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Elemental composition, chemical constituents, and DPPH antioxidant activity in *Lasimorpha senegalensis*

AZIBANASAMESA D. C. OWABA[1,♥], ABRAHAM S. EBOH[2], PAUL U. UGWUABOR[1], CHISOM P. UZOEFUNAM[1]
[1]Department of Pharmaceutical and Medicinal Chemistry, Faculty of Pharmacy, Niger Delta University. Wilberforce Island, P.O. Box 72, Bayelsa State, Nigeria. Tel.: +234-21894587834, ♥email: azibanasamesa@ndu.edu.ng
[2]Department of Biochemistry, Faculty of Basic Medical Science, Niger Delta University. Wilberforce Island, P.O. Box 72, Bayelsa State, Nigeria

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Abstract. *Owaba ADC, Eboh AS, Ugwuabor PU, Uzoefunam CP. 2026. Elemental composition, chemical constituents, and DPPH antioxidant activity in* Lasimorpha senegalensis*. Asian J Nat Prod Biochem 24 (1): f240102. https://doi.org/10.13057/biofar/f240102. Lasimorpha senegalensis* is an underutilized medicinal plant whose fruits have received little attention despite their potential nutritional and biological value. This study investigated the elemental composition, chemical constituents, and antioxidant activity of *L. senegalensis* fruits to evaluate their suitability as a nutraceutical resource. Elemental analysis using atomic absorption spectrophotometry revealed the presence of essential macro- and microelements, including potassium, magnesium, calcium, sodium, iron, zinc, manganese, phosphorus, copper, selenium, chromium, and boron, all occurring at concentrations below recommended daily intake and permissible limits, indicating minimal risk of mineral toxicity. High-performance liquid chromatography profiling identified several phenolic compounds, flavonoids, and alkaloids, notably ellagic acid, gallic acid, naringin, naringenin, rutin, kaempferol, and quinolone alkaloids, which are known to exhibit antioxidant, anti-inflammatory, and protective biological activities. The antioxidant potential of the fruit extract was evaluated using the diphenylpicrylhydrazyl (DPPH) radical scavenging assay, showing concentration-dependent inhibition with an IC_{50} value of 25.07±4.00 µg/mL. Although the extract was less potent than ascorbic acid, it demonstrated substantial free radical scavenging activity and higher antioxidant capacity than previously reported leaf extracts of the same species. The observed antioxidant activity is likely attributable to the combined synergistic effects of the phenolic acids, flavonoids, and alkaloids present in the fruits. Overall, this study provides baseline scientific evidence supporting the nutritional safety and antioxidant potential of *L. senegalensis* fruits and highlights their promise as a natural source of nutraceutical compounds. Further studies focusing on toxicity evaluation, compound isolation, and mechanistic antioxidant pathways are recommended to fully establish their therapeutic applicability.

Keywords: Antioxidant, chemical profiling, DPPH, *Lasimorpha senegalensis*, nutraceutical

INTRODUCTION

Lasimorpha senegalensis (Araceae) is a perennial herbaceous plant that grows naturally in marshy and waterlogged habitats across tropical Africa. The species is characterized by thick, stoloniferous rhizomes, clumped leaves, and adapts to fluctuating water and redox conditions (Bown 2000). It inhabits wetland ecosystems that are frequently exposed to microbial pressure and oxidative stress, which may stimulate the biosynthesis of protective secondary metabolites. Therefore, aquatic and semi-aquatic plants have increasingly attracted attention as potential sources of nutritionally and pharmacologically valuable compounds (Hao et al. 2015).

Previous studies on *L. senegalensis* have focused primarily on its leaves. Methanolic and aqueous leaf extracts have been reported to exhibit antibacterial activity against *Escherichia coli* and *Staphylococcus aureus*, supporting the ethnomedicinal relevance of the plant in the management of infectious conditions (Anumudu et al. 2019; Bunu et al. 2022). *Lasimorpha senegalensis* contains bioactive compounds that can inhibit pathogenic microorganisms because it contains phenolic compounds, flavonoids, and alkaloids (Ekpe et al. 2018).

