

Research Article

IN-VITRO ANTIMICROBIAL, ANTIOXIDANT AND TOXICITY STUDIES OF *DIOSCOREA ESCULENTA* L. (DIOSCOREACEAE) TUBER EXTRACTS**¹Lourdu Pouline S, ^{2*}Leon Stephan Raj T, ³Sarath Kumar R and ⁴Raja P**^{1,2}Plant Molecular Biology Research Unit, Department of Botany, St. Xavier's College (Autonomous), Palayamkottai- 627002. (Affiliated to Manonmaniam Sundaranar University, Abishekapatti) Tirunelveli 627012, Tamil Nadu. India.^{3,4}Department of Zoology, St. Xavier's College (Autonomous), Palayamkottai- 627002. (Affiliated to Manonmaniam Sundaranar University, Abishekapatti) Tirunelveli 627012, Tamil Nadu. India.**Article History:** Received 11th June 2026; Accepted 7th August 2026; Published 10th October 2026**ABSTRACT**

Dioscorea esculenta (Lour.) Burkill is an ethnomedicinally important lesser yam widely used in traditional medicine across tropical Asia. Despite its historical use, scientific validation of its bioactive potential remains limited. This study aimed to evaluate the phytochemical profiles and the antimicrobial, antioxidant, and cytotoxic activities of hexane, ethyl acetate, and ethanol tuber extracts of *D. esculenta*. Extracts were prepared by cold maceration and subjected to qualitative phytochemical screening and GC-MS analysis. Antimicrobial activity was assessed against *Escherichia coli* (MTCC 433), *Vibrio cholerae* (MTCC 3906), *Pseudomonas aeruginosa* (MTCC 424), *Aspergillus niger* (MTCC-872), and *Aspergillus flavus* (MTCC-2501) using agar well diffusion and broth microdilution (MTT-based MIC). Antioxidant capacity was evaluated by DPPH radical scavenging assay, and cytotoxicity by *Artemia salina* brine shrimp lethality assay. Phytochemical screening detected tannins, flavonoids, cardiac glycosides, phenols, and steroids, predominantly in the ethanol extract. GC-MS identified four major compounds, with Cholest-5-en-3-ol (3 β)-tetradecanoate as the dominant constituent (38.88%). The ethanol extract demonstrated the broadest antimicrobial spectrum, with inhibition zones up to 15.17 mm and MIC values as low as 1250 μ g/mL. DPPH scavenging reached 90.51% at 800 μ g/mL (IC₅₀: 47.65 μ g/mL). Brine shrimp assay LC₅₀ values exceeded 1000 mg/L for all extracts, indicating comparatively lower acute lethality in the assay. *D. esculenta* tubers are a promising source of bioactive steroidal and tannin compounds with notable antimicrobial and antioxidant properties. These findings demonstrate that *Dioscorea esculenta* tubers possess significant bioactive potential with promising antimicrobial and antioxidant properties and low toxicity, highlighting their potential as a natural source of therapeutic compounds.

Keywords: *Dioscorea esculenta*, Phytochemical screening, Antimicrobial, Antioxidant capacity, Brine shrimp lethality.**INTRODUCTION**

Infectious diseases caused by pathogenic microorganisms, including bacteria, viruses, fungi, and parasites, continue to pose a serious threat to global public health, contributing significantly to illness and death worldwide, particularly among vulnerable populations in healthcare settings (WHO, 2023; Salam *et al.*, 2023). The escalating problem of antimicrobial resistance has made conventional treatments increasingly ineffective, prompting researchers to look toward plant-based alternatives as more sustainable and potentially multi-targeted therapeutic options (Ashraf

et al., 2023). Medicinal plants are known to harbour a rich arsenal of bioactive secondary metabolites such as alkaloids, flavonoids, tannins, terpenoids, and phenolic compounds that exert antimicrobial effects through diverse mechanisms, including disruption of microbial cell membranes, enzyme inhibition, and suppression of biofilm formation (Silva *et al.*, 2023; Bushra *et al.*, 2025). Notably, the synergistic interaction among multiple phytochemicals within a single plant extract may amplify its antimicrobial potency while simultaneously reducing the likelihood of resistance development (Shin *et al.*, 2018). Beyond antimicrobial properties, plant-derived phenolic and

