Jurnal Farmasi Galenika (*Galenika Journal of Pharmacy*) (e-Journal) 2026; 12 (2): x – x
ISSN: 2442-8744 (electronic); 2442-7284 (printed)
Journal Homepage: https://bestjournal.untad.ac.id/index.php/Galenika
DOI: 10.22487/j24428744. 2026.v2.i12.17946

Analysis of the Effect of Solvent Type and Extraction Method on the Antioxidant Activity of Tammate Bark (*Lannea coromandelica* (Houtt.) Merr.) Using the ABTS Method

(Analisis Pengaruh Jenis Pelarut dan Metode Ekstraksi terhadap Aktivitas Antioksidan Kulit Batang Tammate (Lannea coromandelica (Houtt.) Merr.) menggunakan Metode ABTS)

Hardi[1], Muhammad Syahrir[2], Khairuddin[3], Rosni Octaviany[3], Funny Glorita Rongko[3], Muh. Azwar AR[1*], Dyah Ratna Ayu Puspita Sari[1], Sri Sulistiana Sulaiman[1], Ni Made Susilawati[1]

[1]*Fakultas Matematika dan Ilmu Pengetahuan Alam, Universitas Tadulako, Sulawesi Tengah*
[2]*Fakultas Kesehatan Masyarakat, Universitas Tompotika, Sulawesi Tengah*
[3]*Fakultas Ilmu Kesehatan, Universitas Almarisah Madani, Sulawesi Selatan*
Email: muhammadazwar5439@gmail.com

Article Info:
Received: 23 January 2026
in revised form: 19 April 2026
Accepted: 01 October 2026
Available Online: 01 October 2026

Keywords:
Antioxidants
ABTS
Lannea coromandelica
main effect plot
interaction plot

Corresponding Author:
Muh. Azwar AR
Jurusan Farmasi
Fakultas MIPA
Universitas Tadulako
Palu
90245
Indonesia
email:
muhammadazwar5439@gmail.com

ABSTRACT

Background: *Lannea coromandelica* (Houtt.) Merr. is a plant that has long been used in traditional medicine and is known to possess antioxidant properties. **Objectives:** This study aims to evaluate the antioxidant activity of stem bark extracts of Lannea coromandelica, commonly referred to as tammate, using various solvents and extraction methods. **Methods:** Dried stem bark was extracted by maceration, reflux, or sonication using distilled water, 70% ethanol, ethyl acetate, and n-hexane. Antioxidant activity was assessed using the ABTS (2,2'-Azino-bis(3-ethylbenzothiazoline-6-sulfonic acid)) assay and expressed as IC_{50}. In addition, statistical evaluation was performed using analysis of variance (ANOVA) to determine the significance of the effects of extraction methods and solvent types on antioxidant activity. **Results:** The lowest IC_{50} was obtained with 70% ethanol and sonication (10.685 µg/mL), while the highest was obtained with n-hexane and reflux (201.515 µg/mL). Solvent type significantly affected IC_{50} ($p < 0.001$), whereas extraction method did not ($p = 0.992$). **Conclusions:** Based on the results of this study, the highest antioxidant activity was obtained using the sonication method with 70% ethanol (IC_{50} = 10.685 µg/mL, very strong), while the lowest was observed with the reflux method using n-hexane (IC_{50} = 201.515 µg/mL, weak). ANOVA and effect analysis further revealed that both solvent type and extraction method significantly influence antioxidant activity, with a significant interaction indicating that the effectiveness of each method depends on the solvent used.

Copyright © 2019 JFG-UNTAD
This open access article is distributed under a Creative Commons Attribution (CC-BY-NC-SA) 4.0 International license.

