

Study on the Chemical Composition, Anti-inflammatory, Antioxidant, and Antihypertensive Activities of the Essential Oil of Water Primrose (Ludwigia adscendens)

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Abstract
According to traditional medicine, water primrose has been used in folk remedies to treat conditions such as infections, dermatological disorders, and gastrointestinal diseases. Several recent reports have revealed the diversity of the phytochemical composition of this plant species associated with its therapeutic potential. This study used gas chromatography-tandem mass spectrometry (GC-MS/MS) to determine the chemical composition of the essential oil of water primrose (Ludwigia adscendens). The antioxidant activity was evaluated by the 2,2-diphenyl-1-picrylhydrazyl (DPPH) free radical scavenging assay, the anti-inflammatory activity was assessed by the nitric oxide (NO) production inhibition assay on the RAW264.7 macrophage cell line, and the angiotensin-converting enzyme (ACE) inhibitory activity was evaluated by optical absorption measurement.
Chemical composition analysis of the essential oil of water primrose (*Ludwigia adscendens*) collected in Dak Lak Province identified 15 compounds. The main constituents were D-Limonene (37.67%), 2-Aminobenzamide (11.52%), 1,8-Cineole (9.01%), γ-Terpinene (7.77%), β-Phellandrene (4.79%), and Phytol (1.69%).
Biological activity assays showed that the essential oil of water primrose (*Ludwigia adscendens*) exhibited antioxidant activity by the DPPH method, reaching 82.69% at the tested concentration of 80 µg/mL, and anti-inflammatory activity with an NO production inhibition rate of 63.93% at 256 µg/mL. For ACE inhibitory activity, the essential oil inhibited 65.44% of enzyme activity at 1000 µg/mL. The results demonstrate that the essential oil of water primrose (*Ludwigia adscendens*) is a plant material source with useful biological activities.

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Keywords: Ludwigia adscendens, essential oil, antioxidant, anti-inflammatory, angiotensin-converting enzyme inhibition

1. Introduction

The genus Ludwigia is one of the largest and most diverse genera in the family Onagraceae. Plant species of the genus *Ludwigia* have many pharmacological effects, such as anti-inflammatory, antibacterial, supportive treatment of type 2 diabetes, cytotoxic activity against cancer cells, and cell protection [1]. Species of the genus Ludwigia L. are distributed mainly in tropical regions of Asia, Africa, and North America. In Vietnam, the genus Ludwigia has six species, among which water primrose is a common species found in most lowland, midland, and low mountainous areas below 600 m altitude. The plant usually grows in waterlogged soils. Water primrose is commonly used in folk medicine to treat fever, dry cough, bloody dysentery, swelling and sores, wounds, snakebites, cystitis, etc. [2].
According to previous studies, the genus Ludwigia contains major chemical groups such as flavonoids, tannins, potassium and sodium salts, and a large amount of mucilage. Water primrose contains protid, glucid, cellulose, calcium, iron, carotene, and vitamin C, providing anti-inflammatory, anticancer, antibacterial, analgesic, etc. effects [3, 4].

Although it has great potential as a medicinal material, in-depth studies on the chemical composition and biological activities of water primrose essential oil remain limited [4, 5, 6]. In particular, no work has fully reported the chemical composition or biological activities of samples cultivated and collected in Dak Lak, an area with specific soil and climatic conditions that may produce different changes in the composition and content of active compounds in the essential oil.

This paper determines the chemical composition, anti-inflammatory, antioxidant, and angiotensin-converting enzyme inhibitory activities of the essential oil of water primrose (*Ludwigia adscendens*) growing in Dak Lak. This study not only contributes to the scientific database on this plant species but also provides a basis for exploiting and applying water primrose in the production of products supporting the treatment of infections and hypertension from local medicinal resources.

2. Materials and Methods

2.1. Materials

The above-water part of water primrose (*Ludwigia adscendens*) was collected in Ea Kao Ward in January 2026 and scientifically identified by the Institute of Biology, Vietnam Academy of Science and Technology.

