JMPI p-ISSN : 2442-6032
e-ISSN : 2598-9979

DOI : 10.35311/jmpi.v11i2.865

Antibacterial Activity of Bajakah Tampala (*Spatholobus littoralis* Hassk.) Methanol Extract in Roll-On Deodorant against *Staphylococcus epidermidis*

Fath Dwisari[1], Abdurraafi' Maududi Dermawan[2]*, Nur Atika Rahma[1], Tessa Nathalia Tjoadri[1], Khoirul Rista Abidin[1]

[1]Politeknik 'Aisyiyah Pontianak
[2]Universitas Tanjungpura

Cite: Dwisari, F., Dermawan, A. M., Rahma, N. A., Tjoadri, T. N., & Abidin, K. R. (2025). Antibacterial Activity of Bajakah Tampala (*Spatholobus littoralis* Hassk.) Methanol Extract in Roll-On Deodorant against *Staphylococcus epidermidis*. *Jurnal Mandala Pharmacon Indonesia*, **11(2)**, 458–463. https://doi.org/10.35311/jmpi.v11i2.865

Submitted: 08 July 2025
Accepted: 16 December 2025
Published: 25 December 2025

*Corresponding Author:
Abdurraafi' Maududi Dermawan
Email:
abdurrafimaududi@pharm.untan.ac.id

ABSTRACT

Body malodor results from the bacterial breakdown of apocrine gland secretions, with *Staphylococcus epidermidis* identified as a key contributor. Conventional deodorants often rely on synthetic compounds that may cause skin irritation or pose long-term health risks. This study aimed to formulate and assess an antibacterial roll-on deodorant containing methanolic extract of *Spatholobus littoralis* Hassk., a Kalimantan-native medicinal plant known for its antibacterial properties. The extract, prepared via maceration, was incorporated into a multiphase emulsion base comprising zinc ricinoleate, aluminum potassium sulfate, Carbopol 940, triethanolamine, Lexemul CS20, BHT, and phenoxyethanol. The formulations were evaluated for their physicochemical characteristics—pH, spreadability, adhesiveness, and homogeneity—as well as antibacterial activity against *S. epidermidis* using the disc diffusion assay. The extract-containing formulations (F1–F3) exhibited a beige color, herbal aroma, and uniform texture. The pH values (4.12–4.35) were within the dermally acceptable range. The spreadability varied from 4.59 to 4.81 cm, while the adhesiveness ranged from 2.04 to 3.26 min, indicating favorable application and retention properties. Antibacterial testing showed inhibition zones of 10.40–12.37 mm, comparable to a commercial control ($p > 0.05$). These findings suggest that *S. littoralis* extract is a potential natural, skin-compatible antibacterial agent for topical deodorant applications.

Keywords: Roll-on Deodorant, *Spatholobus littoralis* Hassk., Bajakah Tampala, *Staphylococcus epidermidis*

INTRODUCTION

Sweating is a natural thermoregulatory mechanism of the human body; however, it often leads to the formation of unpleasant body odor, which can diminish self-confidence and negatively affect social interactions (Teerasumran et al., 2023). Body odor arises from the microbial decomposition of naturally odorless sweat secretions into volatile compounds (Pessemier et al., 2022).

This phenomenon is more than a hygienic concern; it plays a role in chemosensory communication and is associated with various social behaviors essential for human interaction and survival, including mate selection (de Groot et al., 2017; Mussi et al., 2024). Although sweating and body odor are biologically normal processes, they are often perceived as signs of poor hygiene, leading to embarrassment and decreased self-esteem (Kanlayavattanakul & Lourith, 2011). The malodour associated with sweat is primarily due to the metabolic activities of skin-residing bacteria, including *Staphylococcus aureus*, *Staphylococcus epidermidis*, *Corynebacterium acne*, *Pseudomonas aeruginosa*, and *Streptococcus pyogenes* (McManus et al., 2017). Therefore, controlling both sweating and odor remains a significant focus of cosmetic and pharmaceutical research.

