



Antibacterial Potential of Traditionally Prepared Aqueous Extract of White Galangal (*Alpinia galanga* L. Willd) Against *Escherichia coli* and *Staphylococcus aureus*

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Article Info	ABSTRACT
Received: 12-04-2026 Revised: 09-06-2026 Accepted: 20-06-2026 *Corresponding author: Abdurraafi' Maududi Dermawan Email: abdurrafimaududi@pharm.untan.ac.id	Background: Antimicrobial resistance is a growing global health threat that necessitates the development of alternative antibacterial agents. <i>Alpinia galanga</i> (L.) Willd. (white galangal) is widely used in traditional Indonesian medicine and represents a promising natural source of antibacterial compounds. However, previous studies have primarily investigated organic solvent extracts, whereas the antibacterial activity of traditional aqueous infusions remains poorly understood. This study addresses this gap by evaluating the phytochemical profile and antibacterial activity of white galangal aqueous infusion against both <i>Staphylococcus aureus</i> and <i>Escherichia coli</i>. Objective: This study aimed to systematically evaluate the inhibitory capacity of <i>A. galanga</i> rhizome aqueous extracts against the targeted clinical pathogens, <i>Staphylococcus aureus</i> and <i>Escherichia coli</i>. Methods: Disk diffusion assays were performed at four distinct concentration gradients (25%, 50%, 75%, and 100%) to determine their specific antibacterial profiles. Results: The assays successfully demonstrated a clear dose-dependent antibacterial effect. For the <i>S. aureus</i> strain, the resulting inhibition zone diameters were 7.36, 8.31, 8.93, and 9.94 mm. Parallel testing against the <i>E. coli</i> strain yielded corresponding inhibition zones of 7.35, 8.07, 8.73, and 9.80 mm across the same concentration gradients. Conclusion: This study highlights the practical relevance of aqueous-based extraction, which accurately reflects traditional preparation methods, thereby validating its ethnopharmacological application. Empirical evidence confirmed the efficacy of the extract against both Gram-positive and Gram-negative bacterial strains. Such robust inhibitory activity not only reinforces its potential as a natural therapeutic agent but also establishes a scientific basis for its sustained use within traditional medicine frameworks. Keywords: Antibacterial, White Galangal, <i>Staphylococcus aureus</i>, <i>Escherichia coli</i>

INTRODUCTION

Natural products have remained the principal scaffolds for clinical antibiotic development since the mid-20th century

(Rossiter et al., 2017). Despite this, the continuous overprescription and misuse of antibiotics have exacerbated the global threat of antimicrobial resistance, yielding strains of *Escherichia coli* and *Staphylococcus*

aureus that are highly refractory to standard agents (Blair et al., 2015; Miryala & Ramaiah, 2019). The rapid global dissemination of antimicrobial resistance, combined with the paucity of effective drugs to combat multidrug-resistant pathogens in both human and veterinary medicine, highlights the urgent need for alternative antibacterial strategies (Dai et al., 2022).

Natural products remain invaluable in this pursuit, acting not only as direct antibacterial agents but also as potentiators of other drugs, immunomodulators of host responses, and inhibitors of bacterial virulence mechanisms (Aulia & Ermawati, 2023; Dai et al., 2022; Dwisari et al., 2025; Theuretzbacher et al., 2020). *Alpinia galanga* (L.) Willd (Zingiberaceae), a perennial herb, has a long history of use across Asia as both a culinary spice and an ethnobotanical remedy (Aziz et al., 2024). Galangal, widely cultivated in Indonesia and other Southeast Asian countries, holds cultural, medicinal, and nutritional significance. In Ayurveda and other traditional medical systems, it has long been used to treat various ailments (Khairullah et al., 2020; Suciati & Maryati, 2023).

The pharmacological efficacy of *A. galanga* is attributed to its diverse phytochemical profile, which encompasses flavonoids, terpenoids, saponins, phenolic acids, and essential oils, all of which are widely recognized for their substantial bactericidal activity (Aziman et al., 2014; Aziz et al., 2024; Das et al., 2020; Eram et al., 2019; Zhou et al., 2021).