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polyphenolic compounds have drawn considerable attention for their antioxidant capabilities. Oxidative stress, resulting from an imbalance between reactive oxygen species (ROS) production and the body's antioxidant defence, underlies many chronic diseases, including cardiovascular disorders, neurodegeneration, and cancer (Pizzino *et al.*, 2017). While synthetic antioxidants are widely used, concerns over their stability during industrial processing and the potential generation of harmful by-products have intensified interest in natural alternatives (Zeb, 2020). Approximately 80% of the global population continues to depend on traditional plant-based medicines for primary healthcare, underscoring the importance of validating ethnomedicinal knowledge through rigorous scientific investigation (Tyagi and Malik, 2012).

The genus *Dioscorea*, encompassing approximately 900 species distributed across tropical and subtropical regions, represents an important group of both nutritional and medicinal plants (Ruiz-González *et al.*, 2023). Species within this genus are widely consumed as staple food crops and are traditionally employed in managing inflammatory conditions, digestive disorders, and cardiovascular diseases, with documented anti-inflammatory, anticancer, and antioxidant properties (Gandhi, *et al.*, 2017). Among them, *Dioscorea esculenta* L. commonly known as lesser yam is an edible tuber native to Thailand and Indochina, widely cultivated and consumed across Southeast Asia and other tropical regions (Ode *et al.*, 2020). The tuber is nutritionally rich in carbohydrates, dietary fibre, and essential bioactive compounds, including dioscorin and diosgenin, which contribute to its reported health-promoting properties (Fera & Masrikhiyah, 2019; Silalahi, 2022). Ethnomedicinally, *D. esculenta* has been used as an anti-inflammatory, antidiabetic, antifatigue, and immunomodulatory agent, with recent studies further demonstrating its potential in preventing and managing metabolic and inflammatory diseases (Silalahi, 2022; Wang *et al.*, 2023).

Despite these promising attributes, scientific investigation into the antimicrobial and antioxidant potential of *D. esculenta* remains limited, particularly with respect to mid-polar extracts and their activity against clinically relevant human pathogens. Prior work has indicated that ethyl acetate extracts of this species exhibit notable antibacterial action against antibiotic-resistant strains of *Staphylococcus aureus* and *Escherichia coli* (Olayemi & Ajaiyeoba, 2007; Nandhini *et al.*, 2022). Furthermore, the toxicity profile of plant extracts is a critical consideration in drug development, and the brine shrimp lethality assay using *Artemia salina* has been widely adopted as a rapid, cost-effective, and reliable preliminary toxicity screening tool for medicinal plant research (Dominguez-Martín *et al.*, 2020; Ruiz-Gonzalez *et al.*, 2023).

Therefore, the present study aims to evaluate, for the first time, the *in vitro* antibacterial and antioxidant activities of *D. esculenta* tuber extracts sourced from Kerala, alongside a toxicity assessment using the brine shrimp lethality assay. In addition, GC-MS analysis will be employed to identify the volatile and semi-volatile phytochemical constituents responsible for the observed biological activities, while pharmacokinetic and toxicological profiling of key bioactive compounds will be explored to elucidate their potential mechanisms of action (Azwanida, 2015). This work seeks to bridge existing knowledge gaps and provide a scientific foundation for the development of *D. esculenta* as a natural source of antimicrobial and antioxidant agents.

MATERIALS AND METHODS

Collection of plant materials

The fresh plant and tubers of *Dioscorea esculenta* were collected from Thiruvananthapuram, Kerala in February 2025. The plant material was authenticated and a voucher specimen was deposited in St. Xavier's Research Foundation, Xavier's College, Palayamkottai. (Register number: XCH-40795).

