BIOLOGY, MEDICINE, & NATURAL PRODUCT CHEMISTRY ISSN 2089-6514 (paper)
Volume 15, Number 2, October 2026 | Pages: 2145-2154 | DOI: 10.14421/biomedich.2026.152.2145-2154 ISSN 2540-9328 (online)

Phytochemical Screening and Antioxidant Activity of *Jatropha curcas* L. Root Extract

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Manuscript received: 21 July 2026. Revision accepted: 07 November 2026, Published: 17 November 2026.

Abstract

Research on the antioxidant activity of *Jatropha curcas* L. has mainly focused on the leaves, whereas studies on the secondary metabolites and antioxidant potential of its roots remain limited. Therefore, this study aimed to identify the secondary metabolites and evaluate the antioxidant activity of *Jatropha curcas* root extract. The roots were cleaned, naturally dried, ground, and sieved to obtain an 80-mesh powder prior to extraction. Extraction was performed using the Soxhlet method with analytical-grade ethanol for 6 h at 79°C, resulting in an extraction yield of 0.44%. Phytochemical screening revealed the presence of alkaloids, flavonoids, tannins, and saponins in the root extract. Antioxidant activity was evaluated using the 2,2-diphenyl-1-picrylhydrazyl (DPPH) assay at 517 nm. Radical scavenging activity increased with increasing extract concentration, reaching a maximum inhibition of 90.95% at 500 µg/mL. The half-maximal inhibitory concentration (IC_{50}) of the root extract was 206.389 µg/mL, whereas ascorbic acid, used as the positive control, exhibited an IC_{50} value of 4.59204 µg/mL. These findings indicate that *Jatropha curcas* root extract exhibits moderate antioxidant activity and has potential as a natural source of antioxidants.

Keywords: antioxidant activity; DPPH assay; *Jatropha curcas* L.; Jarak pagar; phytochemical screening.

Abbreviations: (2,2-Diphenyl-1-picrylhydrazyl (DPPH), Half-Maximal Inhibitory Concentration (IC_{50}), Ultraviolet-Visible (UV-Vis).

INTRODUCTION

Indonesia is a tropical country with exceptionally rich biodiversity, making it one of the world's important centers of plant diversity. Favorable geographical and climatic conditions enable a wide variety of plant species to thrive and be utilized as food, cosmetics, and traditional medicines (Nasution et al., 2019). The use of medicinal plants has long been practiced by Indonesian communities because they are readily available and contain natural bioactive compounds that provide various health benefits (Harefa, 2020). One of the medicinal plants that has attracted considerable attention is *Jatropha curcas* L. This species originated in Central America and was introduced to Indonesia in the eighteenth century by Portuguese traders. *Jatropha curcas* L. is well adapted to diverse environmental conditions, including hot, dry, and rocky areas, with an optimum temperature of 25-35 °C and soil pH of 5.0-6.5 (Syakir, 2010**;** Sarimole et al., 2014). Its remarkable adaptability and wide distribution make this species a promising source of natural bioactive compounds for pharmaceutical and healthcare applications.

Traditionally, different parts of *Jatropha curcas* L. have been used in folk medicine. The seeds have been utilized as antibacterial agents and laxatives, whereas the leaves have been used to treat malaria, fever, rheumatism, and blood disorders. In addition, the latex has been traditionally used to relieve diarrhea (Nasution et al., 2019). These traditional medicinal uses are closely associated with the presence of secondary metabolites, including flavonoids, alkaloids, saponins, tannins, polyphenols, steroids, and terpenoids (Rahman et al., 2023) These phytochemicals exhibit antioxidant properties by scavenging free radicals and mitigating oxidative stress. Free radicals are atoms or molecules containing one or more unpaired electrons, making them highly reactive and capable of damaging cellular components when produced in excessive amounts. Oxidative stress caused by excessive free radical accumulation contributes to the development of various degenerative diseases, including cancer, cardiovascular diseases, Parkinson's disease, Alzheimer's disease, and other neurological disorders. Therefore, natural antioxidants are essential for protecting biological systems against oxidative damage and have attracted

considerable attention as safer alternatives to synthetic antioxidants (Rahman et al., 2023)

