

# 4. 14583-53201-2-CE.docx

*anonymous marking enabled*

---

**Submission date:** 16-Mar-2025 01:50PM (UTC-0700)

**Submission ID:** 2616227587

**File name:** 4\_14583-53201-2-CE.docx (450.98K)

**Word count:** 4190

**Character count:** 25499



## A Literature Review: Antimicrobial Phenolic Compounds in Nutmeg (*Myristica fragrans* Houtt)

Jasria Ipaenin<sup>1</sup>, Lutfi Chabib<sup>1</sup>, Hasnaeni<sup>2\*</sup>, Risman Tunny<sup>3</sup>

<sup>1</sup> Department of Pharmacy, Faculty of Mathematics and Natural Sciences, University Islam Indonesia, Yogyakarta, Indonesia, 55584

<sup>2</sup> Master of Pharmacy Program, Faculty of Pharmacy, University Muslim Indonesia, Makassar, Indonesia, 90231

<sup>3</sup> High School of Health Science Maluku Husada, Faculty of Pharmacy, Maluku, Indonesia, 97345

\* Corresponding Author e-mail: [hasnaeni.hasnaeni@umi.ac.id](mailto:hasnaeni.hasnaeni@umi.ac.id)

### Article History

Received: 29-01-2025

Revised: 12-02-2025

Published: 28-02-2025

**Keywords:** *Myristica fragrans* houtt; phenolic; antimicrobial agent; literature review

### Abstract

In various countries, testing of phenolic compounds in plants is always carried out because these compounds have various health benefits such as antioxidant, anti-inflammatory, and antimicrobial activities. The types of medicinal plants in Indonesia are known to be very diverse where those included in the medicinal plant group reach more than 1000 species, one of which is nutmeg (*Myristica fragrans* Houtt.) Nutmeg (*Myristica fragrans* Houtt.) itself is native to the Maluku Islands, Indonesia. However, besides the Moluccas, nutmeg is also cultivated in several other tropical countries. The main objective of this literature review is to critically examine the antimicrobial properties and identify the specific antimicrobial components of phenolic compounds contained in nutmeg (*Myristica fragrans* Houtt.) The methodology used in this study involved a comprehensive literature review by utilizing reputable academic databases such as Google Scholar, PubMed, and Science Direct related to articles published between 2019 and 2024. The results of this study were obtained through a thorough search process, resulting in eight articles that were considered to meet the established inclusion criteria. A number of articles showed the effectiveness of nutmeg as an antimicrobial because nutmeg contains phenolic compounds that have antibacterial and antifungal properties, which make it effective as an antimicrobial agent. Therefore, with a more comprehensive understanding of the content of phenolic compounds and their mechanism of action, nutmeg can be a further basis for study in the health sector and the pharmaceutical industry.

**How to Cite:** Ipaenin, J., Chabib, L., Hasnaeni, H., & Tunny, R. (2025). A Literature Review: Antimicrobial Phenolic Compounds in Nutmeg (*Myristica fragrans* Houtt). *Hydrogen: Jurnal Kependidikan Kimia*, 13(1), 39-48. doi:<https://doi.org/10.33394/hjkk.v13i1.14583>

<https://doi.org/10.33394/hjkk.v13i1.14583>

This is an open-access article under the CC-BY-SA License.



## INTRODUCTION

Indonesia has a wide variety of medicinal plants. The use of traditional medicine is generally considered safer than modern medicine. This is due to the relatively fewer side effects of traditional medicine compared to modern medicine. There are more than 1,000 types of plants that have medicinal properties, one of which is nutmeg (*Myristica fragrans* Houtt) (Usman et al., 2024). Nutmeg, which is native to Indonesia, grows in the tropics at altitudes above 700 meters above sea level. It thrives in hot and humid temperatures, with rainfall between 2,000 and 3,500 mm per year, and without significant dry periods. Nutmeg is known as a spice plant that has high economic value and many benefits, because every part of the nutmeg plant, including seeds, fruit, and skin, can be utilized in various industries (Nasir & Marwati, 2022).

Nutmeg<sup>60</sup> is a perennial evergreen tree that can grow to a height of 20-25 feet with soft grayish brown bark and spreading branches (Kaawoan et al., 2016). The plant grows well in warm and humid climates, at an altitude of 1,000 m above sea level with rainfall between 150-250 cm (Ashokkumar et al., 2022; Bayani et al., 2023, 2024). Nutmeg is commonly cultivated in the Maluku Islands, especially Ambon and Banda, Manado, West Sumatra, West Java, and Papua (Simanjan et al., 2020). Nutmeg (*Myristica fragrans* Houtt) is known as a spice plant that has economic and multipurpose value because every part of the plant can be utilized in various food, beverage, medicine, perfume and cosmetic industries (Ginting et al., 2018).

The habit of using nutmeg as a seasoning or consuming it in the form of syrups and sweets will have a very good impact on health, considering that this fruit with a fragrant fragrance has many health benefits. The chemical content contained can overcome insomnia, slim<sup>7</sup> cough, help digestion, relieve muscle spasms and others. Based on research conducted by the National Science and Technology Authority, in its book Guidebook on the proper use of medicinal plants. Nutmeg contains chemical compounds that are beneficial for health. The skin and flesh of nutmeg, for example, contain essential oils and tanning substances. While mace or nutmeg flowers contain essential oils, tanning agents and starch substances. While the seeds are very high in essential oils, saponins, myristicin, elemisi, lipase enzymes, pectin, lemonene and oleanolic acid. Almost all parts<sup>7</sup> of nutmeg contain chemical compounds that are beneficial to health, including being able to help treat colds, insomnia (insomnia disorders), are stomachic (facilitate digestion and increase appetite), carminative (facilitate bowel movements), antiemetic (overcome nausea and vomiting), menstrual pain and rheumatism (Agaus & Agaas, 2019; Fibonacci & Hulyadi, 2018; Hulyadi et al., 2023).