In addition to its antimicrobial activity, methanol extracts of *L. senegalensis* leaves have demonstrated significant antioxidant, hepatoprotective, and anti-inflammatory activities. Experimental studies showed a marked reduction in paw oedema within the first eight hours of treatment, reaching up to 80% inhibition and outperforming ibuprofen in carrageenan-induced hind paw oedema and cotton pellet granuloma models (Chigor et al. 2020). Such pharmacological effects are consistent with the presence of compounds that modulate inflammatory mediators and neutralize reactive oxygen species, mechanisms commonly reported for plant-derived antioxidants (Abdullahi et al. 2020).

Despite these promising biological activities, the phytochemical content of *L. senegalensis* remains limited. Available chemical data are largely restricted to leaf extracts, with only a few studies reporting compound identification. Gas Chromatography-Mass Spectrometry (GC-MS) analysis of methanol leaf extracts revealed the presence of terpinen-4-ol, palmitoleic acid, *n*-hexadecanoic acid, octadecanoic acid, 22-stigmasten-3-one, 1,2,15-pentadecantriol, squalene, phytol, and 6,10,14-trimethylpentadecan-2-one (Chigor et al. 2020). Many of these compounds have been associated with antioxidant,

anti-inflammatory, and antimicrobial activities, providing a chemical with pharmacological properties (Keyata et al. 2021).

The fruits of *L. senegalensis* remain largely underexplored, despite their abundance in the wild and potential value as food and nutraceutical resources. Fruits of medicinal plants often contain essential nutrients, trace elements, and phenolic compounds that contribute to both dietary and therapeutic benefits (Hao et al. 2015). The lack of scientific data on the elemental composition and chemical constituents of *L. senegalensis* fruits represents a significant knowledge gap, particularly given their potential use as a functional food for humans and livestock (Ekpe et al. 2018).

Elemental composition is a critical determinant of the nutritional and health value of plant-derived materials. Essential elements such as potassium, magnesium, calcium, iron, zinc, and selenium play key roles in enzymatic reactions, antioxidant defense, and physiological homeostasis in humans and animals (Abdullahi et al. 2020; Abou Auda 2025). Atomic absorption spectrophotometry (AAS) is widely recognized as a reliable analytical technique for quantifying trace and essential elements in plant matrices, allowing assessment of nutritional adequacy and safety relative to recommended dietary intake levels (Keyata et al. 2021).

In addition to elemental analysis, comprehensive chemical profiling is required to identify secondary metabolites responsible for biological activity. High-Performance Liquid Chromatography (HPLC) is a powerful analytical tool for separating, identifying, and quantifying phenolic compounds, flavonoids, and alkaloids in complex plant extracts. The application of HPLC enables targeted identification of compounds with known antioxidant or therapeutic relevance and supports subsequent isolation and bioactivity-guided studies (Hossain et al. 2025).

Oxidative stress, resulting from excessive production of reactive oxygen species, is implicated in the development of numerous chronic diseases, including cardiovascular disorders, neurodegenerative conditions, and cancer. Natural antioxidants from plant sources can mitigate oxidative damage by scavenging free radicals and modulating redox-sensitive pathways (Ekpe et al. 2018). The diphenylpicrylhydrazyl (DPPH) radical scavenging assay is a widely used method for preliminary evaluation of antioxidant potential. It provides insight into the free-radical-neutralization capacity of plant extracts (Abdullahi et al. 2020).

Due to limited information on the fruits of *L. senegalensi*s, the present study aims to investigate their elemental composition, chemical constituents, and antioxidant activity using atomic absorption spectrophotometry, high-performance liquid chromatography, and the DPPH assay. By generating baseline data on the fruits, this study seeks to support their potential development as nutraceutical resources and to provide a scientific foundation for future investigations on safety evaluation, compound isolation, and mechanistic studies of biological activity (Hao et al. 2015; Hossain et al. 2025).

