Jurnal Jamu Indonesia (2026) 11(2): 99–103
https://jamu-journal.ipb.ac.id/index.php/JJI/index

ISSN 2407-7178
eISSN 2407-7763

Short Communication
Doi: https://doi.org/10.29244/jji.v11i2.451

Formulation and Antibacterial Evaluation of Ethanolic Garlic Peel Emulgel Against *Staphylococcus aureus* and *Propionibacterium acnes*

Formulasi dan Evaluasi Antibakteri Emulgel Ekstrak Etanol Kulit Bawang Putih terhadap *Staphylococcus aureus* dan *Propionibacterium acnes*

Michrun Nisa[1]*, Sukriani Kursia[1], Rahmah Mustarin[2], Zulfiah[1], Wiranda Karmianti[1]

[1]*Pharmacy Study Program, Faculty of Health Sciences, Universitas Almarisah Madani, Makassar, 90245, Indonesia*
[2]*Pharmacy Study Program, Faculty of Medicine and Health Sciences, Universitas Muhammadiyah Makassar, Makassar, 90221, Indonesia*

ARTICLE INFO

Article history
Received on: 2025-10-12
Revised on: 2026-01-07
Accepted on: 2026-02-24

Keyword:
Antibacterial activity
Emulgel
Garlic peel extract
Staphylococcus aureus
Propionibacterium acnes

Kata kunci:
Aktivitas antibakteri
Emulgel
Ekstrak kulit bawang putih
Staphylococcus aureus
Propionibacterium acnes

ABSTRACT

Garlic peel (*Allium sativum* L.) is a household waste that contains bioactive compounds with potential antibacterial activity. This study aimed to formulate an emulgel containing ethanolic garlic peel extract and evaluate its physical characteristics and antibacterial activity against *Staphylococcus aureus* and *Propionibacterium acnes*. The emulgel was evaluated for organoleptic properties, homogeneity, pH, and viscosity. Antibacterial activity was tested using the agar diffusion method. The formulation showed acceptable physical characteristics for topical use. The emulgel inhibited the growth of both bacteria, with inhibition zones of 12.16 mm against *S. aureus* and 11.02 mm against *P. acnes*. The antibacterial activity may be related to the presence of flavonoids, saponins, phenolic compounds, and allicin in garlic peel extract. These results suggest that garlic peel extract can be formulated into an emulgel with potential antibacterial activity.

ABSTRAK

Kulit bawang putih (*Allium sativum* L.) merupakan limbah rumah tangga yang mengandung berbagai senyawa bioaktif yang berpotensi sebagai antibakteri. Penelitian ini bertujuan untuk memformulasi emulgel ekstrak etanol kulit bawang putih serta mengevaluasi karakteristik fisik dan aktivitas antibakterinya terhadap *Staphylococcus aureus* dan *Propionibacterium acnes*. Sediaan emulgel dievaluasi meliputi organoleptik, homogenitas, pH, dan viskositas. Aktivitas antibakteri diuji menggunakan metode difusi agar. Hasil penelitian menunjukkan bahwa emulgel memiliki karakteristik fisik yang sesuai untuk sediaan topikal. Emulgel ekstrak kulit bawang putih mampu menghambat pertumbuhan *S. aureus*dan *P. acnes* dengan diameter zona hambat masing-masing sebesar 12,16 mm dan 11,02 mm. Aktivitas antibakteri tersebut diduga berkaitan dengan kandungan flavonoid, saponin, senyawa fenolik, dan allicin pada ekstrak kulit bawang putih. Hasil ini menunjukkan bahwa ekstrak kulit bawang putih dapat diformulasikan dalam bentuk emulgel dengan potensi aktivitas antibakteri.