Previous reports have indicated that aqueous preparations of galangal rhizomes restrict bacterial growth (Badriyah et al., 2024; Fransiska et al., 2017). However, differences in extraction procedures, extract concentrations, bacterial strains, and evaluation methods have resulted in inconsistent findings, limiting direct

comparisons across studies. This study addresses these limitations by applying a standardized aqueous infusion protocol, combining phytochemical screening with concentration-dependent antibacterial evaluation, and directly comparing the inhibitory effects against representative Gram-positive and Gram-negative bacteria.

This study assessed the antibacterial activity of aqueous rhizome extract of *Alpinia galanga* (white galangal) against two clinically relevant bacterial pathogens, *Staphylococcus aureus* and *Escherichia coli*. The adoption of an aqueous extraction method reflects traditional preparation techniques, emphasizing its practicality, accessibility, and cultural significance of the method. By aligning traditional knowledge with scientific validation, this approach offers translational value to community-based health-care applications. The findings of this study reinforce the scientific basis underlying the ethnomedicinal application of *A. galanga* and highlight its potential as a natural source for the development of alternative antibacterial agents.

MATERIALS AND METHODS

Materials

White Galangal (*Alpinia galanga* L. Willd) rhizomes were collected from Seponti Jaya Village, Kayong Utara, West Kalimantan, and taxonomically authenticated at the Biology Laboratory, Faculty of Mathematics and Natural Sciences, Tanjungpura University, Pontianak, Indonesia.

Methods

Preparation of Extract and Phytochemical Screening

Fresh white galangal rhizomes (100 g) were peeled, blended, and extracted with 100 mL of distilled water by boiling in a water bath at 90 °C for 15 min with intermittent stirring. The mixture was filtered, and the

final volume was adjusted to 100 mL with warm water to obtain a 100% aqueous infusion. Dilutions of 25%, 50%, and 75% were prepared from the stock solution using distilled water (Fransiska et al., 2017). Phytochemical screening of the aqueous extract was performed following the procedure described by Nadya et al. (2022) and Agustyarini et al. (2024) to detect the presence of flavonoids, terpenoids, quinones, and phenols.

Antibacterial Activity Assay

Antibacterial activity was assessed using the Kirby–Bauer disc diffusion method.

Standardized inocula of *E. coli* ATCC 25922 and *S. aureus* ATCC 6538 and prepared for testing (0.5 McFarland, OD 0.08–0.12 at 625 nm) were spread on Mueller–Hinton Agar plates, followed by placement of 6 mm sterile discs containing 20 µL of aqueous extract at concentrations of 25%, 50%, 75%, and 100%, and incubated at 37 °C for 18–24 h. Ciprofloxacin discs and sterile distilled water served as positive and negative controls, respectively (CLSI, 2022; Dermawan et al., 2019).