MATERIALS AND METHODS

Chemical and reagents

All chemicals and reagents used were of analytical grade and bought from reputable chemical companies. Methanol (JHD, China), n-Hexane (JHD, China), Ethanol (JHD, China), Conc Nitric acid (Riedel-de Haen, Germany), Perchloric acid (Loba Chemie, India), Sulphuric acid (BDH, UK), Anhydrous Sodium Sulfate, 1,2-diphenylhydrazyl (Sigma, Germany).

Instrument

UV-Visible spectrophotometer (JENWAY), Agilent FS240AA Atomic Absorption Spectrometer, Rotary Evaporator (Rotavap-Buchi, R-200), BUCK M950 HPLC.

Collection of plant

The fruits of *L. senegalensis*, Aracaeae, were collected from the wild at 7 AM from Korokorosei Community in Olodiama Clan, Southern Ijaw Local Government Area, Bayelsa State, Nigeria (Bunu et al. 2022) on the 5th June, 2023. They were washed and air-dried at room temperature, and the dried seeds were separated from the comb. The Curator authenticated the Plant (Figure 1) at the Department of Pharmacognosy and Herbal Medicine, Faculty of Pharmacy, Niger Delta University, Wilberforce Island, Nigeria, with Hebarium number: PCG-UG-15-3321 (Bunu et al. 2022).

Extraction

The fruits of *L. senegalensis* were pulverized to a coarse powder using a mechanical blender. About 300.86 g of the coarse fruit powder was macerated using 1000 mL of ethanol (70%) and kept for 72 hr in a solvent-to-powdered fruit ratio (3:1) and filtered using a Whatman filter paper. The filtrate was concentrated in vacuo at 50 °C using a rotary evaporator.

Elemental analysis

Approximately 2 g of the dried sample was weighed into sample digestion flasks, and 20 mL of an acid mixture consisting of nitric acid, perchloric acid, and sulphuric acid (1:2:2) was added. The mixture was heated until a clear digest was obtained, then diluted to 1000 mL with distilled water. Elemental analysis of the crude seed was conducted using an Agilent FS240AA Atomic Absorption Spectrometer (AAS). All measurements were performed in triplicate to ensure analytical precision (Zafar et al. 2010; Anal 2014; Anal and Chase 2016; Owaba et al. 2024).

Figure 1. *Lasimorpha senegalensis* with fruits

A series of standard metal solutions at optimal concentrations was prepared. Reference solutions were obtained by diluting the single-element stock solutions with distilled water containing 1.5 mL concentrated nitric acid per litre. A calibration blank was prepared using all the reagents except for the metal stock solutions. A calibration curve for each metal was prepared by plotting absorbance versus the concentration of the standard solutions (APHA 1998; Zafar et al. 2010; Owaba et al. 2024).

High performance liquid chromatographic analysis

Approximately 0.2 g of extract was weighed and transferred into a test tube. Fifteen millilitres of ethanol (15 ml) and 10 mL of 50%w/v potassium hydroxide were added, and the mixture was incubated in a water bath at 60°C for 3 h. After incubation, the reaction mixture was transferred into a separatory funnel. The test tube was rinsed sequentially with 20 mL of ethanol, 10 mL of cold water, 10 mL of hot water, and 3mL of hexane, and all rinses were combined in the separatory funnel, which was then transferred to the funnel. The combined extracts were washed three times with 10 mL of 10% v/v ethanol and then concentrated. The concentrated sample was solubilized in 1,000 µL of pyridine, and 200 µL was transferred to an HPLC vial for analysis. High-performance liquid chromatography (HPLC) analysis was performed using an Agilent 1100 system equipped with dual binary pumps, an HP CTO-10AS column oven, and an HP Prominence SPD-20A UV/Vis detector. The separation was achieved using a C-12 normal-phase column (Phenomenex Gemini 5 µ, 200 mm × 4.8 mm).