Previous studies on *Jatropha curcas* L. have mainly focused on the phytochemical constituents and antioxidant activity of the leaves. Rahman et al. (2023) reported that leaf extracts contain flavonoids, saponins, alkaloids, polyphenols, and tannins and exhibit strong antioxidant activity, suggesting their potential as anticancer agents. Rahmayulis et al. (2024) further reported that fresh ethanolic leaf extracts were positive for steroids, phenolics, flavonoids, and saponins, although their antioxidant activity was relatively weak. In addition, ethyl acetate leaf extracts have also been reported to possess antioxidant and anticancer potential due to the presence of various bioactive compounds (Rahman et al., 2025). These findings indicate that the phytochemical composition and antioxidant activity of *Jatropha curcas* L. may vary depending on the plant part investigated. However, scientific information regarding the phytochemical constituents and antioxidant activity of the roots remains limited. Since different plant organs perform distinct physiological functions, they are likely to differ in their secondary metabolite composition and biological activities. Therefore, investigating the roots is essential to complement the existing scientific knowledge regarding the bioactive potential of *Jatropha curcas* L. as a natural source of antioxidants. Accordingly, this study aimed to perform phytochemical screening and evaluate the antioxidant activity of *Jatropha curcas* L. root extract using the 2,2-diphenyl-1-picrylhydrazyl (DPPH) radical scavenging assay.

MATERIALS AND METHODS

Study Area and Plant Material Identification

The plant material used in this study was identified as *Jatropha curcas* L. based on its taxonomic classification, as presented in Table 1. Root samples of *Jatropha curcas* L. were collected using a purposive sampling technique from their natural habitat in Ogan Komering Ulu Regency, South Sumatra, Indonesia (Figure 1). The sampling technique was applied to select healthy plants older than two years, free from pests and diseases, and growing under relatively uniform environmental conditions to minimize environmental variation. The collected root samples were transported to the Chemistry Education Laboratory, Department of Chemistry Education, Faculty of Teacher Training and Education, Universitas Sriwijaya, Indonesia, for sample preparation, extraction, phytochemical screening, and antioxidant activity analysis.

Table 1. Taxonomic classification of *Jatropha curcas* L.

Taxonomic rank	Classification
Kingdom	Plantae
Division	Spermatophyta
Subdivision	Angiospermae
Class	Dicotyledonae
Order	Euphorbiales
Family	Euphorbiaceae
Genus	*Jatropha*
Species	*Jatropha curcas* L.

Note: Taxonomic classification was adapted from Dillasamola, Yanri and Nurlatifah, (2023).



Figure 1. Root samples of Jatropha curcas L. collected from their natural habitat in Ogan Komering Ulu Regency, South Sumatra, Indonesia.

Materials

The materials used in this study included *Jatropha curcas* L. roots, absolute ethanol (analytical grade), methanol (analytical grade), distilled water, chloroform ($CHCl_3$), concentrated sulfuric acid (H_2SO_4), 2 N hydrochloric acid (HCl), 10% sodium hydroxide (NaOH), magnesium powder (Mg), 1% ferric chloride ($FeCl_3$) solution, Mayer's reagent, Dragendorff's reagent, Wagner's reagent, 0.1 mM 2,2-diphenyl-1-picrylhydrazyl (DPPH) solution, and ascorbic acid.

Apparatus

The equipment used included a basin, knife, blender, 80-mesh sieve, airtight container, analytical balance, Soxhlet extraction apparatus, rotary evaporator, drying oven, amber bottle, 10 mL and 20 mL test tubes, test tube rack,

10, 100, and 250 mL graduated cylinders, 1 and 10 mL volumetric pipettes, micropipette, glass funnel, filter paper, spatula, 100 and 250 mL beakers, test tube holder, Bunsen burner, tripod stand, wire gauze, 10, 50, and 100 mL volumetric flasks, vortex mixer, quartz cuvette, and a UV-Visible spectrophotometer.

Procedures

Sample Preparation

Sample preparation was performed according to the method described by Surahmaida et al. (2021). The roots of *Jatropha curcas* L. were washed thoroughly under running water to remove adhering impurities, cut into small pieces, and air-dried at room temperature for approximately two weeks. The dried samples were ground using a blender and sieved through an 80-mesh sieve to obtain a fine simplicia powder, which was subsequently stored in an airtight container until extraction.

Soxhlet Extraction

Extraction was carried out using the Soxhlet method following Rahman et al. (2023) with minor modifications. A total of 30 g of powdered simplicia was extracted with 500 mL of absolute ethanol (analytical grade) for 6 h at approximately 79°C with approximately ten extraction cycles. The extraction procedure was repeated six times under identical conditions. The extract was concentrated using a rotary evaporator, dried in an oven to obtain a viscous crude extract, and stored in an amber bottle until further analysis.

Phytochemical Screening

Phytochemical screening was performed to identify the presence of alkaloids, flavonoids, tannins, and saponins in the root extract of *Jatropha curcas* L. Alkaloids were detected using Mayer's, Dragendorff's, and Wagner's reagents, indicated by the formation of white, orange, and reddish-brown precipitates, respectively. Flavonoids were identified using the magnesium-hydrochloric acid (Mg-HCl) test, indicated by the appearance of red, yellow, or orange coloration. Tannins were detected using 1% ferric chloride ($FeCl_3$), producing a greenish-black coloration, whereas saponins were identified by the formation of stable foam that persisted for approximately 10 min.

