creams do not meet cosmetic safety requirements because they were found to contain mercury (Hg). Referring to Food and Drug Supervisory Agency Regulation No. 16 of 2024 on Contaminant Limits in Cosmetics, the limit for mercury (Hg) contamination in cosmetics is set at no more than 1 mg/kg, so the presence of mercury in the samples warrants attention since all samples were found to contain mercury.

ACKNOWLEDGEMENT

The author would like to express gratitude to the Cendekia Utama Kudus Institute of Health Technology, the Bachelor of Pharmacy program, the academic advisor, and the examiners for providing adequate facilities and infrastructure during the conduct of this research. The author would also like to thank the staff of the Cendekia Utama Kudus Laboratory and the Integrated Laboratory at Diponegoro University in Semarang for their technical assistance, support, and help in conducting the research and processing the data.

REFERENCES

- Ainia, Q. (2025). Dampak kosmetik yang mengandung merkuri pada organ tubuh selain kulit. *Maliki Interdisciplinary Journal*, 3, 200–206.
- Allison, J. S., Santana, L., & Visagie, I. J. H. J. (2022). A primer on simple measures of association taught at undergraduate level. *Teaching Statistics*, 22(04), 96–103.
- Bamidele, O. D., Kayode, B. A., Eniayewu, O. I., Adegbola, A. J., Olatoye, R. S., Njinga, N. S., Abdullahi, S. T., & Odunola, M. T. B. (2023). Quality assessment of hydroquinone, mercury, and arsenic in skin - lightening cosmetics marketed in Ilorin, Nigeria. *Scientific Reports*, 13(20992), 1–12.
- Bastiansz, A., Ewald, J., Saldaña, V. R., Santa-rios, A., & Basu, N. (2022). A systematic review of mercury exposures from skin-lightening products. *Environmental Health Perspectives*, 130(11), 1–11.
- BPOM. (2022). *Peraturan Badan Pengawas Obat dan Makanan Nomor 21 Tahun 2022 tentang tata cara pengajuan notifikasi kosmetika*. Jakarta. Badan Pengawas Obat dan Makanan.
- BPOM. (2024). *Peraturan badan pengawas obat dan makanan nomor 16 Tahun 2024 tentang batas cemaran dalam kosmetik*. Jakarta. Badan Pengawas Obat dan Makanan.
- BPOM RI. (2022). *Peraturan Badan Pengawas Obat dan Makanan Nomor 17 Tahun 2022 tentang perubahan atas peraturan badan pengawasan obat dan makana nomor 23 tahun 2019 tentang persyaratan teknis bahan kosmetik*. Jakarta. Badan Pengawas Obat dan Makanan Republik Indonesia.
- Chen, J., Ye, Y., Ran, M., Li, Q., Ruan, Z., & Jin, N. (2020). Inhibition of tyrosinase by mercury chloride: spectroscopic and docking studies. *Frontiers In Pharmacology*, 11, 1–10.
- Dampang, H., Huriia, & Jasril. (2023). Analisis kualitatif merkuri pada beberapa krim pemutih wajah yang beredar di pasar tradisional sentral palopo. *Jurnal Surya Medika (JSM)*, 3(9), 162 – 165.
- Danimayostu, A. A., Putri, A. R., Nurhayati, A., Jasmine, J., Arbidely, M. M. Z., & Wulan, N. D. (2026). Qualitative and quantitative analysis of hydroquinone and mercury contents in body whitening creams. *Journal of Research in Pharmacy*, 30(1), 72–84.
- Diuli, S. N., Lukum, A., & Sukamto, K. (2025). Studi komparatif kandungan logam pada depot air minum isi. *Jurnal Entropi*, 20(September), 79–87.
- Dwijayanti, E., & Susanti. (2018). Analysis of mercury (Hg) in whitening cream distributed in palu