Nutmeg is generally traded in the form of seeds and mace. The flesh of the fruit is yellowish-white in color, contains a watery gummy liquid, tastes astringent and has astringent properties. Therefore, when the fruit is unripe, the nutmeg pulp cannot be consumed directly but must be processed into various food products. The weight of wet nutmeg meat is equal to 823% of the weight of dried nutmeg seeds. Nutmeg flesh, which is the largest part of nutmeg (77.8%), is usually not utilized. One of the utilization of nutmeg meat is to make nutmeg fruit extract beverage products that are r<sup>20</sup> in benefits. The nutritional values contained in every 100 g of nutmeg meat are calories (42 cal), protein (0.30 g), fat (0.20 g), carbohydrates (10.90 g), calcium (32 mg), phosphorus (24 mg), iron (1.50 mg), vitamin A (29.50 IU), vitamin C (22 mg), and water (88.10 g) (Aulia et al. 2020).

In addition, nutmeg is reported to have a variety of unique pharmacological therapeutic effects, such as anti-inflammatory, antidiabetic, and antidiarrheal activities. The main chemical components in nutmeg include fat, protein, starch, fixed oil, and essential oil containing myristicin (Biswas, 2022).

In addition to being a spice, nutmeg also has potent<sup>36</sup> as an antimicrobial agent in traditional medicine, especially in the Asian region (Usman et al., 2024). A number of studies have revealed the pharmacological potential<sup>42</sup> nutmeg, especially in antimicrobial activity where the study states that nutmeg extract can inhibit the growth of gram-positive bacteria such as *S. aureus* and gram-nega<sup>72</sup> bacteria such as *Escherichia coli*. This antimicrobial activity is thought to be related to the content of phenolic compounds and antioxidants that have potential as antimicrobials (Nurhasanah, 2014).

Although many studies have revealed the benefits of nutmeg in various aspects of health and industry, studies on the specific pharmacological potential of nutmeg extracts as antimicrobial agents are still very limited. The content of phenol compounds in nutmeg is thought to play an important role in antimicrobial activity. Therefore, this literature review aims to further explore the antimicrobial activity of nutmeg pulp extracts, especially related to the presence of phenol

compound<sup>36</sup> and antioxidants that act as antimicrobial<sup>66</sup> agents. Thus, this literature review is expected to provide a deeper insight into the potential of nutmeg (*Myristica fragrans* Houtt) as an antimicrobial agent. Through a more comprehensive understanding<sup>29</sup> of the content of phenolic compounds and their mechanism of action, this research can also serve as a foundation for further studies in the health sector and pharmaceutical industry.

## METHOD

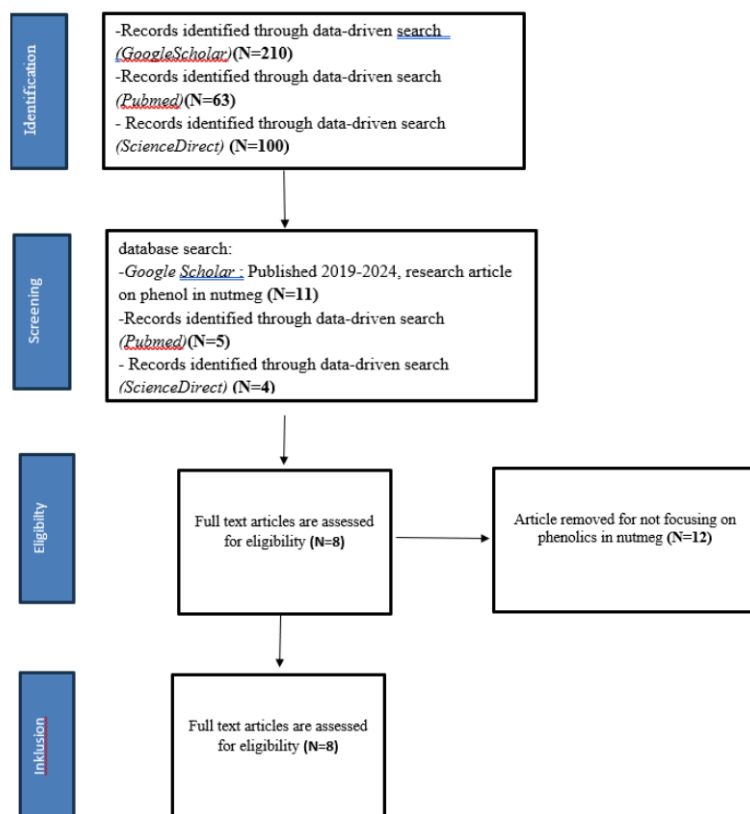


Figure 1: PRISMA Research Flow Diagram

The approach used was an observational study strategy, which involved a comprehensive examination of the existing literature and an in-depth analysis of the potential antimicrobial properties of nutmeg and its components that have antimicrobial effects. Literature review and meta-analysis procedures were conducted based on the guidelines of the preferred reporting items for systematic reviews and meta-analyses (PRISMA) (Arrizqiyani et al., 2018; Fauziyah

& Kuswanto, n.d.; Handa<sup>26</sup> et al., 2024; Ismail et al., 2024; Makanaung et al., 2021; Melati Sirait et al., n.d.; Nikolic et al., 2021; Putri Anastasya et al., 2022; Rahman et al., 2022; Rashidian et al., 2022; Rokhmah et al., 2024; S. Aulia, 2020; Suhartini, 2022, 2020; Vakili et al., 2023; Yam, 2024).

Conducting literature searches using Google Scholar, PubMed and Science Direct databases. The search terms entered in the PubMed and Science Direct database queries were “Myristica fragrans Houtt” OR “Phenols in nutmeg, while the search terms used in Google Scholar were ‘Nutmeg’ OR “(Myristica fragrans Houtt.)” AND “Phenols in nutmeg”. From these search results, a total of 20 journals were obtained. However, after applying the inclusion criteria, only 8 journals were considered suitable. The inclusion criteria in this study included full articles, both national and international, written in Indonesian or English, covering the period 2019 to 2024, and focusing on experimental research. In addition, the exclusion criteria included review articles, articles published before 2013, articles that were not in full-text format, and articles that did not contain the specific keyword “Myristica fragrans Houtt”.