Antioxidant Activity Assay

The antioxidant activity was evaluated using the 2,2-diphenyl-1-picrylhydrazyl (DPPH) radical scavenging assay according to (Wahyudi et al., 2025). The DPPH solution was prepared by dissolving 2.46 mg of DPPH in 100 mL of methanol (analytical grade), and the maximum absorbance wavelength was determined at 517 nm using a UV-Visible spectrophotometer. Ascorbic acid was used as the positive control, whereas a mixture of methanol and DPPH solution served as the negative control. A 1000 ppm stock solution of the extract was prepared and diluted to final concentrations of 15.625, 62.5, 125, 250, and 500 ppm. One milliliter of each extract solution was mixed with 1 mL of DPPH solution, vortexed, incubated in the dark for 30 min at room temperature, and the absorbance was measured at 517 nm.

Data Analysis

The antioxidant activity of the extract was evaluated based on the percentage inhibition of DPPH radical. The percentage inhibition was calculated using the equation adapted from Hapida et al. (2024).

$$Inhibition\ (\%) = \frac{Control\ Absorbance - Sample\ Absorbance}{Control\ Absorbance} \times 100\% \quad (1)$$

The relationship between extract concentration and percentage inhibition was analyzed using linear regression to determine the IC_{50} value according to the following equation.

$$Y = bX + a \quad (2)$$

Where Y is the percentage of DPPH radical inhibition (%), X is the extract concentration (ppm), a is the regression intercept, and b is the slope of the regression line. The IC_{50} value was determined as the extract concentration required to inhibit 50% of DPPH free radicals based on the linear regression equation. A lower IC_{50} value indicates stronger antioxidant activity.

RESULTS AND DISCUSSION

Preparation of *Jatropha curcas* Root Simplicia

The *Jatropha curcas roots* used in this study were collected from Saung Naga Village, Baturaja Barat District, Ogan Komering Ulu Regency. The roots were thoroughly washed to remove adhering soil and other contaminants before further processing. This cleaning step is essential to obtain high-quality simplicia and to minimize microbial contamination, as microorganisms readily proliferate under moist conditions. The cleaned roots were then cut into smaller pieces to increase the surface area, thereby accelerating moisture removal during drying and reducing the risk of microbial growth (Cempaka et al., 2024).

Drying was performed by air-drying at room temperature for approximately two weeks. This method was selected because it effectively lowers the moisture content while preserving heat-sensitive secondary metabolites, particularly phenolic compounds and flavonoids, which are susceptible to degradation at elevated temperatures (Cempaka et al., 2024; Herawati et al., 2025). In addition, reducing the moisture content suppresses enzymatic activity and microbial growth, thereby improving the stability and quality of the simplicia (Herawati et al., 2025).

The dried roots were ground and sieved through an 80-mesh sieve to obtain a uniform particle size. Smaller particles provide a larger contact surface between the sample and extraction solvent, thereby enhancing solvent penetration and improving the extraction efficiency of phytochemical compounds (Prasedya et al., 2021). Uniform particle size also contributes to better analytical reproducibility by minimizing variation during extraction. Finally, the powdered simplicia was stored in airtight containers to protect it from oxygen, moisture, and light exposure, which may accelerate oxidation and degradation of phenolic compounds during storage (Thitilertdecha, 2022; Mrázková et al., 2023).

Soxhlet Extraction of *Jatropha curcas* Root

The Soxhlet extraction of *Jatropha curcas* root was carried out using 90 g of powdered simplicia and absolute ethanol as the extraction solvent. The process produced 0.4 g of crude extract with an extraction yield of 0.44%, as presented in Table 2.

Table 2. Soxhlet extraction yield of *Jatropha curcas* root.

Sample	Sample weight (g)	Crude extract (g)	Yield (%)
Jatropha curcas root	90	0.4	0.44

Note: Yield (%) = (weight of crude extract / weight of dried simplicia) × 100%.

The relatively low extraction yield suggests that only a limited proportion of ethanol-soluble metabolites was present in the root sample. Extraction efficiency is influenced by several factors, including solvent polarity, particle size, extraction duration, and extraction conditions (Wijaya et al., 2022). Absolute ethanol was selected because its intermediate polarity enables the extraction of both polar and semi-polar phytochemicals, including flavonoids, alkaloids, tannins, saponins, and other phenolic compounds (Fadhilah et al., 2023; Swandono et al., 2024).

