



An ethnomedicine study of the Tengger Tribe in Probolinggo East Java and anti-inflammatory activity

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ABSTRACT

The Tengger Tribe in East Java, Indonesia, has long utilized medicinal plants to treat various diseases, including inflammatory conditions. This study aimed to identify medicinal plants used by the Tengger Tribe and determine their anti-inflammatory activity through in vitro and in vivo assays. An ethnomedicinal survey was conducted using snowball sampling and semi-structured interviews with key informants. Plant importance was assessed using the Use Value and Informant Consensus Factor indices. Selected plants were extracted with ethanol and evaluated for anti-inflammatory activity using the Human Red Blood Cell membrane stabilization assay in vitro and a carrageenan-induced paw edema model in vivo. Four medicinal plant species with high ethnomedicinal significance were selected for biological evaluation. Among the tested extracts, *Borreria laevis* exhibited the strongest anti-inflammatory activity, with an IC₅₀ value of 133.57 ppm in the HRBC assay. The experimental data met the assumption of ANOVA $p > 0.000$. In the in vivo model, Tepung Otot (*Borreria laevis*) showed the highest anti-inflammatory effect, with inhibition percentages of 76.39%, 79.27%, and 81.55% at doses of 105, 210, and 560 mg/kg body weight. These findings support the traditional use of Tengger medicinal plants and highlight Tepung Otot (*Borreria laevis*) as a promising natural anti-inflammatory agent.

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1. Introduction

Indonesia is recognized as one of the world's megabiodiversity countries, possessing a rich diversity of plant species with potential applications in traditional and modern medicine (Febriyanti et al., 2026). Medicinal plants continue to play an important role in primary healthcare, particularly among indigenous communities that preserve traditional knowledge and healing practices (Bhagawan et al., 2025). Consequently, ethnobotanical and ethnomedical studies have gained increasing attention as valuable approaches for identifying bioactive plants that may serve as sources of novel therapeutic agents (Ningsih et al., 2024).

One indigenous community that maintains a strong tradition of medicinal plant use is the Tengger Tribe, which inhabits the area surrounding Mount Bromo in East Java, Indonesia. Traditional

knowledge regarding the medicinal use of local plant species has been transmitted across generations and remains an integral part of the community's healthcare system (Lahardo et al., 2024). Previous studies have documented the use of various medicinal plants by the Tengger people for treating fever, digestive disorders, pain, and other health conditions (Jadid et al., 2020). Traditional healers continue to play an important role in preserving and applying this ethnomedical knowledge (Nugraha et al., 2024).

Inflammation is a common physiological response associated with numerous acute and chronic diseases. Although conventional anti-inflammatory drugs are widely available, their long-term use may result in adverse effects, encouraging the search for safer alternatives derived from natural products (Renny et al., 2024; Zhang et al., 2020). Numerous plant-derived secondary metabolites, including flavonoids, phenolic compounds, and terpenoids have demonstrated anti-inflammatory activity through the modulation of inflammatory mediators and signaling pathways (Fatima et al., 2021). Therefore, medicinal plants traditionally used by indigenous communities represent promising candidates for the discovery of new anti-inflammatory agents (Bhagawan et al., 2023; Nugraha et al., 2022).

The Human Red Blood Cell (HRBC) membrane stabilization assay is widely employed as a preliminary method for evaluating anti-inflammatory activity because of its simplicity and its ability to reflect membrane-protective effects associated with inflammation (Aidoo et al., 2021). In addition, in vivo models such as carrageenan-induced inflammation are commonly used to validate anti-inflammatory activity under physiological conditions (Fujiati et al., 2022).