RESULTS AND DISCUSSION

Several studies have identified different types of phenols in nutmeg, including myristicin, eugenol, and safrole, which have potential as antimicrobials. The activity<sup>47</sup> of these compounds has been tested against various types of pathogenic bacteria such as *Staphylococcus aureus*, *Escherichia coli*, and *Pseudomonas aeruginosa*, as well as fungi such as *Candida albicans*.

The following that met the inclusion criteria presented various studies related to the antimicrobial activity of<sup>47</sup> phenolic compounds in nutmeg, including the test methods used, the types of microbes tested, and the results obtained are presented in table 1.

Table 1. Search Articles that Meet the Inclusion Criteria

NO	Author(S)	Title	Methods	Result
1	(Trifan <sup>35</sup> et al., 2023)	Article Essential Oils and Sustainability: In Vitro Bioactivity Screening of Myristica fragrans Houtt. Post-Distillation By-Products	Empirical method in which LC-HRMS/MS is used to analyze phenolic compounds.	The results showed that it was rich in phenolic compounds, with total <sup>70</sup> phenolics reaching 63.31 ± 0.72 mg GAE/g. These phenolic compounds, which include flavonoids and phenolic acids, contributed significantly to the antioxidant activity found in the nutmeg waste extract.
2	(Rizwana et al., <sup>47</sup> 2021)	Antifungal, Antibacterial, and Cytotoxic Activities of Silver Nanoparticles Synthesized from Aqueous Extracts	An empirical method in which using the FTIR method reveals the presence of important functional groups such as phenols, alcohols, and carbonyls, which are	That nutmeg (Myristica fragrans) contains phenolic compounds identified through FTIR. These phenolic compounds contribute to the

NO	Author(s)	Title	Methods	Result
		of Mace-Arils of <i>Myristica fragrans</i>	detected through spectral peaks at wavelengths.	bioactive properties of nutmeg,
3	(Shori, 2022)	Storage quality and antioxidant properties of yogurt fortified with polyphenol extract from nutmeg, black pepper, and white pepper	Empirical method in which using the Total Phenolic Content (TPC) of samples in the Folin-Ciocalteu method. Which involves oxidation-reduction reactions between phenolic compounds and Folin-Ciocalteu reagents.	Ferric Reducing Antioxidant Potential (FRAP) value in nutmeg yogurt was the highest ( $p < 0.05$ ).
4	(Blessymol et al., 2024)	An antioxidant study of Titanium dioxide (TiO <sub>2</sub> ) nanoparticles against mace of nutmeg in <i>Myristica fragrans</i> houtt, rhizomes of <i>Curcuma longa</i> linn and <i>Kaempferia galanga</i> extracts	Empirical method in which using FTIR method	The addition of TiO <sub>2</sub> synthesis of nutmeg extract occurred the formation of TiO <sub>2</sub> , which changes the color of the solution from light beige to beige. DPPH antioxidant test shows it has antioxidant activity.
5	(Dareda et al., 2020)	Characterization and antioxidant activity of dietary fiber from nutmeg ( <i>Myristica fragrans</i> Houtt) pulp	Empirical method in which using FTIR method	the presence of absorption at wave number 3371.57 cm <sup>-1</sup> and for nutmeg 3417.86 cm <sup>-1</sup> indicates the OH stretch of the hydroxyl group.
6	(Makanaung et al., 2021)	Phytochemical analysis and sedative effect test of ethanol extract and some fractions of nutmeg pulp ( <i>Myristica Fragrans</i> Houtt)	Empirical method in which using UV-Vis spectrophotometric method and Sedative effect test	The highest total phytochemical content in nutmeg meat is found in the petroleum ether fraction with a value for total phenolic content of 29.203µg/mL.
7	(Suloi et al., 2023)	Effect of solvent concentration on the chemical content of extracts of fakfak nutmeg ( <i>Myristica argentea</i> Warb) pulp	Empirical method in which using Folin-Ciocalteu colorimetric method	Fakfak nutmeg extract has potential as an antioxidant characterized by the presence of phenol content of 12.12 mg/ml at 60% ethanol concentration.
8	(Nomor et al., 2024)	Antioxidant Activity and Determination of	Empirical method where using DPPH (2,2-diphenyl-1-	There were high levels of total flavonoid compounds in the

NO	Author(s)	Title	Methods	Result
43		Total Flavonoid Content of Nutmeg Fraction ( <i>Myristica fragrans</i> Houtt)	picrylhydrazyl) method and UV-Vis spectrophotometry.	chloroform fraction 142.55 ± 3.83, ethyl acetate fraction 431.89.

The literature search yielded eight publications that met specific inclusion criteria, namely national and international journals containing complete articles, published between 2019 and 2024, and focusing on experimental research. All selected journals have conducted phytochemical analysis of nutmeg (*Myristica fragrans* Houtt.). Specifically, eight publications explored the phenolic compounds in nutmeg (*Myristica fragrans* Houtt.) and their potential as antimicrobial agents.

Research by (Trifan et al., 2023) examined the bioactivity of *Myristica fragrans* essential oil distillation waste using the LC-HRMS/MS method. The results showed that nutmeg waste is rich in phenolic compounds, with a total phenolic content of  $63.31 \pm 0.72$  mg GAE/g. These phenolic compounds, including flavonoids and phenolic acids, contributed greatly to the antioxidant activity found in the nutmeg waste extract. (Rizwana et al., 2021) examined the antifungal, antibacterial, and cytotoxic activities of silver nanoparticles synthesized using the aqueous extract of nutmeg mace. Using the FTIR method, this study revealed the presence of important functional groups such as phenols, alcohols, and carbonyls detected through spectral peaks at certain wavelengths. The identified phenolic compounds play a role in the bioactive properties of nutmeg.