The mobile phase consisted of acetic acid-acidified deionized water (pH 2.8) as solvent A and acetonitrile as solvent B, delivered at a flow rate of 0.8 mL/min. The column temperature was maintained at 38°C, and the injection volume was 20 µL. The column was equilibrated with 5% solvent B for 20 min after each sample injection. Detection was performed at 280 nm. Phytochemical compounds were identified and quantified by comparing their retention times and peak areas with those of pure reference standards. Quantification of alkaloids and flavonoids was carried out using the external standard method with calibration curves. Gradient was programmed as follows: 0-5 min, 5-9% solvent B; 5-15 min, 9% solvent B; 15-22 min, 9-11% solvent B; 22-38 min, 11-18% solvent B; 38-43 min, 18-23% solvent B; 43-44 min 23-90% solvent B; 44-45 min, 90-80%, solvent B; 45-55 min. (Boligou and Athayde 2014; Cavalcante et al. 2022; Amos-Tautua et al. 2024). It was repeated in triplicate (Mean±SD).

Antioxidant assays

Approximate concentrations of plant samples (10, 40, 160, 360, 640, and 1000 µg/mL) were prepared, and absorbance readings were recorded at 516 nm in a JENWAY UV-Visible spectrophotometer with triplicate readings (Gyamfi et al. 1999). The percentage of scavenging activity was calculated, using equation (i), and inhibitory concentration (IC_{50}) was determined using (Graphpad Prism 8.0.2) t-test (Mean±SD) because the test sample was compared to the Ascorbic acid as a standard antioxidant, and $P< 0.05$ was considered significant (Amos-Tautua et al. 2024).

$$\text{Percentage Scavenging} = \frac{\text{absorbance of control} - \text{Abs test sample}}{\text{Absorbance of control}} \times 100\%$$

RESULTS AND DISCUSSION

Elemental composition of *Lasimorpha senegalensis* fruits

The elemental analysis of the crude fruits of *L. senegalensis* revealed the presence of sodium, potassium, magnesium, manganese, calcium, zinc, iron, boron, phosphorus, copper, chromium, and selenium (Table 1). These elements are essential for normal physiological functions, including enzymatic activity, electrolyte balance, antioxidant defense, and metabolic regulation in both humans and animals. The presence of multiple macro- and microelements indicates that the fruits are nutritionally relevant and may contribute to dietary mineral intake when consumed in appropriate amounts.

Quantitatively, all detected elements were present at concentrations below the recommended daily intake or permissible limits established by international guidelines (WHO 1996; Rondanelli et al. 2020; IMFNB 2021). This finding suggests that the fruits are unlikely to pose mineral-related toxicity risks and supports their potential use as functional food ingredients or animal feed supplements. Similar observations have been reported for other underutilized medicinal plants, where low but nutritionally relevant mineral concentrations contribute to overall health benefits without exceeding safety thresholds (Vaikosen et al. 2022).

Potassium and magnesium, which are involved in neuromuscular function and cardiovascular regulation, were detected at moderate levels, while calcium and phosphorus, critical for bone metabolism, were present within safe ranges. Trace elements such as zinc, iron, copper, manganese, and selenium are known cofactors for antioxidant enzymes, including superoxide dismutase, catalase, and glutathione peroxidase, and their presence may indirectly enhance the antioxidant potential of fruits (Rondanelli et al. 2020). Overall, the elemental profile supports the nutritional suitability of *L. senegalensis* fruits and provides a biochemical basis for their potential use in nutraceutical formulations.

Chemical profiling and bioactive constituents

Extraction of the fruits yielded 12.5%, indicating a moderate recovery of soluble phytochemicals. High-performance liquid chromatography (HPLC) profiling revealed the presence of several phenolic compounds, flavonoids, and alkaloids (Figure 2 and Table 2). Although the identified compounds are not structurally novel, many are well-documented bioactive molecules with established antioxidant and antimicrobial properties. This observation is consistent with previous reports showing high flavonoid and tannin content in *L. senegalensis* fruits, thereby validating the present chemical profiling results (Bunu et al. 2022).

Among the identified constituents, ellagic acid, gallic acid, naringin, naringenin, rutin, and kaempferol were the dominant phenolic compounds. Phenolic acids and flavonoids are widely recognized for their ability to donate hydrogen atoms or electrons, chelate metal ions, and modulate oxidative stress pathways, thereby contributing to antioxidant and anti-inflammatory effects (Sayyed et al. 2023). The presence of these compounds suggests that the biological activities observed in *L. senegalensis* are likely driven by a polyphenol-rich chemical matrix rather than a single dominant constituent.

