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Bioactive Potential of Ethanol Extracts of Avocado Leaves: Review of Antioxidant and Antibacterial Activities

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ABSTRACT

Changing lifestyles and increasing bacterial resistance pose a serious challenge to global health. Free radicals and bacterial infections are major contributors to degenerative and infectious diseases. Avocado (*Persea americana* Mill.) leaves contain bioactive compounds such as flavonoids, tannins, and polyphenols that may provide such benefits. This study is a literature review with a qualitative descriptive approach that aims to evaluate the antioxidant and antibacterial activities of the ethanol extract of avocado leaves. Data were obtained from 396 articles from searches on Google Scholar, PubMed, PLOS One, and Science Direct databases, then selected based on inclusion and exclusion criteria until 12 eligible articles were obtained. The review results showed that the antioxidant activity of avocado leaf ethanol extract varied based on the extraction method, type and concentration of solvent, and extraction time, with the best IC_{50} value of 9.24 µg/mL (very strong category). Antibacterial activity showed the ability to inhibit the growth of Gram-positive and Gram-negative bacteria with inhibition zones reaching the strong category, especially against *Escherichia coli*, *Staphylococcus aureus*, *Lactobacillus acidophilus*, *Streptococcus mutans*, and *Pseudomonas aeruginosa*. It can be concluded that the ethanol extract of avocado leaves has strong potential as an antioxidant and antibacterial agent. However, the current evidence is mainly based on in vitro studies, so further in vivo and clinical research is needed to validate these findings.

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Keywords:
Persea americana Mill.; Avocado leaves; Antioxidant activity; Antibacterial activity; Bioactive compounds

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1. Introduction

In the current era of globalization, lifestyle changes and environmental pollution lead to an increased risk of degenerative and infectious diseases. An unbalanced diet, lack of physical activity, as well as exposure to pollution and bad habits such as smoking or alcohol consumption can trigger the formation of free radicals and weaken the immune system [1], [2]. On the other hand, increasing bacterial resistance to antibiotics is also a global health problem, so an effective and safe alternative to antibacterial agents is needed [3].

Free radicals are atoms or molecules that have one or more unpaired electrons. To achieve stability, free radicals will attract electrons from other molecules in the body. This mechanism can damage essential biomolecules such as lipids, proteins, and DNA, disrupting redox homeostasis and contributing to diseases like stroke, hypertension, preeclampsia, and cancer [2], [4]. To counteract this, the body needs antioxidants. In addition to endogenous antioxidants, consumption of exogenous antioxidants is essential to help maintain oxidative balance, especially when the body is exposed to free radical-induced stress [5], [6].

Exogenous antioxidants can be classified into two categories: natural and synthetic. The synthetic variants consist of chemical substances such as butylated hydroxyanisole (BHA), butylated hydroxytoluene (BHT), and tetrabutylhydroquinone (TBHQ), which are commonly used in the food and pharmaceutical industries [7], [8]. Meanwhile, natural antioxidants can be obtained from various plants such as fruits, vegetables, nuts, or rhizomes [2]. Compared to synthetic antioxidants, natural antioxidants are preferred because they are considered safer, do not contain a mixture of synthetic chemicals, and are more easily found in the surrounding environment [8].

Indonesia is one of the countries in Asia that has biodiversity and herbal medicines, where there are more than 30,000 medicinal plants from 40,000 plant species that have been identified in the world, including plants that have potential as a source of natural bioactive compounds [9]. Among these plants is avocado (*Persea americana* Mill.), a member of the Lauraceae family, which has been traditionally utilized for generations. In addition to its fruit, the leaves of the avocado plant are also rich in bioactive constituents such as flavonoids, tannins, saponins, polyphenols, and vitamin E, all of which exhibit antioxidant and antibacterial properties. [10], [11].

Numerous studies have indicated that extracts from avocado leaves possess significant antioxidant properties and are capable of inhibiting the growth of both Gram-positive and Gram-negative bacterial strains [12]. Consequently, further research is essential to explore the biological properties of avocado leaves, particularly their antioxidant and antimicrobial potential. In line with this, the present review aims to examine existing studies on the antioxidant and antibacterial effects of ethanol-based extracts from avocado leaves, as a step toward identifying natural compounds with prospective applications in the healthcare field.

2. Method

This research utilized a qualitative expository design using an overview of existing research approach to collect, evaluate, and synthesize scientific information related to the antioxidant and antibacterial bioactive properties of avocado leaves (*Persea americana* Mill.). The article search was conducted online through four major databases: Google Scholar, PLOS One, PubMed, and ScienceDirect. The search used a combination of keywords, including "*Persea americana* Mill.", "avocado leaf extract", "ethanol extract", "antioxidant activity", and "antibacterial activity", which were combined using Boolean operators "AND" and "OR" to expand and refine the search for more relevant studies. The last database search was conducted in June 2025.

Articles were selected based on specific eligibility criteria (**Figure 1**). The inclusion criteria were: open access articles in PDF format, original studies published in accredited journals in either Indonesian or English, containing a DOI, relevant to the topic, and published between 2015 and 2025. Meanwhile, the exclusion criteria consisted of non-open-access articles, non-study publications, irrelevant content, duplicated

articles across databases, and publications released before 2015. The article selection process was carried out by two reviewers who independently screened the title, abstract, and full text of each article. Differences of opinion are resolved through discussion involving a third reviewer to reach an agreement.