- city by atomic absorption spectroscopy (AAS). *Journal Applied Chemical Science*, 5(1), 430–433.
- Esati, N. K., Cahyadi, K. D., Ayu, G., & Lestari, D. (2023). Uji kualitatif dan kuantitatif tetrasiklin dalam simulasi sampel secara spektrofotometri Uv-Vis. *Jurnal Farmamedika*, 8(1), 56–66.
- Haryanti, R., Suwantika, A. A., & Bratadiredja, M. A. (2020). Efek toksik merkuri dalam krim pencerah wajah dari perspektif klinis. *Jurnal Farmasi Klinik Indonesia*, 9(3), 245–254.
- Hasma, & Panaungi, A. N. (2023). Identifikasi kandungan merkuri (Hg) pada krim pemutih wajah tanpa izin BPOM yang beredar di kota pare-pare. *Journal of Pharmaceutical Science and HerbalTechnology*, 1(1), 16–21.
- Karim, B. K., & Amalia, E. (2025). Article review: analisis kadar merkuri pada sediaan kosmetik menggunakan metode spektrofotometri serapan atom. *Vitalitas Medis : Jurnal Kesehatan Dan Kedokteran*, 2(3), 79–92.
- Karsanto, N., Kresnadipayana, D., & Narang, Y. A. (2024). Uji toksisitas merkuri (Hg) terhadap organ ginjal pada tikus galur wistar (*Rattus norvegicus*) dengan pemeriksaan ureum dan kreatinin serta histopatologi ginjal. *Jurnal Analis Kesehatan Klinik Sains*, 12(1), 121–131.
- Lewis, J. (2023). Global beauty hazard: assessing mercury in skin-lightening products. *Environmental Health Perspectives*, 131(1), 9–10.
- Maulina, N., Zubir, & Nelvia, D. D. (2021). Uji kualitatif dan kuantitatif kandungan merkuri (Hg) pada krim pemutih wajah yang beredar di pasar kota panton labu tahun 2021. *Averrous: Jurnal Kedokteran Dan Kesehatan Malikussaleh*, 7(2), 112–121.
- Mustarin, R., Lestari, D., Suhartini, Ida, N., Hasan, T., Hapsari, Y., Werawati, A., Jati, M. A. S., Azzahrah, R., Astriani, A. D., & Gustini, N. (2025). *Analisis bahan baku farmasi*. Eureka Media Aksara.
- Nuradi, Mawar, & Baraling, J. D. K. (2024). Analisis kadar logam berat timbal(Pb),kadmium (Cd), dan tembaga (Cu) pada ikan teri kering yang dijual disekitar topejawa kecamatan mangarabombang. Poltekkes Kemenkes Makassar.
- Oktavia, E. P., Supardi, R. H., & Akune, N. A. S. (2025). Analisis kadar merkuri (Hg) pada krim pemutih wajah yang beredar di pasar 45 kota manado menggunakan metode spektrofotometri serapan atom. *Jurnal Kesehatan Dan Pengembangan Terbaru*, 6(4), 7–15.
- Padi, M., Suleman, N., Lyabu, H., Isa, I., Kilo, J. La, & Najmah. (2024). Analisis kandungan merkuri (Hg) pada krim pemutih wajah tanpa izin BPOM yang beredar di pasar wonosari. *Dalton: Jurnal Pendidikan Kimia Dan Ilmu Kimia*, 7(3), 248–254.
- Purnomo, F. O., Waluyo, D. A., Larasati, D. A., Habibillah, R., Widiyawati, D., & Lestari, P. A. (2024). Analisis kadar merkuri pada krim pencerah wajah menggunakan atomic absorption spectroscopy (AAS). *Jurnal Kesehatan Tambusai*, 5(4), 11076–11084.
- Qudus, H. I., Purwadi, P., Holilah, I., & Hadi, S. (2021). Analysis of mercury in skin lightening cream by microwave plasma atomic emission spectroscopy (MP-AES). *Molecules*, 26(3130), 1–10.
- Rahman, H., Wilantika, I., & Latief, M. (2019). Analisis kandungan merkuri pada krim pemutih ilegal di kecamatan pasar kota jambi menggunakan spektrofotometri serapan atom (SSA). *Pharmacy: Jurnal Farmasi Indonesia*, 16(01), 59–73.
- Rahmawati, A. S. N., Wicaksono, A. S., Nisa', T. D. El, Latifah, M. T. S., & Hutahaean, P. M. (2024). Analisis kadar logam berat dalam kosmetik dengan metode AAS: studi kasus pada sediaan krim pemutih wajah. *Jurnal Ilmiah Wahana Pendidikan*, 10(16), 43–56.
- Samaniyah, S., Meilina, R., & Asyura, S. (2025). Analisis kadar merkuri (Hg) krim pemutih wajah menggunakan spektrofotometri serapan atom (SSA) di kota banda aceh. *Journal of Healthcare Technology and Medicine*, 11(1), 323–330.
- Sende, I. F., Adin Wira Pramudita, Salafuddin, M. G., & Yunianto, E. P. (2020). Peredaran kosmetik pemutih ilegal di indonesia dan upaya penanggulangannya. *Eruditio*, 1(1), 48–62.
- Stalikas, C., & Sakkas, V. (2024). From a glimpse into the key aspects of calibration and correlation to their practical considerations in chemical analysis. *Microchimica Acta*, 1–15.
- Svehla, G. (1979). *Vogel's textbook of macro and semimicro qualitative inorganic analysis*. London. Logman.
- Triasih, S. D. (2025). Dampak kosmetik berbahan merkuri terhadap kesehatan kulit. *Maliki Interdisciplinary Journal*, 3(Januari), 36–42.