2.2. Essential Oil Distillation Method

The above-water part of water primrose (*Ludwigia adscendens*) after collection was cleaned and cut into small pieces. Next, the plant sample was subjected to steam distillation for 80 min using a Clevenger apparatus. The essential oil was separated from the distillate using diethyl ether and dried with anhydrous Na_2SO_4 to completely remove residual water. Finally, the obtained essential oil was stored in a dark glass bottle, tightly sealed, and kept at 10 °C in the dark to avoid degradation by light and temperature before being used in analyses of chemical composition and evaluation of biological activities.

2.3. Method for Determining Chemical Composition

The chemical composition of the essential oil of water primrose (*Ludwigia adscendens*) was determined by gas chromatography-tandem mass spectrometry (GC-MS/MS).

The operating parameters of the GC-MS/MS system were as follows: an Agilent 8890 GC System coupled with an Agilent 7000E triple quadrupole mass spectrometer detector (tandem mass spectrometry) (700E GC/TQ) from Agilent. The stationary phase used an HP-5MS capillary column with the following specifications: internal diameter 0.25 mm, column length 60 m, and stationary phase film thickness 0.25 µm. The mobile phase (carrier gas) was helium (He) at a flow rate of 1 mL/min, effectively and optimally separating the constituents in the sample. The GC oven temperature program was as follows: initial temperature held at 60 °C, then increased at 4 °C/min until reaching 240 °C.

2.4. Antioxidant Activity Assay

The assay was performed according to the DPPH free radical scavenging method: DPPH (2,2-diphenyl-1-picrylhydrazyl) can generate stable free radicals in methanol and has maximum optical absorption at 517 nm [7]. Different concentration ranges of the test sample prepared in methanol and the positive control (ascorbic acid) were mixed with 3 mL of 0.1 mM DPPH solution in methanol. Then, the reaction mixture was shaken vigorously and incubated in the dark for 30 min to allow complete reaction. The optical density (OD) of the solutions was measured using an Agilent Cary 60 UV-Vis molecular absorption spectrophotometer (Agilent, USA) at 517 nm against a blank (control solution containing no extract/test sample or ascorbic acid). Each experiment was repeated three times independently to ensure accuracy and statistical reliability.

The DPPH free radical inhibition (scavenging) capacity was calculated according to the following formula:

$$\%IC = \frac{OD_{control} - OD_{test}}{OD_{control} - OD_{blank}} \times 100\%$$

Where:

$OD_{control}$: optical density of the negative control sample (DPPH solution containing no test sample).

OD_{test}: optical density of the test sample.

OD_{blank}: optical density of the blank sample (methanol solvent).

The antioxidant activity results were expressed as IC_{50}, the concentration of the test sample that scavenges 50% of DPPH free radicals under the defined experimental conditions. The lower the IC_{50} value, the stronger the DPPH free radical scavenging activity.

2.5. Anti-inflammatory Activity Assay

Anti-inflammatory activity was evaluated by the nitric oxide (NO) production inhibition assay on the RAW264.7 macrophage cell line [8, 9].

The RAW264.7 cell line was provided by the American Type Culture Collection (ATCC, Manassas, VA, USA). Cell culture medium DMEM (Dulbecco's Modified Eagle Medium), MTT reagent (3-(4,5-dimethylthiazol-2-yl)-2,5-diphenyltetrazolium bromide), Griess reagent, and LPS (lipopolysaccharide) were purchased from Sigma-Aldrich (now Merck KGaA, Darmstadt, Germany) and Thermo Fisher Scientific (Waltham, MA, USA).