Extraction was performed for 6 h at approximately 79°C under continuous reflux. The Soxhlet system continuously renews the solvent in contact with the sample, promoting efficient mass transfer and improving the recovery of secondary metabolites compared with conventional extraction methods (Maghfiroh et al., 2025). Following extraction, the solvent was removed using a rotary evaporator under reduced pressure to obtain a concentrated extract while minimizing thermal degradation of heat-sensitive compounds. The extract was subsequently dried and stored in airtight containers prior to phytochemical screening and antioxidant evaluation.

Phytochemical Screening

Phytochemical screening demonstrated that the ethanol extract of *Jatropha curcas* root contained alkaloids, flavonoids, tannins, and saponins (Tables 4-7). The presence of these secondary metabolites indicates that the extract possesses various bioactive compounds that may contribute to its biological activities, particularly antioxidant properties.

Alkaloid

The alkaloid test produced positive results with Mayer, Dragendorff, and Wagner reagents, as indicated by the formation of white, orange, and brownish-orange precipitates, respectively (Table 3).

Table 3. Alkaloid screening results of *Jatropha curcas* root extract.

Parameter	Reagent	Observation	Result
Alkaloid	Mayer	White precipitate	+
	Dragendorff	Orange precipitate	+
	Wagner	Brownish-orange precipitate	+

Note: (+) = positive reaction indicating the presence of alkaloids.

The positive reaction observed with Mayer reagent resulted from the formation of an insoluble complex between protonated alkaloids and potassium tetraiodomercurate, producing a characteristic white precipitate (Oktavia & Sutoyo, 2021). This reaction occurs because the nitrogen atom in alkaloid molecules donates an electron pair to mercury ions, forming a stable coordination complex (Ferdinan et al., 2021). Likewise, Dragendorff reagent produced an orange precipitate through the interaction between alkaloid cations and bismuth iodide complexes, confirming the presence of nitrogen-containing compounds in the extract (Pangisian et al., 2022; Ferdinan et al., (2021). Wagner reagent also gave a positive result by producing a brownish-orange precipitate due to the formation of polyiodide complexes between iodine and alkaloid molecules (Karneng et al., 2022; Fajri & Kristanty, 2022). The consistent positive responses obtained with all three reagents strengthen the reliability of alkaloid identification because each reagent detects alkaloids through a different reaction mechanism.

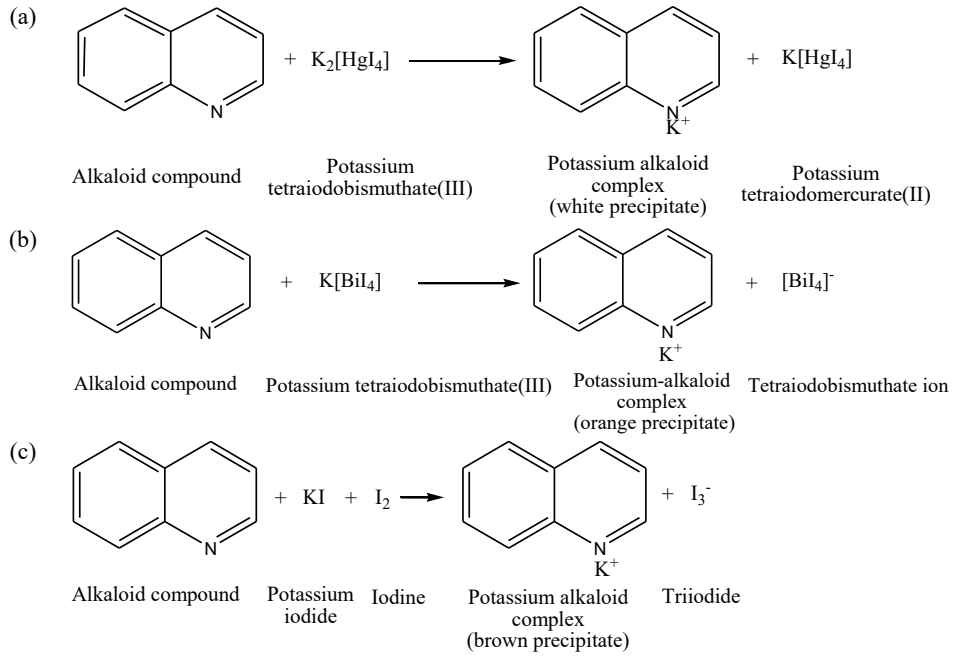


Figure 2. Proposed reaction mechanisms of alkaloid detection using Mayer (a), Dragendorff (b), and Wagner (c) reagents (adapted from Oktavia and Sutoyo, 2021).