(Shori, 2022) examined the storage quality and antioxidant properties of yogurt fortified with polyphenolic extracts from nutmeg, black pepper, and white pepper. Using the Folin-Ciocalteu method to measure Total Phenolic Content (TPC), this study showed that yogurt containing nutmeg extract had the highest Ferric Reducing Antioxidant Potential (FRAP) value ( $p < 0.05$ ), indicating strong antioxidant activity. (Blessymol et al., 2024) studied the antioxidant activity of Titanium dioxide (TiO<sub>2</sub>) nanoparticles against mace extracts of nutmeg, Curcuma longa rhizome, and Kaempferia galanga. Using the FTIR method, this study confirmed the synthesis of TiO<sub>2</sub> through changes in the color of the solution from light beige to cream. DPPH antioxidant test showed that the synthesized compound has significant antioxidant activity.

Meanwhile, (Dareda et al., 2020) examined the characterization and antioxidant activity of dietary fiber from nutmeg pulp using the FTIR method. This study found absorption at wave numbers  $3371.57 \text{ cm}^{-1}$  and  $3417.86 \text{ cm}^{-1}$ , which indicates the presence of hydroxyl groups (OH). This indicates that dietary fiber from nutmeg has potential as a natural antioxidant. (Makanaung et al., 2021) conducted phytochemical analysis and sedative effect tests of ethyl extracts and several nutmeg meat fractions using UV-Vis spectrophotometric methods. The results showed that the highest phytochemical content was found in the petroleum ether fraction, with a total phenolic content of 29.203 ug/mL, which has the potential to provide sedative effects.

(Suloi et al., 2023) examined the effect of solvent concentration on the chemical content of nutmeg extract from Fakfak (*Myristica argentea* Warb) using the Folin-Ciocalteu colorimetric method. This study found that Fakfak nutmeg meat extract has potential as an antioxidant, with a phenol content of 12.12 mg/ml at 60% ethanol concentration. (Nomor et al., 2024) examined the antioxidant activity and total flavonoid content of nutmeg meat fractions using the DPPH method and UV-Vis spectrophotometry. The results showed that the chloroform fraction had a total flavonoid content of  $142.55 \pm 3.83$ , while the ethyl acetate fraction had a higher flavonoid content of 431.89, indicating high antioxidant potential.



Based on the studies that have been reviewed, phenolic compounds in nutmeg (*Myristica fragrans*) have great potential as antimicrobial agents. Several studies have shown that phenolic compounds, including flavonoids and phenolic acids, contribute to the bioactive properties of nutmeg, such as antioxidant, antibacterial, and antifungal activities. Research by (Rizwana et al., 2021) confirmed that nutmeg mace extract containing phenolic compounds showed significant antifungal and antibacterial activity through FTIR analysis. This suggests that phenolic compounds in nutmeg have a role in inhibiting the growth of microorganisms. In addition, research by (Trifan et al., 2023) and (Blessymol et al., 2024) also confirmed the presence of phenolic compounds in nutmeg that contribute to antioxidant activity, which can indirectly increase resistance to microbes by counteracting oxidative stress in cells. Furthermore, research by (Makanaung et al., 2021) found that the phenolic content in the petroleum ether fraction of nutmeg pulp is quite high, which could potentially have pharmacological effects, including as antibacterial and antifungal agents.

## CONCLUSION

Phenolic compounds in nutmeg have strong potential as natural antimicrobial agents, whether in the form of extracts, nanoparticles, or other synthesized products. These antimicrobial properties are most likely derived from the interaction of phenolic compounds with the microbial cell wall, causing disruption of the microorganism's cell structure and function. However, further research is needed to understand the specific mechanisms and their effectiveness in various pharmaceutical and food applications. The results of the overall literature review indicate that phenolic compounds in nutmeg have potential as promising natural antimicrobial agents. Where the main impact of this literature review is the emphasis on the importance of phenolic compounds as active ingredients that can be used in the development of nature-based antimicrobial products where nutmeg containing phenolic compounds also has the potential to replace synthetic chemicals in the control of microorganisms. The main novelty of this literature review lies in the evidence showing that not only extracts, but also nanoparticles and other synthesized forms of phenolic compounds can enhance antimicrobial activity, which may not have previously been widely discussed in the literature. And it is hoped that it can serve as a foundation for further studies in healthcare and the pharmaceutical industry.

## RECOMMENDATIONS

This research can still be continued by examining in more detail what affects each method so that the phenolic compounds produced by nutmeg are more optimal.

## BIBLIOGRAPHY

10. Agaus, L. R., & Agaus, R. V. (2019). Manfaat Kesehatan Tanaman Pala (*Myristica fragrans*). *Medula*, 6(3), 662–666.
5. Arrizqiyani, T., Sumiati, S., & Meliansyah, M. (2018). Aktivitas Antibakteri Daging Buah dan Daun Pala (*Myristica Fragrans*) terhadap *Escherichia Coli*. *Jurnal Vokasi Kesehatan*, 4(2), 81. <https://doi.org/10.30602/jvk.v4i2.119>
- Ashokkumar, K., Simal-Gandara, J., Murugan, M., Dhanya, M. K., & Pandian, A. (2022). Nutmeg (*Myristica fragrans* Houtt.) essential oil: A review on its composition, biological, and pharmacological activities. In *Phytotherapy Research* (Vol. 36, Issue 7, pp. 2839–2851). John Wiley and Sons Ltd. <https://doi.org/10.1002/ptr.7491>