Although several studies have documented the medicinal plants used by the Tengger community and their traditional therapeutic applications, scientific evidence supporting their anti-inflammatory properties remains limited. Previous research has primarily focused on ethnobotanical documentation, with little attention given to pharmacological validation. To the best of our knowledge, no previous study has integrated ethnomedical indices, including Use Value (UV) and Informant Consensus Factor (ICF), with both in vitro and in vivo anti-inflammatory evaluations of medicinal plants used by the Tengger Tribe. The novelty of this study lies in the integration of ethnomedical documentation and pharmacological validation to identify promising anti-inflammatory plants based on their cultural importance. We hypothesized that medicinal plants with high UV and ICF values would exhibit significant anti-inflammatory activity. Therefore, this study aimed to identify medicinal plants used by the Tengger community in Probolinggo, East Java, and evaluate the anti-inflammatory potential of selected species through in vitro and in vivo approaches.

2. Methods

Study Area and Ethnomedical Survey

This study was conducted among the Tengger community in Probolinggo Regency, East Java, Indonesia. An ethnomedical survey was carried out to document medicinal plants traditionally used for the treatment of inflammatory-related conditions. Informants were selected using the snowball sampling method, in which key informants identified additional knowledgeable participants within the community. A total of 29 informants participated in the study. Data were collected through semi-structured interviews using open-ended questions regarding local plant names, plant parts used, preparation methods, therapeutic uses, and modes of administration. The ethnomedical importance of each species was evaluated using the Use Value (UV) and Informant Consensus Factor (ICF) indices.

Plant Identification

Medicinal plants with the highest UV and ICF values were selected for further pharmacological evaluation. Plant specimens were collected from the study area and taxonomically identified by experts at Materia Medica Batu, East Java, Indonesia. The identified species were subsequently used for extraction and biological activity testing.

Materials and Plant Extraction

The materials used in this study included sodium diclofenac (Merck), sodium citrate (Merck), citric acid (Merck), sodium chloride (Merck), phosphate buffer (pH 7.4, 0.15 M), magnesium powder (Merck), concentrated hydrochloric acid (Merck), amyl alcohol (Merck), ethanol (Merck), n-hexane (Merck), ethyl acetate (Merck), dimethyl sulfoxide (DMSO) (Merck), and carrageenan. The equipment

included analytical balances (AND GF-02), UV-Visible spectrophotometers (Shimadzu), centrifuges (Hettich EBA 200), rotary evaporators (RE-100S), ultrasonic cleaners, water baths, autoclaves, ovens (Mettler), volumetric pipettes (Pyrex), micropipettes (Socorex), and standard laboratory glassware (Pyrex).

Dried plant materials (1000 g) were macerated in 10 L of 96% ethanol for five days at room temperature. The extracts were filtered using Whatman No. 1 filter paper and concentrated under reduced pressure using a rotary evaporator at temperatures below 45°C to obtain crude extracts.

In Vitro Anti-Inflammatory Assay

Anti-inflammatory activity was evaluated using the human red blood cell (HRBC) membrane stabilization assay according to the method described by Oyedapo (2010). Human blood samples were obtained from the Indonesian Red Cross (PMI) and used to prepare erythrocyte suspensions. Extracts were tested at concentrations of 50, 100, 200, 400, and 800 ppm. Sodium diclofenac was used as a positive control. Following incubation at 37°C for 30 minutes, samples were centrifuged at 3000 rpm for 20 minutes. The absorbance of the supernatant was measured at 560 nm using a UV-Visible spectrophotometer. The percentage of membrane stabilization was calculated, and IC₅₀ values were determined by linear regression analysis (Yesmin et al., 2020).

In Vivo Anti-Inflammatory Assay

Twenty-five male Wistar rats (*Rattus norvegicus*) obtained from the Laboratory of Universitas Setia Budi were used in this study. The animals were acclimatized for one week under standard laboratory conditions with free access to food and water. Body weight and health status were monitored before the experiment.

The rats were randomly divided into five groups (n = 5 per group): (I) negative control (1% CMC), (II) positive control (methylprednisolone, 0.072 mg/kg body weight), (III) ethanol extract of the selected plant at 105 mg/kg body weight, (IV) ethanol extract at 210 mg/kg body weight, and (V) ethanol extract at 560 mg/kg body weight.