Current strategies to combat body odor and excessive sweating fall into two primary categories: deodorants and antiperspirants. Regular soap use is often insufficient for managing body odor; hence, many individuals opt to use deodorants as a complementary approach (Komala et al., 2019). Despite ongoing innovations, many commercial formulations still rely on conventional active agents such as triclosan and aluminum salts, which have been widely used for over four decades (Oliveira et al., 2021).

Growing safety concerns regarding synthetic compounds such as triclosan and aluminum salts, which are linked to conditions such as Alzheimer's disease, certain cancers, and dermatitis, have driven consumer interest toward natural, plant-based alternatives (Naseef PP et al., 2024; Oliveira et al., 2021). Herbal extracts with antimicrobial properties are increasingly used in deodorant and antiperspirant formulations because of their perceived safety, skin compatibility, and long-term use in traditional care (Naseef PP et al., 2024). As the routine application of these products remains high, especially in the axillary region, the demand for effective natural solutions that reduce body odor without harmful side effects continues to grow (Akshatha R S et al., 2023; Pessemier et al., 2022).

Spatholobus littoralis Hassk., a medicinal plant native to Kalimantan, Indonesia, is known for its rich content of bioactive phenolic compounds, such as flavonoids, tannins, alkaloids, and phenols, which exhibit notable antibacterial properties (Afifah & Iskandar, 2024; Farhan et al., 2022; Hamzah et al., 2023; Mochtar et al., 2022; Novalia Rahmawati Sianipar et al., 2023). These compounds have been reported to damage bacterial cell walls, interfere with intracellular metabolism, and inhibit biofilm formation (Khairani et al., 2023; Putri et al., 2024).

Although the antibacterial activity of *S. littoralis* has been widely reported, its application in topical delivery systems, such as roll-on deodorants, remains unstudied. In particular, no formulation studies have evaluated its physicochemical characteristics or antibacterial effectiveness against *Staphylococcus epidermidis*, a key bacterium involved in body odor formation.

This study presents a novel roll-on deodorant formulated using methanolic *S. littoralis extract*. *S. littoralis* was selected due to its high phenolic content and strong, previously documented antibacterial activity, offering a potent alternative to commonly used plant-based deodorant ingredients. Despite its promising bioactivity, its incorporation into topical cosmetic systems, particularly roll-on formulations, has not been investigated. This study evaluated the physicochemical properties and antibacterial efficacy of the formulation against *Staphylococcus epidermidis*, addressing a research gap and supporting the development of effective natural-derived functional cosmetic products.

RESEARCH METHODS

Research Materials

The materials used in this study included *Spatholobus littoralis* Hassk. root (Ketapang, West Kalimantan), methanol (Merck), Carbopol 940, triethanolamine (TEA), butylated hydroxytoluene (BHT), and distilled water. Microbiological assays employed *Staphylococcus epidermidis* ATCC 12228, Mueller Hinton Agar (Oxoid), and sterile NaCl solution. Instrumentation included standard laboratory glassware, an analytical balance, UV–Vis spectrophotometer (Genesys), pH meter, rotary evaporator (IKA), incubator (Memmert), centrifuge, and other microbiological tools such as an autoclave, inoculating loop, blender, mortar and pestle, and hotplate.

Sample Preparation

Spatholobus littoralis Hassk. The plant collected from Ketapang, West Kalimantan, was taxonomically verified at the Department of Biology, Universitas Tanjungpura. Sample preparation and extraction procedures were conducted as described by Hamzah et al. (2023) with slight modifications. Fresh *S. littoralis* rods were washed, sorted, and air-dried under sunlight for three days. The dried material was then coarsely ground and stored in an airtight container. A total of 100 g of powdered simplicia was macerated in methanol (Merck) under sealed conditions for 72 h. The filtrate was concentrated under reduced pressure at 50 °C using a rotary evaporator (IKA) to obtain a viscous methanolic extract.

Preparation of Roll-on Deodorant

The roll-on deodorant formulations were prepared using three different formulas (Table 1) with extract concentrations of 1%, 3%, and 5%. These levels were selected based on the findings of Mochtar et al. (2022), who reported increased bioactivity with increasing extract concentrations. Accordingly, higher concentrations were evaluated in this study to determine whether further enhancement of the functional performance could be achieved.