*Corresponding author:
Michrun Nisa (mnmichrunnisa84@gmail.com)

Citation: Nisa, M., Kursia, S., Mustarin, R., Zulfiah, & Karmianti, W. (2026). Formulation and Antibacterial Evaluation of Ethanolic Garlic Peel Emulgel Against *Staphylococcus aureus* and *Propionibacterium acnes*. *Jurnal Jamu Indonesia*, *11*(2), 99–103. https://doi.org/10.29244/jji.v11i2.451

1. INTRODUCTION

According to data from the Indonesian Ministry of Environment and Forestry (KLHK), total waste generation in Indonesia reached 21.88 million tons in 2021, with household waste accounting for approximately 42.23% of the national total. Among the various types of household waste, garlic peel represents a material that has not yet been optimally utilized, despite its potential as an environmentally friendly and economically valuable raw material (Suci et al., 2023).

Garlic (*Allium sativum*) has been widely recognized for its therapeutic properties due to the presence of diverse secondary metabolites, particularly organosulfur and phenolic compounds that contribute to various biological activities (Gultom et al., 2024). Previous studies have also reported that garlic peel extract contains several bioactive constituents, including alkaloids, quinones, flavonoids, saponins, and polyphenols, which are associated with multiple biological effects, including antibacterial activity (Nugrahani et al., 2022).

Several studies have demonstrated the antibacterial potential of garlic peel extract. For instance, Nisa et al. (2021) reported that a 3% concentration of 70% ethanolic garlic peel extract inhibited the growth of *Staphylococcus aureus*, producing an inhibition zone of 10.9 mm. Natural antibacterial agents are commonly developed into topical dosage forms such as creams, gels, and ointments. Among these formulations, emulgel has attracted considerable attention because it combines the advantages of both emulsion and gel systems. This dual-phase system can improve patient acceptability, enhance spreadability, and increase adhesion to the skin, thereby supporting the effectiveness of topical therapy (Ningrat, 2024).

Although garlic peel extract has been reported to exhibit antibacterial activity, studies focusing on its formulation as an emulgel and the evaluation of its physicochemical characteristics and antibacterial effectiveness remain limited. Therefore, this study aimed to formulate an emulgel containing ethanolic garlic peel extract, evaluate its physicochemical characteristics, and determine its antibacterial activity against *S. aureus* and *Propionibacterium acnes*.

2. METHODS

2.1. Materials

Garlic peel was obtained from a local collector at Daya Market, Makassar, Indonesia. The materials used in this study included 70% ethanol, Carbopol 940, DMDM hydantoin, Span 60, Tween 60, olive oil, phenoxyethanol, propylene glycol, triethanolamine (TEA), and butylated hydroxytoluene (BHT), all supplied by PT Brataco, Indonesia. Distilled water (aquadest) was used as the solvent. Mueller–Hinton agar (Merck®, Merck KGaA, Germany) was used as the culture medium. The test microorganisms were *P. acnes* (ATCC 6919) and *S. aureus* (ATCC 25923), obtained from the culture collection of the Microbiology Laboratory, Universitas Almarisah Madani, Indonesia.

2.2. Extraction

A total of 1800 g of garlic peel powder was macerated using 70% ethanol with a material-to-solvent ratio of 1:10 (w/v) for 3 × 24 h at room temperature (25 ± 2°C) under protected light conditions. The filtrate was collected, and the maceration process was repeated until the solvent became pale. All filtrates were combined, filtered again, and concentrated using a rotary vacuum evaporator (Buchi, Germany) at 40–50°C to obtain a viscous extract. The extraction process was carried out in a closed environment protected from light.

2.3. Formulation of Garlic Peel Emulgel

The ethanolic garlic peel extract was formulated into an emulgel with an extract concentration of 3% (w/w). The emulgel base consisted of Carbopol (3%), olive oil (5%), propylene glycol (10%), Span 60 (1.13%), Tween 60 (3.87%), phenoxyethanol (0.5%), DMDM hydantoin (0.2%), BHT (0.01%), and TEA (1%).

2.4. Preparation of Gel

Carbopol 940 was dispersed in distilled water and allowed to hydrate for 24 h. Triethanolamine (TEA) was gradually added with continuous stirring until a gel was formed with a target pH of 6 ± 0.2.