How to cite (APA 6th Style):
Hardi., Syahrir M., Khairuddin., Octaviany R., Rongko F.G., AR Muh. Azwar., Sari Dyah Ratna Ayu Puspita., Sulaiman Sri Sulistiana., Susilawati Ni Made., (2026). Antioxidant Activity Variation of Solvent and Extraction Method of Tammate Bark (*Lannea coromandelica* (Houtt.) Merr.) Using ABTS Method. *Jurnal Farmasi Galenika: Galenika Journal of Pharmacy (e-Journal)*, *x*(x), x-x. doi:10.22487/j24428744.2026.v2.i12.17946

INTRODUCTION

Indonesia is one of the most biodiverse countries in the world, with approximately 35,000-70,000 plant species recognized for their medicinal applications. One such plant is *tammate* (Henri et al., 2022). *Lannea coromandelica*, commonly referred to as "tammate" in Indonesia, is a widely recognized species due to its extensive use in traditional medicine. This plant has been utilized for the treatment of various health conditions, including cough, gastric disorders, eye diseases, fever, diabetes, and postpartum care (Raihandhany, 2022). It contains secondary metabolites such as saponins, tannins, and phenolic compounds (Calsum et al., 2018). Research conducted by Azzarah et al. (2019) demonstrated that this plant exhibits antioxidant activity. Antioxidants can neutralize reactive radical species through electron or hydrogen-atom transfer, thereby limiting radical-mediated oxidative reactions (Asih et al., 2022). Free radicals contain one or more unpaired electrons and are often highly reactive (Setiawan et al., 2018).

The successful isolation of secondary metabolites from plants depends on the extraction method and the polarity level of the solvent used. For instance, Hikmawanti et al. (2021) conducted an extraction study on katuk leaves (*Sauropus androgynus* (L.) Merr.) to evaluate antioxidant activity using a comparison of maceration, Soxhlet, and ultrasonic extraction methods. The results showed that the ultrasonic extraction method produced the highest antioxidant activity, with an IC_{50} value of 81.43 ± 2.63 ppm. Previous studies have also investigated the antioxidant properties of *L. coromandelica*, which may be associated with phenolic and flavonoid constituents. Earlier studies have shown that antioxidant activity varies depending on the solvent used, with the ethyl acetate fraction demonstrating superior activity, likely due to its higher concentration of bioactive compounds (Kumar, 2015). Nevertheless, existing studies have predominantly concentrated on leaf extracts and have not extensively examined the combined influence of solvent type and extraction method. Therefore, further investigation is needed to systematically evaluate these factors, particularly in underexplored plant parts such as the stem bark of *L. coromandelica*, to achieve optimal extraction conditions. Therefore, this study compared the antioxidant activity of *tammate* stem bark (*L. coromandelica* (Houtt.) Merr.) extracts prepared using different extraction methods and solvents.

MATERIAL AND METHODS

Materials

The equipment used in this study included aluminum foil, a stirring rod, a maceration vessel (glass jar), a blender (Miyako®), porcelain crucibles, funnels (Pyrex®), Erlenmeyer flasks (Iwaki®), beakers (Iwaki®), graduated cylinders (Iwaki®), a heating mantle (B-One®), filter paper, clamps, a condenser, round-bottom flasks (Pyrex®), volumetric flasks (Iwaki®), micropipettes (Dragonlab Micropipette®), a simplicia oven (IL80EN®), dropper pipettes, a UV-Vis spectrophotometer (Shimadzu®), a sonicator

Accepted

(Branson® 1800), a retort stand, an analytical balance (Mettler Toledo®), a simplicia balance, vials, and a water bath (B-One®).

The materials used in this study included ABTS (2,2'-azino-bis(3-ethylbenzothiazoline-6-sulfonic acid)) powder, distilled water, *tammate* stem bark extract (*L. coromandelica* (Houtt.) Merr.), 70% ethanol, pro-analysis (PA) ethanol, ethyl acetate, potassium persulfate, quercetin, and n-hexane.

Methods

Sample Preparation

Tammate stem bark samples were collected from Paccerakkang Village, Biringkanaya District, Makassar City, Indonesia. The bark was separated from impurities, washed thoroughly under running water, cut into small pieces, and dried in a simplicia oven at 40 °C. The dried material was then sieved using an 18-mesh sieve (Prasetyorini et al., 2021).

