

Natural Based Gel Body Soap from *Chromolaena Odorata*

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Abstract

The gel body soap formulated from *Chromolaena odorata* is a natural-based product specially designed for skin care. The primary ingredients used in the formulation of this soap are *Chromolaena odorata* leaf extract, glycerin, sodium benzoate, citric acid and other safe, skin-friendly additives. The leaves contain antioxidants, vitamins, and minerals that are beneficial for skin health, helping to refresh, moisturize, and maintain the skin's pH balance. This product is suitable for all age groups and various skin types. A heavy metal analysis of the soap samples was conducted using ICP-MS (Inductively Coupled Plasma Mass Spectrometry), a sensitive and precise detection method. Test results showed that all parameters were within the permitted safety limits. Lead (Pb) concentration was found to be less than 1.00 ppm (maximum limit: 20.0 ppm), Cadmium (Cd) at 0.02 ppm, and Arsenic (As) at 0.05 ppm (both within the 5.0 ppm limit), while Mercury (Hg) content was less than 0.01 ppm (maximum limit: 1.0 ppm). Overall, the results confirm that the product is free from harmful heavy metal contamination and safe for use. In addition, survey findings indicated a high level of effectiveness of the gel body soap, based on feedback from the majority of the 15 respondents. This demonstrates the potential of the product as a safe and effective natural alternative to conventional body soaps.

Key Words: *Chromolaena odorata*, natural body soap, skincare, antioxidants, natural alternative

1. Introduction

The growing awareness of the adverse health effects linked to synthetic ingredients in cosmetic products has led to a significant shift toward plant-based alternatives (Babich et al., 2025). This increasing demand for natural and skin-friendly personal care products has catalyzed the development of innovative formulations utilizing botanical extracts. Among these, a gel body soap incorporating *Chromolaena odorata* leaf extract has garnered attention for its promising dermatological properties.

Chromolaena odorata, a plant known for its rich content of antioxidants, vitamins, and essential minerals, has been shown to exhibit a wide range of bioactivities, including antioxidant, anti-inflammatory, analgesic, antimicrobial, and cytoprotective effects (Jagatheesh et al., 2020). Leveraging these properties, the formulated body soap integrates *C. odorata* extract with glycerin and other mild, non-toxic additives to create a moisturizing and gentle product suitable for diverse skin types and age groups.

To evaluate its safety profile, the product underwent heavy metal analysis using Inductively Coupled Plasma Mass Spectrometry (ICP-MS). Results confirmed that concentrations of lead (Pb), cadmium (Cd), arsenic (As), and mercury (Hg) were all well below established safety thresholds, indicating the absence of hazardous contamination. Additionally, user feedback collected via a structured survey revealed high levels of satisfaction and positive perceptions regarding the soap's effectiveness, highlighting its potential as a viable, natural alternative to conventional gel body cleansers.

2. Material and Method

The gel body soap was formulated using *Chromolaena odorata* leaf extract as the primary active ingredient, combined with glycerin, sodium benzoate, citric acid and other skin-safe additives. Fresh *Chromolaena odorata* leaves were collected, thoroughly washed, and subjected to an extraction process to obtain the leaf extract. The extract was then incorporated into a gel base along with glycerin and additional formulation components to produce the final body soap.

To assess the safety of the product, particularly with regard to heavy metal contamination, samples of the formulated gel soap were analyzed using Inductively Coupled Plasma Mass Spectrometry (ICP-MS). This method was chosen for its high sensitivity and precision in detecting trace levels of heavy metals. Compared to traditional atomic absorption spectroscopy (AAS), ICP techniques offer greater speed, precision, and sensitivity (Skoog et al., 2014). Inductively Coupled Plasma Mass Spectrometry (ICP-MS) is a powerful technique for detecting heavy metals in various samples. Studies have used ICP-MS to analyze thyme products (Akoury et al., 2022), environmental samples (Greda et al., 2022), and freshwater fish (Mielcarek et al., 2022) for the presence of lead (Pb), cadmium (Cd), arsenic (As), and mercury (Hg). The concentrations of lead (Pb), cadmium (Cd), arsenic (As), and mercury (Hg) were measured and compared against established safety limits. Cosmetic soap products are required to comply with safety regulations and must not contain hazardous substances such as heavy metals, which are known to be toxic and harmful to human health (Endah & Surantaatmadja, 2023). In cosmetic science, the preparation of cosmetic samples for the analysis of heavy and toxic metals such as lead (Pb), mercury (Hg), cadmium (Cd), and arsenic (As) is critically important, as the complex nature of cosmetic matrices poses significant challenges in sample handling and accurate elemental determination (Papadopoulos, Assimomytis & Varvaresou, 2022). Citric acid is a better choice for final bath pH adjustments because it's more stable, provides more consistent pH control, and is safer to use.