RAW264.7 cells were cultured for 48 h in DMEM at 37 °C, 5% CO_2, supplemented with 10% fetal bovine serum (FBS). Then, the cell suspension was transferred to a 96-well plate at a density of 2.5×10^5cells/well. Cells were stimulated for inflammation with 2 µL LPS (0.1 mg/mL) for 24 h while the test substance was added at different concentrations. Cardamonin was used as the positive control (+). The cell culture supernatant was incubated with Griess reagent; $NaNO_2$ solutions at different concentrations were used to construct a standard curve for nitrite quantification. The absorbance of the reaction mixture was measured at λ=570nm.

The percentage inhibition of NO production (%IC%IC) was determined according to the formula:

$$\%UC = ([X_{cell}]_{control} - [X_{cell}]_{LPS})/([X_{cell}]_{control} - [X_{cell}]_{LPS}) \times 100$$

Where: $[X_{cell}]$ is the average NO concentration calculated based on the $NaNO_2$ standard curve equation.

The remaining cells in the wells after collecting the supernatant for *in vitro* activity evaluation were supplemented with MTT solution (0.5 mg/mL in PBS) and incubated for 4 h in a 5% CO_2 incubator at 37 °C. The insoluble formazan metabolite crystals were dissolved in

dimethyl sulfoxide (DMSO, Sigma-Aldrich), and optical density was measured at λ=540/720nm on an Infinite F50 microplate reader (Tecan, Männedorf, Switzerland).
The cell survival rate (CS%) was calculated as a percentage relative to the control sample

$$\text{Cell survival / inhibition rate (\%)} = [(OD_{[sample]}/OD_{[negative\ control\ (-)]}) \times 10^{0]} \pm \sigma$$

The standard deviation (σσ) was calculated according to the formula:

$$\sigma = \sqrt{(\sum(xi - \bar{x})\text{^}2)/(n-1)}$$

2.6. Method for Evaluating Angiotensin-Converting Enzyme (ACE) Inhibitory Activity

The chemicals used included: angiotensin-converting enzyme (ACE extracted from rabbit lung; dipeptidyl carboxypeptidase, EC 3.4.15.1; activity 20 units/mg protein), substrate hippuryl-L-histidyl-L-leucine (HHL), captopril, hippuric acid (HA), benzenesulfonyl chloride (BSC), hydrochloric acid (HCl), boric acid, and pyridine. All chemicals were of analytical purity and supplied by Sigma Chemical Co. Optical density was measured on a TECAN GENIOS microplate reader.
The assay for determining the angiotensin-converting enzyme (ACE) inhibitory activity of the test sample was performed in a 96-well flat-bottom glass plate with a lid, with a total reaction mixture volume of 50 µL, including: 20 µL of test sample at different concentrations, 10 µL of ACE enzyme solution (100 mU/mL), and 20 µL of HHL substrate solution (12.5 mM). The reaction mixture was incubated at 37 °C for 30 min. The enzyme reaction was stopped by adding 40 µL of 1 M HCl. Next, 80 µL of pyridine and 40 µL of BSC were added to the reaction mixture. The mixture was mixed on an ice tray for 1 min, after which the absorbance of the colored solution was measured at 410 nm (A_{410}). The percentage inhibition of ACE activity of the test sample was calculated according to the formula:

$$\%\ \text{Inhibition} = \frac{A410\ \text{positive control} - A410\ \text{test sample}}{A410\ \text{positive control} - A410\ blank}$$

Where: in positive control wells (100% enzyme activity control), the test sample was replaced with sample solvent; in blank wells, the HHL substrate was replaced with reaction buffer. The standard positive control compound used was captopril.
The IC_{50} value (concentration of the test substance inhibiting 50% of ACE activity under the experimental conditions) was calculated using Microsoft Excel and TableCurve [10, 11].

2.7. Statistical analysis

All measurements represent technical triplicates (n = 3), and results are expressed as mean ± standard deviation (SD) based on three independent measurements.

3. Results and Discussion

3.1. Thành phần hóa học của tinh dầu cây Trạng Nguyên (*Euphorbia pulcherrima*)

From the essential oil sample of water primrose (*Ludwigia adscendens*), qualitative and relative quantitative analysis of the chemical composition was performed by gas chromatography-tandem mass spectrometry (GC-MS/MS); the results are presented in Figure 3.1 and Table 3.1.