- 3 Bayani, F., Kurniasari, B. A., Hamdani, A. S., Yuliana, D., Wahyuni, I., & Mujaddid, J. (2023). Identification of Secondary Metabolite Compounds from Melandean (Bridelia micrantha) Leaf Extract. *Hydrogen: Jurnal Kependidikan Kimia*, 11(6), 858–873. <https://doi.org/10.33394/hjkk.v11i6.9879>
- 14 Bayani, F., Muhali, M., Yuliana, D., Hulyadi, H., & Gargazi, G. (2024). Review of Secondary Metabolites From Melandean Bark Extract (Bridellia Micrantha): Bioactive Potential and Applications in Health. *Hydrogen: Jurnal Kependidikan Kimia*, 12(3), 413–428. <https://doi.org/10.33394/hjkk.v12i3.11956>
- 23 Biswas, D. (2022). The site of Anthropocene and colonial entanglement: Reviewing The Nutmeg's Curse. *Journal of Environmental Studies and Sciences*, 12(4), 905–908. <https://doi.org/10.1007/s13412-022-00783-9>
- 1 Blessymol, B., Yasotha, P., Kalaiselvi, V., & Gopi, S. (2024). An antioxidant study of Titanium dioxide (TiO<sub>2</sub>) nanoparticles against mace of nutmeg in *Myristica fragrans* houtt, rhizomes of *Curcuma longa* and *Kaempferia galanga* extracts. *Results in Chemistry*, 7(December 2023), 101291. <https://doi.org/10.1016/j.rechem.2023.101291>
- Dareda, C. T., Suryanto, E., & Momuat, L. I. (2020). Karakterisasi dan Aktivitas Antioksidan Serat Pangan dari Daging Buah Pala (*Myristica fragrans* Houtt). *Chemistry Progress*, 13(1), 48–55. <https://doi.org/10.35799/cp.13.1.2020.29661>
- 25 Fauziyah, E. V. A., & Kuswantoro, D. P. (n.d.). *Prospek pengembangan pala* (. 32–39.
- Fibonacci, A., & Hulyadi, H. (2018). Uji Aktivitas Antimikroba Daun Sirsak (*Annona muricata* L.) Terhadap *Bacillus subtilis* dan *Eschericia coli*. *Walisongo Journal of Chemistry*, 1(1), Article 1. <https://doi.org/10.21580/wjc.v2i1.2669>
- 1 Ginting, B., Maira, R., . M., Helwati, H., Desiyana, L. S., & Mujahid, R. (2018). Isolation OF Essensial Oil of Nutmeg (*Myristica fragrans* Houtt) and Antioxidant Activity Test with DPPH. *Jurnal Natural*, 18(1), 11–17. <https://doi.org/10.24815/jn.v18i1.6604>
- 8 Handayani, S. W., Somadayo, N. A. S., Fiskia, E., & Nur, A. (2024). Efek Ekstrak Daging Buah Pala ( *Myristica fragrans* Houtt .) terhadap Histopatologi Pankreas Tikus Putih ( *Rattus norvegicus* ) Diabetes ( *The Effect of Nutmeg ( Myristica fragrans* Houtt .) Pulp Extract on The Pancreatic Histopathology Of Diabetic White Ra. 16(2), 84–91.
- 3 Hulyadi, H., Bayani, F., Muhali, M., Khery, Y., & Gargazi, G. (2023). Correlation Profile of Cognition Levels and Student Ability to Solve Problems in Biodiesel Synthesis. *Jurnal Penelitian Pendidikan IPA*, 9(6), Article 6. <https://doi.org/10.29303/jppipa.v9i6.3130>
- 4 Ismail, Y. S., Ulfa, A. H., Putri, I., Sutekad, D., & Fitri, L. (2024). Kemampuan Daya Hambat Ekstrak Buah Pala (*Myristica fragrans* H.) Terhadap *Candida albicans*. *Jurnal Bioleuser*, 8(1), 13–17. <https://doi.org/10.24815/bioleuser.v8i1.37924>
- 15 Kaawoan, P. T., Abidjulu, J., & Siagian, K. V. (2016). Uji daya hambat ekstrak buah pala (*myristica fragrans* Houtt) terhadap bakteri penyebab periodontitis porphyromonas gingivalis secara in vitro. *E-GIGI*, 4(2), 111–114. <https://doi.org/10.35790/eg.4.2.2016.13504>
- 19 Makanaung, E., Rorong, J. A., & Suryanto, E. (2021). Analisis Fitokimia dan Uji Efek Sedatif dari Ekstrak Etanol dan Beberapa Fraksi Daging Buah Pala (*Myristica fragrans* Houtt). *Chemistry Progress*, 14(1). <https://doi.org/10.35799/cp.14.1.2021.34075>
- Melati Sirait, S., Enriyani, R., Studi Penjaminan Mutu Industri Pangan, P., AKA Bogor, P., Studi Analisis Kimia, P., AKA Bogor Jl Pangeran Sogiri No, P., Baru, T., Utara, B., Bogor, K., & Barat, J. (n.d.). *Skrining Fitokimia dan Pengaruh Cara Pengeringan*

