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### **EDITORS**

Pn. Rosliza Ali

Pn. Nunshaimah Salleh

Pn. Norsakina Zurina Zulkifli

Pn. Adibatul Husna Fadzil

Pn. Yanti Yaacob

Pn. Lili Widarti Zainuddin

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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

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# CHARACTERIZATION & ANTIBACTERIAL ACTIVITY OF GOAT'S MILK SOAP ENRICHED WITH *PIPER BETLE* LEAF POWDER

\*Rosliza Ali, Adibatul Husna Fadzil, Norsakina Zurina Zulkifli, Nunshaimah Salleh, Yanti Yaacob  
Faculty of Applied Sciences, Universiti Teknologi MARA, Perak Branch Tapah Campus,  
35400 Tapah Road, Perak, MALAYSIA

\*rosliza\_ali@uitm.edu.my

**Abstract:** The aims of this study are to optimize the best formulation of goat's milk soap enriched with Piper betle leaf powder and to investigate the antibacterial activity against *Staphylococcus epidermidis*. In this study, four goat's milk soap samples were prepared with different ratios. These soaps were characterized for its organoleptic properties, pH, allergy test and antibacterial activity. The antibacterial activity was assessed by measuring the inhibition zones around the bacterial cultures using the agar-well diffusion method. The findings reveal that the inclusion of *Piper betle* leaf powder did not demonstrate antibacterial activity against *Staphylococcus epidermidis*.

**Keywords:** goat's milk soap, *Staphylococcus epidermidis*, *Piper betle*, antibacterial

## INTRODUCTION

The demand for natural and functional skincare products has surged in recent years, with particular attention given to formulations enriched with natural antibacterial agents to enhance skin health and hygiene (Patel et al., 2023). Goat milk soap has gained popularity for its unique properties, including high moisturizing capacity and the presence of essential nutrients such as vitamins, proteins, and fatty acids that promote skin nourishment and repair (Gamage et al., 2022). Enriching goat milk soap with natural antibacterial additives like *Piper betle* (betel leaf) powder could potentially augment its therapeutic properties, as *Piper betle* is recognized for its robust antibacterial and antioxidant activities due to bioactive compounds such as eugenol and chavicol (Kumar & Singh, 2023).

*Piper betle*, widely used in traditional medicine, exhibits antimicrobial efficacy against a range of bacteria, including both Gram-positive and Gram-negative strains (Singh et al., 2023). These properties make it a promising ingredient for skincare applications, especially in soap formulations where antibacterial activity is crucial for preventing skin infections and reducing bacterial growth on the skin surface. The incorporation of *Piper betle* leaf powder into goat milk soap provides a multifunctional product, combining the moisturizing and skin-soothing benefits of goat milk with the antibacterial and antioxidant properties of *Piper betle* (Raj et al., 2023).

This study focuses on characterizing goat milk soap enriched with *Piper betle* leaf powder, examining its physicochemical properties and evaluating its antibacterial activity. Characterization is essential for assessing the stability, quality, and effectiveness of the soap, while antibacterial testing provides insights into its potential use in personal care applications. The findings may contribute to the development of natural and effective antibacterial soaps that align with consumer preferences for minimally processed, plant-based skincare products (Wu & Lin, 2023).

## METHODOLOGY

### 1. Preparation of Soap

The soap synthesis process involved creating two versions: one with plain milk powder and the other with chocolate-flavored milk powder. First, 27 g of milk powder, 68.0 mL of pure water, and 317.0 mL of cooking oil were accurately measured. The milk powder was dissolved in pure water by heating the mixture in a 1000 mL beaker. After dissolving, the milk solution was combined with the cooking oil in a separate beaker and blended thoroughly using a hand mixer. Meanwhile, a lye solution was prepared by weighing 64.10 g of lye powder and 68.0 mL of pure water, which were mixed together with a hand blender in another beaker. This lye solution was then gradually added to the milk-oil mixture and blended until the soap mixture reached trace. Then 5 g of *Piper betle* leaf powder was added and blended until homogenous. The mixture was quickly poured into silicone molds to prevent solidification. The same process was followed using chocolate milk powder to create the second version of soap.

## 2. Antibacterial Testing

The bacterial culture of *Staphylococcus epidermidis* was prepared by first disinfecting the workspace with a 70% alcohol spray. The openings of the broth bottles and bacterial culture bottle were sterilized using a Bunsen burner, along with the inoculating loop. The bacterial culture was then introduced into the broth solution, which was subsequently incubated in a shaker incubator for 24 hours. Bacterial growth was evaluated by assessing the turbidity of the broth.

The antibacterial effectiveness of the soap was tested using both the spread plate technique and the Kirby-Bauer disk diffusion method. The broth solution was diluted to three concentrations ( $10^1$ ,  $10^2$ , and  $10^3$ ) by mixing 1 mL of the broth with 9 mL of saline solution. Agar plates were labeled with the dilution factor, date, and sample identifiers (D for distilled water, De for Dettol, P for plain soap, and C for chocolate soap). A 15  $\mu$ L aliquot of the diluted bacterial sample was pipetted onto the center of each plate and spread evenly with a sterilized glass spreader. This procedure was repeated for each bacterial concentration, with three sets prepared for each sample. For the Kirby-Bauer disk diffusion method, sterilized filter paper disks were placed on the agar plates, and three drops of distilled water, Dettol, plain soap, and chocolate soap were applied to their respective disks. The plates were incubated in an inverted position, and after incubation, the zones of inhibition around each disk were observed and measured.