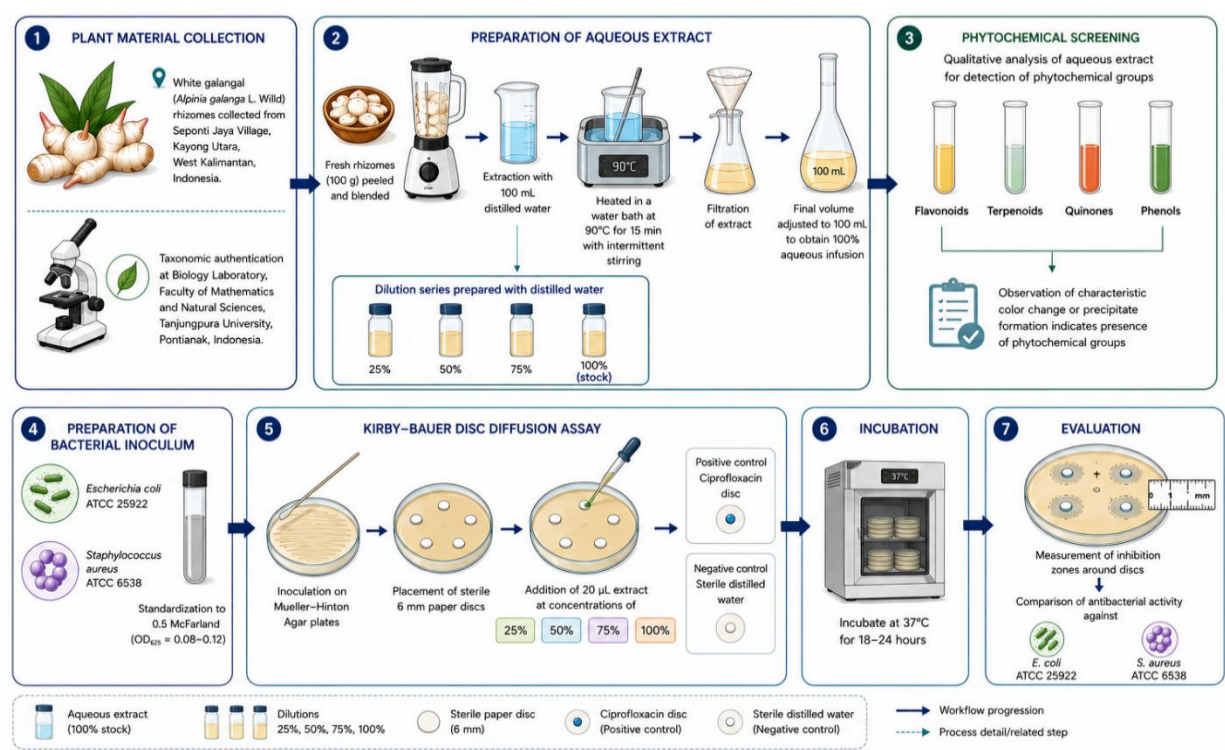


Figure 1. Experimental Workflow of White Galangal (*Alpinia galanga* L. Wild) Aqueous Extract Preparation, Phytochemical Screening and Antibacterial Activity Assay

RESULTS AND DISCUSSION

Alpinia galanga (L.) Willd. (Zingiberaceae), commonly referred to as white galangal, is a perennial rhizome that is extensively utilized as a culinary spice and therapeutic agent in traditional Asian ethnomedicinal practices (Priyono et al., 2024; Trimanto et al., 2021). The species collected from Seponti Jaya Village, Kayong Utara Regency, West Kalimantan, was

taxonomically authenticated as *A. galanga*. Botanically, the species is characterized by a robust, ramified aromatic rhizome that supports an upright pseudostem with alternately arranged lanceolate to oblong foliage. The reproductive structures feature apical inflorescences bearing scented, pale yellow to white blossoms, which subsequently mature into spherical or ellipsoidal capsules displaying hues ranging

from yellow-orange to red (Trimanto et al., 2021).

Based on the screening outcomes summarized in Table 1, the aqueous preparation yielded positive test results exclusively for flavonoids and quinones, whereas phenols and terpenoids were not detected in the aqueous extract. These results are consistent with previous reports describing flavonoids and quinones as the predominant secondary metabolites of *A. galanga*, which are major contributors to its pharmacological activity (Aziz et al., 2024; Badriyah et al., 2024; Eram et al., 2019).

Table 1. Phytochemical Screening Results

Test Parameter	Test Result	Observation
Flavonoid	+	Orange-red coloration
Phenol	–	No dark blue coloration
Quinone	+	Yellow-red coloration
Terpenoid	–	No red coloration

The growing crisis of drug resistance has severely undermined the efficacy of conventional antibiotic treatments, precipitating a dual burden of elevated fatality rates and increasing health-care costs (Aziz et al., 2024). Consequently, the exploration of plant-derived bioactives with antimicrobial potential has gained renewed importance as a complementary or alternative strategy to synthetic antibiotics.

Table 2. Antibacterial activity of aqueous extract of *Alpinia galanga* expressed as inhibition zone diameters (mean ± SD, n = 4)

Group	Inhibition Zone Diameter (mm)	
	<i>E.coli</i>	<i>S. aureus</i>
Control (+)	29.88 ± 1.00	29.91 ± 0.19
Control (-)	0 ± 0.00	0 ± 0.00
25%	7.35 ± 0.31	7.36 ± 0.13
50%	8.07 ± 0.22	8.31 ± 0.33
75%	8.73 ± 0.20	8.93 ± 0.43
100%	9.80 ± 0.14	9.94 ± 0.26

In this context, traditional medicinal plants such as *A. galanga*, which has long been utilized in folk remedies for infection management, offer a valuable reservoir for pharmacological investigations (Dai et al., 2022; Theuretzbacher et al., 2020).