Flavonoid

Flavonoids were positively detected using the Shinoda test, indicated by the appearance of an orange coloration after the addition of magnesium powder and concentrated hydrochloric acid (Table 4).

Table 4. Flavonoid screening results of *Jatropha curcas* root extract.

Parameter	Reagent	Observation	Result
Flavonoid	Mg powder + concentrated HCl	Orange solution	+

Note: (+) = positive reaction indicating the presence of flavonoids.

Heating the extract before analysis increased the solubility of phenolic compounds and promoted the release of flavonoids from plant tissues (Komala & Husni, 2021; (Kautsari et al., 2021). In the Shinoda reaction, magnesium reduces the carbonyl group of flavonoids under acidic conditions, producing flavylium salts responsible for the characteristic orange coloration (Oktavia & Sutoyo, 2021). The presence of flavonoids is particularly important because these polyphenolic compounds possess hydroxyl groups capable of donating hydrogen atoms or electrons to neutralize free radicals, thereby preventing oxidative chain reactions. In addition, flavonoids can chelate pro-oxidant metal ions and reduce the formation of reactive oxygen species (ROS), contributing significantly to the antioxidant potential of plant extracts (Lestari et al., 2022).

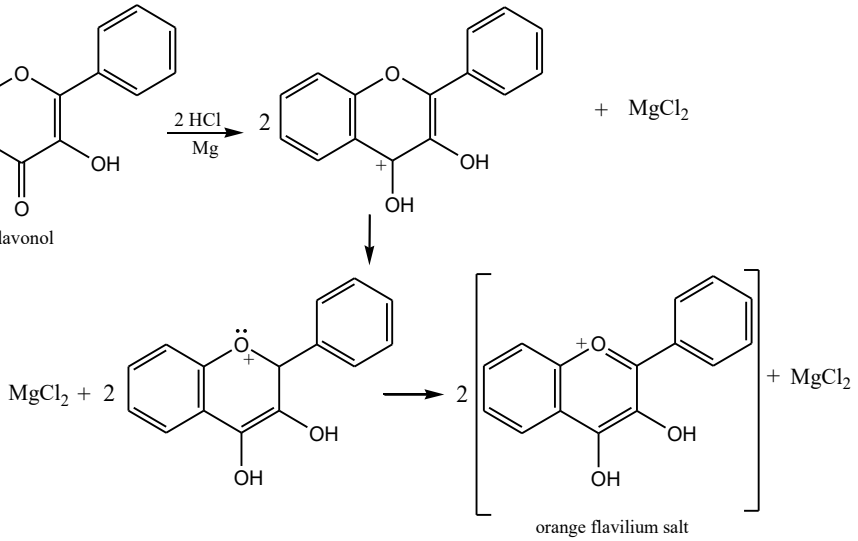


Figure 3. Reaction mechanism of flavonoid detection (Source: Mahmud et al., 2025).

Tannin

The tannin test showed a positive result, indicated by the formation of a greenish-brown color after adding 1% $FeCl_3$ solution (Table 5).

Table 5. Tannin screening results of *Jatropha curcas* root extract.

Parameter	Reagent	Observation	Result
Tannin	1% $FeCl_3$	Greenish-brown solution	+

Note: (+) = positive reaction indicating the presence of tannins.

Prior heating enhanced the extraction efficiency of tannins by facilitating diffusion of phenolic compounds from plant tissues into the solvent (Suhaila et al., 2024; Firda et al., 2023). The positive reaction occurs because Fe^{3+} ions coordinate with phenolic hydroxyl groups to form colored iron-phenolate complexes (Darina et al., 2025). Since tannins belong to the polyphenol group, their presence is closely associated with antioxidant activity through hydrogen atom donation and metal ion chelation, which inhibit oxidative reactions.