In addition to the chemical analysis, a user-based survey was conducted with 15 respondents to evaluate the perceived effectiveness of the gel body soap. Respondents from various age groups and skin types were invited to use the product and provide feedback through a structured questionnaire focusing on skin feel, moisturizing effects, irritation, and overall satisfaction.

3. Result

The results are divided into two parts: the heavy metal test and the mean scores of respondents.

Table 1: Heavy Metal Test

Parameter	Result	Unit	Specification	Method
Lead	< 1.00	ppm	≤20.0	In-House Method based on ICPMS Application
Cadmium	0.02	ppm	≤5.0	In-House Method based on ICPMS Application
Arsenic	0.05	ppm	≤5.0	In-House Method based on ICPMS Application
Mercury	<0.01	ppm	≤1.0	In-House Method based on ICPMS Application

Based on the results of the heavy metal analysis in Table 1 conducted on the sample, it was found that all tested parameters were within the permissible range according to the specified standards. The concentration of Lead (Pb) was less than 1.00 ppm, which is significantly lower than the maximum limit of 20.0 ppm. Cadmium (Cd) recorded a reading of 0.02 ppm, while Arsenic (As) was recorded at 0.05 ppm, both well below the permitted limit of 5.0 ppm. The Mercury (Hg) content was also very low, at less than 0.01 ppm, compared to the maximum limit of 1.0 ppm. Mercury (Hg) is strictly prohibited in all cosmetic products due to its high toxicity and potential health risks, including neurological and kidney damage. Mercury's mechanism of action involves disrupting melanin synthesis and causing direct cellular toxicity (Meena et al., 2024; Jiang & Tao, 2024). Other heavy metals like lead (Pb) and aluminum (Al) in cosmetics have been linked to neurodevelopmental disorders and Alzheimer's disease, respectively (Sarah et al., 2024). A study comparing heavy metal concentrations in blood samples of cosmetic users and non-users found elevated levels of mercury, with some samples exceeding safety limits (Habib et al., 2024). Regulatory agencies, such as the U.S. FDA and

the EU Cosmetic Regulation, permit only trace amounts specifically less than 1 part per million (ppm) and only when it is technically unavoidable under good manufacturing practices. Any product exceeding this limit is considered non-compliant and unsafe for consumer use (Birsan et. al, 2023).



Figure 1: Mean Score of Respondent

Based on Figure 1, this product received very positive feedback from users, with most scores exceeding 4.7. The aspects of soap fragrance, non-stickiness, and cleansing recorded the highest scores (4.93), indicating that users were highly satisfied with these features. This proves that the soap is not only effective in cleaning but also has a pleasant scent and a comfortable texture for use.

However, there were two aspects with slightly lower scores: eliminating body odor (4.67) and not causing irritation (4.73). Although these scores are still high, they may indicate room for improvement. For example, further studies could be conducted to determine whether some users experienced irritation or were less satisfied with the soap's effectiveness in eliminating body odor.

In addition, the scores for “moisturizing” and “overall satisfaction,” each at 4.80, indicate that aside from cleanliness and fragrance, the soap also provides a soft feeling on the skin and delivers consistent overall satisfaction during use. Furthermore, the score for “foaming” (4.87) reinforces the perception that users appreciate the rich, foamy lather during bathing.

Overall, this chart illustrates a well-balanced performance profile for the product, with strengths in cleansing, fragrance, and non-sticky texture. Improvement efforts should focus on enhancing the anti-odor formulation and reducing potential irritation so that all product dimensions reach the same level of excellence as the top-rated attributes especially in terms of effectiveness in eliminating body odor and improving suitability for all skin types.

4. Discussion

Based on the results of the heavy metal test conducted, it can be concluded that the analyzed sample meets all ICP-MS (Inductively Coupled Plasma Mass Spectrometry) safety standards for heavy metal content. The tested parameters (Pb, Cd, As, Hg) showed concentrations well below the maximum permitted limits. This confirms that the sample is safe to use without the risk of harmful heavy metal contamination. These results also reflect good quality control

during the production process or in the sourcing of raw materials. In addition, feedback from the questionnaire respondents was also positive in terms of the product's appearance, color, and texture. The gel body soap has an attractive natural color and a refreshing scent, without an overpowering herbal smell. Its soft, non-sticky gel texture is also a key attraction for users. The size and packaging of the product are considered suitable and practical for users of all age groups, especially because it is easy to carry and convenient for use in various situations. In conclusion, this soap product successfully meets consumer needs with excellent performance in most aspects. With minor improvements in certain areas, the product has the potential to be even better and more widely accepted. The data from this study can also serve as strong evidence to boost customer confidence in the product's quality.