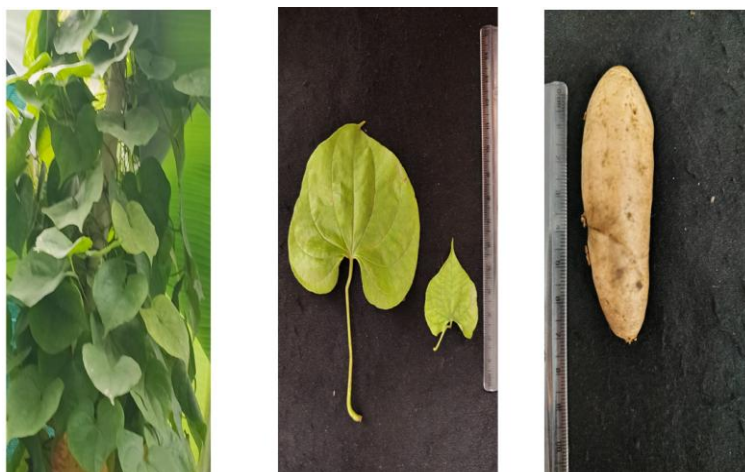


Figure1. Experimental Plant- *Dioscorea esculenta*.

Plant material extraction and fractionation

The extraction was performed using a cold maceration technique (Azwanida, 2015). Briefly, 50 g of dried tuber powder was soaked in 300 mL of hexane, ethyl acetate, and 99% ethanol for 72 hours at room temperature. The mixture was filtered through Whatman No. 1 filter paper, and the filtrate was concentrated under reduced pressure at 45°C using a rotary evaporator. The resulting crude extract was stored at -20°C in amber glass vials until further analysis.

Qualitative Phytochemical Screening

The *Dioscorea esculenta* tuber extracts were screened for major secondary metabolites, including saponins, tannins, steroids, phlobatannins, anthraquinones, cardiac glycosides, alkaloids, reducing sugars, and flavonoids, following standard procedures described by Harborne (1998).

Gas Chromatography–Mass Spectrometry (GC-MS) Analysis

The phytochemical composition of *Dioscorea esculenta* tuber ethanol extract was analysed by Gas Chromatography–Mass Spectrometry (GC-MS) using a Hewlett–Packard Series II gas chromatograph equipped with an HP-5 capillary column (30 mm × 0.25 mm, 0.25 µm film thickness). The injector temperature was set to 280°C and programmed at a heating rate of 1°C/min over the temperature range of 50°C to 280°C. Helium was employed as the carrier gas at a flow rate of 1.0 ml/min. Compound identification was carried out by comparing the retention indices and mass spectra of detected peaks with reference data from the Wiley and NIST mass spectral libraries, as well as authentic laboratory standards and published literature. Retention indices were calculated relative to a homologous series of n-alkanes (C8–C24) under identical operating conditions. The relative concentration of each identified component was determined by peak-area normalisation (Aminianfar *et al.*, 2024).

Test microorganisms and growth media

Three bacterial strains, *Escherichia coli* (MTCC 433), *Vibrio cholera* (MTCC 3906), and *Pseudomonas aeruginosa* (MTCC 424), alongside two fungal isolates, *Aspergillus niger* (MTCC-872) and *Aspergillus flavus* (MTCC- 2501) were used for antimicrobial testing. Bacterial strains were cultured on Mueller Hinton Agar (MHA) at 37°C, while fungal isolates were grown on Potato Dextrose Agar (PDA) at 30°C. All stock cultures were stored at 4°C.

Evaluation of Antimicrobial Activity of *Dioscorea esculenta* tuber Extract

Antimicrobial activity of *Dioscorea esculenta* tuber extracts was assessed against bacteria and fungi using the agar well diffusion method (Bibi *et al.*, 2025). Bacterial inocula (1×10^6 CFU/ml) were swabbed onto Mueller-Hinton Agar (MHA), while fungal inocula (2×10^5 CFU/ml) were spread onto Potato Dextrose Agar (PDA).