In this study, the antimicrobial efficacy of the *A. galanga* water-derived extract against *Staphylococcus aureus* and *Escherichia coli* was systematically determined using the agar disk diffusion protocol (Fig. 2; Table 2). As shown in Figure 2, the aqueous preparation exhibited a clear dose-dependent inhibitory effect. The measured zones of clearance expanded proportionally with the extract concentration, spanning from 7.36 ± 0.13 to 9.94 ± 0.26 mm against *S. aureus*, and from 7.35 ± 0.31 to 9.80 ± 0.14 mm against *E. coli*. Ciprofloxacin, the positive control, produced substantially larger inhibition zones (29.88 ± 1.00 mm and 29.91 ± 0.19 mm, respectively), whereas sterile distilled water (the negative control) exhibited no inhibition. Consequently, the aqueous preparation exhibited a concentration-dependent, moderate antibacterial capacity against a spectrum of Gram-positive and Gram-negative targets. These trends are consistent with historical reports detailing the inhibitory effects of galangal extracts on *E. coli* and *S. aureus* (Boonkusol et al., 2024; Fransiska et al., 2017).

Statistical analyses further substantiate these results. One-way ANOVA for *S. aureus* indicated significant differences among the treatment groups ($p < 0.05$), with post-hoc comparisons revealing meaningful differences across most concentrations (25%, 50%, 75%, and 100%), except between

the 50% and 75% groups. The Kruskal–Wallis test for *E. coli* yielded a p-value of 0.000 ($p < 0.05$), confirming significant differences between groups. These statistical outcomes reinforce the observed dose-dependent antibacterial activities.

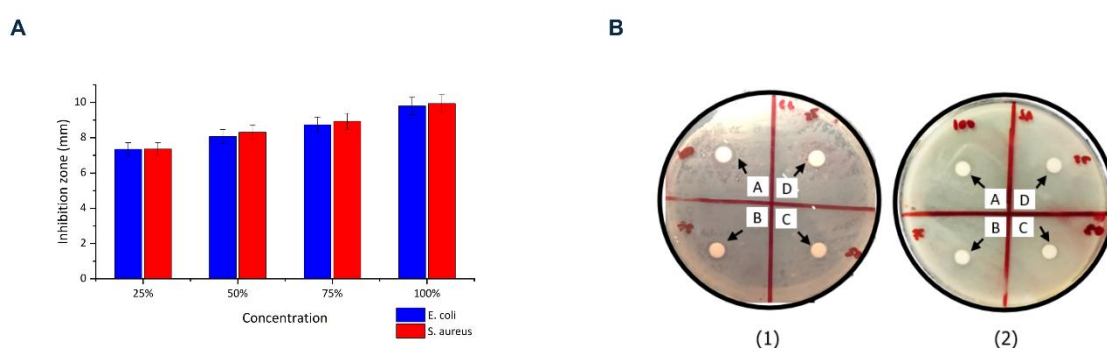


Figure 2. A) Antibacterial activity of the aqueous extract of *Alpinia galanga* L. Willd; B) inhibition zone diameters against (1) *Escherichia coli* and (2) *Staphylococcus aureus*. A = 100%, B = 75%, C = 50%, D = 25% (extract concentration)

The enhanced inhibition at higher extract concentrations can be attributed to the cumulative effects of flavonoids and quinones. Flavonoids are known to compromise bacterial cell membrane integrity, disrupt respiratory chains, and inhibit ATP synthesis, which explains the higher susceptibility of *S. aureus* to flavonoids than that of *E. coli*, which possesses a lipopolysaccharide outer membrane that provides additional resistance (Ralphsody & Lindawati, 2025; Verma & Sharma, 2022; Yuan et al., 2021). In contrast, quinones exert antibacterial effects by forming irreversible complex formation with membrane proteins, inhibition of through irreversible complex formation with membrane proteins, inhibition of microbial adhesion and enzymatic activity, and interference with essential metabolic substrates (Othman et al., 2019).