- Terhadap Kualitas Ekstrak Etanol Daging Buah Pala (Myristica fragrans Houtt)* (Vol. 45, Issue 2).<sup>24</sup>
- Nasir, Muh., & Marwati, E. (2022). Uji Aktivitas Antimikroba Ekstrak Etanol Daging Buah dan Daun Pala (*Myristica fragrans*). *Jurnal Sains Dan Kesehatan*, 4(SE-1), 67–76. <https://doi.org/10.25026/jsk.v4ise-1.1691>
- <sup>11</sup> Nikolic, V., Nikolic, L., Dinic, A., Gajic, I., Urosevic, M., Stanojevic, L., Stanojevic, J., & Danilovic, B. (2021). Chemical Composition, Antioxidant and Antimicrobial Activity of Nutmeg (*Myristica fragrans* Houtt.) Seed Essential Oil. *Journal of Essential Oil-Bearing Plants*, 24(2), 218–227. <https://doi.org/10.1080/0972060X.2021.1907230><sup>46</sup>
- Nomor, V., Disi, M. Z. A., Fakhrur, M., Hi, R., & Rahman, I. (2024). *Aktivitas Antioksidan dan Penentuan Kadar Total Flavonoid Fraksi Daging Buah Pala ( Myristica fragrans Houtt )*. 6, 287–300.
- <sup>38</sup> Nurhasanah. (2014). *Antimicrobial Activity Of Nutmeg (Myristica fragrans Houtt) Fruit Methanol Extract Against Growth Staphylococcus aureus and Escherichia coli*. 3(1), 2301–4678.
- <sup>2</sup> Pashapoor, A., Mashhadyrafie, S., & Mortazavi, P. (2020). The Antioxidant Potential and Antihyperlipidemic Activity of Myristica fragrans Seed (Nutmeg) Extract in Diabetic Rats. *Journal of Human, Environment, and Health Promotion*, 6(2), 91–96. <https://doi.org/10.29252/jhehp.6.2.7>
- <sup>27</sup> Putri Anastasya, T., Runtuwene, M. R. J., & Suryanto, E. (2022). Aktivitas Antioksidan Ekstrak dan Fraksi Pelarut dari Cangkang Biji Pala (*Myristica fragrans* Houtt.). *Chem. Prog*, 15(1), 9–16.
- <sup>18</sup> Rahman, N., Mahmood, K., Kamilah, H., Sulaiman, S., Ibrahim, M., & Ariffin, F. (2022). Effects of blanching and pickling process on the alcohol acyltransferase (AAT) activity, myristicin content and quality parameters of pickled nutmeg (*Myristica fragrans*). *Journal of Food Science and Technology*, 59(2), 542–551. <https://doi.org/10.1007/s13197-021-05038-z>
- <sup>9</sup> Rashidian, G., Shahin, K., Elshopakey, G. E., Mahboub, H. H., Fahim, A., Elabd, H., Prokić, M. D., & Faggio, C. (2022). The Dietary Effects of Nutmeg (*Myristica fragrans*) Extract on Growth, Hematological Parameters, Immunity, Antioxidant Status, and Disease Resistance of Common Carp (*Cyprinus carpio*) against *Aeromonas hydrophila*. *Journal of Marine Science and Engineering*, 10(3). <https://doi.org/10.3390/jmse10030325>
- <sup>2</sup> Rizwana, H., Bokahri, N. A., Alkhattaf, F. S., Albasher, G., & Aldehaish, H. A. (2021). Antifungal, antibacterial, and cytotoxic activities of silver nanoparticles synthesized from aqueous extracts of mace-arils of myristica fragrans. *Molecules*, 26(24). <https://doi.org/10.3390/molecules26247709>
- <sup>33</sup> Rokhmah, N. N., Herlina, N., & Ananda, S. Y. (2024). *Effectiveness of nutmeg flesh extract ( Myristica fragrans H ) as an immunomodulator using the carbon clearance method in mice ( Mus musculus )*. 22(2), 297–306.
- <sup>34</sup> S. Aulia, and S. H. S. (2020). *Diversifikasi Produk Olahan Buah Pala ( Myristica fragrans ) di Desa Sukadamai ( Diversification of Nutmeg ( Myristica fragrans ) Processed Products in Sukadamai Village )*. *J. Pusat Inovasi Masyarakat*, 2(6), 966–972.
- Shori, A. B. (2022). Storage quality and antioxidant properties of yogurt fortified with polyphenol extract from nutmeg, black pepper, and white pepper. *Electronic Journal of Biotechnology*, 57, 24–30. <https://doi.org/10.1016/j.ejbt.2022.03.003>

- Simanjourang, T. M., Irham, Waluyati, L. R., & Mulyo, J. H. (2020). Comparative and competitive advantages of nutmeg farming in two regions in maluku province, indonesia. *Biodiversitas*, 21(3), 1165–1173. <https://doi.org/10.13057/biodiv/d210342>
- Suhartini, W. (2022). Analisis Sensori Varian Minuman Pala (*Myristica argentea* Warb) yang dikombinasikan dengan Ekstrak Kopi (*Coffea Canephora*) dan Ekstrak Kayu Manis (*Cinnamomum burmannii*). *Communication in Food Science and Technology*, 1(1), 25. <https://doi.org/10.35472/cfst.v1i1.958>
- Suloi, A. F., Nurmianti, N., & Wailussy, I. (2023). Pengaruh Konsentrasi Pelarut terhadap Kandungan Kimia Ekstrak Daging Buah Pala Fakfak (*Myristica argentea* Warb). *Pro Food*, 9(1), 82–88. <https://doi.org/10.29303/profood.v9i1.284>
- Trifan, A., Zengin, G., Korona-Glowniak, I., Skalicka-Woźniak, K., & Luca, S. V. (2023). Essential Oils and Sustainability: In Vitro Bioactivity Screening of *Myristica fragrans* Houtt. Post-Distillation By-Products. *Plants*, 12(9). <https://doi.org/10.3390/plants12091741>
- Usman, H., Rusli, R., Putri, L. E., & ... (2024). Formulasi dan Uji Aktivitas Gel Hand Sanitizer Ekstrak Etanol Daging Buah Pala (*Myristica Fragrans* Houtt) dalam Menghambat Pertumbuhan *Staphylococcus Aureus*. ... *of Education and ...*, 4(2).
- Vakili, F., Roosta, Z., Safari, R., Raeisi, M., Hossain, M. S., Guerreiro, I., Akbrazadeh, A., & Hoseinifar, S. H. (2023). Effects of dietary nutmeg (*Myristica fragrans*) seed meals on growth, non-specific immune indices, antioxidant status, gene expression analysis, and cold stress tolerance in zebrafish (*Danio rerio*). *Frontiers in Nutrition*, 9(January), 1–10. <https://doi.org/10.3389/fnut.2022.1038748>
- Yam, J. H. (2024). Kajian Penelitian: Tinjauan Literatur Sebagai Metode Penelitian. *Jurnal Empire*, 4(1), 61–70.