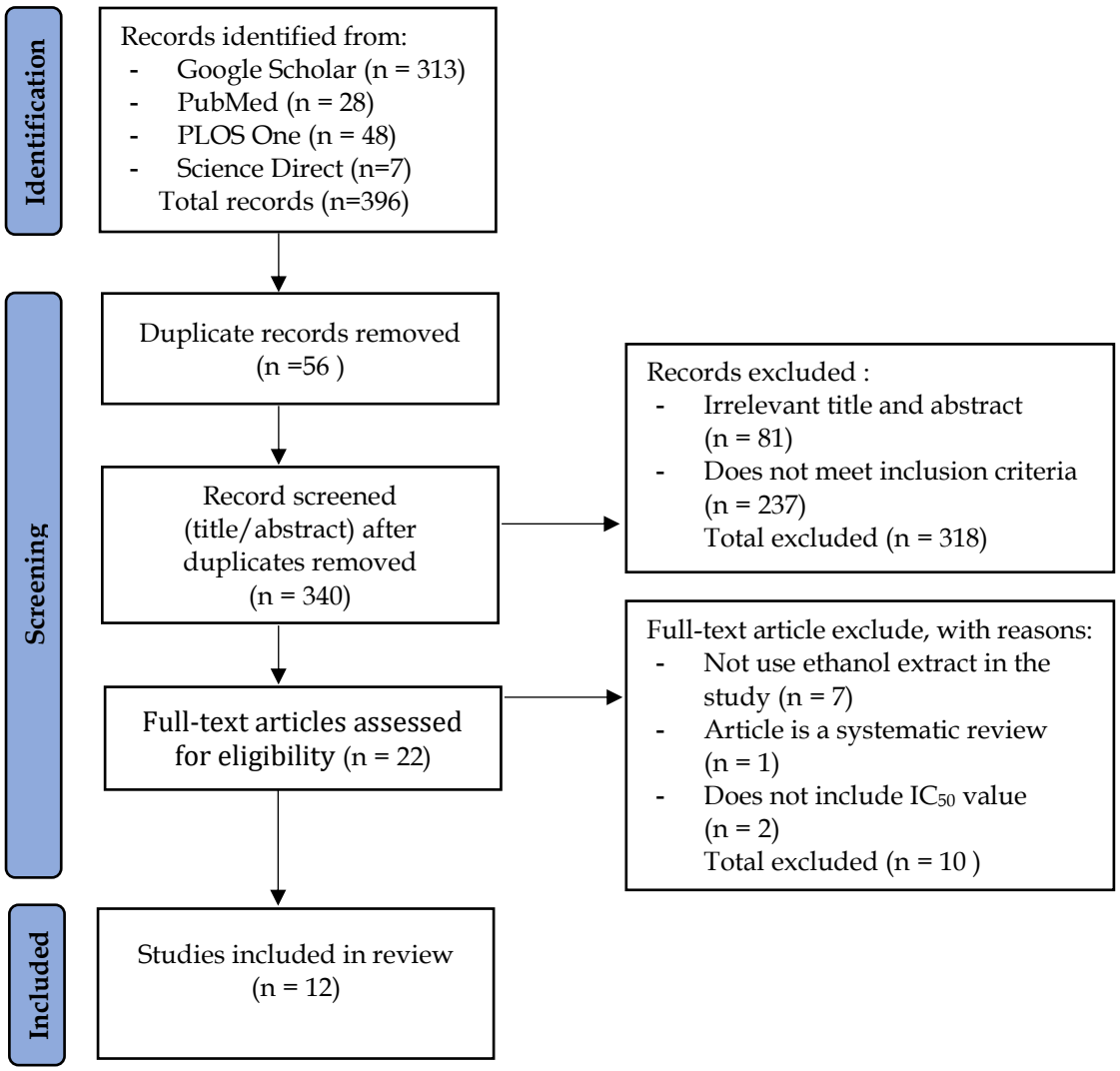

Figure 1. PRISMA Flow Diagram (steps to search for review articles)

3. Results and Discussions

Based on the search for scientific articles, a total of 12 journal articles were obtained that met the inclusion criteria. This review includes plant extracts or preparations derived from avocado leaves that report IC_{50} values (inhibitory concentration 50) or antioxidant activity measurements from ethanol extracts of avocado leaves, along with the corresponding antioxidant activity categories, as presented in **Table 1**. The antibacterial properties exhibited by ethanol extracts of avocado leaves are shown in **Table 2.**

Antioxidant Activity

Avocado leaves (*Persea americana* Mill.) are part of the avocado plant that has antioxidant potential. Antioxidants are compounds that can inhibit free radical reactions or neutralize free radicals in the human body. Thus, antioxidant administration is expected to prevent body damage caused by degenerative diseases due to free radicals. Antioxidant activity is measured based on the electron transfer performed by the antioxidant during the reaction with free radicals [5], [13]. Natural antioxidants present in avocado leaves include phenolic compounds and other bioactive classes such as alkaloids, flavonoids, tannins, saponins, steroids, and glycosides [14], [15].