Acute inflammation was induced using a modified Winter method by subplantar injection of 1 mL of 1% carrageenan dissolved in physiological saline (0.9% NaCl) into the hind paw of each rat. Paw edema volume was measured using a plethysmometer before treatment and at 0.5, 1, 2, 3, 4, 5, and 24 h after carrageenan administration. Anti-inflammatory activity was evaluated by calculating the Area Under the Curve (AUC) and the percentage inhibition of edema.

Statistic Analysis

Data were expressed as mean ± standard deviation (SD). Normality was assessed using the Kolmogorov-Smirnov test. Statistical differences among groups were analyzed using one-way analysis of variance (ANOVA), followed by Tukey's Honestly Significant Difference (HSD) post hoc test when appropriate. Differences were considered statistically significant at $p < 0.05$.

Ethical Approval

This study was approved by the Health Research Ethics Committee, Faculty of Medicine, Universitas Muhammadiyah Surakarta, Indonesia (Approval No. 1931/A.1/KEPK-FKUMS/II/2019).

3. Results and Discussion

Ethnomedicinal Survey

Albuquerque (2006) states that the Informant Consensus Factor is used as a criterion in plant species research to identify the most important categories within a study. This quantitative method aims to identify the species most important to a specific population. Furthermore, a more comprehensive investigation was carried out to assess the anti-inflammatory properties of tepung otot, pangotan, Ganjan, and Asem Tengger. Figure 1 displays the UV values of Tengger medicinal plants that may possess anti-inflammatory properties.

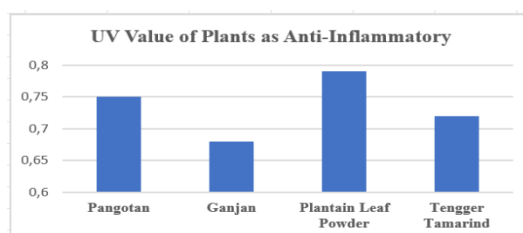


Figure 1. The anti-inflammatory properties of plants

The number of respondents who mentioned a particular plant and the number of respondents who use or are familiar with it determine the usage score. The ethnomedicinal survey documented medicinal plants traditionally used by the Tengger community in Probolinggo Regency, East Java, Indonesia, for the treatment of inflammation-related conditions. The cultural importance of each species and the degree of agreement among informants were evaluated using the Use Value (UV) and Informant Consensus Factor (ICF) indices. These quantitative ethnopharmacological parameters are widely used to assess the relative importance of medicinal plants and the consistency of traditional knowledge within a community. The ICF values for disease categories associated with inflammatory conditions are presented in Table 1.

Table 1.

Informant Consensus Factor scores for types of inflammatory diseases among the Tengger people

Number	Categories Of Inflammatory Diseases Among The Tengger Community	ICF Score
1	Muscle Pain/Stiffness	0,93
2	Rheumatism	0,8
3	Stomach Ache	1

The ICF values ranged from 0.80 to 1.00, indicating a high level of agreement among informants regarding the use of medicinal plants for inflammation-related ailments. High ICF values suggest that traditional knowledge concerning the treatment of these conditions is well preserved and consistently practiced within the Tengger community. Importantly, ICF values reflect the degree of consensus among informants regarding plant use for specific disease categories and should not be interpreted as indicators of disease prevalence or severity. The highest ICF value (1.00) was observed for stomachache, indicating that informants consistently recommended the same plant species for this condition.

Based on the UV analysis, four plant species exhibited the highest utilization values, namely tepung otot (*Borreria laevis*), ganjan (*Artemisia vulgaris* L.), pangotan (*Microsorium buergerianum* (Miq.) Ching), and Tengger tamarind (*Radicula armoracia* Robinson). High UV values indicate that these species are widely recognized and frequently utilized by the local community, reflecting their cultural significance and perceived therapeutic effectiveness. Consequently, these four species were selected for further pharmacological evaluation.

