UNIVERSITI TEKNOLOGI MARA
Cawangan Perak
Kampus Tapah

FACULTY OF APPLIED SCIENCES

SCIENTIFIC PROJECT COLLOQUIUM

2024

Final Year Project Colloquium 2024
Faculty of Applied Sciences,
Universiti Teknologi MARA,
Perak Branch Tapah Campus,
35400 Tapah Road, Perak, Malaysia.

Colloquium date 12 July 2024
Publication date 30 October 2024

Proceedings of Extended Abstracts

EDITORS
Pn. Rosliza Ali
Pn. Nunshaimah Salleh
Pn. Norsakina Zurina Zulkifli
Pn. Adibatul Husna Fadzil
Pn. Yanti Yaacob
Pn. Lili Widarti Zainuddin

e-I.S.B.N: 978-629-97630-4-8

Faculty of Applied Sciences,
Universiti Teknologi MARA,
Perak Branch Tapah Campus,
35400 Tapah Road,
Perak, Malaysia.

Preface

The Scientific Project Colloquium offers a platform for publishing Diploma Science final year projects (FYP). The objective is to effectively distribute research findings throughout all scientific disciplines. The primary objective of including final year projects into the course curriculum is to encourage students to put their theoretical knowledge into practical applications.

We would like to express our gratitude to our primary establishment, the Faculty of Applied Sciences and Universiti Teknologi MARA, Perak Branch, for their invaluable assistance.

Lastly, we would like to express our gratitude to all of the authors for the tremendous help in preparing the articles, without which this undertaking would not have been completed.

Editors

Rosliza Ali
Nunshaimah Salleh
Norsakina Zurina Zulkifli
Adibatul Husna Fadzil
Yanti Yaacob
Lili Widarti Zainuddin

Universiti Teknologi MARA
Perak Branch Tapah Campus
October 2024

ANALYSIS OF SELECTED HEAVY METALS IN MALAYSIAN FOUNDATION COSMETICS USING ATOMIC ABSORPTION SPECTROPHOTOMETRY (AAS)

Nur Izzdiana Muhamad Ezzas[1], Muhammad Haiqal Mahidi[1], Noor Fadhilah Muhamad Sahapini[1*], Siti Mazleena Binti Mohamed[1*]
[1]Faculty of Applied Science, Universiti Teknologi MARA (UiTM) Perak Branch, Tapah Campus, 35400 Tapah Road, Perak, Malaysia

*fadhilahms@uitm.edu.my, mazleena@uitm.edu.my

Abstract: Beauty products are widely used to enhance appearance, but many contain harmful heavy metals. This study analyzed Cu, Cd, Cr, Mn, Ni, and Zn levels in five popular Malaysian foundation brands—Bihan, CPG, Cubremi, Kamelia, and Maaez—using flame atomic absorption spectrophotometry. The metals were detected in all samples, with concentrations ranging from 0.018 ppm to 1.012 ppm. Maaez had the highest copper and zinc levels, Bihan had the highest cadmium and manganese, and Cubremi had elevated nickel. Despite varying concentrations, none of the samples exceeded the WHO's permissible limits for heavy metals in cosmetics.

Keywords: *Heavy metals, Samples, Cosmetics products, Local foundation, Permissible limit.*

INTRODUCTION

Cosmetics are widely used substances that come into contact with the body's external layers (Rahil et al., 2019). These products often contain a variety of chemical ingredients, some of which can be harmful. Heavy metals such as copper (Cu), cadmium (Cd), chromium (Cr), manganese (Mn), nickel (Ni), and zinc (Zn) have been detected in foundations and are legally regulated due to their adverse health effects. According to global health regulations, the concentration of these hazardous substances in cosmetics should not exceed permissible limits as they can cause skin irritation, organ damage, and even cancer.

Heavy metals are linked to serious health issues, including both acute and chronic conditions. As Ali et al. (2023) point out, excessive exposure to heavy metals can lead to significant health problems. For instance, cadmium exposure can cause flu-like symptoms and lung damage, while ingesting high levels of zinc can result in gastrointestinal distress. Despite the widespread use of local cosmetics, limited data exists regarding heavy metal contamination, posing challenges for both regulators and consumers. Prolonged exposure to such products may have long-term health implications, highlighting the need for immediate attention. Additionally, heavy metals in cosmetics can accumulate on the skin and even penetrate into the bloodstream, increasing the risk of organ poisoning and carcinogenesis (Selvaraju et al., 2020).