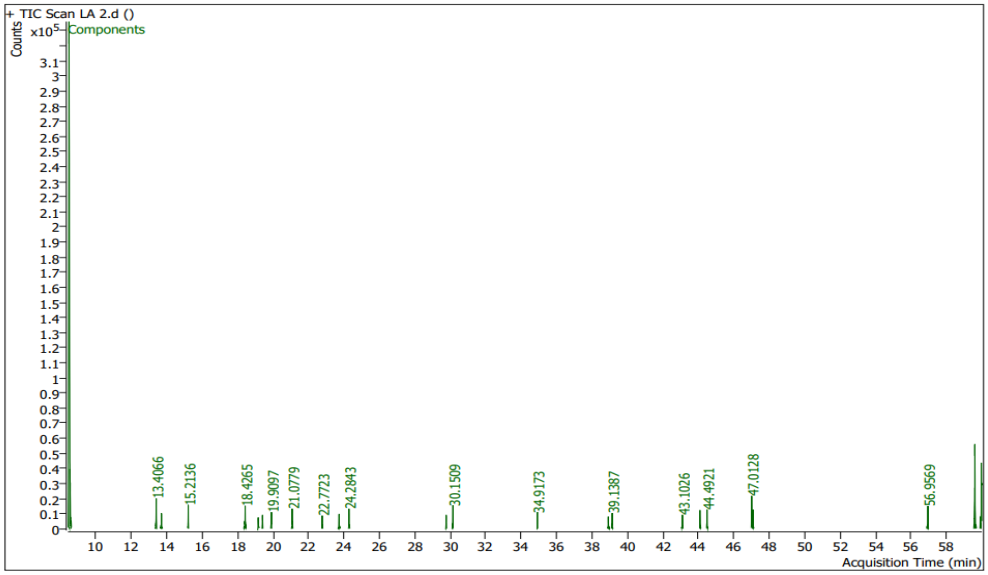
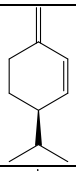
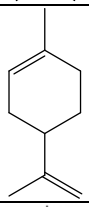
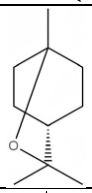
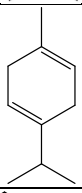
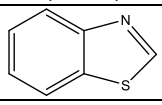
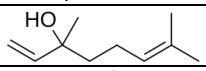
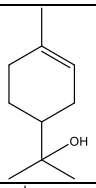
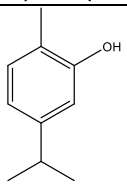
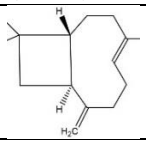
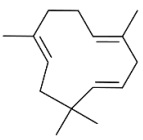
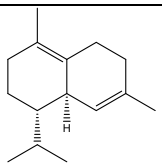
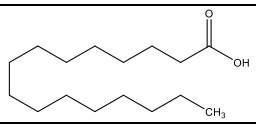
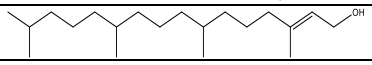
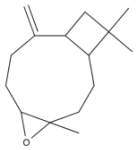


Fig 1: Total ion chromatogram (TIC) analyzed by GC-MS/MS of the essential oil of water primrose (*Ludwigia adscendens*)

Table 1: Chemical composition of the essential oil of water primrose (*Ludwigia adscendens*)