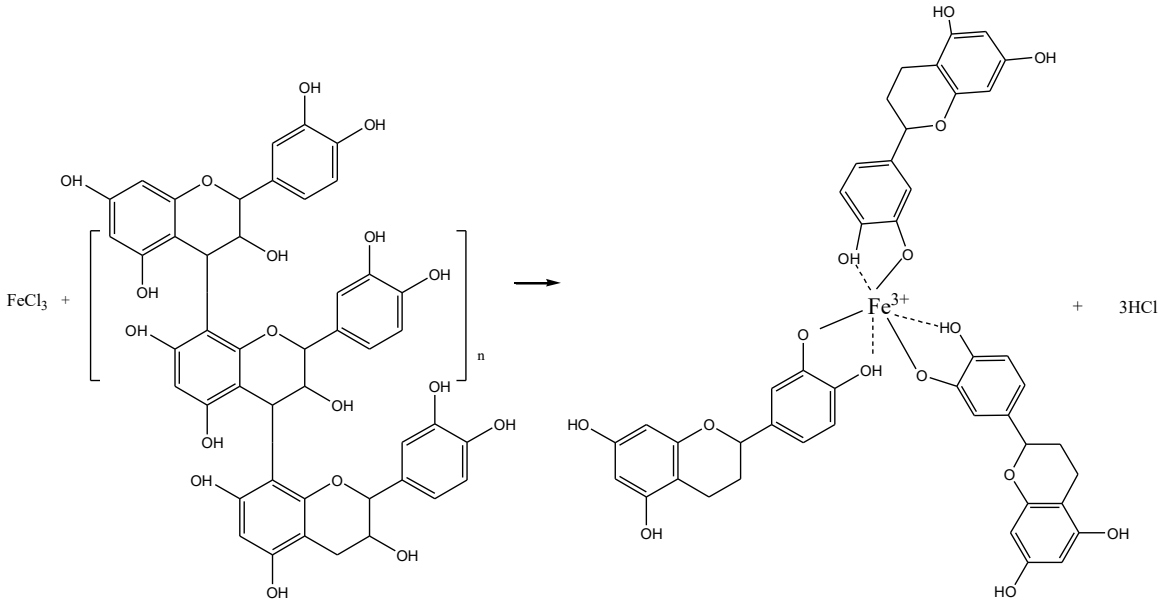


Figure 4. Reaction mechanism of tannin detection (Source: (Mahmud et al., 2025).

Saponin

Saponins were identified by the formation of stable foam that persisted for more than 10 min after vigorous shaking with distilled water (Table 6).

Table 6. Saponin screening results of *Jatropha curcas* root extract.

Parameter	Reagent	Observation	Result
Saponin	Distilled water	Stable foam (>10 min)	+

Note: (+) = positive reaction indicating the presence of saponins.

The stable foam results from the amphiphilic structure of saponins, which contain hydrophilic sugar moieties and hydrophobic aglycone groups. This molecular structure reduces surface tension and stabilizes air bubbles in aqueous solutions (Fadhilah et al., 2023). Persistent foam formation is therefore widely accepted as a qualitative indicator of saponins (Hanifa et al., 2021). Besides their surfactant properties, saponins exhibit antimicrobial, anti-inflammatory, and antioxidant activities and may act synergistically with phenolic compounds to enhance the overall biological activity of plant extracts (Hanifa et al., 2021).

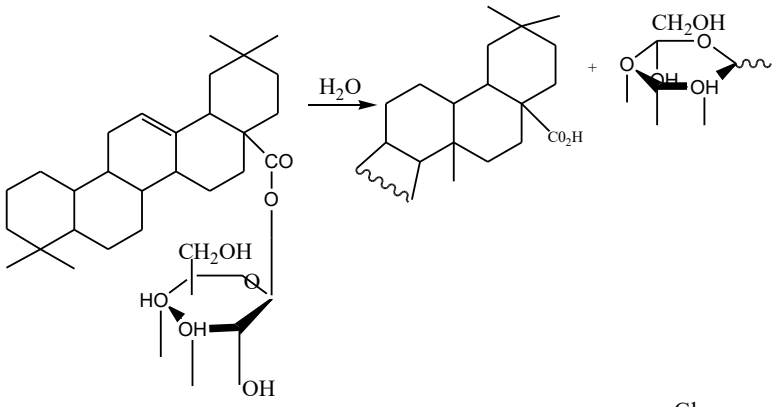


Figure 5. Reaction mechanism of saponin detection *(Source: Hanifa et al., 2021).*

Overall, phytochemical screening confirmed that the ethanol extract of *Jatropha curcas* root contains alkaloids, flavonoids, tannins, and saponins. The coexistence of these bioactive metabolites suggests that the extract possesses considerable pharmacological potential, particularly as a natural antioxidant, which is further supported by the DPPH antioxidant assay discussed in the following section.

Antioxidant Activity

The antioxidant activity of the *Jatropha curcas* root extract was evaluated using the 2,2-diphenyl-1-picrylhydrazyl (DPPH) radical scavenging assay, while ascorbic acid was employed as the positive control. The DPPH assay is one of the most widely used in vitro methods for evaluating antioxidant capacity because it measures the ability of antioxidant compounds to donate hydrogen atoms or electrons to stabilize DPPH radical, resulting in a decrease in absorbance at 517 nm (Gulcin & Alwasel, 2023). The antioxidant activity results are presented in Table 7.

Table 7. Antioxidant activity of *Jatropha curcas* root extract and ascorbic acid.