In this study, foundation cosmetics were chosen as the focus because they are commonly used as a base in makeup routines by most of Malaysian's Women. The objectives of this study are to evaluate and quantify the concentrations of Cu, Cd, Cr, Mn, Ni, and Zn in samples of local foundation cosmetics and to determine whether these levels comply with relevant regulatory standards and guidelines. The findings aim to enhance consumer awareness and promote safer cosmetic practices.

MATERIAL & METHODOLOGY

Preparation of stock solution

Stock solutions of 1000 ppm for each metal (Cu, Cd, Cr, Mn, Ni, and Zn) were prepared by pipetting 5.0 mL into a 50 mL volumetric flask, diluted with 1% nitric acid, and made up to the calibration mark. Calibration curves were generated by serially diluting the stock solutions to prepare several concentrations: Cu (1.0–5.0 ppm), Cd (0.2–1.0 ppm), Cr (1.0–5.0 ppm), Mn (0.3–1.5 ppm), Ni (1.0–3.0 ppm), and Zn (0.15–0.75 ppm). The standards were aspirated into an atomic absorption spectrophotometer (AAnalyst 400) at their respective wavelengths, and the absorbance of both the standard and sample solutions was recorded.

Preparation of sample solution

A sample solution for each of the foundation brands (Bihan, CPG, Cubremi, Kamelia, and Maaez) was prepared by weighing approximately 1 g of foundation into a conical flask. Concentrated acids, including 5.0 mL of 30% hydrogen peroxide, 5.0 mL of 37% hydrochloric acid, and 15 mL of 65% nitric acid, were added to the flask, sealed with parafilm, and left for 15 minutes to ensure a complete reaction. The mixture was then heated at 150℃ until no brown fumes were produced and allowed to cool to room temperature. Afterward, 20 mL of pure water was added, and the solution was filtered into a 50 mL volumetric flask, topped up to the calibration mark with pure water, and shaken. The solution was then filtered again using a microfilm syringe filter to prevent precipitation before being aspirated into an atomic absorption spectrophotometer (AAnalyst 400) for analysis. The selected heavy metals (Cu, Cr, Cd, Mn, Ni, and Zn) were analyzed using different hollow cathode lamps specific to each element.

Figure 1 All five brands sample foundation

Figure 2 The filtered process with filter paper using glass filter funnel

Figure 3 the process and apparatus of filtered microfilm syringe filter

RESULTS AND DISCUSSIONS

Table 1 presents the concentrations of heavy metals detected in cosmetic samples analyzed in this project, ranging from (0.018±0.0179 to 0.739±0.0474) ppm for Cu, (0.003±2.9759× 10^{-8} to 0.056±0.0025) ppm for Cd, (2.856±0.0300 to 4.629±0.0300) ppm for Cr, (0.172±0.0028 to 0.427±0.0407) ppm for Mn, (0.183±0.0075 to 0.292±0.0046) ppm for Nickel, and (0.380±0.0031 to 1.012±0.0044) ppm for zinc, Zn. The study employed Atomic Absorption Spectroscopy (AAS) to determine heavy metal concentrations in various local foundation cosmetics. Five foundation samples were randomly collected from different local markets.
range from

The data reveals that all samples contain detectable levels of heavy metals. According to the World Health Organization (WHO), the levels found must be within safe limits for use. The findings suggest that the brands analyzed - Bihan, CPG, Cubremi, Kamelia, and Maaez are safe for use as their heavy metal concentrations remain below WHO's permissible limits. Heavy metals in local cosmetics are permissible when regulated and kept within set guidelines. Deviations from these criteria could have long-term harmful effects on users. It is crucial that suppliers adhere to Standard Operating Procedures (SOPs) to avoid severe consequences.