No.	Retention time (min)	Compound name	Công thức phân tử	Molecular formula	Relative composition (%)
1	8.479	β-Phellandrene	$C_{10}H_{16}$		4.79
2	8.483	D-Limonene	$C_{10}H_{16}$		37.67
3	8.487	1,8-Cineole	$C_{10}H_{16}$		9.01
4	9.528	γ-Terpinene	$C_{10}H_{16}$		7.77
5	9.541	2-Aminobenzamide	$C_7H_8N_2O$		11.52
6	9.548	Linalool	$C_{10}H_{16}$		1.0
7	11.972	Borneol	$C_{10}H_{16}O$		0.88
8	14.467	α-Terpineol	$C_{10}H_{18}O$		0.78
9	19.133	Carvacrol	$C_{10}H_{14}O$		0.41
10	24.329	β-Caryophyllene	$C_{15}H_{24}$		0.94
11	26.035	α-Humulene	$C_{15}H_{24}$		0.45
12	28.996	δ-Cadinene	$C_{15}H_{24}$		0.67
13	38.545	Unknown compound			3.45

14	43.596	Palmitic acid	$C_{16}H_{32}O_2$		0.71
15	49.367	Phytol	$C_{20}H_{40}O$		1.69
16	30.878	Caryophyllene oxide	$C_{15}H_{24}O$		1.04
Total monoterpene hydrocarbons (%)					3 (50.23%)
Total oxygenated monoterpenes (%)					4 (11.67%)
Total sesquiterpene hydrocarbons (%)					3 (2.06%)
Total oxygenated sesquiterpenes (%)					1 (1.04%)
Total other compounds (%)					5 (35.03%)
Total identified compounds (%)					15 (96.55%)
Total unidentified compounds (%)					1 (3.45%)

Results of chemical composition analysis of the essential oil of water primrose (*Ludwigia adscendens*) collected in Dak Lak by gas chromatography-tandem mass spectrometry (GC-MS/MS) identified a total of 15 compounds, accounting for about 96.55% of the total essential oil content. The most predominant group was monoterpene hydrocarbons (50.23%), with main constituents including D-Limonene (37.67%), 2-Aminobenzamide (11.52%), 1,8-Cineole (9.01%), γ-Terpinene (7.77%), β-Phellandrene (4.79%), and Phytol (1.69%).

When comparing the analysis results of the essential oil sample of water primrose (*Ludwigia adscendens*) collected in the rainy season in Dak Lak in this study with the report by Ngũ Trường Nhân *et al*. (2026) [12] on essential oil samples collected in the dry season in Dak Lak, the difference in chemical composition was very clear. While the study by Ngũ Trường Nhân *et al*. (2026) identified 54 compounds with the main constituent β-Caryophyllene (23.52%), the present study recorded only 15 compounds but had a much higher D-Limonene content (37.67% vs. 8.04% in Ngũ Trường Nhân *et al*.). Other common constituents also differed considerably: Borneol (2.24%) and α-Humulene (1.23%) contents in Ngũ Trường Nhân *et al*. were higher, whereas Phytol (1.69%) accounted for a larger proportion in this study (compared with 0.10% in the previous publication). This difference indicates large variation in secondary metabolites under the influence of climatic conditions between the two harvest seasons.

D-Limonene, a monocyclic monoterpene usually extracted from citrus plants (Rutaceae), is a compound with high chemotherapeutic potential due to its strong antioxidant activity. *in vitro* tests have demonstrated that this compound can efficiently scavenge reactive oxygen species (ROS) in a concentration-dependent manner through five mechanisms (DPPH, ABTS, FRAP, hydroxyl radical, and superoxide radical), except for iron-ion chelation. By neutralizing excess ROS, D-Limonene helps protect cells from oxidative stress damage, thereby inhibiting cancer cell proliferation without toxicity to healthy liver cells, confirming its promising role in safe cancer treatment regimens [13]. In nature, limonene commonly exists as two enantiomers: d-limonene (used in foods and flavorings) and l-limonene (used in industrial cleaning agents). In addition, this compound has superior oil- and fat-dissolving ability, supports flavor adjustment, and effectively repels insects, and is being extensively studied for its anti-inflammatory and cardiovascular protective potential [14].