***Jatropha curcas* Root Extract**			**Ascorbic Acid**		
Concentration (ppm)	Mean absorbance	% Inhibition	Concentration (ppm)	Mean absorbance	% Inhibition
15.625	0.519	23.00	0.78125	0.425	36.94
62.5	0.480	28.78	1.5625	0.415	38.43
125	0.409	39.32	3.125	0.365	45.85
250	0.293	56.53	6.25	0.293	56.53
500	0.061	90.95	12.5	0.158	76.56

Note: IC_{50} of *Jatropha curcas* root extract = 206.389 µg/mL; IC_{50} of ascorbic acid = 4.592 µg/mL. Values represent the mean absorbance obtained from DPPH assay.

DPPH solution was prepared by dissolving 2.46 mg of DPPH in methanol to obtain a final concentration of 62.5 µM. Methanol was selected because it effectively dissolves DPPH while maintaining radical stability, and the solution was protected from light to prevent photodegradation (Gulcin & Alwasel, 2023). The maximum absorbance wavelength was confirmed at 517 nm prior to analysis, consistent with the characteristic absorption peak of DPPH radical (Gulcin & Alwasel, 2023).

The extract was evaluated at concentrations of 15.625, 62.5, 125, 250, and 500 ppm. The concentration range was selected to establish an appropriate concentration-response relationship for accurate IC_{50} determination using linear regression analysis (Prasetyo et al., 2021). Following mixing with DPPH solution, all samples were incubated for 30 min in the dark to ensure complete reaction while minimizing DPPH degradation caused by light exposure. The remaining DPPH radical were subsequently quantified by measuring absorbance at 517 nm.

The antioxidant activity of the extract increased markedly with increasing concentration. Radical scavenging activity increased from 23.00% at 15.625 ppm to 90.95% at 500 ppm, accompanied by a reduction in absorbance from 0.519 to 0.061. This trend indicates that increasing extract concentration enhanced the ability of bioactive compounds to reduce DPPH radical, demonstrating a concentration-dependent antioxidant response. In contrast, ascorbic acid exhibited considerably stronger antioxidant activity, achieving 36.94-76.56% inhibition at concentrations of only 0.78125-12.5 ppm, confirming its superior radical scavenging efficiency as a standard antioxidant.

The antioxidant activity observed in the extract is closely associated with the presence of secondary

metabolites identified during phytochemical screening, particularly flavonoids, tannins, alkaloids, and saponins. Flavonoids and tannins contain phenolic hydroxyl groups capable of donating hydrogen atoms or electrons to stabilize DPPH radical, whereas phenolic compounds also inhibit oxidation through electron transfer and metal-chelating mechanisms (Isromarina et al., 2022; Putri et al., 2025). Alkaloids may further contribute through electron transfer and chelation of pro-oxidant metal ions, while saponins are believed to enhance antioxidant performance through synergistic interactions that improve the solubility and bioavailability of phenolic compounds (Hanifa et al., 2021).

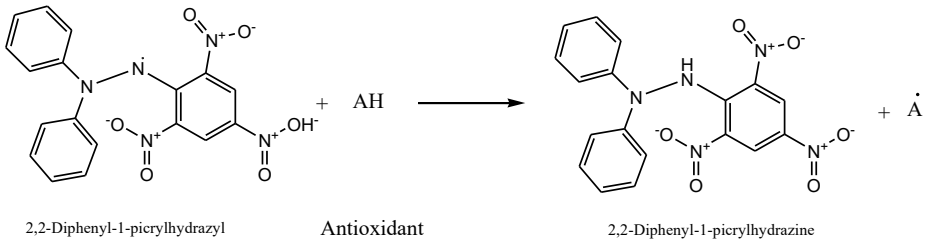


Figure 6. Proposed mechanism of DPPH radical scavenging by antioxidant compounds (Source: (Tanzaq et al., 2021).

The reduction of DPPH radical involves electron or hydrogen atom transfer from antioxidant molecules to the nitrogen-centered DPPH radical, producing the stable non-radical form (DPPH-H). This reaction is accompanied by a visible color change from deep purple to pale yellow, which corresponds to the decrease in absorbance measured spectrophotometrically (Tanzaq et al., 2021).

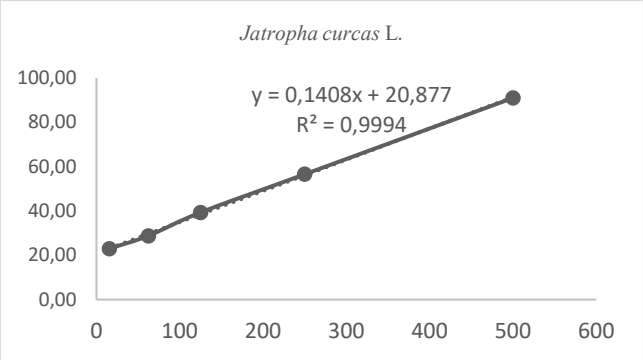


Figure 7. Linear regression of DPPH radical scavenging activity of *Jatropha curcas* root extract.