2.5. Preparation of Emulsion

The oil phase consisting of Span 60, phenoxyethanol, BHT, and olive oil was heated at 70°C until melted. The aqueous phase consisting of distilled water, Tween 60, propylene glycol, and DMDM hydantoin was heated to 80°C. After both phases reached the target temperature, the oil phase was slowly added to the aqueous phase under constant stirring at 800 rpm until a stable emulsion was formed.

2.6. Preparation of Emulgel

The emulgel was prepared by gradually mixing the emulsion base and gel base in a 1:1 ratio under continuous stirring until a homogeneous system was obtained. The extract was incorporated into the emulsion phase before mixing with the gel base. Stirring was continued until a homogeneous emulgel was formed.

2.7. Physical Evaluation of Emulgel

Organoleptic Test. The emulgel formulation was visually observed to evaluate its color, appearance, and consistency (Ogedengbe & Kolawole, 2024).

Homogeneity Test. Homogeneity was evaluated by spreading a small amount of emulgel on a glass slide. The formulation was considered homogeneous if it showed uniform distribution without visible coarse particles. The test was performed three times (Muliasari et al., 2022).

pH Evaluation. The pH of the emulgel was measured using a calibrated pH meter. Approximately 0.5 g of emulgel was diluted with 5 mL of distilled water and homogenized. The measurement was conducted at 25°C, and the results were expressed as mean ± standard deviation (Muliasari et al., 2022).

Viscosity Evaluation. Viscosity was measured using a Brookfield viscometer with spindle No. 64 at a speed of 12 rpm. The measurement was performed at 25 ± 1°C. Viscosity values were recorded in centipoise (cP), and the results were expressed as mean ± standard deviation.

2.8. Antibacterial Activity Test

The antibacterial activity of the emulgel formulation was evaluated using the agar diffusion method, modified from the Kirby–Bauer technique with a double-layer well diffusion system. The test microorganisms used were *S. aureus* and *P. acnes*.

A base layer was prepared by pouring 10 mL of sterile Mueller–Hinton agar (MHA) into sterile Petri dishes and allowing it to partially solidify (Inayah et al., 2024). Three metal cylinders were then placed on the agar surface to create wells with a uniform diameter of approximately 6 mm. For the second layer, 20 µL of bacterial suspension was mixed with 10 mL of molten MHA (45–50°C), homogenized, and poured over the base layer. After the medium completely solidified, the cylinders were aseptically removed to form wells.

Each well was filled with 100 µL of the emulgel formulation using a micropipette. Mediklin® gel (100 µL) and Emina® gel (100 µL) were used as positive controls, while the emulgel base without extract (100 µL) served as the negative control. The plates were incubated at 37°C for 24 h.

After incubation, the diameter of the inhibition zones formed around each well was measured using a caliper. Each treatment was performed in triplicate to ensure reproducibility.

2.9. Data Analysis

All data were expressed as mean ± standard deviation (SD) from three independent experiments.

3. RESULTS AND DISCUSSION

3.1. Extraction Yield

Garlic peel extraction was performed using the maceration method with 70% ethanol as the solvent. The extraction process produced a yield of **5.06%**.

3.2. Physical Evaluation of Garlic Peel Emulgel

Based on organoleptic observation, the emulgel of garlic peel extract (**Figure 1**) showed a light brown color, with a thick and smooth consistency, and a homogeneous texture. The results of the physical evaluation are presented in **Table 1**.

Table 1. Physical Evaluation of Garlic Peel Extract Emulgel

Parameter	Result
Color	Light brown
Consistency	Thick
Homogeneity	Homogeneous
pH	4.9 ± 0.047
Viscosity (cP)	32,033 ± 47.14

The homogeneity test indicated that the formulation was homogeneous, as no coarse particles were observed when the emulgel was spread on a glass slide. A preparation is considered homogeneous when no visible particles are present, whereas the presence of coarse particles indicates non-homogeneity (Yati et al., 2018).