Previous ethnopharmacological studies have demonstrated that medicinal plants with high UV and ICF values often exhibit relevant biological activities when subjected to laboratory investigation. Therefore, the use of UV and ICF as selection criteria provides a rational and scientifically supported approach for prioritizing candidate species for pharmacological validation. The selection of these four species represents an important step in bridging traditional medicinal knowledge and modern pharmacological research. The findings of this study highlight the strong relationship between indigenous knowledge and medicinal plant utilization among the Tengger community. The high UV and ICF values observed for the selected species indicate their important role in traditional healthcare practices and provide a scientific basis for further investigations into their anti-inflammatory potential.

In Vitro Anti-Inflammatory Activity

The stabilisation of red blood cell membranes is one method of assessing anti-inflammatory efficacy in vitro. Stabilising lysosomal membranes is crucial for reducing the inflammatory response, as it

prevents the release of enzymes from lysosomes during inflammation. Lysosomal membranes and red blood cell membranes are sufficiently similar to influence inflammation in the same way. Whether acute or chronic, lysosomal enzymes produced during inflammation (via neutrophil activation) are associated with a number of diseases. Another way to measure lysosomal membrane resistance is to observe how red blood cell membranes react to hypotonic solutions (Kumar, 2012). The results of the membrane stability test for the extract are shown in Table 2.

Table 2.
Stabilisation of erythrocyte membranes by plant extracts

Concentration (ppm)	Sample		absorbance of the test solution	absorbance of the test control solution	% stability membrane
2000	Plantain Powder	Leaf	0,059	0,045	79,71
	Pangotan		0,073	0,049	65,27
	Tengger		0,084	0,055	57,97
	Tamarind				
	Ganjan		0,085	0,053	46,37
1000	Plantain Powder	Leaf	0,065	0,041	65,21
	Pangotan		0,075	0,045	56,52
	Tengger		0,088	0,051	44,92
	Tamarind				
	Ganjan		0,094	0,047	31,78
500	Plantain Powder	Leaf	0,068	0,039	57,97
	Pangotan		0,076	0,041	49,27
	Tengger		0,090	0,047	37,68
	Tamarind				
	Ganjan		0,098	0,045	23,18
250	Plantain Powder	Leaf	0,070	0,036	50,72
	Pangotan		0,078	0,038	42,02
	Tengger		0,086	0,040	33,33
	Tamarind				
	Ganjan		0,099	0,038	18,84

As the results mentioned above suggest that the plant may possess anti-inflammatory properties, IC_{50} calculations were performed. Table 3 presents the findings.

Table 3.
Linear regression of red blood cell membrane stability

Sample	linear regression	IC_{50}
Plantain Leaf Powder	$Y = 0,0151x + 47,983$	133,57 ppm
Pangotan	$Y = 0,0125x + 41,582$	673,44 ppm
Tengger Tamarind	$Y = 0,0139x + 30,431$	1407 ppm
Ganjan	$Y = 0,0157x + 15,35$	2207 ppm

The anti-inflammatory activity of the selected plant extracts was evaluated using the Human Red Blood Cell (HRBC) membrane stabilization assay. This method is widely employed as a preliminary screening technique because erythrocyte membranes share structural similarities with lysosomal membranes (Mancipe et al., 2023). Therefore, compounds capable of stabilizing erythrocyte membranes may also prevent the release of lysosomal enzymes and inflammatory mediators during inflammatory responses. The results demonstrated that all tested extracts exhibited membrane-stabilizing activity, with the percentage of protection increasing in a concentration-dependent manner. Among the

evaluated species, *Borreria laevis* showed the highest membrane stabilization activity ($79.71 \pm 2.14\%$) at a concentration of 2000 ppm, followed by *Microsorium buergerianum* ($65.27 \pm 1.87\%$), *Radicula armoracia* ($57.97 \pm 2.03\%$), and *Artemisia vulgaris* ($46.37 \pm 1.76\%$) ($n = 3$). Statistical analysis using the Shapiro–Wilk test confirmed normal data distribution ($p > 0.05$), while Levene’s test indicated homogeneity of variance ($p > 0.05$). One-way ANOVA revealed significant differences among treatment groups ($p < 0.05$), and Tukey’s HSD test demonstrated that *B. laevis* exhibited significantly higher membrane-stabilizing activity than the other extracts at the same concentration.