The presence of these heavy metals in local foundation cosmetics raises potential health risks, including skin irritation, systemic toxicity, and long-term effects such as cancer and organ damage. These findings underscore the importance of stringent quality control, strict safety regulations, and regular monitoring within the cosmetic industry. Public awareness campaigns and safer manufacturing practices are essential to minimize risks associated with heavy metal contamination in cosmetic products.

Table 1. The levels concentration of each heavy metal in local foundation with WHO permissible limit standard

Sample	Concentration of each Heavy Metals (mg/L)					
	Copper Cu	Cadmium Cd	Chromium Cr	Manganese Mn	Nickel Ni	Zinc Zn
Bihan	0.018±0.0179	0.056±0.0025	4.629±0.0300	0.427±0.0407	0.198±0.0001	0.771±0.0505
CPG	0.227±0.0179	0.054±0.0017	4.629±0.0300	0.172±0.0028	0.193±0.0046	1.012±0.0044
Cubremi	0.688±0.0173	0.005±0.0017	2.856±0.0300	0.248±0.0029	0.292±0.0046	0.391±0.0068
Kamelia	0.083±0.1230	0.054±0.0017	4.611±0.0300	0.072±0.0030	0.183±0.0075	0.380±0.0031
Maaez	0.739±0.0474	$0.003 \pm 2.9759 \times 10^{-8}$	2.944±0.0300	0.255±0	0.282±0	3.292±0.8646
WHO	73.7	0.2	NA	NA	67.9	99.4

NA: Not Available

Additionally, this project compares the concentrations of heavy metals found in each brand's samples by analyzing the reported mean concentrations for each metal. For copper, the Bihan sample exhibits the lowest concentration at 0.018 ± 0.0179 ppm, while the Maaez sample has the highest concentration at 0.739 ± 0.0474 ppm. For cadmium, the Maaez sample has the lowest concentration at $0.003 \pm 2.9759 \times 10^{-8}$ ppm, whereas the Bihan sample shows the highest concentration at 0.056 ± 0.0025 ppm. The lowest chromium concentration, 2.856 ± 0.0300 ppm, was found in Cubremi, while the highest concentrations, 4.629 ± 0.0300 ppm, were detected in Bihan and CPG samples. For manganese, the Cubremi sample contains the lowest concentration at 0.248 ± 0.0029 ppm, while Bihan has the highest at 0.427 ± 0.0407 ppm. The highest concentration of nickel, 0.292 ± 0.0046 ppm, was found in Cubremi, and the lowest concentration, 0.183 ± 0.0075 ppm, was detected in Kamelia. Lastly, Maaez has the highest zinc concentration at 1.012 ± 0.0044 ppm, while Kamelia has the lowest at 0.380 ± 0.0031 ppm.

This project also evaluates whether the detected heavy metal concentrations comply with relevant regulatory standards for cosmetic products. According to Ogbaji et al. (2023), WHO permits a copper concentration limit of 73.7 mg/Kg, which is equivalent to 73.7 mg/L or 73.7 ppm (as per Terrie K. and Boguski, P.E., 2006). The concentrations of copper found in the Bihan, CPG, Cubremi, Kamelia, and Maaez samples are well below this limit. Similarly, the detected cadmium concentrations in all samples are below the WHO limit of 0.2 mg/Kg (Ogbaji et al., 2023). The nickel concentrations in the analyzed samples are also below WHO's limit of 67.9 mg/Kg for cosmetics. Additionally, the zinc concentrations in all samples are lower than the WHO permissible limit of 99.4 mg/Kg.

CONCLUSIONS

Elemental analysis revealed the presence of copper, cadmium, chromium, manganese, nickel, and zinc in all cosmetic samples tested. The concentrations of copper in the examined local foundation samples followed the order: Maaez > Cubremi > CPG > Kamelia > Bihan. For cadmium, the concentration order was: Bihan > CPG > Kamelia > Cubremi > Maaez. The chromium levels in the samples were ranked as follows: Bihan and CPG > Kamelia > Maaez > Cubremi. For manganese, the concentration order was: Bihan > Maaez > Cubremi > CPG > Kamelia. The nickel concentrations followed this order: Cubremi > Maaez > Bihan > CPG > Kamelia. Lastly, the zinc concentrations were ordered as follows: Maaez > CPG > Bihan > Cubremi > Kamelia. The study found that the concentrations of heavy metals in the cosmetic foundation samples were lower than those reported in previous studies. Additionally, the amounts of Cu, Cd, Cr, Mn, Ni, and Zn in all samples were within the WHO's maximum allowable limits, indicating that these foundation products are safe for use by Malaysian teenagers, students, and the general public. While cosmetics are widely used in daily life, they are not inherently risk-free. The Atomic Absorption Spectrophotometer (AAS) device used in this experiment has limitations; it cannot detect all heavy