The moderate yet statistically significant antibacterial activity of the aqueous extract supports its long-standing

use in traditional therapy and highlights its potential for application in the development of natural antibacterial formulations. The choice of aqueous extraction in this study was intentional to replicate the traditional mode of preparation and consumption, thus bridging empirical ethnomedicinal practices with modern pharmacological validation. Previous studies have similarly demonstrated antibacterial activity in aqueous extracts or infusions of *A. galanga* and related Zingiberaceae species, confirming the preservation of active compounds even in water-based preparations (Boonkusol et al., 2024; Fransiska et al., 2017; Raja Johnley et al., 2020).

Evaluating the antibacterial efficacy of the water extract not only affirms its cultural and therapeutic relevance but also provides compelling evidence that its pharmacological activity is not exclusively dependent on organic solvent extraction, thereby reinforcing its practical applicability

in community-based traditional medicine systems.

CONCLUSION

The aqueous extract of *Alpinia galanga* (L.) Willd. exhibited antibacterial activity against both *Escherichia coli* and *Staphylococcus aureus* in a concentration-dependent manner. The mean inhibition zone diameters against *S. aureus* at extract concentrations of 25%, 50%, 75%, and 100% were 7.36, 8.31, 8.93, and 9.94 mm, respectively, whereas the corresponding inhibition zone diameters against *E. coli* were 7.35, 8.07, 8.73, and 9.80 mm. Among the tested concentrations, the 100% aqueous extract exhibited the strongest antibacterial effects against both bacterial strains. These findings confirm that the water extract of *A. galanga* exhibits concentration-dependent antibacterial activity, supporting its traditional therapeutic applications and its potential as a natural antibacterial agent.

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CONFLICT OF INTEREST

The authors declare that no potential conflicts of interest have been reported.

REFERENCES

Agustyarini, P. K. D., Setiawan, P. Y. B., Hita, I. P. G. A. P., & Septiari, I. G. A. A. (2024). Uji Aktivitas Antioksidan Ekstrak Etanol Daun Bawang Merah (*Allium cepa* L.) dengan Metode DPPH.

BENZENA Pharmaceutical Scientific Journal, 03(02), 65.
<https://doi.org/10.31941/benzena.v3i02.5094>

Aulia, R. G., & Ermawati, N. (2023). Tingkat Pengetahuan Masyarakat Tentang Penggunaan Obat Tradisional di Desa Landungsari Kecamatan Pekalongan Timur Kota Pekalongan. *BENZENA Pharmaceutical Scientific Journal*, 02(02), 66-88.
<https://doi.org/10.31941/benzena.v2i02.3746>

Aziman, N., Abdullah, N., Noor, Z. M., Kamarudin, W. S. S. W., & Zulkifli, K. S. (2014). Phytochemical Profiles and Antimicrobial Activity of Aromatic Malaysian Herb Extracts against Food-Borne Pathogenic and Food Spoilage Microorganisms. *Journal of Food Science*, 79(4), M583–M592.
<https://doi.org/https://doi.org/10.1111/1750-3841.12419>

Aziz, I. M., Alfuraydi, A. A., Almarfadi, O. M., Aboul-Soud, M. A. M., Alshememry, A. K., Alsaleh, A. N., & Almajhdi, F. N. (2024). Phytochemical analysis, antioxidant, anticancer, and antibacterial potential of *Alpinia galanga* (L.) rhizome. *Heliyon*, 10(17).
<https://doi.org/10.1016/j.heliyon.2024.e37196>

Badriyah, L., Mutripah, S., & Vifta, R. L. (2024). Skrining Senyawa Metabolit Sekunder dan Hasil Rendemen Ekstrak Rimpang Lengkuas Putih (*Alpinia galanga* L.) Melalui Empat Metode Ekstraksi. *Jurnal Wiyata: Penelitian Sains Dan Kesehatan*, 11(2), 204.
<https://doi.org/10.56710/wiyata.v11i2.935>