As presented in **Table 1**, the antioxidant properties of ethanol extracts from avocado leaves were assessed through multiple analytical techniques, such as DPPH (1,1-diphenyl-2-picrylhydrazyl), ABTS (2,2′-azino-bis(3-ethylbenzothiazoline-6-sulfonic acid)), and FRAP (Ferric Reducing Antioxidant Power). The ABTS assay determines antioxidant effectiveness by measuring the capacity to scavenge ABTS-derived free radicals. It has higher sensitivity than DPPH, works rapidly across a wide pH range, and is applicable to both aqueous and organic systems [16]. The FRAP method measures electron transfer from antioxidants to the Fe^{3+}-TPTZ complex, representing oxidants that may damage cells. It is simple, low-cost, and uses easily prepared reagents [17].

The DPPH assay is one of the most widely applied methods for evaluating antioxidant activity due to its notable advantages, including low sample requirement, straightforward procedures, ease and speed of execution, and high sensitivity in detecting the antioxidant capacity of natural substances [18]. In this method, antioxidant effectiveness is typically expressed using the IC_{50} value, which refers to the concentration of an antioxidant compound required to inhibit 50% of DPPH free radical activity [19], [20]. A lower IC_{50} value indicates a higher antioxidant potency [20].

Table 1. Antioxidant Activity Literature Search Results

No	Study Title	Method	Result	Category	Reference
1.	Phytochemical Analysis and Evaluation of Antioxidant Potential of Ethanol Extract of Avocado (*Persea americana* Mill.) Using the DPPH Assay	DPPH	The ethanol extract of avocado leaves exhibited antioxidant activity with an IC_{50} value of 9.24 µg/mL.	Very strong	[14]
2.	Antibacterial Effects via Membrane Disruption and Antioxidant Activity of Purified Phenolic Compounds from Avocado (*Persea americana*) Leaf Extract	DPPH ABTS FRAP	The ethanol extract of avocado (*Persea americana* Mill.) leaves exhibited antioxidant activity as measured by three different assays: DPPH with a value of 508.5 ± 2.8 mg ET/g, ABTS at 223.5 ± 0.9 mg ET/g, and FRAP showing 1477.4 ± 3.9 µM Fe(II)/g.	Very strong	[21]

3.	Development and Antioxidant Evaluation of Gel Facial Cleanser Containing Avocado Leaf Extract (*Persea americana* Mill.) Using the DPPH Assay	DPPH	Evaluation of the antioxidant potential of avocado leaf extract produced an IC_{50} of 70.97 ppm, suggesting its capability to inhibit 50% of DPPH radical activity at that concentration.	Strong	[22]
4.	Phytochemical Constituents of Avocado (*Persea americana* L.) Extracts: Evaluation of Antioxidant Capacity, Amylase Inhibitory Effects, and Their Potential Role in Type 2 Diabetes Management	DPPH	The ethanol extract of avocado (*Persea americana* Mill.) leaves exhibited an IC_{50} value of 421.6 µg/mL, indicating relatively weak antioxidant activity.	Very weak	[23]
5.	Influence of Different Solvents on the Antioxidant Potential of Avocado (*Persea americana* Mill.) Leaf Extracts	DPPH	An IC_{50} value of 24.69 ppm was obtained for the antioxidant activity of avocado leaf ethanol extract, indicating a high capacity for free radical scavenging.	Very strong	[24]
6.	Ultrasonic Assisted Extraction of Avocado Leaf Bioactive Components at Various Solvent Types and Concentrations	DPPH	Avocado leaf ethanol extract has an IC_{50} value of 1860 mg/L.	Very weak	[15]

Antioxidant activity based on IC_{50} values can be classified as very strong (< 50 µg/mL), strong (50–100 µg/mL), moderate (100–150 µg/mL), weak (151–200 µg/mL), and very weak (> 200 µg/mL) [14]. As shown in **Table 1**, the antioxidant capacity of avocado (*Persea americana* Mill.) leaf isolate varies considerably, with IC_{50} values falling across all these categories from very strong to very weak. This variability may result from various factors, such as variations in extraction methods, duration of extraction, and solvent concentration employed during the process.

The extraction method has an important influences both the composition and concentration of bioactive constituents successfully isolated from a plant [25]. According to Widarta and Arnata [15], the use of 70% ethanol solvent with an ultrasound-assisted extraction method resulted in an IC_{50} value of 1860 mg/L. In comparison, Cicilia et al. [24] reported that using the same solvent, 70% ethanol, but with a maceration extraction method, produced an IC_{50} value of 24.69 ppm. Ultrasonic methods can cause partial degradation or structural changes of phenolic compounds that are sensitive to temperature or ultrasonic vibrations. This is due to the phenomenon of ultrasonic

cavitation which generates high heat and pressure locally when the cavitation bubbles burst [26]. Meanwhile, the maceration method provides a longer contact time between the solvent and the material, allowing the diffusion and dissolution process of bioactive compounds to run more optimally without physical interference. Choosing the right extraction method can increase the amount of secondary metabolites extracted in a plant extract [27].

The length of extraction time also contributes to the results obtained. The longer the extraction process takes place, the longer the contact between the solvent and the material will be, thus allowing maximum mass diffusion to achieve a balance of concentration between the solution inside and outside the material [28]. Abd Elkader et al. [23] reported that extraction with 70% ethanol using a maceration time of 3 hours resulted in an IC_{50} value of 421.6 µg/mL. In comparison, Cicilia et al. [24] found that the same solvent but with a longer extraction duration produced a much stronger IC_{50} value, with an IC_{50} value of 24.69 ppm. Similarly, Rahmah et al. [14] who applied maceration with 96% ethanol for 5 days, reported an IC_{50} value of 9.24 µg/mL. Meanwhile, Suwardi et al. [22], although using the same method and solvent, but with a shorter extraction duration of 4 days, the IC_{50} value obtained was 70.97 ppm.