A roll-on deodorant was prepared using a multi-phase emulsification technique adapted from Mayangsari et al. (2023), with modifications. In the aqueous phase, Carbopol 940 was dispersed in half the total volume of distilled water and allowed to fully hydrate. Triethanolamine (TEA) was then added dropwise with continuous stirring to form a homogeneous gel and adjust the pH to approximately 6. Separately, the oil phase was prepared by melting Lexemul CS20, butylated hydroxytoluene (BHT), and zinc ricinoleate at 80 °C until fully dissolved. In another beaker, the remaining distilled water was heated to 70 °C and used to dissolve aluminum potassium sulfate. The aqueous solution was gradually incorporated into the oil phase under continuous stirring to form an emulsion. After achieving uniformity, phenoxyethanol and the preformed gel were added and mixed thoroughly. Finally, *the S. littoralis* methanolic extract was incorporated into formulations F1, F2, and F3, and the resulting deodorant creams were stirred until consistent and homogeneous.

Table 1. Roll-on Deodorant Formulation

No.	Bahan	Formula (%)			
		F0	F1	F2	F3
1	*S. littoralis* extract	-	1	3	5
2	*Zinc ricinoleate*	2	2	2	2
3	Potassium aluminium sulfate	2	2	2	2
4	Carbopol 940	0.5	0.5	0.5	0.5
5	TEA	0.5	0.5	0.5	0.5
6	Lexemul CS20	5	5	5	5
7	BHT	0.1	0.1	0.1	0.1
8	Phenoxyetanol	1	1	1	1
9	Aquadest	88.9	87.9	85.9	83.9

Physical Evaluation of Roll-on Deodorant

1. Homogeneity and organoleptic evaluation

The homogeneity of the cream deodorant formulations was evaluated by spreading 0.5 g of each sample onto a watch glass and observing the uniformity. The preparations were considered homogeneous if no visible particles, granules, or phase separation were detected upon visual and tactile inspection. The organoleptic properties, including texture, color, and odor, were assessed to ensure the consistency and acceptability of the formulation (Lidia et al., 2022).

2. pH measurement

For pH analysis, 0.5 g of the cream deodorant was dispersed in 5 mL of distilled water and mixed thoroughly. The pH was measured using a calibrated digital pH meter. According to the Indonesian National Standard (SNI 16-4951-1998), an acceptable pH range for cream deodorant formulations is between 3.0 and 7.5 (Megantara et al., 2017).

3. Spreadability test

Spreadability was assessed by placing 0.5 g of the cream sample between two glass plates. After one minute of equilibration under its own weight, the initial spread diameter was measured. Incremental loads (20–125 g) were then applied sequentially using calibrated standard weights, each maintained for one minute before measuring the resulting diameter. The procedure was performed in triplicate to ensure reproducibility. The optimal spreadability value for topical preparations is typically within the range of 5–7 cm (Lidia et al., 2022).

4. Adhesiveness test

Adhesiveness was evaluated by placing 0.5 g of the cream formulation between two glass plates to ensure uniform contact. A 1 kg weight was applied for 5 min to establish adhesion, followed by the addition of a 100 g detachment weight. The time required for the plates to separate was recorded subsequently. The test was conducted in triplicate to ensure accuracy and reproducibility (Megantara et al., 2017).

In Vitro Antibacterial Activity

The antibacterial activity of the roll-on deodorant formulations was evaluated using the disc diffusion method against *Staphylococcus epidermidis,* as described by Khattak et al. (2022), with slight modifications. Bacterial cultures in the logarithmic growth phase were obtained by overnight subculturing. A standardized inoculum was evenly spread onto Mueller–Hinton Agar (Oxoid) (25 mL per plate) using a sterile cotton swab. Sterile 5 mm paper discs were impregnated with the test samples (F1, F2, and F3) and placed on the agar surface within 15 min of inoculation.