## ORIGINALITY REPORT

48%

SIMILARITY INDEX

43%

INTERNET SOURCES

35%

PUBLICATIONS

22%

STUDENT PAPERS

## PRIMARY SOURCES

1	<a href="http://ouci.dntb.gov.ua">ouci.dntb.gov.ua</a> Internet Source	3%
2	<a href="http://link.springer.com">link.springer.com</a> Internet Source	3%
3	<a href="http://e-journal.undikma.ac.id">e-journal.undikma.ac.id</a> Internet Source	2%
4	Submitted to Universitas Andalas Student Paper	2%
5	<a href="http://profood.unram.ac.id">profood.unram.ac.id</a> Internet Source	2%
6	<a href="http://repository.usd.ac.id">repository.usd.ac.id</a> Internet Source	2%
7	<a href="http://importanceofhealth.wordpress.com">importanceofhealth.wordpress.com</a> Internet Source	2%
8	<a href="http://discovery.researcher.life">discovery.researcher.life</a> Internet Source	1%
9	Jae-Ho Choi, Jun-Hwan Kim. "Toxic effects of sub-acute microplastic (polyamide) exposure on the accumulation, hematological, and antioxidant responses in crucian carp, <i>Carassius carassius</i> ", Environmental Toxicology and Pharmacology, 2023 Publication	1%
10	<a href="http://e-journal.politanisamarinda.ac.id">e-journal.politanisamarinda.ac.id</a> Internet Source	1%

11	Submitted to Florida International University Student Paper	1 %
12	<a href="http://www.ciimar.up.pt">www.ciimar.up.pt</a> Internet Source	1 %
13	<a href="http://www.jurnal.unsyiah.ac.id">www.jurnal.unsyiah.ac.id</a> Internet Source	1 %
14	<a href="http://journal-center.litpam.com">journal-center.litpam.com</a> Internet Source	1 %
15	<a href="http://journal.uin-alauddin.ac.id">journal.uin-alauddin.ac.id</a> Internet Source	1 %
16	Submitted to National University of Singapore Student Paper	1 %
17	<a href="http://pmc.ncbi.nlm.nih.gov">pmc.ncbi.nlm.nih.gov</a> Internet Source	1 %
18	Submitted to University of Western Sydney Student Paper	1 %
19	<a href="http://www.ejournal.akfarsurabaya.ac.id">www.ejournal.akfarsurabaya.ac.id</a> Internet Source	1 %
20	<a href="http://www.e3s-conferences.org">www.e3s-conferences.org</a> Internet Source	1 %
21	<a href="http://online.agris.cz">online.agris.cz</a> Internet Source	1 %
22	Muhammad Zulfian A. Disi, Muhammad Fakhrur Rajih Hi Yusuf, Ismail Rahman. "Aktivitas Antioksidan dan Penentuan Kadar Total Flavonoid Fraksi Daging Buah Pala (Myristica fragrans houtt)", Journal Syifa Sciences and Clinical Research, 2024 Publication	1 %
23	Submitted to East Carolina University Student Paper	1 %

24	<a href="http://journal.aspirasi.or.id">journal.aspirasi.or.id</a> Internet Source	1 %
25	<a href="http://jurnal.unej.ac.id">jurnal.unej.ac.id</a> Internet Source	1 %
26	<a href="http://technicalgeography.org">technicalgeography.org</a> Internet Source	1 %
27	<a href="http://lenterafarma.id">lenterafarma.id</a> Internet Source	1 %
28	<a href="http://journal.yp3a.org">journal.yp3a.org</a> Internet Source	1 %
29	<a href="http://www.science.gov">www.science.gov</a> Internet Source	1 %
30	Zhipeng Cao, Wei Xia, Xiaoyu Zhang, Huiya Yuan, Dawei Guan, Lina Gao. "Hepatotoxicity of nutmeg: A pilot study based on metabolomics", Biomedicine & Pharmacotherapy, 2020 Publication	1 %
31	<a href="http://www.investigo.biblioteca.uvigo.es">www.investigo.biblioteca.uvigo.es</a> Internet Source	<1 %
32	Submitted to Universitas Tanjungpura Student Paper	<1 %
33	Submitted to Universitas Pancasila Student Paper	<1 %
34	<a href="http://journal.ipb.ac.id">journal.ipb.ac.id</a> Internet Source	<1 %
35	Xinzhong Li, Junchi Wang, Jiahui Zhou, Haiyan Xiao et al. "Myristica fragrans water extract modulates multiple biological processes to pre-protect anhydrous ethanol-induced gastric ulcers via Akt/JNK/Nrf2 pathway	<1 %

36

Zaryab Shafi, Vinay Kumar Pandey, Umme Habiba, Rahul Singh et al. "Exploring the Food Safety and Preservation Landscape of *Myristica fragrans* (L.) against Foodborne Pathogen: A Review of Current Knowledge", Journal of Agriculture and Food Research, 2025

Publication

<1 %

37

[ejournal.uniramalang.ac.id](http://ejournal.uniramalang.ac.id)

Internet Source

<1 %

38

[www.jlsuboptimal.unsri.ac.id](http://www.jlsuboptimal.unsri.ac.id)

Internet Source

<1 %

39

[www.researchgate.net](http://www.researchgate.net)

Internet Source

<1 %

40

Submitted to Sriwijaya University

Student Paper

<1 %

41

[ejournal.unsrat.ac.id](http://ejournal.unsrat.ac.id)

Internet Source

<1 %

42

[sciresol.s3.us-east-2.amazonaws.com](http://sciresol.s3.us-east-2.amazonaws.com)

Internet Source

<1 %

43

Andika Dwi Mahendra, Suci Hanifah, Chynthia Pradiftha Sari. "Cross-sectional study of potential incompatibility of intravenous medications in a neonatal intensive care unit in Indonesia", Farmacia Hospitalaria, 2023

Publication

<1 %

44

[www.pjlss.edu.pk](http://www.pjlss.edu.pk)