Furthermore, comparison with some studies on solvent extracts of this plant species in different regions worldwide also shows significant differences. Comparison of the analysis results of *Ludwigia adscendens* essential oil in Dak Lak with the ethyl acetate and n-butanol extract fractions of Mostafa H. Baky *et al*. (2022) [15] clearly reflects the difference in chemical nature between the two extraction methods. Solid–liquid extraction with organic solvents recovered polar, nonvolatile, high-molecular-weight compounds such as triterpenoids (hederagenin), flavonoids, and saponins. In contrast, steam distillation in Dak Lak only recovered hydrophobic, volatile constituents, including 15 compounds typically represented by D-Limonene (37.67%), the nitrogen-containing aromatic amide derivative 2-Aminobenzamide (11.52%), and the cyclic ether monoterpene 1,8-Cineole (9.01%). This result confirms the contrasting physicochemical properties of the two product systems: the essential oil concentrates volatile constituents, whereas the fractionated extract contains polar, nonvolatile compounds.

Comparison with the methanol extract in the study by Bhuiyan M. A. *et al*. (2023) [16] further demonstrates the decisive influence of solvent polarity. The methanol extract dissolved a broad spectrum of polar and nonvolatile secondary metabolite groups, including tannins, flavonoids, saponins, alkaloids, steroids, and glycosides. In contrast, the essential oil obtained in Dak Lak is a collection of small-molecule, volatile molecules including monoterpene hydrocarbons (50.23%) and amide derivatives, typically D-Limonene (37.67%), 2-Aminobenzamide (11.52%), and 1,8-Cineole (9.01%). The absence of polar compounds in the essential oil sample demonstrates that steam distillation thoroughly separated the hydrophobic volatile constituents from the nonvolatile matrix components of the plant tissue.

The study by Baky *et al*. (2021) [17], which comparatively analyzed volatile constituents between water primrose (*Ludwigia adscendens*) and *Ludwigia stolonifera*, also indicated clear chemical differentiation. Baky's study on 85 volatile compounds of *L. stolonifera* showed the predominance of straight-chain (aliphatic) and aromatic hydrocarbons, typically dodecane (9.44%), undecane (9.38%), and 2-phenylundecane (4.93%). In contrast, *L. adscendens* essential oil in this study (with 15 identified

compounds) was rich in monoterpene hydrocarbons (50.23%), among which D-Limonene had the highest content (37.67%), accompanied by 2-Aminobenzamide (11.52%) and 1,8-Cineole (9.01%). This completely different chemical profile strongly supports the hypothesis of the existence of chemotypes and characteristic phytochemical grouping within the genus *Ludwigia*, the cause of differentiation possibly originating from the genetic characteristics of the species as well as the influence of climatic and edaphic ecological conditions.

3.2. Anti-inflammatory Activity

Anti-inflammatory activity of the essential oil sample of water primrose was determined by evaluating the inhibition rate of nitric oxide (NO) production on the RAW264.7 macrophage cell line (cultured in DMEM) by optical density measurement; the results are presented in Table 3.2.

Table 2: Anti-inflammatory activity of the essential oil of water primrose (*Ludwigia adscendens*)

No.	Essential oil concentration (µg/mL)	Inhibition rate of NO production (%)	IC_{50} (µg/mL)
1	16	35,33 ± 1,52	**66,32**
2	32	42,48 ± 2,11	
3	64	49,63 ± 1,87	
4	128	56,78 ± 1,23	
5	256	63,93 ± 2,34	
Positive control (+): Cardamonin			2,65

Data in Table 3.2 show that the NO production inhibition rate of water primrose essential oil increased in a concentration-dependent manner from 35.33% to 63.93% as the essential oil concentration increased from 16 to 256 µg/mL, indicating that the essential oil sample exhibited *in vitro* anti-inflammatory activity. However, this activity was relatively weak; the determined IC_{50} value (66.32 µg/mL) was much higher (i.e., lower activity) than that of the positive control Cardamonin (IC_{50} = 2.65 µg/mL).