Once solidified, 6-mm wells were aseptically bored into each plate, and 100 µL of extract at 50 mg/mL was loaded into each well. DMSO served as the negative control; streptomycin (5 mg/ml) and clotrimazole (5 mg/ml) were used as antibacterial and antifungal positive controls, respectively. Plates were incubated at $35 \pm 2^\circ\text{C}$ for 24 hours in triplicate, and activity was quantified by measuring inhibition zone diameters (mm).

Minimum Inhibitory Concentration (MIC) of *Dioscorea esculenta* tuber Extracts

The Minimum Inhibitory Concentration (MIC) of *Dioscorea esculenta* tuber extracts was determined using the broth microdilution method (Rani and Rao, 2013) with slight modifications. Hexane, Ethyl acetate, and ethanol extracts were serially diluted in Müller-Hinton broth to achieve a concentration range of 3000 to 5.85 µg/0.1 ml. Bacterial suspensions were prepared in Müller Hinton broth at 1×10^6 CFU/ml, while fungal suspensions were prepared in Potato Dextrose Broth (PDB) at 2×10^5 CFU/ml. Following incubation at $25 \pm 2^\circ\text{C}$ for 24 hours, MTT reagent (5 mg/mL) was added to each well to assess metabolic activity. Microbial growth was indicated by a colour change from yellow to purple-pink, and absorbance was measured at 500 nm using an ELISA microplate reader. Streptomycin served as the positive control, and DMSO combined with the respective microbial suspension served as the negative control.

Antioxidant activity

Antioxidant activity of the plant extracts was evaluated using the DPPH (2,2-diphenyl-1-picrylhydrazyl) radical scavenging assay as described by Bibi *et al.* (2025). Each extract (500 µL) was combined with 5 mL of 0.1 mM methanolic DPPH solution in triplicate and vortexed thoroughly. Methanol (100 µL) added to 5 mL of DPPH solution served as the negative control, DPPH in methanol alone as the blank, and a methanol-DPPH-BHT mixture as the positive control. All mixtures were kept in the dark at room temperature for 20 minutes, after which absorbance was measured at 517 nm against the blank. Scavenging activity was indicated by a color transition from purple to pale yellow, and the percentage of inhibition was calculated from the recorded absorbance values using the formula:

$$\text{Percentage inhibition} = \frac{[\text{Absorbance of Control} - \text{Absorbance of test}]}{\text{Absorbance of control}} \times 100\%$$

Toxicity study

The toxicity of *Dioscorea esculenta* tuber extracts was evaluated using the brine shrimp lethality assay (Anderson *et al.*, 2018) with minor modifications. Artificial seawater was prepared at 38 g/L sea salt and pH-adjusted to 8.5 with 1N NaOH. *Artemia* sp. eggs were hatched over 48 hours in 300 mL of aerated seawater. Hexane, ethyl acetate, and ethanol extracts dissolved in DMSO were tested at concentrations of 10, 100, 200, 400, 500, and 1000, 2000 ppm, with 30 nauplii introduced per concentration in

triplicate. Potassium dichromate served as the positive control. Mortality was recorded after 24 hours, and the lethal concentration causing 50% nauplii death (LC₅₀) was determined by probit analysis (Bastos *et al.*, 2009; Manickam *et al.*, 2020).

Statistical analysis

The results of the assays were expressed as mean $\pm$ SD of five replicates. After assessing the homogeneity of variance using Bartlett's test, one way ANOVA was done to assess the significant difference between the groups. Tukey's HSD was used for Post hoc analysis and the *P* value was set at ≤ 0.05 . All the statistical analyses were done using GraphPad Prism (version 8.0.2).

RESULTS AND DISCUSSION

The phytochemical analysis revealed that cardiac glycosides were present only in the hexane extract, whereas tannins, saponins, flavonoids, phenols, and steroids were present in the ethyl acetate extract. The ethanol extract contained tannins, flavonoids, cardiac glycosides, phenols, steroids, and cholesterol. The tannins present in the tuber extract exhibit growth inhibition against a variety of pathogens, suggesting antioxidant properties. GC-MS analysis of the ethanol extract of *Dioscorea esculenta* tuber identified four bioactive compounds (Table 1).