Internet Source

<1 %



45 S Edi, Rustam. "Visitors' Perceptions of Cultivation Technology Innovation in Agro Innovation Park, BPTP Jambi", IOP Conference Series: Earth and Environmental Science, 2021  
Publication

<1 %

46 [ejurnal.ung.ac.id](http://ejurnal.ung.ac.id)  
Internet Source

<1 %

47 [ksascholar.dri.sa](http://ksascholar.dri.sa)  
Internet Source

<1 %

48 [www.mdpi.com](http://www.mdpi.com)  
Internet Source

<1 %

49 [www.jptcp.com](http://www.jptcp.com)  
Internet Source

<1 %

50 Barry Roseveld Joseph Siegers, Eka Astuty, Yuniasih M.J. Taihuttu. "UJI ANTIBAKTERI EKSTRAK ETANOL DAGING BUAH PALA (*Myristica Fragrans* Houtt.) TERHADAP BAKTERI *STAPHYLOCOCCUS AUREUS* DAN *ESCHERICHIA COLI*", PAMERI: Pattimura Medical Review, 2022  
Publication

<1 %

51 E Erizal, M Hanafiah, M Mudatsir, TZ Helmi, M Yusuf. "Determination of Total Phenolic Content and Total Flavonoid Content of Nutmeg Flesh (*Myristica Fragrans* Houtt) Ethanol Extract from South Aceh Province", IOP Conference Series: Earth and Environmental Science, 2024  
Publication

<1 %

52 [avehjournal.org](http://avehjournal.org)  
Internet Source

<1 %

[oak.jejunu.ac.kr](http://oak.jejunu.ac.kr)

53

Internet Source

&lt;1 %

54

Dwi Sakti, Edi Suryanto, Jan Rudolf Assa. "Analisis Kandungan Amilosa dan Antioksidan dari Tepung Pisang Goroho (*Musa acuminata*, sp)", CHEMISTRY PROGRESS, 2025

Publication

&lt;1 %

55

biotechnologicalresearch.com

Internet Source

&lt;1 %

56

gupea.ub.gu.se

Internet Source

&lt;1 %

57

ijpsr.com

Internet Source

&lt;1 %

58

Humaira Rizwana, Mona S. Alwhibi, Rawan A. Al-Judaie, Horiah A. Aldehaish, Noura S. Alsaggabi. "Sunlight-Mediated Green Synthesis of Silver Nanoparticles Using the Berries of *Ribes rubrum* (Red Currants): Characterisation and Evaluation of Their Antifungal and Antibacterial Activities", *Molecules*, 2022

Publication

&lt;1 %

59

Leo M.L. Nollet, Semih Ötleş. "Handbook of Analysis and Extraction Methods of Anthocyanins", CRC Press, 2025

Publication

&lt;1 %

60

Muhammad Tauseef Sultan, Farhan Saeed, Hassan Raza, Aneeqa Ilyas et al. " Nutritional and therapeutic potential of nutmeg ( ): A concurrent review ", *Cogent Food & Agriculture*, 2023

Publication

&lt;1 %

61

ijamer.feb.dinus.ac.id

Internet Source

<1 %

62

[jifi.farmasi.univpancasila.ac.id](http://jifi.farmasi.univpancasila.ac.id)

Internet Source

<1 %

63

[nlsinfo.org](http://nlsinfo.org)

Internet Source

<1 %

64

[repository.penerbiteureka.com](http://repository.penerbiteureka.com)

Internet Source

<1 %

65

Melda Yunita, Morgan Ohiwal, Saiful Alimudi, Eka Astuty, Rosdiana Mus, Muthmainnah Abbas, Miftah H Makatita, Juen C Warella. "Peningkatan Level Pengetahuan Masyarakat Mengenai Manfaat Pala Sebagai Tanaman Rempah Obat (TARO)", Darmabakti : Jurnal Pengabdian dan Pemberdayaan Masyarakat, 2024

Publication

<1 %

66

[jsk.farmasi.unmul.ac.id](http://jsk.farmasi.unmul.ac.id)

Internet Source

<1 %

67

[media.neliti.com](http://media.neliti.com)

Internet Source

<1 %

68

[nepjol.info](http://nepjol.info)

Internet Source

<1 %

69

David Yudianto, Prasetyo Wahyu Widhisono, Shofi Dwika Adha, Nurhasanah Nurhasanah, Sri Hadisetyana. "Quality Evaluation of Chili Flakes by Variation of Packaging and Storage Temperature", Journal of Tropical Food and Agroindustrial Technology, 2020

Publication

<1 %

70

Adriana Trifan, Gokhan Zengin, Izabela Korona-Glowniak, Krystyna Skalicka-Woźniak, Simon Vlad Luca. "Essential Oils and

<1 %

## Sustainability: In Vitro Bioactivity Screening of *Myristica fragrans* Houtt. Post-Distillation By-Products", Plants, 2023

Publication

- 71 Amal Bakr Shori. "Storage quality and antioxidant properties of yogurt fortified with polyphenol extract from nutmeg, black pepper, and white pepper", Electronic Journal of Biotechnology, 2022

Publication

- 72 Amit Kumar Rai, Anu Appaiah K. A.. "Bioactive Compounds in Fermented Foods - Health Aspects", Routledge, 2021

Publication

- 73 Junior Bernardo Molina-Hernandez, Carlos David Grande-Tovar, Lilia Neri, Johannes Delgado-Ospina et al. "Enhancing postharvest food safety: the essential role of non-thermal technologies in combating fungal contamination and mycotoxins", Frontiers in Microbiology, 2025

Publication

- 74 Kaliyaperumal Ashokkumar, Jesus Simal-Gandara, Muthusamy Murugan, Mannananil Krishnankutty Dhanya, Arjun Pandian. "Nutmeg ( Houtt.) essential oil: A review on its composition, biological, and pharmacological activities ", Phytotherapy Research, 2022

Publication

Exclude quotes Off

Exclude matches Off

Exclude bibliography Off