A commercial deodorant was used as the positive control, and the base formulation (F0) was used as the negative control. The plates were incubated at 37 °C for 24 h. The zones of inhibition were measured in millimeters using a caliper to assess the antibacterial efficacy. All experiments were performed in triplicate, and the results are presented as mean values ± standard deviation. Data were analyzed using one-way analysis of variance (ANOVA) in SPSS software, with post-hoc tests conducted where applicable. Statistical significance was set at $p < 0.05$.

RESULTS AND DISCUSSION

The plant material used in this study was sourced from Ketapang, West Kalimantan, and taxonomically verified at the Department of Biology, Universitas Tanjungpura, Pontianak, Indonesia. The specimen was identified as *Spatholobus littoralis* Hassk., a species traditionally used in ethnomedicine.

It is rich in phenolic compounds, including flavonoids, tannins, alkaloids, and phenols, which contribute to its antibacterial properties (Afifah & Iskandar, 2024; Farhan et al., 2022; Hamzah et al., 2023; Mochtar et al., 2022; Novalia Rahmawati Sianipar et al., 2023). These bioactive constituents have been reported to exert antimicrobial effects by disrupting bacterial cell membranes, impairing metabolic pathways, and inhibiting biofilm formation (Khairani et al., 2023; Putri et al., 2024).

Following identification, a roll-on deodorant was formulated using *S. littoralis* methanolic extract as the active ingredient. The base formulation was developed using a multiphase emulsification technique adapted from Mayangsari et al. (2023), incorporating key excipients, including zinc ricinoleate (odor absorber), potassium aluminum sulfate (astringent and antimicrobial), Carbopol 940 (gelling agent), triethanolamine (neutralizer), Lexemul CS20 (emulsifier), BHT (antioxidant), and phenoxyethanol (preservative). These components were selected to ensure that the final product met the physicochemical requirements for topical application, including suitable pH, spreadability, adhesion, and homogeneity (Kanlayavattanakul & Lourith, 2011; Naseef PP et al., 2024).

The organoleptic evaluation of the *S. littoralis* roll-on deodorant revealed a color shift from off-white in the base formulation (F0) to beige in the extract-containing variants (F1, F2, and F3) (Table 2). This was attributed to the natural pigments from phenolic compounds in the plant (Putri et al., 2024). Formulations also exhibited a distinct herbal scent characteristic of *Bajakah Tampala*, in contrast to the odorless control.

All samples displayed a soft, semi-solid, and easily spreadable consistency, supported by the gelling and emulsifying properties of Carbopol 940 and Lexemul CS20 (Mayangsari et al., 2023). The absence of phase separation or particulate matter indicates good physical uniformity (Khattak et al., 2022).Homogeneity testing further confirmed the consistent dispersion of the ingredients across all the formulations.

Table 2. Homogeneity and Organoleptic Evaluation

No.	Formulation	Organoleptic			Homogeneity
		Color	Odor	Texture	
1	F0	White	Odorless	Soft, easily spreadable, semi-solid	Homogen
2	F1	Beige	Typical of Bajakah Tampala	Soft, easily spreadable, semi-solid	Homogen
3	F2	Beige	Typical of Bajakah Tampala	Soft, easily spreadable, semi-solid	Homogen
4	F3	Beige	Typical of Bajakah Tampala	Soft, easily spreadable, semi-solid	Homogen

The results of the pH, spreadability, and adhesiveness tests are presented in Table 3. The pH of the *S. littoralis* roll-on deodorant formulations was assessed using a calibrated pH meter to ensure dermal compatibility, as the potential for skin irritation is closely related to product acidity (Ijaz et al., 2022). As shown in Table 3, the pH values ranged from 4.12 to 4.56, which fall within the acceptable limits for topical products (pH 4.0–6.0), as suggested by Chen et al. (2016), indicating that the formulations are safe for regular skin application. Spreadability, defined as the ease with which a semisolid formulation is distributed across the skin, is critical for ensuring uniform dosage and optimal therapeutic efficacy in topical applications (Chen et al., 2016). In the present study, the spreadability values of the extract-based deodorant ranged between 4.59 and 4.81 cm (Table 3), which is slightly below the recommended range of 5–7 cm for ideal topical performance (Bakhrushina et al., 2022). This modest reduction in spreadability may be attributed to the relatively high viscosity, which potentially limits the smoothness of the application and consumer acceptability (Rahim et al., 2023). Adhesiveness evaluation demonstrated significant variations between the formulations. F2 and F3 exhibited extended detachment times of 3.26 min and 2.29 min, respectively, suggesting adequate retention on the skin, which is beneficial for sustained deodorant activity. In contrast, F1 displayed a considerably lower adhesion time of 2.04 min . Nevertheless, based on established criteria, an adhesion time exceeding 1 s is considered acceptable for topical preparations (Kurniawan & Aryani, 2024), indicating that all formulations possessed sufficient bioadhesive properties to ensure effective skin contact and functional performance.