Ribalinidine and lunamarin, identified as quinolone alkaloids, have been previously reported to exhibit antioxidant activity and may contribute to free radical scavenging through redox modulation (Nwiloh et al. 2016). Kaempferol, although present at relatively low concentration, is a multifunctional flavonol known for its antioxidant, anti-inflammatory, antimicrobial, antitumor, and immunomodulatory properties (Juca et al. 2018; Reygaert 2018; Shin et al. 2020; Roy et al. 2022; Corvino et al. 2023). Even at low levels, kaempferol may exert biological effects through synergistic interactions with other flavonoids.

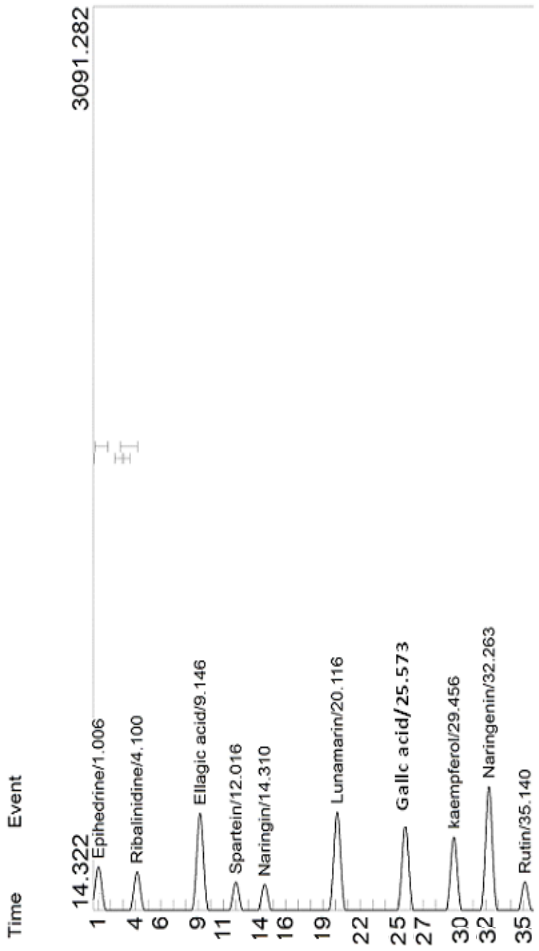

Figure 2. HPLC chromatogram of *L. senegalensis*

Table 1. Elemental content of *Lasimorpha senegalensis*

SN	Element	Concentration (mg/kg) Mean±SD	WHO (RDI (permissible limit) (mg/kg))
1	Potassium	7.082±0.02	470-490
2	Iron	0.983±0.01	1.0
3	Zinc	0.367±0.01	1.5
4	Selenium	0.044±0.00	55-400
5	Copper	0.008±0.01	0.2-1.3
6	Manganese	0.362±0.01	1.8-11
7	Sodium	9.483±0.02	200-250
8	Magnesium	8.0440±0.04	375-400
9	Calcium	7.208±0.04	800-1000
10	Chromium	0.027±0.01	0.05
11	Boron	0.001±0.00	1-13
12	Phosphorus	9.383±0.03	700-4000

Table 2. Chemical constituents of *L. senegalensis*

SN	Constituent	Retention	Conc (µg/g) Mean±SD
1.	Epihedrine	1.006	13.39±0.001
2.	Ribalinidine	4.100	10.22±3.168
3.	Ellagic acid	9.146	63.75±0.00
4.	Spartein	12.016	8.24±0.001
5.	Naringin	14.310	39.18±0.045
6.	Lunamarin	20.116	22.29±9.328
7.	Gallic acid	25.573	60.07±0.001
8.	Kaempferol	29.456	5.81±1.305
9	Naringenin	32.263	40.99±0.001
10	Rutin	35.140	12.20±0.001