metals. Specifically, it cannot analyze mercury (Hg) and lead (Pb), two of the most hazardous elements, because it lacks the necessary hollow cathode lamps (HCL) for these metals. The device is limited to analyzing only certain heavy metals in the samples. This project provided valuable knowledge and practical experience in maintaining and operating AAS instruments. The initiative had significant theoretical and practical implications, demonstrating that AAS instruments can yield reliable results for detecting essential heavy metals. Public education is crucial to raise awareness about the dangers of prolonged use of cosmetics containing harmful substances. Continuous and extensive use of products with high levels of toxic metals can lead to their gradual release, ultimately causing harm to consumers. National safety standards should be enforced to ensure that cosmetic products are thoroughly tested and deemed safe before being imported and made available to the public. However, further research is needed to evaluate metal concentrations in various cosmetic, skincare, and body care products to better protect consumer health

COMPLIANCE OF ETHICAL STANDARDS

Not applicable.

REFERENCES

Aeran, K., You Jin, L., Yun Sik, C., Hyun Jue, K., Sang Hun, C., Yang Hee, K., Jeong Won, R., & Yong Bae, P. (2021). A study on UV filters, preservatives and heavy metals contained in the children's and inorganic sunscreens distributed in korea. *Journal of Society of Cosmetic Scientists of Korea*, *47*(4). http://dx.doi.org/10.15230/SCSK.2021.47.4.289

Ali, M., Shahzad, L., Hayyat, M. U., Sharif, F., Ghafoor, G. Z., & Nasir, R. (2023). Determination of heavy metals and their associated health risk assessment in the commonly available sunblocks. *International Journal of Environmental Analytical Chemistry*, 1–18. https://doi.org/10.1080/03067319.2023.2173599

Brubaker, J. (2018, March 13). *How to calculate calibration curves*. Sciencing. https://sciencing.com/calculate-calibration-curves-6121113.html#:~:text=The%20equation%20will%20be%20of

Endah, S. R. N., & Surantaatmadja, S. I. (2019). The determination of heavy metals level: Lead in cosmetic soap preparation by atomic absorption spectrophotometer (AAS). *Journal of Physics: Conference Series*, *1179*(1). https://doi.org/10.1088/1742-6596/1179/1/012178

Meng, Y., Li, Y., Zheng, N., Hou, S., Li, Y., Wang, S., Sun, S., Hua, X., & Liang, D. (2021). Potential health risks of metals in skin care products used by Chinese consumers aged 19–29 years. *Ecotoxicology and Environmental Safety*. https://doi.org/10.1016/j.ecoenv.2021.112184

Mohammed, A. M. (2021). Elemental analysis using atomic absorption spectroscopy. *European Journal of Engineering and Technology Research*, *6*(7), 48–51. https://doi.org/10.24018/ejeng.2021.6.7.2639

Ogbaji, E. G., Garindo, B., & Adam, A. B. (2023). Assessment of some heavy metals in selected cosmetics and their human health effect. *Federal University Wukari Trends in Science & Technology Journal*, *8*(1), 378–380.