Blair, J. M. A., Webber, M. A., Baylay, A. J., Ogbolu, D. O., & Piddock, L. J. V. (2015). Molecular mechanisms of antibiotic resistance. *Nature Reviews Microbiology*, 13(1), 42–51.
<https://doi.org/10.1038/nrmicro3380>

Boonkusol, D., Sawasdee, S., Detraksa, J., Duangsrikaew, K., & Watcharabundit, P. (2024). Evaluation of Anti-*Escherichia coli* K88 from Diarrhea Piglets and Phytochemicals of Galangal Rhizome Extracts. *Trends in*

- Sciences, 21(1).
<https://doi.org/10.48048/tis.2024.7112>
- CLSI. (2022). *M100 Performance Standards for Antimicrobial Susceptibility Testing A CLSI supplement for global application. 32nd Edition.* www.clsi.org.
- Dai, C., Lin, J., Li, H., Shen, J., Shen, Z., Wang, Y., & Velkov, T. (2022). The Natural Product Curcumin as an Antibacterial Agent: Current Achievements and Problems. In *Antioxidants* (Vol. 11, Number 3). MDPI.
<https://doi.org/10.3390/antiox11030459>
- Das, G., Patra, J. K., Gonçalves, S., Romano, A., Gutiérrez-Grijalva, E. P., Heredia, J. B., Talukdar, A. Das, Shome, S., & Shin, H.-S. (2020). Galangal, the multipotent super spices: A comprehensive review. *Trends in Food Science & Technology*, 101, 50–62.
<https://doi.org/https://doi.org/10.1016/j.tifs.2020.04.032>
- Dermawan, A. M., Julianti, E., Putra, M. Y., & Karim, F. (2019). Identification and Evaluation of Antibacterial Compounds from the *Vibrio* sp. associated with the Ascidian *Pycnoclavella diminuta*. *Pharmaceutical Sciences and Research*, 6(3).
<https://doi.org/10.7454/psr.v6i3.4673>
- Dwisari, F., Dermawan, A. M., Amalia, P., Tjoedri, T. N., & Rahma, N. A. (2025). Evaluation of the Antimicrobial Efficacy of *Hibiscus sabdariffa* L. Antiperspirant Preparations Against *Staphylococcus epidermidis*. *Indonesian Journal of Chemical Research*, 13(2), 121–127.
<https://doi.org/10.30598/ijcr.2025.13-fat>
- Eram, S., Mujahid, M., Bagga, P., Ansari, V. A., Ahmad, M. A., Kumar, A., Ahsan, F., & Akhter, M. S. (2019). A Review on Phytopharmacological Activity of *Alpinia Galanga*. *International Journal of Pharmacy and Pharmaceutical Sciences*, 6–11.
<https://doi.org/10.22159/ijpps.2019v11i3.31352>
- Fransiska, A., Oenzil, F., & Dharma Rafke, H. (2017). Perbandingan Efektivitas Antibakteri Infusum Lengkuas Putih dan Merah Terhadap *Staphylococcus aureus*. *Cakradonya Dent J*, 9(2), 101–106.
- Khairullah, A. R., Solikhah, T. I., Nur, A., Ansori, M., Fadholly, A., Ramandinianto, S. C., Ansharieta, R., Widodo, A., Hendriana, K., Riwu, P., Putri, N., Proboningrat, A., Khaliim, M., Kusala, J., Rendragraha, B. W., Rozaqi, A., Putra, S., & Anshori, A. (2020). A Review of an Important Medicinal Plant: *Alpinia galanga* (L.) Willd. In *Systematic Reviews in Pharmacy* (Vol. 11, Number 10).
- Miryala, S. K., & Ramaiah, S. (2019). Exploring the multi-drug resistance in *Escherichia coli* O157:H7 by gene interaction network: A systems biology approach. *Genomics*, 111(4), 958–965.
<https://doi.org/https://doi.org/10.1016/j.ygeno.2018.06.002>
- Nadya, S., Yuniarti & Rosidah. (2022). Uji Fitokimia Terhadap Tanaman Obat Kratom (*Mitragyna speciosa*) di KHDTK ULM. *Jurnal Sylva Scientiae*, 05(2), 218–224.
- Othman, L., Sleiman, A., & Abdel-Massih, R. M. (2019). Antimicrobial activity of polyphenols and alkaloids in middle eastern plants. In *Frontiers in Microbiology* (Vol. 10, Number MAY). Frontiers Media S.A.
<https://doi.org/10.3389/fmicb.2019.00911>
- Priyono, Q. A. P., Yusniasari, P. A., Alifiansyah, M. R. T., Suryanto, G. Y., Widyowati, R., Herdiansyah, M. A., Ansori, A. N. M., Purnobasuki, H., Pratiwi, I. A., Makhmudov, F., Azimova, S., Kizatova, M., Rebezov, M., Jakhmola, V., Sahadewa, S., & Durry, F. D. (2024). Ethnomedical Potentials, Phytochemicals, and Medicinal Profile of *Alpinia galanga* L.: A Comprehensive Review. In *BIO Integration* (Vol. 5, Number 1). Compuscript Ltd.
<https://doi.org/10.15212/bioi-2024-0032>