Differences in ethanol concentration affect solvent polarity, subsequently altering the ability to dissolve bioactive substances. contained therein [29]. According to Suwardi et al. [22], the use of 96% ethanol solvent with a maceration duration of 4 days resulted in an IC_{50} value of 70.97 ppm, which falls into the category of strong antioxidant activity. In contrast, Cicilia et al. [24] reported that using 70% ethanol solvent with a shorter maceration time of 18 hours produced an IC_{50} value of 24.69 ppm, which is classified as very strong antioxidant activity. This difference can be explained by the polarity of the solvent. 70% ethanol has a higher polarity than 96% ethanol, so it is better able to dissolve phenolic and flavonoid compounds which are generally polar in nature. Therefore, extraction with 70% ethanol tends to produce a higher content of active compounds, so that the antioxidant activity produced is also greater than the use of 96% ethanol [30], [31].

Antibacterial Activity

Based on the studies summarized in **Table 2**, ethanol extracts of avocado (*Persea americana* Mill.) leaves exhibit antibacterial activity against Gram-positive bacteria such as *Staphylococcus aureus*, *Staphylococcus epidermidis*, *Streptococcus mutans*, and *Lactobacillus acidophilus*, as well as Gram-negative bacteria including *Escherichia coli*, *Pseudomonas aeruginosa*, and *Salmonella typhi*. Such antimicrobial effects were evidenced by the presence of inhibition zones formed around the bacterial colonies on the growth medium [32]. Assessment of antibacterial effectiveness is done by referring to the inhibition zone diameter category [33]. The inhibition zone data is then processed into a percentage of bacterial inhibitory ability. Based on the percentage of bacterial growth inhibition, antibacterial activity can be classified as strong when inhibition is ≥ 70%, moderate at 50–70%, and weak at < 50% [34]. Alternatively, Geofani et al. [35] classify inhibition zones as weak (< 5 mm), moderate (5–10 mm), strong (11–20 mm), and very strong (≥ 21 mm).

Table 2. Antibacterial Activity Literature Search Results

No	Study Title	Test Method	Result	Inhibition Zone	Reference
1.	Antibacterial Activity of Ethanol Extract of Avocado (*Persea americana* Mill.) Leaves Against *Escherichia coli, Salmonella typhi,* and *Pseudomonas aeruginosa*	Disc diffusion (Kirby-Bauer)	The ethanol extract of avocado (*Persea americana* Mill.) at a concentration of 500 mg/mL exhibited. Leaves exhibited antibacterial activity, as indicated by inhibition zone diameters of 12.37 ± 0.15 mm for *Escherichia coli,* 11.60 ± 0.20 mm for *Salmonella typhi*, and 10.87 ± 0.15 mm for *Pseudomonas aeruginosa.*	Strong	[36]
2.	Antibacterial Effect Through Membrane Disruption and Antioxidant Activity of Purified Phenolic Compounds from Avocado (*Persea americana*) Leaf Extract	Broth dilution method	The ethanol extract of avocado (Persea americana Mill.), administered at a concentration of 1000 µg/mL, exhibited(*Persea americana* Mill.) leaves demonstrated inhibitory effects against *Staphylococcus aureus* (77.8 ± 1.0%), *Escherichia coli* (65.9 ± 0.9%), *Pseudomonas aeruginosa* (61.0 ± 1.4%), and *Salmonella choleraesuis* (43.2 ± 1.4%).	Strong (*S. aureus*), Moderate (*E. coli, P. aeruginosa*), and Weak (*S. choleraesuis*)	[21]
3.	Evaluation of Antibacterial Activity of Avocado (*Persea americana* Mill.) Leaf Ethanol Extract Against *Salmonella typhi* and *Staphylococcus aureus*	Disc diffusion	Ethanol extract of avocado (*Persea americana* Mill.) leaves at concentrations of 20%, 40%, 60%, and 80% did not exhibit any inhibitory effect against *Staphylococcus aureus*. Antibacterial activity against *S. aureus* and *Salmonella Typhi* was only evident at 100% concentration, with inhibition zones measuring 10.68 ± 0.43 mm and 9.44 ± 0.36 mm, respectively.	Strong (*S. aureus*) and Moderate (*S. Typhi*)	[37]
4.	Antibacterial Activity of Avocado Leaf Extracts and	Disc diffusion	The ethanol extract of avocado leaves at concentrations of 25%, 50% and 100% has an	Strong	[38]