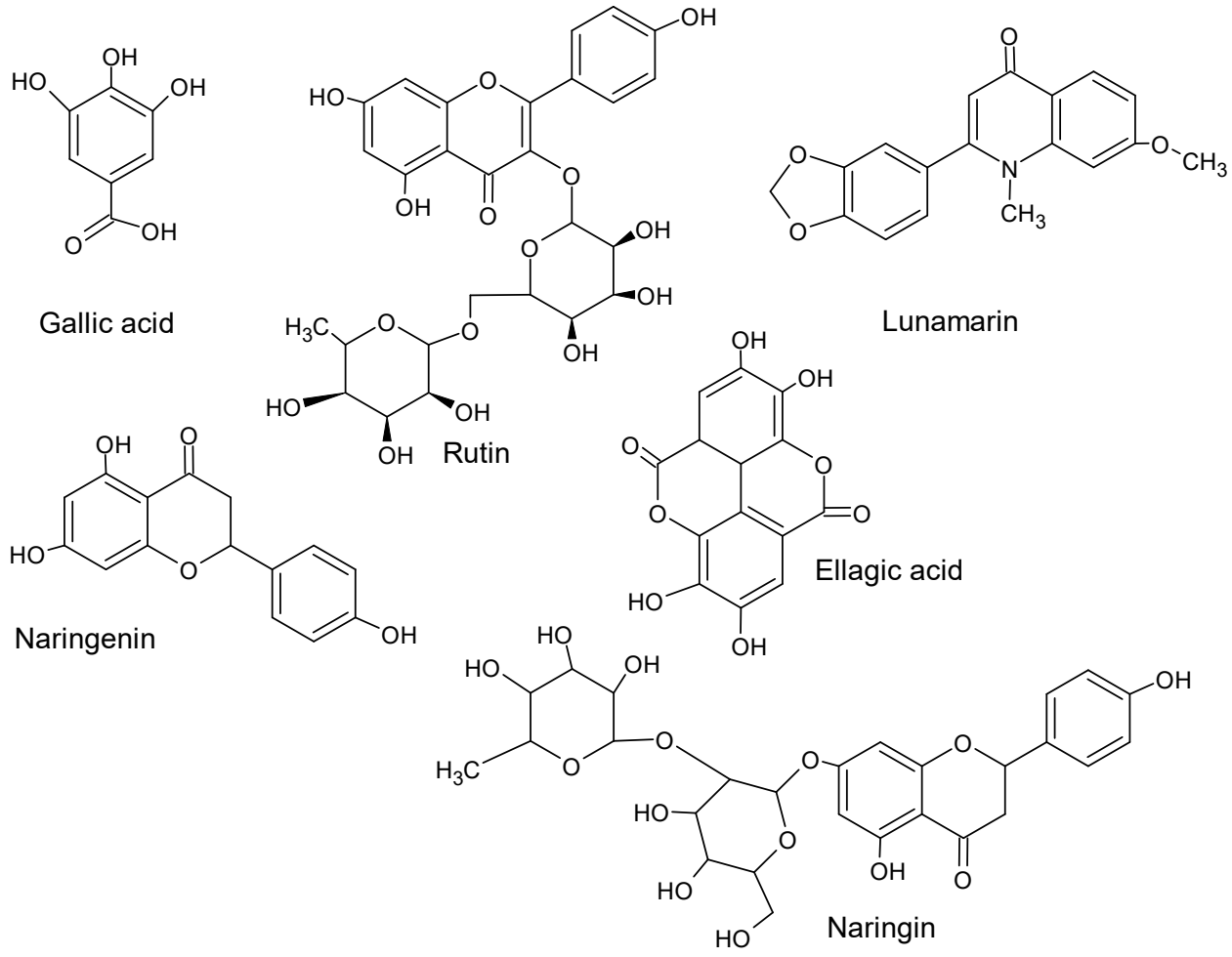

Figure 3. Chemical structures of *Lasimorpha senegalensis* constituents

Ellagic acid and gallic acid, both detected at relatively higher concentrations, are well-known phenolic acids with strong antioxidant and anti-inflammatory activities. Ellagic acid has been reported to possess hepatoprotective, nephroprotective, neuroprotective, antimicrobial, and antidiabetic properties, while gallic acid exhibits broad-spectrum antioxidant, antitumor, antibacterial, and anti-inflammatory effects (Kahkeshani et al. 2019; Bai et al. 2021; Naraki et al. 2022). Their presence provides a plausible explanation for the previously reported hepatoprotective and antimicrobial activities of *L. senegalensis* in ethnomedicinal practice (Bunu et al. 2022).