The pH of the emulgel was 4.9, which is still within the acceptable range for topical preparations. Maintaining an appropriate pH is important because very low pH may cause skin irritation, while excessively high pH can disturb the balance of the skin's normal flora (Jufri et al., 2018).

Viscosity is an important parameter in topical formulations because it affects both the consistency of the preparation and the release of the active compounds (Khan et al., 2020). The viscosity of the emulgel was within the acceptable range for topical preparations (2,000–50,000 cP), indicating that the formulation had suitable physical characteristics (Erwiyani et al., 2022).

3.3. Antibacterial Activity

The antibacterial activity of the garlic peel extract emulgel was evaluated using the agar diffusion method. Two commercial products, Mediklin® gel and Emina® gel, were used as positive controls to compare the inhibition zones produced by the test formulation. As shown in **Table 2**, the garlic peel extract emulgel produced an inhibition zone of 12.16 ± 0.31 mm against *S. aureus*. According to the Davis and Stout classification, inhibition zones of 10–20 mm indicate strong antibacterial activity (Safitri et al., 2017).

Against *P. acnes*, the emulgel produced an inhibition zone of 11.02 ± 0.07 mm. This value was slightly lower than that observed against *S. aureus*, but still indicated antibacterial activity. In comparison, Mediklin® gel showed a larger inhibition zone, while Emina® gel produced inhibition zones that were relatively similar to those of the emulgel formulation. The emulgel base without extract did not show antibacterial activity.

Figure 1. Garlic Peel Extract Emulgel

Table 2. Inhibition Zone Diameter of Garlic Peel Extract Emulgel

Sample	S. aureus (mm)	P. acnes (mm)
Garlic peel extract emulgel	12.16 ± 0.31	11.02 ± 0.07
Mediklin® gel	33.7 ± 0.02	33.33 ± 0.06
Emina® gel	9.65 ± 0.22	10.33 ± 0.09
Base without extract	0	0

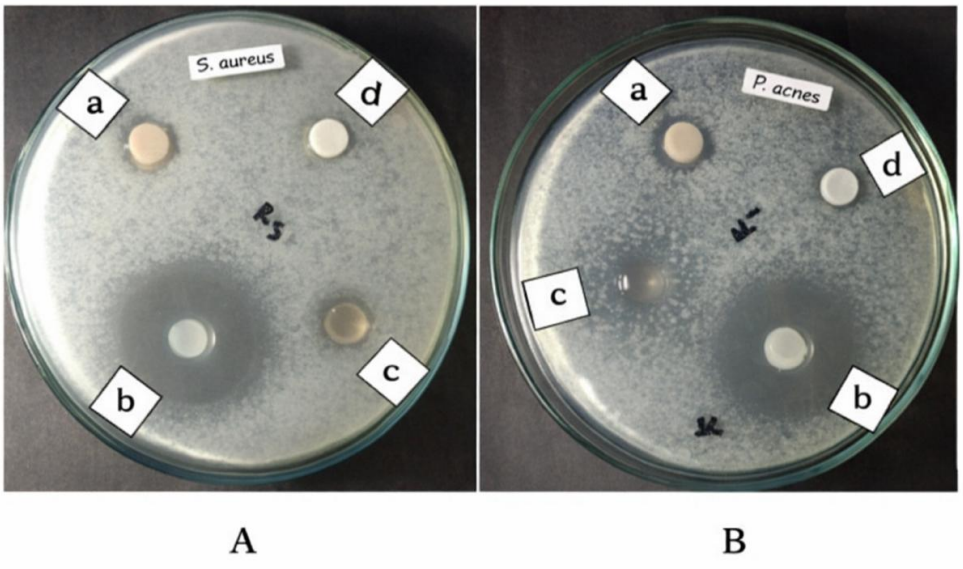

Figure 2. Antibacterial Activity of Ethanolic Garlic Peel Emulgel. (A) *S. aureus*; (B) *P. acnes*. Note: a = emulgel formulation, b = Mediklin® gel, c = Emina® gel, and d = negative control.