Preparation of Extracts

A total of 100 g of *tammate* stem bark simplicia powder was weighed for each solvent (distilled water, ethanol, ethyl acetate, and n-hexane) with a solvent ratio of 1:7.5 (w/v), equivalent to 1 g sample in 7.5 mL solvent (total solvent volume 750 mL). Three extraction methods were used: maceration, reflux, and sonication.

For maceration, 100 g of simplicia was placed into a maceration vessel and 750 mL of each solvent was added. The mixture was macerated for three days with occasional stirring (Adiwibowo et al., 2020).

For reflux extraction, 100 g of simplicia was placed in a round-bottom flask, followed by the addition of solvent. The flask was then placed on a heating mantle and refluxed for 2 hours at the solvent's boiling point (approximately 50-100 °C) (AR et al., 2019).

For sonication, 100 g of simplicia was placed in an Erlenmeyer flask, followed by addition of solvent. The flask was covered with aluminum foil to prevent solvent evaporation and extracted using a sonicator for 30 minutes at a temperature of 50 °C with a frequency of 40 kHz (Poorhashemi et al., 2020).

The extracts from each method were subsequently filtered and concentrated using a water bath at 60 °C until a thick extract was obtained.

Preparation of the ABTS Solution

The ABTS stock solution was prepared by weighing 7.1 mg of ABTS powder and 3.5 mg of potassium persulfate, each dissolved in 5 mL of distilled water. The two solutions were then mixed and incubated for 12-16 hours in the dark at room temperature. After incubation, the volume was adjusted to 25 mL using pro-analysis ethanol (Sukweenadhi et al., 2020).

Accepted

Determination of Maximum Absorption Wavelength of the ABTS Stock Solution

A total of 1 mL of the ABTS solution was transferred into a volumetric vessel and diluted to 5 mL with pro-analysis ethanol. The solution was incubated for 30 minutes, and its absorbance was measured at a maximum wavelength of 751.20 nm using a UV-Vis spectrophotometer.

Measurement of Antioxidant Activity of the Standard Solution

A quercetin stock solution (1,000 ppm) was prepared and diluted to concentrations of 1, 2, 3, 4, and 5 ppm. One milliliter of ABTS solution was added to each dilution, and the final volume was adjusted to 5 mL with analytical-grade ethanol. After mixing and incubation for 30 min, absorbance was measured at 751.20 nm using a UV-Vis spectrophotometer.

Measurement of Antioxidant Activity of Sample Solutions

Stock solutions of the extracts were prepared at 1,000 µg/mL and diluted to the following concentrations: 10, 20, 30, 40, and 50 µg/mL for the distilled-water extracts; 4, 8, 12, 16, and 20 µg/mL for the 70% ethanol extracts; and 50, 100, 150, 200, and 250 µg/mL for the ethyl acetate and n-hexane extracts.

For each concentration, 1 mL of ABTS solution was added and the volume was adjusted to 5 mL using pro-analysis ethanol. The solutions were then homogenized and incubated for 30 minutes, followed by measurement of absorbance at 751.20 nm using a UV-Vis spectrophotometer to determine antioxidant activity. The ABTS radical cation solution was prepared and its absorbance was measured at 751.20 nm, corresponding to the maximum wavelength (λmax) obtained from spectral scanning using the available UV-Vis spectrophotometer. Although the standard ABTS method is commonly measured at 734 nm (Re et al., 1999), the selected wavelength falls within the absorption range of ABTS and was applied consistently throughout the analysis.

Data Analysis

The absorbance measurements were used to calculate percentage inhibition and obtain concentration-response regression equations ($y = ax + b$), where y is the percentage inhibition, x is the extract concentration, a is the slope, and b is the intercept. The IC_{50} value was calculated from each regression equation. The effects of solvent type and extraction method were evaluated using Minitab 21. Statistical significance was assessed at $p < 0.05$.

RESULTS AND DISCUSSION

In this study, the stem bark was extracted using three methods (maceration, reflux, and sonication) and four solvents (distilled water, 70% ethanol, ethyl acetate, and n-hexane), at a solid-to-solvent ratio of 1:7.5 (w/v). The extract yields obtained from each method and solvent type are presented in Table 1.