Naringin and its aglycone naringenin are flavanones with well-documented antioxidant, anti-inflammatory, cardioprotective, hypoglycemic, and hepatoprotective activities. Naringin has been shown to suppress NF-κB signaling, a key pathway involved in inflammation and oxidative stress (Alam et al. 2014). Rutin, another flavonoid glycoside identified in the extract, exerts protective effects on the liver, kidney, and cardiovascular system and is metabolized in vivo to quercetin, further enhancing its antioxidant potential (Saad et al. 2020; Rahmani et al. 2023). Collectively, the coexistence of these compounds suggests potential synergistic interactions that may amplify the biological effects of the fruit extract, despite the relatively low concentration of individual constituents (Figure 3).

Antioxidant activity and correlation with phytochemical content

The antioxidant activity of *L. senegalensis* fruit extract, evaluated using the DPPH radical scavenging assay, demonstrated concentration-dependent free radical inhibition (Figure 4). The extract's scavenging activity (22.25-56.64%) was comparable but significantly different from that of the standard antioxidant ascorbic acid (23.41-57.27%). Ascorbic consistently showed higher activity. The extract showed lower potency than the plant extract.

The IC_{50} value of the fruit extract (25.07±4.00 µg/mL) further confirms its antioxidant potential, although it was less potent than ascorbic acid (13.48±4.00 µg/mL) (Figure 5). Notably, the IC_{50} of the fruits was substantially lower than that previously reported for the leaf extract of *L. senegalensis* (0.52 mg/mL), suggesting that the fruits may possess higher antioxidant capacity than the leaves (Chigor et al. 2020). This enhanced activity may be attributed to the higher abundance of flavonoids and phenolic acids detected in the fruits.

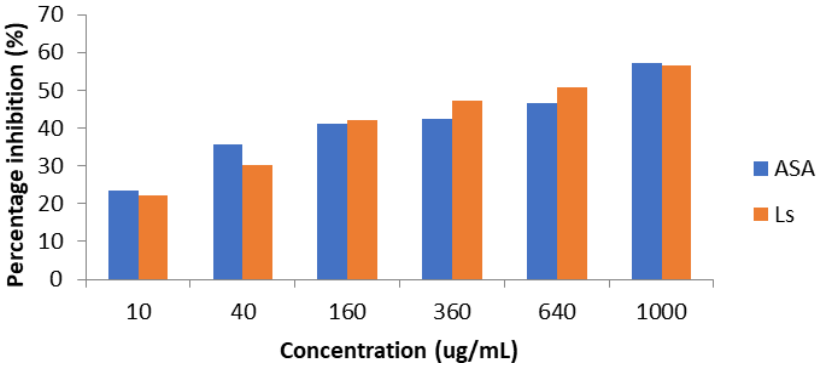

Figure 4. Percentage scavenging effect of *L. senegalensis*. Note: n=3, Mean±SD, P>0.0001, ASA: Ascorbic acid, Ls: *Lasimorpha senegalensis*