The antibacterial activity of the garlic peel extract emulgel may be related to the presence of bioactive compounds such as flavonoids, saponins, and phenolic compounds. These compounds are known to affect bacterial cell membranes and enzyme activity, which may contribute to the inhibition of bacterial growth.

Overall, the emulgel showed stronger activity against *S. aureus* than against *P. acnes*. This difference may be related to differences in the cell wall structure and physiological characteristics of the two bacteria. The peptidoglycan layer of *S. aureus* may be more susceptible to certain compounds such as allicin (Mardiana et al., 2015). In addition, *P. acnes* is an aerotolerant anaerobic bacterium, which may influence its sensitivity to antibacterial agents (Zahrah et al., 2019).

4. CONCLUSION

Ethanolic garlic peel (*A. sativum*) extract was successfully formulated into an emulgel with acceptable physical properties for topical application. The formulation showed antibacterial activity against *S. aureus* and *P. acnes*, with inhibition zones of 12.16 mm and 11.02 mm, respectively. These findings suggest that garlic peel extract has potential as a natural antibacterial component in topical formulations, although further studies on safety and stability are still required.

AUTHOR CONTRIBUTIONS

Conceptualization, M.N. and S.K.; methodology, M.N. and S.K.; investigation, M.N.; formal analysis, M.N. and R.M.; data curation, M.N.; visualization, M.N.; writing—original draft preparation, M.N.; writing—review and editing, S.K., R.M., Z., and W.K.; supervision, S.K.; project administration, S.K. All authors have read and agreed to the published version of the manuscript.

INSTITUTIONAL REVIEW BOARD STATEMENT

Not applicable. This study did not involve human participants or animals.

INFORMED CONSENT STATEMENT

Not applicable.

DATA AVAILABILITY STATEMENT

Data supporting the findings of this study are available from the corresponding author upon reasonable request.

FUNDING

This research received no external funding.

ACKNOWLEDGMENT

The authors would like to thank the Microbiology Laboratory of Universitas Almarisah Madani for providing laboratory facilities and bacterial cultures used in this study.

CONFLICTS OF INTEREST

The authors declare no conflict of interest.

ROLE OF FUNDERS

Not applicable.

DECLARATION OF GENERATIVE ARTIFICIAL INTELLIGENCE (AI) USE

During the preparation of this manuscript, the authors used ChatGPT (OpenAI) to assist in improving the clarity and readability of the text. The authors carefully reviewed and edited the manuscript and take full responsibility for the final content.

REFERENCES

Erwiyani, A. R., Ayu, S. M., Ningtyas, W. A., & Vifta, R. L. (2022). Formulation and evaluation of pumpkin fruit (*Cucurbita maxima* L.) emulgel. *Jurnal Ilmiah Farmasi*, 68–78. https://doi.org/10.20885/jif.specialissue2022.art9

Gultom, E., Hestina, H., & Tafonao, I. S. (2024). Pemanfaatan limbah kulit bawang putih (*Allium sativum*) sebagai pengendali hama kutu kebul pada tanaman cabai. *CHEDS: Journal of Chemistry, Education, and Science, 8*(1), 128–135. https://doi.org/10.30743/cheds.v8i1.9408

Inayah, N., Pratama, K. J., & Permata, B. R. (2024). Formulasi dan uji aktivitas antibakteri sediaan gel anti jerawat ekstrak kulit buah kakao (*Theobroma cacao* L.) terhadap bakteri *Propionibacterium acnes* ATCC 11827. *Jurnal Kajian Ilmiah Multidisipliner, 8*(9), 105–114.