When comparing anti-inflammatory activity, the results of Vũ Hải Nam *et al*. on extracts of water primrose collected in Hai Duong [4] recorded stronger anti-inflammatory activity, with IC_{50} values of the ethyl acetate fraction (LAE) and total ethanol extract (LA) reaching 32.09 µg/mL and 55.88 µg/mL, respectively.

3.3. Angiotensin-Converting Enzyme (ACE) Inhibitory

The ability of water primrose (*Ludwigia adscendens*) essential oil to inhibit angiotensin-converting enzyme (ACE) was evaluated by absorption spectrophotometry; the experimental results are presented in Table 3.3.

Table 3: Angiotensin-converting enzyme (ACE) inhibitory activity of the essential oil of water primrose (*Ludwigia adscendens*)

No.	Essential oil concentration (µg/mL)	ACE inhibition rate (%)	IC_{50} (µg/mL)
1	62,5	23,85 ± 1,64	**357,34**
2	125	34,25 ± 2,15	
3	250	44,65 ± 1,82	
4	500	55,04 ± 2,56	
5	1000	65,44 ± 2,31	
Positive control (+): Captopril			3,25

Results in Table 3.3 show that the ACE inhibition efficiency of water primrose essential oil increased from 23.85% to 65.44% as the essential oil concentration increased from 62.5 to 1000 µg/mL, confirming that the essential oil has ACE inhibitory capacity. However, this inhibitory activity was not potent; the IC_{50} value (357.34 µg/mL) indicates that the angiotensin enzyme inhibitory activity of the essential oil was significantly lower than that of the positive control drug Captopril (IC_{50} = 3.25 µg/mL).

To date, no published scientific work has focused on the angiotensin-converting enzyme inhibitory activity of water primrose (*Ludwigia adscendens*) essential oil. Therefore, the results of this study open a new approach for exploiting the biological potential of water primrose essential oil to control target enzymes related to hypertension, contributing scientific evidence for the application of this plant species in the medicinal field.

3.4. Antioxidant Activity

The essential oil sample of water primrose (*Ludwigia adscendens*) was evaluated for antioxidant activity by the DPPH free radical scavenging method with ascorbic acid as the positive control. The experimental results are presented in Table 3.4 and Figure 3.2.

Table 4: Antioxidant activity of the essential oil of water primrose (*Ludwigia adscendens*)

Essential oil concentration (µg/mL)	DPPH inhibition (%)				IC_{50} (µg/mL)
	1	2	3	Mean inhibition (%)	
20	23.87	24.52	25.81	24.73 ± 0.99	**46.58**
35	37.42	39.03	39.35	38.60 ± 1.04	
50	52.90	56.45	53.23	54.19 ± 1.96	
65	67.42	68.06	62.90	66.13 ± 2.81	
80	81.94	83.87	82.26	82.69 ± 1.04	
Positive control: Ascorbic acid					**15.95**