Accepted

Table 1. Yield of *Tammate* (*L. coromandelica* (Houtt.) Merr.) Stem Bark Extracts

Sample	Extraction Method	Solvent	Simplicia Weight (g)	Solvent Volume (mL)	Extract Weight (g)	Yield (%)
Tammate Stem Bark (*Lannea coromandelica* (Houtt.) Merr.)	Maceration	Aquadest	100	750	7.0768	7.0761
		Ethanol 70%			17.2467	17.2455
		Ethyl acetate			2.9286	2.9284
		n-hexane			1.8099	1.8090
	Reflux	Aquadest	100	750	6.116	6.1158
		Ethanol 70%			13.1276	13.1275
		Ethyl acetate			2.2558	2.2555
		n-hexane			1.1346	1.1345
	Sonication	Aquadest	100	750	3.4021	3.4018
		Ethanol 70%			8.6419	8.6391
		Ethyl acetate			1.0912	1.0910
		n-hexane			0.7134	0.7132

As shown in Table 1, it can be observed that there are differences in the extract weights obtained. The table shows that ethanol extracts produced using maceration, reflux, and sonication methods exhibit higher yield percentages compared to those obtained with other solvents. This indicates the ability of ethanol to extract a larger amount of compounds present in the sample. Ethanol is an effective solvent for penetrating cell membranes, allowing it to extract intracellular constituents from plant materials. Ethanol, a polar solvent, is capable of extracting a wide range of compounds, including both polar and nonpolar substances, with high efficiency (Lee et al., 2024). Although ethanol produced the highest extraction yield, this does not necessarily correlate with higher antioxidant activity, as antioxidant capacity is primarily determined by specific bioactive compounds such as phenolics and flavonoids rather than the total extract obtained (Do et al., 2014; Nawaz et al., 2020).

Antioxidant activity testing was conducted to assess the extent to which a natural material is capable of suppressing or inhibiting free radicals. In this study, antioxidant activity was evaluated using the ABTS method to determine IC_{50} values with the aid of a UV-Vis spectrophotometer.

Accepted

Table 2. Antioxidant Activity Potential of *Tammate* (*Lannea coromandelica* (Houtt.) Merr.) Stem Bark

Sample	Extraction Method	Solvent	IC_{50} Value µg/mL	Category (Jumina et al., 2019)
Quercetin	-	-	3.814	Very strong
Tammate Stem Bark (*Lannea coromandelica* (Houtt.) Merr.)	Maceration	Aquadest	32.891	Very strong
		Ethanol 70%	10.852	Very strong
		Ethyl acetate	160.071	Weak
		n-hexane	183.898	Weak
	Reflux	Aquadest	38.326	Very strong
		Ethanol 70%	12.781	Very strong
		Ethyl acetate	129.843	Moderate
		n-hexane	201.515	Weak
	Sonication	Aquadest	27.784	Very strong
		Ethanol 70%	10.685	Very strong
		Ethyl acetate	165.762	Weak
		n-hexane	155.174	Weak

Among the 12 extract conditions, sonication with 70% ethanol produced the lowest IC_{50} value (10.685 µg/mL), indicating the highest observed antioxidant activity. This result indicates a higher antioxidant activity compared to previous findings reported by Alwi et al. (2023), where methanolic extracts of *Lannea coromandelica* exhibited IC_{50} values of 19.819 µg/mL for the leaves and 20.778 µg/mL for the bark, obtained using the maceration method with methanol as the solvent. The higher antioxidant activity observed in the ethanol extract, particularly at 70% concentration, can be explained by its intermediate polarity, which promotes the efficient extraction of phenolic and flavonoid compounds that are primarily responsible for antioxidant properties (Azwanida, 2015). In addition, the use of sonication enhances extraction efficiency through acoustic cavitation, where the formation and collapse of microbubbles disrupt plant cell structures and improve the release of intracellular bioactive compounds (Chemat et al., 2017). Furthermore, the combined use of ethanol as a solvent and ultrasound-assisted extraction has been reported to enhance the recovery of bioactive compounds and improve antioxidant activity compared to conventional extraction methods (Ruzi et al., 2025).