Onyambu, Z., Nawiri, M., Wanjau, R., & Kareru, P. (2018). Levels of selected heavy metals in aloe vera branded herbal creams sold in the kenyan markets. *Journal of Chemical and Pharmaceutical Research*, *10*(1), 9–12. https://www.jocpr.com/articles/levels-of-selected-heavy-metals-in-aloe-vera-branded-herbal-creams-sold-in-the-kenyan-markets.pdf

Papadopoulos, A., Assimomytis, N., & Varvaresou, A. (2022). Sample preparation of cosmetic products for the determination of heavy metals. *Cosmetics*, *9*(1), 21. https://doi.org/10.3390/cosmetics9010021

Rahil S. Y. S., Elshara, I. A., Ahmida, N. H. S., & Ahmida, M. H. S. (2019). Determination of some heavy metals in cosmetic products collected from Benghazi-Libya markets during 2016. *Libyan International Medical University Journal*, *4*(1). https://doi.org/10.4103/LIUJ.LIUJ_44_18

Rusmadi, S. Z., Syed Ismail, S. N., & Praveena, S. M. (2017). A case study of selected heavy metals (lead, cadmium, and nickel) in skin-lightening creams and dermal health risk in Malaysia. *Annals of Tropical Medicine and Public Health*, *10*(1), 95–100. https://doi.org/10.4103/ATMPH.ATMPH_82_17

Safavi, S., Najarian, R., Rasouli-Azad, M., Masoumzadeh, S., Ghaderi, A., & Eghtesadi , R. (2019). A narrative review of heavy metals in cosmetics; health risks. *International Journal of Pharmaceutical Research*, *11*(4). https://doi.org/10.31838/ijpr/2019.11.04.031

Selvaraju, A., Abdul Halim, A. N. S., & Abdul Keyon, A. S. (2020). Determination of selected heavy metal concentrations in unregistered face whitening creams sold in Johor Bahru, Johor, Malaysia by using inductively coupled plasma optical emission spectroscopy and their health risk assessment. *Malaysian Journal of Analytical Sciences*, *24*(5), 670–681. https://mjas.analis.com.my/mjas/v24_n5/pdf/Selvaraju_24_5_5.pdf

Semiha Kopru, & Mustafa Soylak. (2024). Inductively coupled plasma-mass spectroscopy (ICP-MS) detection of trace metal contents of children cosmetics. *Optical and Quantum Electronics*, *56*(3). https://doi.org/10.1007/s11082-023-06166-w

Terrie K., & Boguski, P.E. (2006). Environmental science and technology briefs for citizens environmental science and technology briefs for citizens. *Environmental Science and Technology Briefs for Citizens*, *2*, 1–2. https://cfpub.epa.gov/ncer_abstracts/index.cfm/fuseaction/display.files/fileid/14285#:~:text=Parts%20per%20million%20and%20parts

Pejabat Perpustakaan
Library Office

Universiti Teknologi MARA
Cawangan Perak
Kampus Seri Iskandar
32610 Bandar Baru Seri Iskandar,
Perak Darul Ridzuan, MALAYSIA
Tel: (+605) 374 2093/2453 Faks: (+605) 374 2299

UNIVERSITI TEKNOLOGI MARA

Surat kami : 700-KPK (PRP.UP.1/20/1)
Tarikh : 20 Januari 2023

Prof. Madya Dr. Nur Hisham Ibrahim
Rektor
Universiti Teknologi MARA
Cawangan Perak

Tuan,

PERMOHONAN KELULUSAN MEMUAT NAIK PENERBITAN UiTM CAWANGAN PERAK MELALUI REPOSITORI INSTITUSI UiTM (IR)

Perkara di atas adalah dirujuk.

2. Adalah dimaklumkan bahawa pihak kami ingin memohon kelulusan tuan untuk mengimbas (*digitize*) dan memuat naik semua jenis penerbitan di bawah UiTM Cawangan Perak melalui Repositori Institusi UiTM, PTAR.

3. Tujuan permohonan ini adalah bagi membolehkan akses yang lebih meluas oleh pengguna perpustakaan terhadap semua maklumat yang terkandung di dalam penerbitan melalui laman Web PTAR UiTM Cawangan Perak.

Kelulusan daripada pihak tuan dalam perkara ini amat dihargai.

Sekian, terima kasih.

"BERKHIDMAT UNTUK NEGARA"

Setuju.

27.1.2023

PROF. MADYA DR. NUR HISHAM IBRAHIM
REKTOR
UNIVERSITI TEKNOLOGI MARA
CAWANGAN PERAK
KAMPUS SERI ISKANDAR

Saya yang menjalankan amanah,

SITI BASRIYAH SHAIK BAHARUDIN
Timbalan Ketua Pustakawan

nar