- Raja Johnley, I. I., Somasundaram, G., J Salwe, K., & Manimekalai, K. (2020). Anti Ulcerogenic and Anti-Oxidant Activity of Alpinia Galanga Rhizomes Aqueous Extract in Indomethacin Induced Gastric Mucosal Damage in Wistar Albino Rats. *Biomedical and Pharmacology Journal*, 13(1), 55–60. <https://doi.org/10.13005/bpi/1860>
- Ralphsody, D. H. G., & Lindawati, N. Y. (2025). Pengaruh Konsentrasi Etanol Terhadap Aktivitas Antibakteri Ekstrak Daun Lili Paris (*Chlorophytum comosum*). *BENZENA Pharmaceutical Scientific Journal*, 04(01). 39. <https://doi.org/10.31941/benzena.v4i01.6644>
- Rossiter, S. E., Fletcher, M. H., & Wuest, W. M. (2017). Natural Products as Platforms To Overcome Antibiotic Resistance. *Chemical Reviews*, 117(19), 12415–12474. <https://doi.org/10.1021/acs.chemrev.7b00283>
- Suciati, A., & Maryati. (2023). Systematic Review: Anticancer Potential of Active Compounds from Galangal (Alpinia galanga) . *Proceedings of the 4th International Conference Current Breakthrough in Pharmacy (ICB-Pharma 2022)*, 3. https://doi.org/10.2991/978-94-6463-050-3_23
- Theuretzbacher, U., Outtersson, K., Engel, A., & Karlén, A. (2020). The global preclinical antibacterial pipeline. In *Nature Reviews Microbiology* (Vol. 18, Number 5, pp. 275–285). Nature Research. <https://doi.org/10.1038/s41579-019-0288-0>
- Trimanto, T., Hapsari, L., & Dwiyantri, D. (2021). Alpinia galanga (L.) willd: Plant morphological characteristic, histochemical analysis and review on pharmacological. *AIP Conference Proceedings*, 2353. <https://doi.org/10.1063/5.0052687>
- Verma, R. K., & Sharma, N. (2022). Phytochemical and Pharmacological activities of Alpinia galangal: A review. *Asian Journal of Pharmacy and Pharmacology*, 8(3), 74–85. <https://doi.org/10.31024/ajpp.2022.8.3.3>
- Yuan, G., Guan, Y., Yi, H., Lai, S., Sun, Y., & Cao, S. (2021). Antibacterial activity and mechanism of plant flavonoids to gram-positive bacteria predicted from their lipophilicities. *Scientific Reports*, 11(1), 10471. <https://doi.org/10.1038/s41598-021-90035-7>
- Zhou, C., Li, C., Siva, S., Cui, H., & Lin, L. (2021). Chemical composition, antibacterial activity and study of the interaction mechanisms of the main compounds present in the Alpinia galanga rhizomes essential oil. *Industrial Crops and Products*, 165, 113441. <https://doi.org/10.1016/j.indcrop.2021.113441>