Conversely, the lowest antioxidant activity was observed using the reflux method with n-hexane, yielding an IC_{50} value of 201.515 µg/mL, classified as weak. Overall, the measurements indicate that *Tammate* stem bark (*Lannea coromandelica* (Houtt.) Merr.) exhibits very strong antioxidant activity, as evidenced by IC_{50} values below 50 µg/mL.

Accepted

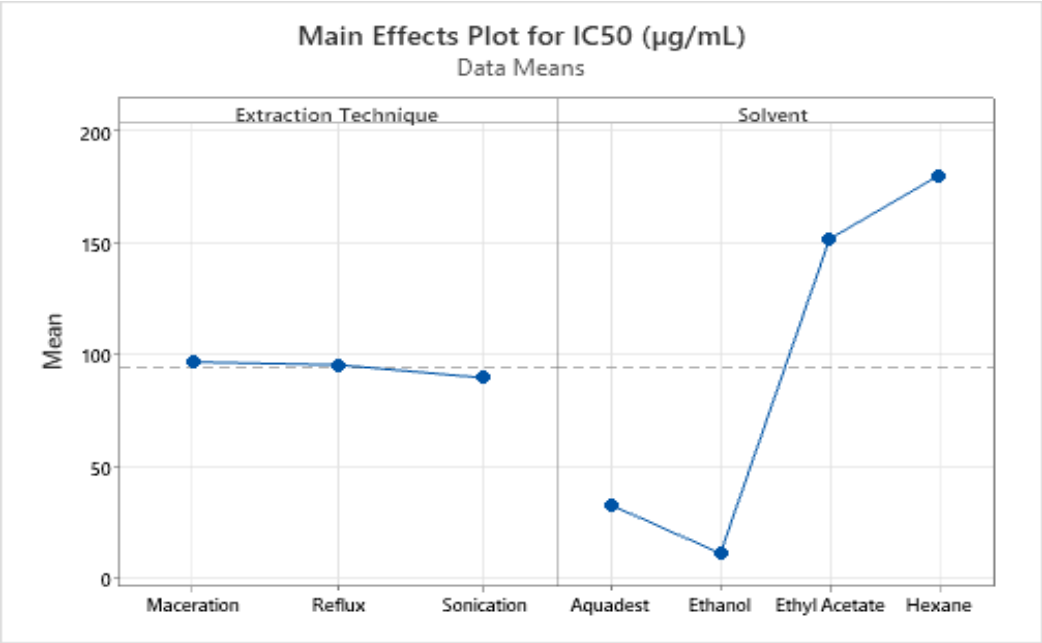

Figure 1. Effect of Extraction Method and Solvent on Antioxidant Potential (IC_{50}).

Figure 1 shows significant differences in mean IC_{50} values among solvents, whereas the mean values for the three extraction methods are relatively similar. When the lines are horizontal (parallel to the x-axis), no main effect is present. The steeper the slope of the line, the greater the main effect. The main effects plot demonstrated that solvent type exerted a significant influence on antioxidant activity (IC_{50}), whereas differences in the extraction method did not significantly affect the observed IC_{50} values. To examine the interaction effects between solvent and extraction method on antioxidant activity, an interaction plot analysis was conducted. The results of this analysis are presented in Figure 2 below.