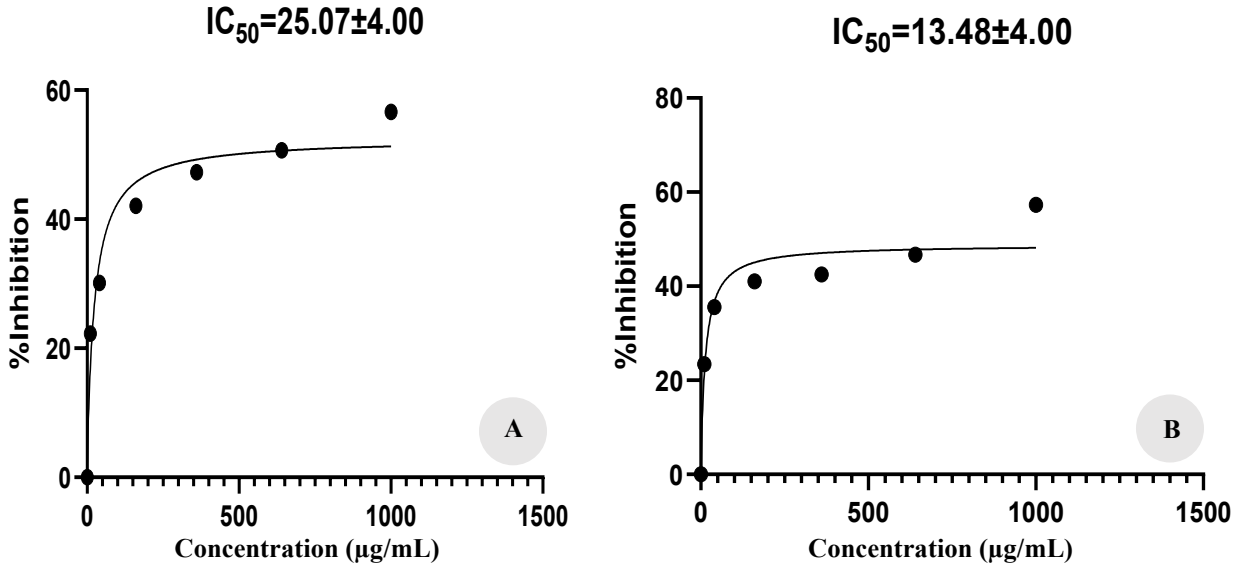

Figure 5. The IC_{50} of: A. *Lasimorpha senegalensis* (LS) and B. The standard drug ascorbic acid (ASA, Mean±SD)

The antioxidant activity is likely the result of the combined effects of phenolic acids, flavonoids, and alkaloids acting through multiple mechanisms, including hydrogen atom donation, electron transfer, and metal chelation. Such synergistic interactions are commonly reported in plant extracts, where the overall antioxidant effect cannot be attributed to a single compound but rather to the integrated action of multiple phytochemicals (Sayyed et al. 2023; Okelola et al. 2025). These findings support the potential application of *L. senegalensis* fruits as a natural antioxidant source and justify further investigations using additional antioxidant models and mechanistic assays.

In conclusion, this study provides baseline scientific evidence on the elemental composition, chemical constituents, and antioxidant activity of *L. senegalensis* fruits, an underutilized plant resource with potential nutraceutical value. Elemental analysis revealed the presence of essential macro- and microelements at concentrations below recommended daily intake and permissible limits, indicating that the fruits are unlikely to pose mineral-related toxicity risks and may contribute to nutritional supplementation for humans and animals. HPLC profiling demonstrated that the fruit extract contains a diverse range of phenolic compounds, flavonoids, and alkaloids, including ellagic acid, gallic acid, naringin, naringenin, rutin, kaempferol, and quinolone alkaloids. Although these compounds are not structurally novel, their established biological activities provide a clear chemical basis for the antioxidant and protective effects associated with *L. senegalensis*. The coexistence of multiple bioactive constituents suggests that the observed biological activity is likely driven by synergistic interactions rather than by a single dominant compound. The DPPH radical scavenging assay confirmed that the fruit extract exhibits significant antioxidant activity, with an IC_{50} value indicating moderate potency compared to ascorbic acid. Notably, the antioxidant capacity of the fruits was higher than previously reported for the leaves of the same species, highlighting the fruits as a promising source of natural antioxidants. Overall, the findings support the potential use

of *L. senegalensis* fruits as a nutraceutical resource and provide a foundation for future studies. Further investigations should focus on comprehensive safety and toxicity evaluation, bioactivity-guided isolation of key compounds, and assessment of antioxidant mechanisms using multiple in vitro and in vivo models to fully establish their therapeutic and functional applications.

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