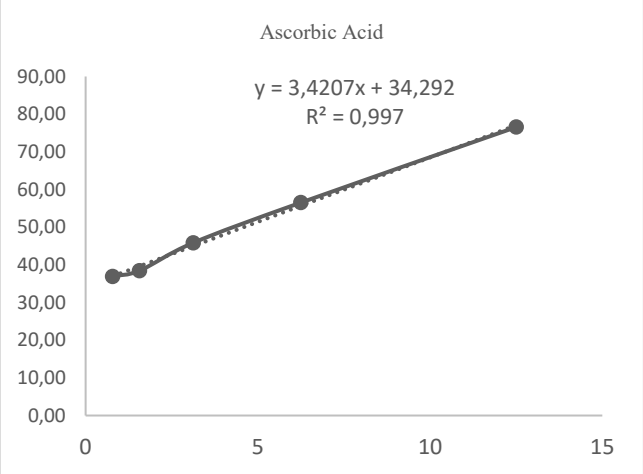


Figure 8. Linear regression of DPPH radical scavenging activity of ascorbic acid.

Linear regression analysis of the extract produced the equation $y = 0.1408x + 20.877$ with an excellent coefficient of determination ($R^2 = 0.9994$), indicating a strong positive relationship between extract concentration and radical scavenging activity. The high R^2 value demonstrates that the regression model accurately describes the concentration-dependent antioxidant behavior of the extract.

The calculated IC_{50} value of the *Jatropha curcas* root extract was 206.389 µg/mL, whereas the IC_{50} of ascorbic acid was only 4.592 µg/mL. Since IC_{50} represents the concentration required to inhibit 50% of DPPH radical, lower IC_{50} values indicate stronger antioxidant activity. According to the classification proposed by Aji & Sutiswa, 2023, extracts with IC_{50} values between 100 and 250 µg/mL are categorized as having moderate antioxidant activity. Therefore, the *Jatropha curcas* root extract can be classified as a moderate natural antioxidant. Although its antioxidant capacity was lower than that of pure ascorbic acid, the extract still demonstrated considerable radical scavenging ability and may serve as a promising source of natural antioxidants (Aji & Sutiswa, 2023).

Overall, the antioxidant activity of the extract is consistent with its phytochemical composition. The presence of flavonoids, tannins, alkaloids, and saponins suggests that these metabolites collectively contribute to radical scavenging through complementary mechanisms, including hydrogen atom transfer, electron donation, metal ion chelation, and synergistic enhancement of phenolic compound activity (Hanifa et al., 2021; Isromarina et al., 2022; Putri et al., 2025). These findings demonstrate that the ethanol extract of *Jatropha curcas* root possesses moderate antioxidant potential and supports its prospective application as a natural antioxidant source.

CONCLUSIONS

This study confirmed that the ethanol extract of *Jatropha curcas* L. root contains alkaloids, flavonoids, tannins, and saponins as the major secondary metabolites. Soxhlet extraction of the root produced a yield of 0.44%, while antioxidant evaluation using the DPPH assay demonstrated concentration-dependent radical scavenging activity with an IC_{50} value of 206.389 µg/mL, indicating moderate antioxidant activity. Compared with ascorbic acid (IC_{50} = 4.592 µg/mL), the extract exhibited lower antioxidant potency but still showed considerable free radical scavenging capability. The antioxidant activity is likely associated with the presence of phenolic compounds, particularly flavonoids and tannins, together with the synergistic contribution of other secondary metabolites. These findings suggest that *Jatropha curcas* root represents a promising natural source of antioxidant compounds and provides a scientific basis for further studies on the isolation of active constituents and evaluation of their biological activities.

Acknowledgements: The authors would like to thank Universitas Sriwijaya for providing research facilities and technical support during this study.

Authors' Contributions: Nabilah Muazarah designed the study, collected the plant samples, carried out the laboratory work, co-wrote the manuscript, and funded the experimental work. Muhammad Rafi Farhan assisted with the laboratory work, contributed to data interpretation, elucidated and interpreted the chemical reaction mechanisms, led the manuscript writing, and provided scientific suggestions throughout the study. Andi Suharman supervised the research, provided scientific guidance and constructive suggestions, and critically reviewed the manuscript. All authors read and approved the final version of the manuscript.

Competing Interests: The authors declare that there are no competing interests.

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