Accepted

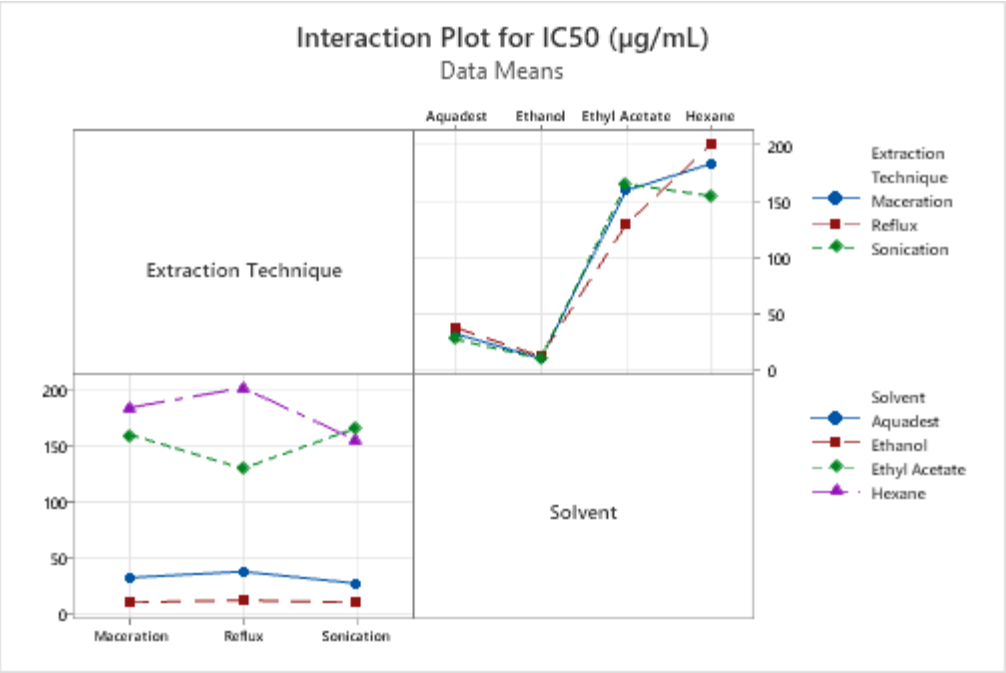

Figure 2. Effect of the Interaction between Solvent (Distilled Water, Ethyl Acetate, 70% Ethanol, and n-Hexane) and Extraction Method (Maceration, Reflux, and Sonication) on IC_{50} Values.

Figure 2 illustrates that the extraction method graph (bottom left) shows that among all the extraction techniques used, ethanol as a solvent consistently resulted in the highest antioxidant activity across all methods. In the solvent graph (top right), the use of ethanol produced similar antioxidant activity regardless of the extraction technique employed. To determine whether there is a significant effect of the interaction between solvent type and extraction method on the antioxidant activity of the extracts, an analysis of variance (ANOVA) was performed by evaluating the P-value. A P-value less than 0.05 was considered statistically significant.

Table 3. Analysis of Variance of Solvent Effect on Antioxidant Activity

Source	DF	Adj SS	Adj MS	F-Value	P-Value
Solvent	3	63955	21318.4	89.86	<0.001
Error	8	1898	237.2		
Total	11	65853			

Table 4. Analysis of Variance of Extraction Method Effect on Antioxidant Activity

Source	DF	Adj SS	Adj MS	F-Value	P-Value
Extraction Technique	2	113.4	56.69	0.01	0.992
Error	9	65739.7	7304.41		
Total	11	65853.1			

The one-way ANOVA results showed a statistically significant effect of solvent type on IC_{50} ($F = 89.86$, $p < 0.001$; Table 3). In contrast, the effect of extraction method was not statistically significant ($F = 0.01$, $p = 0.992$; Table 4). Thus, differences among solvent types were more pronounced than differences

among extraction methods in these data. This suggests that variations in solvent play a dominant role in determining antioxidant activity, likely due to differences in solvent polarity affecting the extraction of bioactive compounds. In contrast, the extraction method did not show a significant effect ($p > 0.05$), indicating that variations in extraction technique alone do not substantially influence antioxidant activity. This may be explained by the fact that, although methods such as sonication and reflux can enhance mass transfer, the type of solvent remains the primary factor controlling the solubility and recovery of antioxidant compounds. Furthermore, the observed interaction between solvent type and extraction method suggests that the effectiveness of a given extraction technique depends on the solvent used, indicating that optimal antioxidant activity is achieved through a specific combination of both factors rather than each acting independently.