## 3. Physicochemical Testing

Following the completion of the soap production process, an evaluation was conducted to determine the quality of the final product. During this phase, comprehensive physicochemical analyses were performed to assess the efficacy of soap formulated with goat milk powder and *Piper betle* powder, in comparison to a control soap without *Piper betle* powder. The physical testing was divided into five key components: color, hardness, solubility, allergenicity, and foam production assessments. The pH of the goat's milk soap was also assessed.

## FINDINGS

Table 1: Formulation of plain and chocolate goat milk soap with *Piper betle* leaf powder

Sample	Mass of lye (g)	Volume of distilled water for lye (ml)	Mass of goat milk powdered (g)	Volume of distilled water for milk (ml)	Mass of cooking oil (g)	Volume of essential oil (ml)	Mass of Piper betle leaf powder (g)
I	60	25	27	30	250	3	2.5
II	60	28	27	30	280	3	2.5
III	64	34	27	34	317	3	5
IV	64	35	27	35	320	5	5

Sample III was identified as the optimal soap formulation, indicating that its specific composition offers superior quality and functionality. This formulation, consisting of 64 g of lye, 34 ml of distilled water for lye dissolution, 27 g of goat milk powder in 34 ml of distilled water, 317 g of cooking oil, 3 ml of essential oil, and 5 g of *Piper betle* leaf powder, achieves an ideal balance of physicochemical properties, including enhanced solubility and foam stability.

Table 2: pH of goat's milk soap

Types of goat's milk soap	pH
Plain goat milk	10.3
Plain goat milk + <i>piper betle</i>	10.7
Chocolate goat milk	10.2
Chocolate goat milk + <i>piper betle</i>	10.5

The pH measurements for the various goat milk soap formulations reveal slight variations depending on the ingredients. The plain goat milk soap exhibited a pH of 10.3, while the addition of *Piper betle* increased the pH to 10.7. Similarly, chocolate goat milk soap demonstrated a pH of 10.2, which rose to 10.5 with the incorporation of *Piper betle*. These results suggest that the presence of *Piper betle* may contribute to a modest increase in the soap's alkalinity across formulations.



Figure 1: Plain and chocolate goat milk soap

Table 3: Physicochemical testing of goat's milk soap

Types of goat's milk soap	Physical Test				
	Color	Hardness	Solubility test	Foam test	Allergic test
Plain goat milk	Milky white	Hard	Low soluble	Less foam	Negative
Plain goat milk + <i>piper betle</i>	Brown	Hard	Low soluble	More foam	Negative
Chocolate goat milk	Brown	Hard	Low soluble	Less foam	Negative
Chocolate goat milk + <i>piper betle</i>	Brown	Hard	Low Soluble	More foam	Negative

The absence of a zone of inhibition around the sample may be attributed to the use of cherry blossom essential oil, which, like other essential oils, exhibits antimicrobial properties that vary based on its chemical composition (Kumar et al., 2023; Le et al., 2022). Essential oils contain diverse bioactive compounds, such as terpenes, phenols, and aldehydes, that are generally responsible for their antibacterial activity. However, the specific compounds

within cherry blossom essential oil may not be sufficiently effective against *Staphylococcus epidermidis* due to the oil's narrow antimicrobial spectrum or limited efficacy against this specific bacterial strain (Liu et al., 2023).

*Staphylococcus epidermidis* is a known pathogen capable of developing resistance to various antibiotics and antimicrobial agents, including essential oil constituents (Zhou et al., 2023). This inherent resistance mechanism could reduce its susceptibility to the antibacterial components of cherry blossom essential oil. Additionally, the concentration of the essential oil within the soap formulation is a critical factor; if the concentration of active antibacterial compounds is too low, it may be insufficient to inhibit *S. epidermidis* (Smith & Hayes, 2023).

The quality of the cherry blossom essential oil used in the formulation also plays a significant role. Lower-grade essential oils may contain fewer active antibacterial compounds or contaminants that could impair antibacterial efficacy, further contributing to the lack of an inhibition zone (Chen et al., 2022). Therefore, the absence of a zone of inhibition could result from either a low concentration or the compromised quality of the cherry blossom essential oil within the soap formulation.

## CONCLUSIONS

The antimicrobial testing of the expired goat milk soap enriched with *Piper betle* leaf powder yielded no evidence of antibacterial activity. Across multiple trials using the spread plate technique with *Staphylococcus epidermidis* as the test organism, the soap solutions consistently failed to inhibit bacterial growth, indicating insufficient antibacterial efficacy in the current formulation. This limitation may be attributed to suboptimal extraction methods for *Piper betle* leaf powder, which likely reduced its antibacterial effectiveness. Additionally, the inclusion of essential oil could have contributed to reduced antibacterial activity.

In conclusion, this study demonstrates that while expired goat milk can be repurposed into a functional soap, there remain significant areas for improvement, especially in enhancing antibacterial and moisturizing properties. These findings highlight the potential for incorporating food waste into eco-friendly personal care products; however, practical formulation adjustments are necessary to overcome current limitations. Future research should prioritize optimizing ingredient ratios and evaluating alternative antibacterial and moisturizing agents to develop a more effective and skin-compatible product.

## COMPLIANCE OF ETHICAL STANDARDS

All procedures performed in studies involving human participants were in accordance with the ethical standards of the institutional. Informed consent was obtained from all individual participants included in the study.

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Saya yang menjalankan amanah,

*Setuju.*

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KAMPUS SERI ISKANDAR

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