The antibacterial activity of the roll-on deodorant formulations containing *Spatholobus littoralis* (Bajakah Tampala) extract was assessed using the disc diffusion method against *Staphylococcus epidermidis*, a Gram-positive bacterium that is a predominant contributor to body odor due to its role in the degradation of apocrine sweat components (McManus et al., 2017). As shown in Table 4, all extract-based formulations (F1–F3) demonstrated inhibitory activity, with inhibition zones ranging from 10.40 to 12.37 mm, while the positive control (commercial roll-on deodorant) showed the highest activity at 13.23 ± 0.535 mm. Among the test groups, F3 exhibited the highest inhibition zone (12.37 ± 4.078 mm), followed closely by F2 (12.32 ± 1.882 mm), suggesting that these concentrations of the methanolic extract effectively suppressed bacterial growth. These results are consistent with those of previous studies reporting that phenolic compounds, such as flavonoids, tannins, and alkaloids, found in *S. littoralis* exert antibacterial effects by damaging bacterial cell walls and inhibiting biofilm formation (Afifah & Iskandar, 2024; Farhan et al., 2022; Hamzah et al., 2023; Mochtar et al., 2022; Novalia Rahmawati Sianipar et al., 2023).

Table 3. The Result of pH, Spreadability and Adhesiveness Test

No.	Formulation	pH	Spreadability (cm)	Adhesiveness (min)
1	F0	4.56 ± 0.012	4.02 ± 0.602	1.21 ± 0.297
2	F1	4.35 ± 0.010	4.81 ± 0.072	2.04 ± 0.200
3	F2	4.12 ± 0.015	4.59 ± 0.071	3.26 ± 1.127
4	F3	4.26 ± 0.021	4.71 ± 0.385	2.29 ± 0.191

Interestingly, F1 produced the lowest inhibition zone (10.40 ± 1.011 mm) among the extract-containing formulations, possibly due to insufficient extract concentration or less optimal distribution of active constituents within the base matrix (Herbig et al., 2023). Despite its lower activity, F1 exhibited a measurable antibacterial effect above the negative control, F0 (11.52 ± 0.945 mm), which lacked the plant extract and demonstrated minimal inhibition, likely attributable to the presence of aluminum potassium sulfate and zinc ricinoleate, components known to provide antimicrobial properties (Abendrot & Kalinowska-Lis, 2018; O Amadi, 2020).

Statistical analysis using one-way ANOVA showed no significant differences in antibacterial activity among the groups ($p = 0.573$; $p > 0.05$), indicating that the observed variations in the inhibition zones were not statistically attributable to the treatments.

Tukey's post hoc test further confirmed that the formulations containing S. littoralis extract (F1–F3) exhibited no significant differences compared to the commercial deodorant used as the positive control. These findings suggest that the extract-based formulations demonstrated antibacterial activity comparable to that of the established commercial product under the experimental conditions used in this study.