The IC_{50} values further confirmed the superior anti-inflammatory activity of *B. laevis*. Among the tested extracts, *B. laevis* showed the lowest IC_{50} value (133.57 ppm), followed by *M. buergerianum* (673.44 ppm), *R. armoracia* (1407.00 ppm), and *A. vulgaris* (2207.00 ppm). Lower IC_{50} values indicate stronger anti-inflammatory activity because lower concentrations are required to achieve 50% membrane stabilization. Furthermore, the high coefficients of determination ($R^2 > 0.95$) indicate a strong relationship between extract concentration and membrane stabilization activity, supporting the reliability of the regression models used to estimate IC_{50} values.

Phytochemical screening revealed the presence of flavonoids, tannins, glycosides, and alkaloids in all tested extracts. These secondary metabolites have been widely associated with anti-inflammatory activity. Flavonoids are known to inhibit cyclooxygenase (COX) and lipoxygenase (LOX) pathways, thereby reducing the synthesis of prostaglandins and leukotrienes. Tannins contribute to membrane stabilization and antioxidant activity, whereas alkaloids may modulate inflammatory signaling pathways. Although all four species contained similar classes of phytochemicals, *B. laevis* exhibited substantially stronger activity than the other extracts. This finding suggests that anti-inflammatory efficacy may depend not only on the presence of bioactive compounds but also on their concentration, composition, and synergistic interactions.

The concentration-dependent increase in membrane stabilization observed in this study supports the hypothesis that secondary metabolites present in Tengger medicinal plants contribute to the observed anti-inflammatory activity. The agreement between ethnomedicinal importance, phytochemical composition, and biological activity provides scientific evidence supporting the traditional use of these plants by the Tengger community. Nevertheless, this study was limited to an in vitro HRBC assay. Further investigations involving active compound isolation, molecular mechanism studies, and in vivo pharmacological evaluation are required to comprehensively validate their therapeutic potential.

In Vivo Anti-Inflammatory Activity

The aim of this test was to evaluate the anti-inflammatory properties of methylprednisolone and plant extracts.

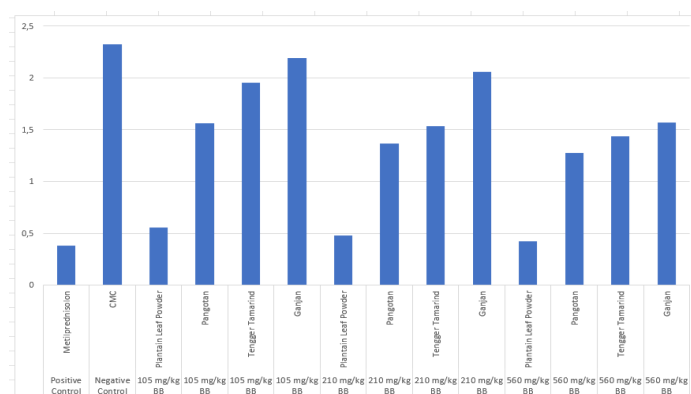


Figure 2. AUC histogram for the control solution and extracts of selected plants

Inflammatory activity is stronger at lower AUC values, as shown in the figure above. Using methylprednisolone as a positive control, this study found that, of the four extracts tested, the muscle

flour extract exhibited the greatest anti-inflammatory effect. At a dose of 560 mg/kg body weight, the area under the curve (AUC) for the muscle flour extract was 0.4200 ± 0.0900 , indicating a reduction. Extracts from pangotan, asam tengger, and ganjan may possess anti-inflammatory effects; however, as shown in Appendix 10, higher doses are required to achieve an effect comparable to that of the positive control, methylprednisolone. The findings regarding the percentage of anti-inflammatory potency are presented in Table 4 below:

Table 4.
AUC results and % anti-inflammatory activity of the control solution and selected plants

Test Solution-Sample	Dosage Mg/Kg Body Weight	AUC $\pm$ SD	Percentage Of Inflammatory Cells
Negative Control (Carboxymethyl Cellulose)	-	2,3260 $\pm$ 0,1184	-
Positive Control (Methylprednisolon)	0,072	0,3780 $\pm$ 0,1188	73,04
Ganjan (<i>Artemisia vulgaris</i> L.)	105	2,1888 $\pm$ 0,2203 ^b	7,437
	210	2,0588 $\pm$ 0,4919 ^b	14,64
	560	1,5730 $\pm$ 0,0544 ^{a,b}	31,54
Asam Tengger (<i>Radicula armoracia</i> Robinson)	105	1,9532 $\pm$ 0,4120 ^b	27,30
	210	1,5324 $\pm$ 0,1962 ^{a,b}	34,01
	560	1,4394 $\pm$ 0,1526 ^{a,b}	38,05
Pangotan (<i>Microsorium buergerianum</i> (Miq.) Ching)	105	1,5654 $\pm$ 0,1899 ^{a,b}	38,05
	210	1,3658 $\pm$ 0,1432 ^{a,b}	40,10
	560	1,2752 $\pm$ 0,1341 ^{a,b}	44,94
Tepung Otot (<i>Borreria laevis</i>)	105	0,5500 $\pm$ 0,1576 ^a	76,39
	210	0,4800 $\pm$ 0,1538 ^a	79,27
	560	0,4200 $\pm$ 0,0900 ^a	81,55

Description: ^a significantly different from the negative control ($p < 0,05$)

^b significantly different from the positive control ($p < 0,05$)

The in vivo anti-inflammatory activity of the selected plant extract was evaluated using the carrageenan-induced paw edema model in rats. All tested extracts reduced edema formation compared with the negative control, as reflected by lower AUC values and higher percentages of inflammation inhibition. The anti-inflammatory activity increased with increasing dose, indicating a positive dose-response relationship.

Among the tested extracts, *Borreria laevis* exhibited the strongest anti-inflammatory activity at all dose levels. At a dose of 560 mg/kg body weight, the extract produced an AUC value of 0.4200 ± 0.0900 and an anti-inflammatory activity of 81.55%. This activity was comparable to that of the positive control, methylprednisolone (73.04%), suggesting a strong anti-inflammatory effect of the extract in the carrageenan-induced inflammation model.

Statistical analysis showed that the data were normally distributed according to the Kolmogorov-Smirnov test ($p > 0.05$), while Levene's test confirmed homogeneity of variance ($p > 0.05$).

Therefore, one-way ANOVA was performed and revealed significant differences among treatment groups ($p < 0.001$). Subsequent Tukey HSD analysis demonstrated that the *B. laevis* extract at 560 mg/kg body weight differed significantly from the other plant extracts ($p < 0.05$) but did not differ significantly from methylprednisolone ($p > 0.05$). These findings indicate that the anti-inflammatory activity of *B. laevis* approached that of the standard anti-inflammatory drug.

The strong activity observed in *Borreria laevis* is consistent with the results of the HRBC membrane stabilization assay, in which this species exhibited the lowest IC_{50} value (133.57 ppm). The agreement between the in vitro and in vivo findings strengthens the evidence that *B. laevis* possesses genuine anti-inflammatory activity. Phytochemical screening revealed the presence of flavonoids, tannins, glycosides, and alkaloids, which have been widely associated with anti-inflammatory effects. Flavonoids are known to inhibit cyclooxygenase (COX) and lipoxygenase (LOX) pathways, thereby reducing the production of prostaglandins and leukotrienes involved in inflammatory responses. In addition, phenolic compounds contribute to antioxidant activity and may reduce oxidative stress and tissue damage at inflammatory sites.