	Fractions (*Persea americana* Mill.) Against *Lactobacillus acidophilus* Bacteria.		inhibition zone diameter against *Lactobacillus acidophilus* bacteria which is 12.79 ± 0.23 mm, 13.97 ± 0.15 mm, and 16.91 ± 0.15 mm, respectively.		
5.	Evaluation of the Antibacterial Effect of Avocado (*Persea americana* Mill.) Leaf Ethanol Extract on the Growth of *Streptococcus mutans*	Well diffusion	At a concentration of 75%, the ethanol extract of avocado leaves exhibited an inhibition zone measuring 10.81 ± 1.63 mm.	Strong	[39]
6.	Antibacterial Effect of Ethanol Extract from Avocado (*Persea americana* Mill.) Leaves Against *Staphylococcus epidermidis*	Disc diffusion	At a concentration of 10%, the ethanolic extract derived from avocado (*Persea americana* Mill.) leaves generated an inhibition zone measuring 8.50 ± 0.28 mm against *Staphylococcus epidermidis*.	Moderate	[40]
7.	Evaluation of the Antibacterial Activity of Avocado (*Persea americana* Mill.) Leaf Ethanol Extract Against *Pseudomonas aeruginosa*	Well diffusion	The average inhibition zone diameters of avocado leaf ethanol extract against *Pseudomonas aeruginosa* at 2%, 4%, 6%, 8%, and 10% were 5.68 ± 0.15 mm, 6.16 ± 0.03 mm, 6.65 ± 0.06 mm, 7.55 ± 0.20 mm, and 6.41 ± 0.06 mm, respectively.	Moderate	[41]

Research on the inhibitory potential of ethanol-based extracts from avocado leaves against bacterial growth has been conducted using various methods, such as disc diffusion (Kirby-Bauer), agar well diffusion, and broth dilution method. Among the three, the diffusion method (disc and well method) is the most frequently used method for antibacterial activity analysis [42].

Based on the review in **Table 2**, it is known that avocado leaf ethanol extracts have varying inhibitory abilities. This variation is influenced by several factors, including extract concentration, solvent type selection, extraction method, and pH conditions. An increase in extract concentration correlates with enhanced antibacterial activity [43]. Nasri et al. [36] reported that ethanol extract of avocado (*Persea americana* Mill.) leaves at a concentration of 500 mg/mL showed strong inhibition against *Escherichia coli* and *Pseudomonas aeruginosa*. In contrast, Solís-Salas et al. [21], although using the same extraction method and type of test bacteria, but with a lower extract concentration of 1000 µg/mL, the inhibitory ability was only classified as moderate.

The extraction method used in all the studies reviewed used the same method, namely the maceration method. However, the duration of soaking used in each study

was different. Just like in antioxidant activity testing, soaking time contributes to the quality of the resulting extract. The selection of solvent during extraction must be considered, because the active ingredients extracted depend on the solvent used [43]. According to Azzahra et al. [37], the use of 70% ethanol as extraction solvent produced moderate inhibitory activity against *Salmonella typhi*. In contrast, Solís-Salas et al. [21] reported that 96% ethanol solvent demonstrated strong inhibition against the same bacteria. This is because 96% ethanol tends to be more nonpolar than 70% ethanol, so it is easier to interact and damage the lipid the bacterial membrane, particularly in Gram-negative species, which possess an outer layer abundant in lipopolysaccharides [44].

This review is limited by the small number of comparative studies and variations in experimental conditions, such as extraction time, solvent concentration, and types of test microorganisms. Moreover, most of the findings are based on in vitro studies, which may not fully represent the effectiveness of avocado leaf extract in more complex biological systems.

4. Conclusion

Based on the reviewed literature, the ethanol extract of avocado (*Persea americana* Mill.) leaves shows promising potential as a natural source of antioxidant and antibacterial agents. Optimal antioxidant performance was achieved using the maceration method with 70% ethanol over an 18-hour extraction period, yielding an IC_{50} value of 24.69 ppm, which falls within the very strong category. In terms of antibacterial activity, the highest effectiveness was observed in extracts obtained via maceration using 96% ethanol, where the extract, at its maximum concentration, effectively inhibited the growth of both Gram-positive and Gram-negative bacteria, showing strong antimicrobial potential. Further research is recommended to explore formulation development, conduct toxicity testing, and perform in vivo studies or clinical trials to ensure safety and efficacy.

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Conflicts of Interest:
The author declares that there are no conflicts of interest in this research.

References

[1] Putriyana, "Antioxidant activity of ethanolic extract of suji leaves (*Dracaena angustifolia*) by the DPPH method (1,1-diphenyl-2-picrylhydrazyl)," *ZAHRA: Journal of Health and Medical Research*, vol. 3, no. 1, pp. 86–87, 2023. [Online]. Available: https://adisampublisher.org/index.php/aisha/article/view/300

[2] L. A. Ni Putu, W. U. Ni Nyoman, and S. P. I. Made Agus, "Literature study: Antioxidant activity of extracts and fractions of white turmeric (*Curcuma zedoaria* (Rosc.)) rhizome," *EMASAINS: Jurnal Edukasi Matematika dan Sains*, vol. 13, no. 2, pp. 1–9, Sep. 2024. [Online]. Available: https://doi.org/10.59672/emasains.v13i2.4033

[3] D. C. Nwobodo *et al.*, "Antibiotic resistance: The challenges and some emerging strategies for tackling a global menace," *J. Clin. Lab. Anal.*, John Wiley & Sons, Sep. 1, 2022. [Online]. Available: https://doi.org/10.1002/jcla.24655

[4] Q. P. Arnanda and R. F. Nuwarda, "Review article: Use of technetium-99m radiopharmaceuticals from glutathione and flavonoid compounds for early detection of cancer-triggering free radicals," *Farmaka*, vol. 17, no. 2, 2019. [Online]. Available: https;//doi.org/10.24198/jf.v17i2.22071.g11642