Table 4. Evaluation of the Antibacterial Efficacy of Bajakah Tampala's Roll-on Deodorant Formulations Against *Staphylococcus epidermidis*

No.	Formulation	Inhibition Zone (mm)
1	F0	11.52 ± 0.945
2	F1	10.40 ± 1.011
3	F2	12.32 ± 1.882
4	F3	12.37 ± 4.078
5	Control (+)	13.23 ± 0.535

A **B**

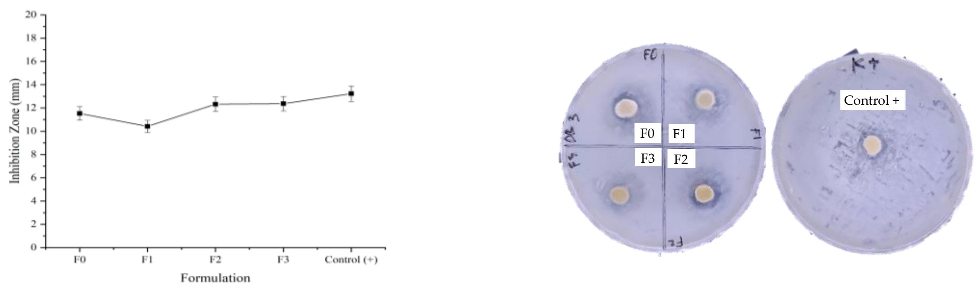

Figure 1. Antibacterial Activity of Bajakah Tampala's Roll-on Deodorant (A) Antibacterial capacity (B) Inhibition Zone of Roll-on Deodorant Formulation

CONCLUSION

This study confirmed that roll-on deodorants containing methanolic extracts of *Spatholobus littoralis* Hassk. possessed acceptable physicochemical and organoleptic characteristics for topical application. Although the spreadability was slightly below the ideal range, the formulations maintained adequate performance. Enhanced adhesiveness in extract-based formulations may contribute to extended skin contact and improved deodorizing. All formulations showed antibacterial activity against *Staphylococcus epidermidis*, although no statistically significant difference was observed compared to the commercial products. These findings indicate the promising potential of *S. littoralis* as a natural antibacterial agent, warranting further investigation through quantitative antimicrobial evaluations.

ACKNOWLEDGMENTS

This work was financially supported by grants from Hibah Internal Politeknik 'Aisyiyah Pontianak (Contract No. 59/II.3.AU/LPPM/XI/2024).

REFERENCES

Abendrot, M., & Kalinowska-Lis, U. (2018). Zinc-containing compounds for personal care applications. *International Journal of Cosmetic Science*, *40*(4), 319–327. https://doi.org/10.1111/ics.12463

Afifah, H., & Iskandar, Y. (2024). Review Artikel: Kandungan Kimia Dan Aktivitas Farmakologi Akar Kayu Bajakah (Spatholobus Littoralis H). *Jurnal Penelitian Farmasi Indonesia*, *13*(1), 12–17. https://doi.org/10.51887/jpfi.v13i1.1796

Akshatha R S, Manasa C Reddy, Ranjitha Suresh, & Thanushree H R. (2023). Formulation and evaluation of antibacterial herbal deodorant stick. *World Journal of Biology Pharmacy and Health Sciences*, *16*(2), 029–034. https://doi.org/10.30574/wjbphs.2023.16.2.0464

Bakhrushina, E. O., Anurova, M. N., Zavalniy, M. S., Demina, N. B., Bardakov, A. I., & Krasnyuk, I. I. (2022). Dermatologic Gels Spreadability Measuring Methods Comparative Study. *International Journal of Applied Pharmaceutics*, *14*(1), 164–168. https://doi.org/10.22159/ijap.2022v14i1.41267

Chen, M. X., Alexander, K. S., & Baki, G. (2016). Formulation and Evaluation of Antibacterial Creams and Gels Containing Metal Ions for Topical Application. *Journal of Pharmaceutics*, *2016*(1), 5754349. https://doi.org/https://doi.org/10.1155/2016/5754349

de Groot, Jasper H B, Semin, Gün R, & Smeets, Monique A M. (2017). On the Communicative Function of Body Odors: A Theoretical Integration and Review. *Perspectives on Psychological Science*, *12*(2), 306–324. https://doi.org/10.1177/1745691616676599

Farhan, M., Zein, F., & Hazar, S. (2022). Uji Sitotoksik Fraksi dan Ekstrak Batang Kayu Bajakah (Uncaria sp.) Menggunakan Metode Brine Shrimp Lethality Test (BSLT). *Bandung Conference Series: Pharmacy*, *2*(2), 1–11. https://proceedings.unisba.ac.id/index.php/BCSP/article/view/4567