Compared with *Microsorium buergerianum*, *Radicula armoracia*, and *Artemisia vulgaris*, *B. laevis* consistently demonstrated superior anti-inflammatory activity across all tested doses. This difference may be attributed to variations in the concentration, composition, and synergistic interactions of bioactive secondary metabolites among the investigated species. The findings support the ethnomedicinal use of *B. laevis* by the Tengger community and provide pharmacological evidence for its potential development as a natural anti-inflammatory agent.

Nevertheless, the present study was limited to preliminary pharmacological evaluation and phytochemical screening. Further studies are required to isolate and characterize the active compounds, investigate their molecular mechanisms of action, and evaluate their long-term safety and efficacy.

4. Conclusion

This study documented the ethnomedicinal knowledge of the Tengger community in Probolinggo, East Java, involving 29 informants from five villages. A total of 47 medicinal plant species, three animal species, and five mineral materials were recorded for the treatment of 29 health conditions. The Use Value (UV) and Informant Consensus Factor (ICF) analyses identified four culturally important medicinal plants, namely *Borreria laevis*, *Microsorium buergerianum* (Miq.) Ching, *Radicula armoracia* Robinson, and *Artemisia vulgaris* L., which were subsequently selected for pharmacological evaluation.

The in vitro HRBC membrane stabilization assay demonstrated that *Borreria laevis* exhibited the strongest anti-inflammatory activity, with the lowest IC_{50} value (133.57 ppm) among the tested species. This finding was supported by the in vivo carrageenan-induced paw edema model, in which *B. laevis* produced the highest anti-inflammatory activity, reaching 81.55% inhibition at a dose of 560 mg/kg body weight. The consistency between the in vitro and in vivo results provides scientific evidence supporting the traditional use of this species by the Tengger community.

Overall, the findings demonstrate that ethnomedicinal knowledge can serve as an effective approach for identifying biologically active medicinal plants. The results highlight *Borreria laevis* as a promising source of natural anti-inflammatory agents and provide a scientific basis for the preservation and utilization of traditional medicinal knowledge. However, this study was limited to preliminary phytochemical screening and pharmacological evaluation. Further studies are required to isolate and characterize the active compounds, investigate their molecular mechanisms, and assess their safety and efficacy through more comprehensive preclinical studies.

References

- Aidoo, D. B., Konja, D., Henneh, I. T., & Ekor, M. (2021). Protective Effect of Bergapten against Human Erythrocyte Hemolysis and Protein Denaturation in Vitro. *International Journal of Inflammation*, 2021. <https://doi.org/10.1155/2021/1279359>
- Bhagawan, W. S., Ekasari, W., & Agil, M. (2023). Ethnopharmacology of medicinal plants used by the Tenggerese community in Bromo Tengger Semeru National Park, Indonesia. *Biodiversitas*, 24(10), 5464–5477. <https://doi.org/10.13057/biodiv/d241028>