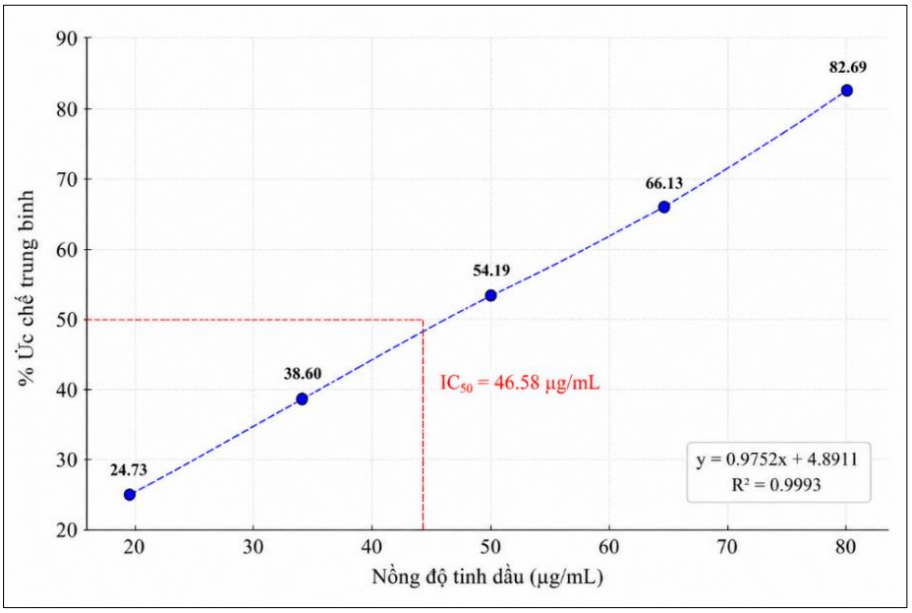


Fig 2: Calibration curve showing the linear dependence between essential oil concentration (µg/mL) and mean DPPH free radical inhibition (%) of water primrose (*Ludwigia adscendens*).

Antioxidant activity of water primrose (*Ludwigia adscendens*) essential oil was evaluated through the DPPH free radical scavenging assay as presented in Table 3.4. Experimental results showed that the water primrose essential oil sample collected in Dak Lak was able to scavenge DPPH free radicals, with the mean inhibition percentage increasing linearly from 24.73% to 82.69% as the essential oil concentration increased from 20 µg/mL to 80 µg/mL. This demonstrates that water primrose essential oil has good DPPH free radical scavenging ability, reaching the highest inhibition efficiency of 82.69% at 80 µg/mL. When comparing the IC_{50} value of the water primrose (*Ludwigia adscendens*) essential oil sample (IC_{50} = 46.58 µg/mL) with the positive control ascorbic acid (IC_{50} = 15.95 µg/mL), the essential oil sample collected in Dak Lak showed lower antioxidant activity than pure ascorbic acid.

Regarding antioxidant activity within the same species, the results of Huỳnh Anh Duy *et al*. on extracts of water primrose collected in Dong Thap [18] recorded slightly weaker antioxidant activity than the essential oil in this study, with IC_{50} = 50.29 µg/mL.

To date, no published study has reported the angiotensin-converting enzyme inhibitory activity of water primrose (*Ludwigia adscendens*) essential oil. Moreover, angiotensin-converting enzyme plays an essential role in the mechanism of blood pressure regulation (renin-angiotensin-aldosterone system) and is a promising molecular target in supportive treatment of hypertension. Therefore, this study opens a new approach for exploiting the biological potential of water primrose (*Ludwigia adscendens*) essential oil to evaluate angiotensin-converting enzyme inhibitory capacity, while adding important scientific data for the application of this plant species in medicinal development.

4. Conclusion

Through investigation of the essential oil sample of water primrose (*Ludwigia adscendens*) collected in Dak Lak Province, the study identified a chemical composition comprising 15 compounds. The main constituents of the essential oil included D-Limonene (37.67%), 2-Aminobenzamide (11.52%), 1,8-Cineole (9.01%), γ-Terpinene (7.77%), β-Phellandrene (4.79%), and Phytol (1.69%). Biological activity testing and screening results showed that water primrose (*Ludwigia adscendens*) essential oil had antioxidant activity by the DPPH method, reaching 82.69% at the tested concentration of 80 µg/mL (IC_{50} = 46.58 µg/mL), and anti-inflammatory activity with an NO production inhibition rate of 63.93% at 256 µg/mL (IC_{50} = 66.32 µg/mL). For angiotensin-converting enzyme (ACE) inhibitory activity, the essential oil inhibited 65.44% of enzyme activity at 1000 µg/mL (IC_{50} = 357.34 µg/mL).

These experimental results initially provide additional valuable scientific information on the antioxidant, anti-inflammatory, and angiotensin-converting enzyme inhibitory capacities of water primrose (*Ludwigia adscendens*) essential oil collected in Dak Lak, providing a basis for further studies and future pharmaceutical applications.

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