Hamzah, H., Pratiwi, S. U. T., Jabbar, A., Hafifah, A. S., Al-Fajri, B. A., & Nurhalisah, N. (2023). Bioactivity Tracing of the Ethanol Extract of Bajakah Tampala (Spatholobus littoralis Hassk.) Typical Plant of Kalimantan Island as Antibiofilm of Staphylococcus aureus. *Open Access Macedonian Journal of Medical Sciences*, *11*(A), 8–14. https://doi.org/10.3889/oamjms.2023.10676

Herbig, M. E., Evers, D. H., Gorissen, S., & Köllmer, M. (2023). Rational Design of Topical Semi-Solid Dosage Forms-How Far Are We? *Pharmaceutics*, *15*(7). https://doi.org/10.3390/pharmaceutics15071822

Ijaz, N., Durrani, A. I., Rubab, S., & Bahadur, S. (2022). Formulation and characterization of Aloe vera gel and tomato powder containing cream. *Acta Ecologica Sinica*, *42*(2), 34–42. https://doi.org/https://doi.org/10.1016/j.chnaes.2021.01.005

Kanlayavattanakul, M., & Lourith, N. (2011). Body malodours and their topical treatment agents. *International Journal of Cosmetic Science*, *33*(4), 298–311. https://doi.org/10.1111/j.1468-2494.2011.00649.x

Khairani, T. N., Fitri, K., Andry, M., & Nasution, M. A. (2023). Antibacterial Activity of Basil Leaves Extract Towards Bacteria Staphylococcus Aureus and Staphylococcus Epidermidis in Deodorant Spray. *Jurnal Farmasi Sains Dan Praktis*, *9*(3), 252–260. https://doi.org/10.31603/pharmacy.v9i3.7542

Khattak, R. Z., Nawaz, A., Alnuwaiser, M. A., Latif, M. S., Rashid, S. A., Khan, A. A., & Alamoudi, S. A. (2022). Formulation, In Vitro Characterization and Antibacterial Activity of Chitosan-Decorated Cream Containing Bacitracin for Topical Delivery. *Antibiotics*, *11*(9). https://doi.org/10.3390/antibiotics11091151

Komala, O., Wiendarlina, I. Y., & Rizqiyana, N. (2019). Antibacterial activity roll on deodorant with Pluchea indica (L.) leaf extract against Staphylococcus epidermidis (Evans 1916) in vitro. *IOP Conference Series: Earth and Environmental Science*, *293*(1). https://doi.org/10.1088/1755-1315/293/1/012031

Kurniawan, M. F., & Aryani, N. M. (2024). Optimization formulation and efficacy examination of cream combination of fig extracts (Ficus carica L.) and pomegranate extracts (Punica granatum L.) as antioxidants. *BIO Web of Conferences*, *135*. https://doi.org/10.1051/bioconf/202413503003

Lidia, L., Munarsih, E., & Aprilianti, D. (2022). Lotion deodorant formulation of ethanolic extract of red betel leaf (Piper crocatum Ruiz & Pav) with stearic acid as base. *Jurnal Ilmiah Farmasi*, 159–168. https://doi.org/10.20885/jif.specialissue2022.art18

Mayangsari, F. D., Pratiwi, E. D., Sari, D. I. K., & Aula Nurwanda, F. S. (2023). Formulasi Krim Deodoran-Antiperspiran Alami yang Mengandung Kombinasi Minyak Atsiri Sebagai Pengaroma. *Majalah Farmasetika*, *9*(1), 91. https://doi.org/10.24198/mfarmasetika.v9i1.49912

McManus, K., Wood, A., Wright, M. H., Matthews, B., Greene, A. C., & Cock, I. E. (2017). Terminalia ferdinandiana Exell. Extracts inhibit the growth of body odour-forming bacteria. *International Journal of Cosmetic Science*, *39*(5), 500–510. https://doi.org/https://doi.org/10.1111/ics.12403

Megantara, I. N. A. P., Megayanti, K., Wirayanti, R., Esa, I. B. D., Wijayanti, N. P. A. D., & Yustiantara, P. S. (2017). Variasi Konsentrasi Trietanolamin Sebagai Emulgator Serta Uji Hedonik Terhadap Lotion Abstrak Raspberry (Rubus rosifolius) memiliki aktivitas antioksidan tinggi yang dapat digunakan dalam perawatan kulit . Salah satu kosmetika untuk perawatan kulit adal. *Jurnal Farmasi Udayana*, *6*(2301–7716), 1–5.