CONCLUSION

Among the conditions investigated, sonication with 70% ethanol produced the lowest IC_{50} value (10.685 µg/mL), whereas reflux extraction with n-hexane produced the highest IC_{50} value (201.515 µg/mL). Solvent type significantly affected ABTS radical-scavenging activity ($p < 0.001$), while extraction method did not show a statistically significant main effect ($p = 0.992$) in the reported one-way ANOVA. Overall, these results emphasize that both solvent selection and extraction technique are critical factors in enhancing the yield of bioactive compounds. This study therefore contributes to a better understanding of how extraction conditions can be optimized for the development of natural antioxidants derived from *Tammate* stem bark (*L. coromandelica* (Houtt.) Merr.) extracts.

CONFLICT OF INTEREST

The authors declare no conflict of interest.

REFERENCES

Adiwibowo, M. T., Herayati, Erlangga, K., & Fitria, D. A. (2020). Pengaruh Metode dan Waktu Ekstraksi Terhadap Kualitas dan Kuantitas Saponin dalam Ekstrak Buah, Daun, dan Tangkai Daun Belimbing Wuluh (Averrhoa bilimbi L.) Untuk Aplikasi Detergen. *Jurnal Integrasi Proses*, *9*(2), 44-50. https://doi.org/10.36055/jip.v9i2.9262

Alwi, A. K., Najib, A., & Waris, R. (2023). Comparative study of free radical scavenging activity between methanol extracts of leaves and bark of *Lannea coromandelica* (Houtt.) Merr. using DPPH method. *Makassar Pharmaceutical Science Journal*, *1*(2), 4-12. https://journal.farmasi.umi.ac.id/index.php/mpsj

AR, M. A., Hikma, N., Yasir, B., Burhan, A., & Khairuddin. (2019). Optimization of Extraction Lannea coromandelica for Antioxidant Activity using Analytical Factorial Design Approach. *Jurnal Farmasi Galenika: Galenika Journal of Pharmacy (e-Journal)*, *9*(2), 185-194. https://doi.org/10.22487/j24428744..v.i.16106

Asih, D. J., Warditiani, N. K., & Wiarsana, I. G. S. (2022). Review Artikel: Aktivitas Antioksidan Ekstrak Amla (Phyllanthus emblica / Emblica officinalis). *Jurnal Ilmiah Multi Disiplin Indonesia*, *1(6)*. https://journal.ikopin.ac.id/index.php/humantech/article/download/1533/1272/5629

Accepted

Azwanida, N. N. (2015). A review on the extraction methods used in medicinal plants: Principle, strength and limitation. *Medicinal & Aromatic Plants*, *4*(3), 196. https://doi.org/10.4172/2167-0412.1000196

Azzarah, N. F., Jamaluddin, A. W., & Adikurniawan, Y. M. (2019). Efektivitas Patch Sederhana dari Ekstrak daun Kayu Jawa (*Lannea coromandelica* (Houtt.) Merr.) Terhadap Penyembuhan Luka Sayat Pada Tikus (*Rattus norvegicus*). *Jurnal Ilmiah As-Syifaa, 11(2), 169-180.* https://doi.org/10.33096/jifa.v11i2.531

Calsum, U., Khumaidi, A., & Khaerati, K. (2018). Aktivitas Ekstrak Etanol Kulit Batang Kayu Jawa (*Lannea coromandelica*) terhadap Penyembuhan Luka Sayat pada Tikus Putih (*Rattus norvegicus* L.). *Galenika Journal of Pharmacy*, *4*(2), 113-118. https://doi.org/10.22487/j24428744.2018.v4.i2.11078

Chemat, F., Rombaut, N., Sicaire, A. G., Meullemiestre, A., Fabiano-Tixier, A. S., & Abert-Vian, M. (2017). Ultrasound-assisted extraction of food and natural products: Mechanisms, techniques, combinations, protocols and applications. *Ultrasonics Sonochemistry*, *34*, 540-560. https://doi.org/10.1016/j.ultsonch.2016.06.035

Do, Q. D., Angkawijaya, A. E., Tran-Nguyen, P. L., Huynh, L. H., Soetaredjo, F. E., Ismadji, S., & Ju, Y. H. (2014). Effect of extraction solvent on total phenol content, total flavonoid content, and antioxidant activity of *Limnophila aromatica*. *Journal of Food and Drug Analysis*, *22*(3), 296-302. https://doi.org/10.1016/j.jfda.2013.11.001