Jufri, M., Rachmadiva, M., Gozan, M., & Suyono, E. A. (2018). Formulation, stability test, and in vitro penetration test of emulgel from tobacco leaves extract. *Journal of Young Pharmacists, 10*(2), S69–S72. https://doi.org/10.5530/jyp.2018.2s.13

Khan, B. A., Ullah, S., Khan, M. K., Alshahrani, S. M., & Braga, V. A. (2020). Formulation and evaluation of *Ocimum basilicum*-based emulgel for wound healing using an animal model. *Saudi Pharmaceutical Journal, 28*(12), 1842–1850. https://doi.org/10.1016/j.jsps.2020.11.011

Mardiana, A. D., Ibrahim, M., & Lisdiana, L. (2015). Potency of *Sansevieria trifasciata* leaves filtrate on the bacteria growth inhibition of *Staphylococcus aureus* and *Escherichia coli*. *LenteraBio, 4*, 6–12.

Muliasari, H., Almira, D., & Subaidah, W. A. (2022). Formulation and evaluation of anti-inflammatory emulgel of *Brucea javanica* (L.) Merr seed extracts. *Jurnal Kimia Riset, 7*(1), 66–73. https://doi.org/10.20473/jkr.v7i1.36010

Ningrat, A. W. S. (2024). Formulation and testing of emulgel preparations from purified fraction of papaya (*Carica papaya* L.) leaves as anti-acne. *Jurnal Ilmiah Farmasi Akademi Farmasi Jember, 7*(1), 36–43. https://doi.org/10.53864/jifakfar.v7i1.166

Nisa, M., Lastri, W. S., & Hendrarti, W. (2021). Formulasi dan uji antibakteri gel ekstrak etanol kulit bawang putih (*Allium sativum* L.) terhadap bakteri *Staphylococcus aureus*. *Pharmacoscript, 4*(1), 109–116. https://doi.org/10.36423/pharmacoscript.v4i1.618

Nugrahani, A. P., Rahmadina, S. A., Lestari, N. D., & Mulyani, S. (2022). Inovasi sunscreen dari ekstrak kulit bawang putih dan bawang merah sebagai anti-kusam, anti-jerawat, dan anti-aging. *Seminar Nasional Kimia dan Pendidikan Kimia (SN-KPK), 13*(1), 153–165.

Ogedengbe, O. T., & Kolawole, O. M. (2024). Formulation and evaluation of fluconazole emulgels for potential treatment of vaginal candidiasis. *Heliyon, 10*(6), e28206. https://doi.org/10.1016/j.heliyon.2024.e28206

Safitri, G. L., Wibowo, M. A., & Idiawati, N. (2017). Uji aktivitas antibakteri ekstrak kasar buah asam paya (*Eleiodoxa conferta* (Griff.) Buret) terhadap bakteri *Staphylococcus aureus* dan *Salmonella typhi*. *Jurnal Kimia Khatulistiwa, 6*(1), 17–20.

Suci, P. R., Raharjeng, S. W., Fitriyany, E., Nur, C. I., Calya, F., & Sari, S. (2023). Pemanfaatan limbah kulit bawang putih (*Allium sativum* L.) sebagai bahan aktif pembuatan sabun cair. *Jurnal Riset Kefarmasian Indonesia, 5*(3), 427–438. https://doi.org/10.33759/jrki.v5i3.392

Yati, K., Jufri, M., Gozan, M., & Dwita, L. P. (2018). Pengaruh variasi konsentrasi hydroxypropyl methyl cellulose (HPMC) terhadap stabilitas fisik gel ekstrak tembakau (*Nicotiana tabacum* L.) dan aktivitasnya terhadap *Streptococcus mutans*. *Pharmaceutical Sciences and Research, 5*(3), 133–141. https://doi.org/10.7454/psr.v5i3.4146

Zahrah, H., Mustika, A., & Debora, K. (2019). Aktivitas antibakteri dan perubahan morfologi dari *Propionibacterium acnes* setelah pemberian ekstrak *Curcuma xanthorrhiza*. *Jurnal Biosains Pascasarjana, 20*(3), 160. https://doi.org/10.20473/jbp.v20i3.2018.160-169