Mochtar, C. F., Saleh, L. O., Hamzah, H., & Ilyas, N. M. (2022). Potensi Bajakah Tampala (Spatholobus littoralis Hassk) Sebagai Antibakteri dan Antijamur Terhadap Staphylococcus aureus dan Candida albicans. *Jurnal Mandala Pharmacon Indonesia*, *8*(2), 177–184. https://doi.org/10.35311/jmpi.v8i2.212

Mussi, L., Baby, A. R., Nogueira, C., de Camargo Junior, F. B., & Magalhães, W. V. (2024). Deodorant Efficacy of Xylityl Sesquicaprylate Vehiculated into Roll-on and Stick Prototype Formulations. *Cosmetics*, *11*(3), 1–8. https://doi.org/10.3390/cosmetics11030088

Naseef PP, Femina K P, Krishnan, N., Shifana, Shijiya Sherin KP, & Vighnesh S. (2024). Design and development of antiperspirant formulation from natural extract: An overview. *International Journal of Pharmaceutical Chemistry and Analysis*, *11*(2), 108–111. https://doi.org/10.18231/j.ijpca.2024.015

Novalia Rahmawati Sianipar, R., Suryanegara, L., Fatriasari, W., Tangke Arung, E., Wijaya Kusuma, I., Setiati Achmadi, S., Izyan Wan Azelee, N., & Ain Abdul Hamid, Z. (2023). The role of selected flavonoids from bajakah tampala (Spatholobus littoralis Hassk.) stem on cosmetic properties: A review. *Saudi Pharmaceutical Journal*, *31*(3), 382–400. https://doi.org/10.1016/j.jsps.2023.01.006

O Amadi, L. (2020). A Review of Antimicrobial Properties of Alum and Sundry Applications. *Acta Scientific Microbiology*, *3*(4), 109–117. https://doi.org/10.31080/asmi.2020.03.0553

Oliveira, E. C. V. de, Salvador, D. S., Holsback, V., Shultz, J. D., Michniak-Kohn, B. B., & Leonardi, G. R. (2021). Deodorants and antiperspirants: identification of new strategies and perspectives to prevent and control malodor and sweat of the body. *International Journal of Dermatology*, *60*(5), 613–619. https://doi.org/https://doi.org/10.1111/ijd.15418

Pessemier, B. De, Daneels, R., Van De Wiele, T., & Callewaert, C. (2022). Underarm Body Odor, the Microbiome, and Probiotic Treatment. In *Good Microbes in Medicine, Food Production, Biotechnology, Bioremediation, and Agriculture* (pp. 52–63). https://doi.org/https://doi.org/10.1002/9781119762621.ch6

Putri, Y. D., Fitriani, D. F., & Tristiyanti, D. (2024). Formulasi Dan Uji Aktivitas Antibakteri Isolat Katekin Dalam Sediaan Deodoran Roll on Terhadap Bakteri Staphylococcus Epidermidis Atcc 12228. *Edu Masda Journal*, *8*(1), 61. https://doi.org/10.52118/edumasda.v8i1.209

Rahim, A. R., Salmiah, & Ihsan, E. A. (2023). Antibacterial Activity Test of Roll on Deodorant Extract Ethanol Tamarind Seed Coat. *Ad-Dawaa' Journal of Pharmaceutical Sciences*, *6*(1), 33–45. https://doi.org/10.24252/djps.v6i1.37568

Teerasumran, P., Velliou, E., Bai, S., & Cai, Q. (2023). Deodorants and antiperspirants: New trends in their active agents and testing methods. *International Journal of Cosmetic Science*, *45*(4), 426–443. https://doi.org/10.1111/ics.12852