[5] S. Purnama *et al.*, "Antioxidant activity of n-hexane fraction from methanolic extract of *Mangifera caesia* Jack. ex Wall leaves using the DPPH method," *Jurnal Ilmu Kefarmasian Indonesia*, vol. 20, no. 1, pp. 55–62, 2019. [Online]. Available: https://doi.org/10.35814/jifi.v20i1.1133

[6] O. Malinda and A. Syakdani, "Antioxidant potential of roselle (*Hibiscus sabdariffa* L.) calyces as anti-aging," *Jurnal Kinetika*, vol. 11, no. 3, pp. 60–65, 2020. [Online]. Available: https://jurnal.polsri.ac.id/index.php/kimia/index60

[7] A. A. S. S. Prabandari, N. N. W. Udayani, G. A. P. Triyansyah, N. P. E. M. K. Dewi, I. A. P. Widiasriani, and N. L. W. E. Wulandari, "Review article: Antioxidant activity of mistletoe (*Dendrophthoe pentandra* (L.) Miq) leaves using the DPPH (2,2-diphenyl-1-picrylhydrazyl) method," *Indonesian Journal of Pharmaceutical Education*, vol. 4, no. 2, Jul. 2024. [Online]. Available: https://doi.org/10.37311/ijpe.v4i2.26638

[8] M. A. Anggarani, M. Ilmiah, and D. N. M. Mahfudhah, "Literature review of antioxidant activity of several onion types and its potential as health supplements," *Indonesian Journal of Chemical Science*, vol. 12, no. 1, 2023. [Online]. Available: http://journal.unnes.ac.id/sju/index.php/ijcs

[9] I I. A. P. Widiasriani, N. N. W. Udayani, G. A. P. Triansyah, N. P. E. M. K. Dewi, N. L. W. E. Wulandari, and A. A. S. S. Prabandari, "Review article: The role of flavonoid antioxidants in inhibiting free radicals," *Journal Syifa Sciences and Clinical Research*, vol. 6, no. 2, Sep. 2024. [Online]. Available: https://doi.org/10.37311/jsscr.v6i2.27055

[10] T. Majid, R. Razak, and Z. Abidin, "Determination of total phenolics in ethanolic extract of avocado (*Persea americana* Mill.) seeds by UV-Vis spectrophotometry," *BULLET: Jurnal Multidisiplin Ilmu*, vol. 2, no. 2, pp. 351–354, 2023. [Online]. Available: https://journal.mediapublikasi.id/index.php/bullet

[11] S. N. Arwanda, Wibisono, and R. P. Sari, "Effectiveness of avocado leaves (*Persea americana*) for health," *Nusantara Hasana Journal*, vol. 1, no. 2, pp. 40–45, 2021. [Online]. Available: https://www.neliti.com/id/publications/348586/efektivitas-daun-alpukat-untuk-kesehatan

[12] N. Fadillah, N. N. Pertiwi, G. I. Dalimunthe, and A. S. Daulay, "Antibacterial activity of ethanol and acetone extracts of avocado (*Persea americana* Mill.) leaves," *Jurnal Kesehatan Tambusai*, vol. 5, no. 4, pp. 11169–11178, 2024. [Online]. Available: https://doi.org/10.31004/jkt.v5i4.32249

[13] I. S. Fatmawati, Haeruddin, and W. O. Mulyana, "Antioxidant activity of ethyl-acetate extract of bilimbi (*Averrhoa bilimbi* L.) leaves by the DPPH method," *SAINS: Jurnal Kimia dan Pendidikan Kimia*, vol. 12, no. 1, pp. 41–49, 2023. [Online]. Available: https://doi.org/10.36709/sains.v12i1.31

[14] R. Rahmah, Y. P. Rahayu, and A. S. Daulay, "Phytochemical screening and antioxidant activity of ethanolic extract of avocado (*Persea americana* Mill.) leaves by the DPPH method," *Journal of Pharmaceutical and Sciences*, vol. 1, no. 1, pp. 9–25, 2023. [Online]. Available: http://repository.umnaw.ac.id/jspui/handle/123456789/3129

[15] I. W. R. Widarta and I. W. Arnata, "Ultrasound-assisted extraction of bioactive compounds from avocado leaves using various solvents and concentrations," *Agritech*, vol. 37, no. 2, pp. 148–157, Sep. 2017. [Online]. Available: https://doi.org/10.22146/agritech.10397

[16] A. D. Puspitasari and Sumantri, "Antioxidant activity of sweet orange (*Citrus sinensis*) and kaffir lime (*Citrus hystrix*) juices using the ABTS method," *Majalah Farmasi dan Farmakologi*, vol. 23, no. 2, pp. 48–51, 2019. [Online]. Available: https://journal.unhas.ac.id/index.php/mff/article/view/6978

[17] S. Maryam, M. Baits, and A. Nadia, "Measurement of antioxidant activity of ethanolic extract of *Moringa oleifera* Lam. leaves using the FRAP method," *Jurnal Fitofarmaka Indonesia*, vol. 2, no. 2, pp. 115–118, 2016. [Online]. Available: https://doi.org/10.33096/jffi.v2i2.181