- Bhagawan, W. S., Ekasari, W., & Agil, M. (2025). Ethnomedicinal survey and scientific validation of inflammation-healing plants used by the Tengger community in East Java, Indonesia. *Biodiversitas*, 26(7), 3160–3173. <https://doi.org/10.13057/biodiv/d260707>
- Fatima, H., Shahid, M., Jamil, A., & Naveed, M. (2021). Therapeutic Potential of Selected Medicinal Plants Against Carrageenan Induced Inflammation in Rats. *Dose-Response*, 19(4). <https://doi.org/10.1177/15593258211058028>
- Febriyanti, R. M., Ramadhania, Z. M., Tjitraresmi, A., Indradi, R. B., Maisyarah, I. T., Maundu, P. M., Muhaimin, M., & Sujarwo, W. (2026). A systematic review of ethnobotanical study in Indonesia: diversity and cultural patterns of medicinal plant use. *Journal of Ethnobiology and Ethnomedicine*. <https://doi.org/10.1186/s13002-026-00879-4>
- Fujiati, F., Haryati, H., Joharman, J., & Utami, S. W. (2022). In Vitro Metabolite Profiling and Anti-Inflammatory Activities of *Rhodomyrtus Tomentosa* with Red Blood Cell Membrane Stabilization Methods. In *Reports of Biochemistry & Molecular Biology* (Vol. 11, Number 3). www.RBMB.net
- Jadid, N., Kurniawan, E., Himayani, C. E. S., Andriyani, Prasetyowati, I., Purwani, K. I., Muslihatin, W., Hidayati, D., & Tjahjaningrum, I. T. D. (2020). An ethnobotanical study of medicinal plants used by the Tengger tribe in Ngadisari village, Indonesia. *PLoS ONE*, 15(7 July). <https://doi.org/10.1371/journal.pone.0235886>
- Lahardo, D., Ekasari, W., & Widyawaruyanti, A. (2024). Ethnomedicine Study of Medicinal Plants for Therapy of Elderly Sleep Disorders in Tengger Tribe. *Borneo Journal of Pharmacy*, 7(3), 306–314. <https://doi.org/10.33084/bjop.v7i3.7272>
- Mancipe, J. C., Vargas-Pinto, P., Rodríguez, O. E., Borrego-Muñoz, P., Castellanos Londoño, I., Ramírez, D., Piñeros, L. G., Mejía, M. C., & Pombo, L. M. (2023). Anti-Inflammatory Effect of Izalpinin Derived from *Chromolaena leivensis*: λ -Carrageenan-Induced Paw Edema and In Silico Model. *Molecules*, 28(9). <https://doi.org/10.3390/molecules28093722>
- Ningsih, I. Y., Mandasari, V. F., Pratama, A. N. W., & Hidayat, M. A. (2024). Ethnopharmacology study of medicinal plants utilization for antidiarrheal remedies by Tengger tribe in Tosari District, Indonesia. *Pharmaciana*, 14(1), 100. <https://doi.org/10.12928/pharmaciana.v14i1.28099>
- Nugraha, A. S., Agustina, R. P., Mirza, S., Rani, D. M., Winarto, N. B., Triatmoko, B., Pratama, A. N. W., Keller, P. A., & Wangchuk, P. (2022). Phytochemistry and Pharmacology of Medicinal Plants Used by the Tenggerese Society in Java Island of Indonesia. In *Molecules* (Vol. 27, Number 21). MDPI. <https://doi.org/10.3390/molecules27217532>
- Nugraha, A. S., Pratama, A. N. W., Triatmoko, B., Agustina, R. P., Mirza, S., Nawiyanto, Wangchuk, P., & Keller, P. A. (2024). Tenggerese traditional medicine of Indonesia: Existing practices and the botanical identification of medicinal plants. *Ethnobotany Research and Applications*, 27(Special Issue). <https://doi.org/10.32859/era.27.39.1-21>
- Renny, A., Sidhic, J., Tom, A., Kuttithodi, A. M., Job, J. T., Rajagopal, R., Alfarhan, A., & Narayanankutty, A. (2024). Methanol Extract of *Thottea siliquosa* (Lam.) Ding Hou Leaves Inhibits Carrageenan- and Formalin-Induced Paw Edema in Mice. *Molecules*, 29(20). <https://doi.org/10.3390/molecules29204800>
- Yesmin, S., Paul, A., Naz, T., Rahman, A. B. M. A., Akhter, S. F., Wahed, M. I. I., Emran, T. Bin, & Siddiqui, S. A. (2020). Membrane stabilization as a mechanism of the anti-inflammatory activity of ethanolic root extract of *Choi* (*Piper chaba*). *Clinical Phytoscience*, 6(1). <https://doi.org/10.1186/s40816-020-00207-7>
- Zhang, H., Shang, C., Tian, Z., Amin, H. K., Kassab, R. B., Abdel Moneim, A. E., & Zhang, Y. (2020). Diallyl Disulfide Suppresses Inflammatory and Oxidative Machineries following Carrageenan Injection-Induced Paw Edema in Mice. *Mediators of Inflammation*, 2020. <https://doi.org/10.1155/2020/8508906>