5. Conclusion

The natural-based gel body soap formulated with *Chromolaena odorata* leaf extract has been successfully developed and demonstrates both product safety and consumer acceptability. Heavy metal analysis using ICP-MS confirmed that the levels of lead (Pb), cadmium (Cd), arsenic (As), and mercury (Hg) were all significantly below established safety limits, indicating the absence of harmful contamination and reflecting good quality control throughout production.

Consumer feedback further supports the product's appeal, highlighting its natural appearance, refreshing scent, soft non-sticky texture, and convenient packaging. These attributes contribute to its suitability for users of all ages and lifestyles. Although most evaluated parameters received high satisfaction scores, minor refinements particularly in enhancing odor elimination and minimizing potential irritation could further elevate the product's performance.

Overall, the findings affirm that this gel body soap meets key consumer expectations while adhering to safety standards. With targeted improvements, it holds strong potential for broader acceptance and marketability. The data presented may also serve as a valuable foundation to build consumer confidence and support future commercialization efforts.

References

- Akoury, E., Baroud, C., Kantar, S., Hassan, H. & Karam, L. (2022). *Determination of heavy metals contamination in thyme products by inductively coupled plasma mass spectrometry*. Toxicology Reports.
- Babich, O., Ivanova, S., Bakhtiyarova, A., Kalashnikova, O. & Sukhikh, S. (2025). *Medicinal plants are the basis of natural cosmetics*. Process Biochemistry, 154, 35-51.
- Birsan, M., Cătălina Stan, C.D., Mielcarek, K., Nowokoski, P., Socha, K., Palimariciuc, M., Scripcariu, S.I., Antonoaea, P., Vlad, R.A., Todoran, N. & Ciurba, A. (2023). *Mercury Exposure in Cosmetics and Human Health Risk*. Farmacia 71(5), 930-937.
- Endah, S.R.N. & Surantaatmadja, S.I. (2023). *The Determination of Heavy Metals Level : Lead in Cosmetic Soap Preparation by Atomic Absorption Spectrophotometer*, Journal of Physics 1-6.
- Greda, K., Welna, M. & Pohl, P. (2022). *Determination of Ag, Bi, Cd, Hg, Pb, Tl, and Zn by inductively coupled plasma mass spectrometry combined with vapor generation assisted by solution anode glow discharge - A preliminary study*. Talanta: The International Journal of Pure and Applied Analytical Chemistry. <https://doi.org/10.1016/j.talanta.2022.123500>
- Habib, U., Pervaiz, A., Murtaza, A., Hussain, A., Sarwar, H., Ullah, M., Ayub, M. A., Ahmad, N., & Bashir, M. (2024). *Assessing The Cumulative Effects Of Heavy Metal Exposure*

- From Cosmetic Products On Local Consumers: Array. Journal of Mountain Area Research*, 9, 149–167. <https://doi.org/10.53874/jmar.v9i0.195>
- Jagatheesh, S., Anandhi, D., Revathi, K., Sundaravalli, K., Jasmin Vigila, J. & Devi, R. (2020). *Biological Potential and Characterization Of Green Synthesized Silver Nanoparticles Using Chromolaena Odorata*. *Annals of R.S.C.B*, 24, 227-238.
- Jiang, S. & Tao, X. (2024). *Literature review of the potential harm and mechanisms of mercury poisoning related to cosmetics*. *American Journal of Translational Research* 16(10).
- Meena, P., Das, P., Rathore, V., Panda, S., & Popa, C. (2024). *Snow White's tale in nephrology: the emerging threat of skin-whitening creams on kidney health*. *Clinical Kidney Journal* 18 (1).
- Mielcarek, K., Nowakowski, P., Jakubik, A.P., Kępka, K.G., Soroczyńska, J., Żukowska, M., Naliwajko, S., Grabia, M., Bielecka, J., Żmudzińska, A., Moskwa, J., Karpińska, E. & Socha, K. (2022). *Arsenic, cadmium, lead and mercury content and health risk assessment of consuming freshwater fish with elements of chemometric analysis*. *Food Chemistry*. <https://doi.org/10.1016/j.foodchem.2022.132167>
- Papadopoulos, A., Assimomytis, N. & Varvaresou, A. (2022) *Sample Preparation of Cosmetic Products for the Determination of Heavy Metals*. *Cosmetics*, 9, 21. <https://doi.org/10.3390/cosmetics9010021>
- Sarah, K. A., Sohaila A. S. & Eshra, A.G. (2024). *Heavy Metals and Cosmetics Industry: A Review Article*. *International Journal of Pharmaceutical Quality Assurance* 15(3):1833-1837.
- Skoog, D., West, D. and Holler, F. (2014). *Fundamentals of Analytical Chemistry*. 9th Edition, Saunders College Publishing, 649-660.