[18] N. Hasanah, R. Yuniart, H. M. Nasution, and Y. P. Rahayu, "Antioxidant activity of ethanolic extract of kuok orange (*Citrus nobilis* L.) leaves by the DPPH (1,1-diphenyl-2-picrylhydrazyl) method," *Journal of Pharmaceutical and Sciences*, vol. 6, no. 3, pp. 1416–1424, 2023. [Online]. Available: https://doi.org/10.36490/journal-jps.com.v6i3.204

[19] N. Ambarsari and R. Dayanti, "Literature review: Antioxidant activity of extracts and fractions of matoa (*Pometia pinnata*) leaves," *Journal Syifa Sciences and Clinical Research*, vol. 5, no. 3, pp. 447–452, Jan. 2024. [Online]. Available: https://doi.org/10.37311/jsscr.v5i3.24251

[20] R. S. Rahayu and C. Wulandari, "Antioxidant activity of soursop (*Annona muricata* L.) leaves: A systematic review," *Journal Syifa Sciences and Clinical Research*, vol. 7, no. 1, pp. 6–17, Jan. 2025. [Online]. Available: https://doi.org/10.37311/jsscr.v7i1.29345

[21] L. M. Solís-Salas, C. A. Sierra-Rivera, L. E. Cobos-Puc, J. A. Ascacio-Valdés, and S. Y. Silva-Belmares, "Antibacterial potential via membrane rupture and antioxidant capacity of purified phenolic fractions of *Persea americana* leaf extract," *Antibiotics*, vol. 10, no. 5, 2021. [Online]. Available: https://doi.org/10.3390/antibiotics10050508

[22] N. A. R. Suwardi, T. A. Listyani, and K. J. Pratama, "Formulation and antioxidant activity of facial-wash gel containing avocado (*Persea americana* Mill.) leaf extract by the DPPH method," *Jurnal Kesehatan Tambusai*, vol. 5, no. 4, pp. 10771–10782, 2024. [Online]. Available: https://doi.org/10.31004/jkt.v5i3.33934

[23] A. M. Abd Elkader *et al.*, "Phytogenic compounds from avocado (*Persea americana* L.) extracts: Antioxidant activity, amylase inhibitory activity, and therapeutic potential for type 2 diabetes," *Saudi Journal of Biological Sciences*, vol. 29, no. 3, pp. 1428–1433, Mar. 2022. [Online]. Available: https://doi.org/10.1016/j.sjbs.2021.11.031

[24] M. Cicilia, W. Purwanjani, and G. K. Sari, "Effect of solvent type on antioxidant activity of avocado (*Persea americana* Mill.) leaf extract," *Jurnal Farmasi IKIFA*, vol. 3, no. 3, pp. 94–106, 2024. [Online]. Available: https://epik.ikifa.ac.id/jfi/article/view/223

[25] N. N. W. Udayani, I. M. A. G. Wirasuta, D. A. K. N. Kartika, and A. P. P. Anggreni, "Sweet potato leaf extract gummy candy as an antioxidant-rich functional food for stunting prevention in children," *Journal Syifa Sciences and Clinical Research*, vol. 7, no. 3, pp. 251–264, Aug. 2025. [Online]. Available: https://doi.org/10.37311/jsscr.v7i3.33862

[26] A. Adhiksana, "Comparison of conventional and ultrasonic methods for pectin extraction from banana peel," *Journal of Research and Technology*, vol. 3, no. 2, pp. 80–88, 2017. [Online]. Available: https://doi.org/10.55732/jrt.v3i2.276

[27] Verawati, T. M. Sari, and H. Savera, "Effect of extraction method on antioxidant activity and total phenolic content of *Moringa oleifera* leaves," *Pharmaceutical Journal of Indonesia*, vol. 17, no. 1, pp. 90–97, 2020. [Online]. Available: https://doi.org/10.30595/pharmacy.v17i1.6013

[28] S. B. Triyanti, F. P. Lestari, P. A. N. Fitriana, H. R. Rostiana, D. D. Silalahi, T. D. Syalsabina, R. Y. Putri, and I. S. Saputra, "Effect of maceration, sonication, and Soxhlet extraction methods on the yield of dragon fruit (*Hylocereus polyrhizus*) peel," *Jurnal Sains dan Edukasi Sains (JuSES)*, vol. 8, no. 1, pp. 71–78, Feb. 2025. [Online]. Available: https://doi.org/10.24246/juses.v8i1p71-78

[29] A. T. Wahyudi and T. Minarsih, "Effect of extraction and ethanol concentration on total flavonoids and antioxidant activity of *Zingiber officinale* var. *amarum* (emprit ginger) extract," *Indonesian Journal of Pharmacy and Natural Product*, vol. 6, no. 1, pp. 30–38, 2023. [Online]. Available: https://doi.org/10.24843/itepa.2019.v08.i01.p04

[30] A. T. Wahyudi and T. Minarsih, "Effect of extraction and ethanol concentration on total flavonoids and antioxidant activity of *Zingiber officinale* var. *amarum* (emprit ginger) extract," *Indonesian Journal of Pharmacy and Natural Product*, vol. 6, no. 1, pp. 30–38, 2023. [Online]. Available: http://dx.doi.org/10.36932/jpcam.v2i2.1

[31] A. T. Wahyudi and T. Minarsih, "Effect of extraction and ethanol concentration on total flavonoids and antioxidant activity of *Zingiber officinale* var. *amarum* (emprit ginger) extract," *Indonesian Journal of Pharmacy and Natural Product*, vol. 6, no. 1, pp. 30–38, 2023. [Online]. Available: https://doi.org/10.35473/ijpnp.v6i01.2208