Henri, Sari, D. P., & Hakim, L. (2022). Medicinal Plants for Traditional Treatment Used by the Malays in South Bangka Regency, Indonesia. *Biosaintifika*, *14*(1), 125-134. https://doi.org/10.15294/biosaintifika.v14i1.34455

Hikmawanti, N. P. E., Fatmawati, S., Arifin, Z., & Vindianita. (2021). Pengaruh Variasi Metode Ekstraksi Terhadap Perolehan Senyawa Antioksidan Pada Daun Katuk (*Sauropus androgynus* (L.) Merr.). *Jurnal Farmasi Udayana, 10(1).* https://doi.org/10.24843/JFU.2021.v10.i01.p01

Jumina, Siswanta, D., Zulkarnain, A. K., Triono, S., Priatmoko, Yuanita, E., Imawan, A. C., Fatmasari, N., & Nursalim, I. (2019). Development of C-arylcalix[4]resorcinarenes and C-arylcalix[4]pyrogallolarenes as antioxidant and UV-B protector. *Indonesian Journal of Chemistry*, *19*(2), 273-284. https://doi.org/10.22146/ijc.26868

Kumar, T., & Jain, V. (2015). Appraisal of total phenol, flavonoid contents, and antioxidant potential of folkloric *Lannea coromandelica* using in vitro and in vivo assays. *Scientifica*, 2015. https://doi.org/10.1155/2015/203679

Lee, J.-E., Jayakody, J. T. M., Kim, J.-I., Jeong, J.-W., Choi, K.-M., Kim, T.-S., Seo, C., Azimi, I., Hyun, J., & Ryu, B. (2024). The influence of solvent choice on the extraction of bioactive compounds from Asteraceae: A comparative review. *Foods*, *13*(19), 3151. https://doi.org/10.3390/foods13193151

Nawaz, H., Shad, M. A., Rehman, N., Andaleeb, H., & Ullah, N. (2020). Effect of solvent polarity on extraction yield and antioxidant properties of phytochemicals from bean (*Phaseolus vulgaris*) seeds. *Brazilian Journal of Pharmaceutical Sciences, 56*, e17129. https://doi.org/10.1590/s2175-97902019000417129

Poorhashemi, S., Arianfar, A., & Mohammadi, A. (2020). Ultrasound-Assisted Extraction and Optimization Process Parameters of Antioxidant and Phenolic Compounds From Myristica fragrans. *Jundishapur Journal of Natural Pharmaceutical Products*, *15*(1). https://doi.org/10.5812/jjnpp.63423

Accepted

Raihandhany, R. (2022). From fences to medicine: A short review on ethnobotanical study of *Lannea coromandelica* (Houtt.) Merr. (Family Anacardiaceae) in Indonesia. *Genbinesia, 2*(1), 43-50. https://doi.org/10.55655/genbinesia.v2i1.46

Ruzi, I. I., Shahpudin, S. N. M., Mohamad, S., & Kassim, M. A. (2025). Impact of extraction techniques and solvent systems on the antioxidant activity and fatty acid composition of *Scenedesmus parvus* extracts. *Food Analytical Methods, 18*, 2220-2229. https://doi.org/10.1007/s12161-025-02864-1

Setiawan, F., Yunita, O., & Kurniawan, A. (2018). Uji Aktivitas Antioksidan Ekstrak Etanol Kayu Secang (*Caesalpinia sappan)* Menggunakan Metode DPPH, ABTS, dan FRAP. *Media Pharmaceutica Indonesiana, 2(2)*. https://journal.ubaya.ac.id/index.php/MPI/article/view/1662

Sukweenadhi, J., Yunita, O., Setiawan, F., Kartini, Siagian, M. T., Danduru, A. P., & Avanti, C. (2020). Antioxidant Activity Screening of Seven Indonesian Herbal Extract. *Biodiversitas*, *21*(5), 2062-2067.

Accepted