[32] D. T. Vinca, M. Iqbal, R. Triyandi, and R. Z. Oktarlina, "Review article: Antibacterial activity of *Moringa oleifera* leaves against *Staphylococcus aureus*," *Medula*, vol. 13, no. 4, pp. 649–654, 2023. [Online]. Available: https://doi.org/10.53089/medula.v13i4.772

[33] U. T. Zahrani, I. D. Rahayu, A. S. Ulandari, and R. Triyandi, "Phytochemical content and antibacterial activity of papaya (*Carica papaya* L.) leaf extract: A narrative review," *Jurnal Riset Ilmu Kesehatan Umum dan Farmasi*, vol. 3, no. 2, 2025. [Online]. Available: https://doi.org/10.57213/jrikuf.v3i2.599

[34] I. Ikhtiarudin, N. Agistia, N. Frimayanti, T. Harlianti, and J. Jasril, "Microwave-assisted synthesis of 1-(4-hydroxyphenyl)-3-(4-methoxyphenyl)prop-2-en-1-one and its activities as antioxidant, sunscreen, and antibacterial," *Jurnal Kimia Sains dan Aplikasi*, vol. 23, no. 2, pp. 51–60, Feb. 2020. [Online]. Available: https://doi.org/10.14710/jksa.23.2.51-60

[35] C. Geofani, N. M. A. N. Septianingrum, and P. S. Dianita, "Literature review: Antibacterial inhibitory effectiveness of *Morinda citrifolia* L. (noni) against *S. aureus* and *E. coli*," *Borobudur Pharmacy Review*, vol. 2, no. 2, pp. 36–49, Oct. 2022. [Online]. Available: https://doi.org/10.31603/bphr.v2i2.6699

[36] N. Nasri, V. E. Kaban, H. D. Syahputra, and D. Satria, "Antibacterial activity of ethanolic extract of avocado (*Persea americana* Mill.) leaves against *Escherichia coli*, *Salmonella typhi*, and *Pseudomonas aeruginosa*," *Herbal Medicine Journal*, vol. 5, no. 1, pp. 13–19, 2022. [Online]. Available: https://doi.org/10.58996/hmj.v5i1.37

[37] F. Azzahra, E. A. Almalik, and A. A. Sari, "Antibacterial activity of ethanolic extract of avocado (*Persea americana* Mill.) leaves against *Salmonella typhi* and *Staphylococcus aureus*," *Jurnal Kefarmasian Akfarindo*, vol. 4, no. 2, pp. 1–10, 2019. [Online]. Available: https://doi.org/10.37089/jofar.v0i0.63

[38] D. Yuliana, Y. Hariningsih, and K. N. Waskita, "Antibacterial activity of extract and fractions of avocado (*Persea americana* Mill.) leaves against *Lactobacillus acidophilus*," *Duta Pharma Journal*, vol. 1, no. 1, pp. 21–31, 2021. [Online]. Available: https://doi.org/10.47701/djp.v1i1.1189

[39] I. Rachmawati, G. Samodra, and D. Nawangsari, "Antibacterial activity of ethanolic extract of avocado (*Persea americana* Mill.) leaves against *Streptococcus mutans*," *Jurnal Pharmascience*, vol. 12, no. 1, pp. 220–232, Mar. 2025. [Online]. Available: https://dx.doi.org/10.20527/jps.v12i1.20260

[40] F. Azzahra and V. Madhani, "Antibacterial activity of ethanolic extract of avocado (*Persea americana* Mill.) leaves against *Staphylococcus epidermidis*," *Jurnal Insan Farmasi Indonesia*, vol. 4, no. 2, pp. 293–301, Dec. 2021. [Online]. Available: https://doi.org/10.36387/jifi.v4i2.799

[41] H. Y. Purnomo and F. Azzahra, "Antibacterial activity of ethanolic extract of avocado (*Persea americana* Mill.) leaves against *Pseudomonas aeruginosa*," *Jurnal Kefarmasian Akfarindo*, vol. 6, no. 3, pp. 7–14, 2021. [Online]. Available: https://doi.org/10.37089/jofar.vi0.102

[42] W. N. Rahmah, F. H. Ramdhani, and A. Hidayani, "Profile of antibiotic susceptibility test results for *Escherichia coli* by disc and well diffusion methods," *Jurnal Surya Medika*, vol. 10, no. 2, pp. 344–348, Aug. 2024. [Online]. Available: https://doi.org/10.33084/jsm.v10i2.7495

[43] N. F. Fitriana, N. Rachmalia, and I. Mukhlishah, "Review: Antibacterial activity of green betel (*Piper betle* Linn.) leaf extract against *Staphylococcus aureus*," *MEDFARM: Jurnal Farmasi dan Kesehatan*, vol. 13, no. 1, pp. 32–46, 2024. [Online]. Available: https://doi.org/10.48191/medfarm.v13i1.313

[44] E. A. Puluh, H. J. Edy, and J. P. Siampa, "Formulation and antibacterial evaluation of peel-off mask gel containing ethanolic extract of avocado (*Persea americana* Mill.) leaves against *Staphylococcus epidermidis*," *Pharmacon*, vol. 8, no. 4, pp. 860–869, 2019. [Online]. Available: https://doi.org/10.35799/pha.8.2019.29363