Table 1. GC-MS analysis of *Dioscorea esculenta* tuber ethyl acetate extract.

Compound name	Retention time	Area %	Molecular formula	Biological activity
4-Ethyl-3-methylhexyl acetate	21.078	20.79	C ₁₁ H ₂₂ O ₂	Phobic disorder treatment Antiseborrheic
Dodecane, 1-iodo-	26.929	19.93	C ₁₂ H ₂₅ I	Sugar phosphate inhibitor
9,10-Secocholesta-5,7,10(19)-triene-3,24,25-triol, (3 β .,5Z,7E)-	28.864	20.41	C ₂₇ H ₄₄ O ₃	Bone disease treatment Antieczematic
Cholest-5-en-3-ol (3. β .)-, tetradecanoate	32.830	38.88	C ₄₁ H ₇₂ O ₂	Cholesterol antagonist Hypolipemic

Cholest-5-en-3-ol (3 β)-tetradecanoate was the dominant compound (38.88%), followed by 4-Ethyl-3-methylhexyl acetate (20.79%), 9,10-Secocholesta-5,7,10(19)-triene-3,24,25-triol (20.41%), and Dodecane, 1-iodo- (19.93%). The mentioned Chemical derivatives supports the traditional medicinal use of *D. esculenta*, as these compounds are associated with anti-inflammatory, antioxidant, and antimicrobial activities. The antimicrobial activities of hexane, ethyl acetate, and ethanol extracts of *Dioscorea esculenta* tuber against selected bacterial and fungal pathogens are presented in Figure 2 and Table 2. At 50 mg/ml, the ethanol extract exhibited the broadest spectrum of activity, producing zones of inhibition of 14.03 $\pm$ 0.55 mm (*E. coli*), 13.03 $\pm$ 0.35 mm (*V. cholerae*), 15.17 $\pm$ 1.25 mm (*P. aeruginosa*), 11.97 $\pm$ 0.45 mm (*A. flavus*),

and 12.97 $\pm$ 0.35 mm (*A. niger*). The ethyl acetate extract showed moderate inhibitory activity against all tested organisms, while the hexane extract demonstrated limited activity, restricted to *E. coli* (8.00 $\pm$ 0.9 mm) and *P. aeruginosa* (8.00 $\pm$ 1.25 mm), with no inhibition recorded against *V. cholerae*, *A. flavus*, and *A. niger*. All extract values were lower than the positive controls, which recorded the highest inhibition zones across all organisms. The superior efficacy of the ethanol extract may be attributed to its ability to solubilize polar phytochemicals such as flavonoids, tannins, and glycosides, known for their membrane-disrupting and enzyme-inhibiting properties, while the inactivity of the hexane extract further confirms the role of polar bioactive constituents in mediating antimicrobial effects.

Table 2. Antimicrobial activities of *D. esculenta* tuber extract against pathogens.

Microbial pathogens	Zone of Inhibition (mm)			
	Hexane (50mg/mL)	Ethyl acetate (50mg/mL)	Ethanol (5mg/mL)	positive control (5mg/mL)
<i>E. coli</i>	8 $\pm$ 0.9 ^d	11.00 $\pm$ 0.40 ^c	14.03 $\pm$ 0.55 ^b	28.00 $\pm$ 2.00 ^a
<i>V. cholerae</i>	0	10.07 $\pm$ 1.10 ^c	13.03 $\pm$ 0.35 ^b	26.00 $\pm$ 0.60 ^a
<i>P. aeruginosa</i>	8 $\pm$ 1.25 ^a	13.07 $\pm$ 1.10 ^b	15.17 $\pm$ 1.25 ^c	22.00 $\pm$ 2.00 ^d
<i>A. flavus</i>	0	10.00 $\pm$ 0.40 ^b	11.97 $\pm$ 0.45 ^c	26.97 $\pm$ 0.45 ^d

<i>A. niger</i>	0	12.00 ± 1.00^b	12.97 ± 0.35^c	25.00 ± 1.20^d
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Values are means $\pm$ SD; The same superscript within the same row indicates no significant difference ($p>0.05$)

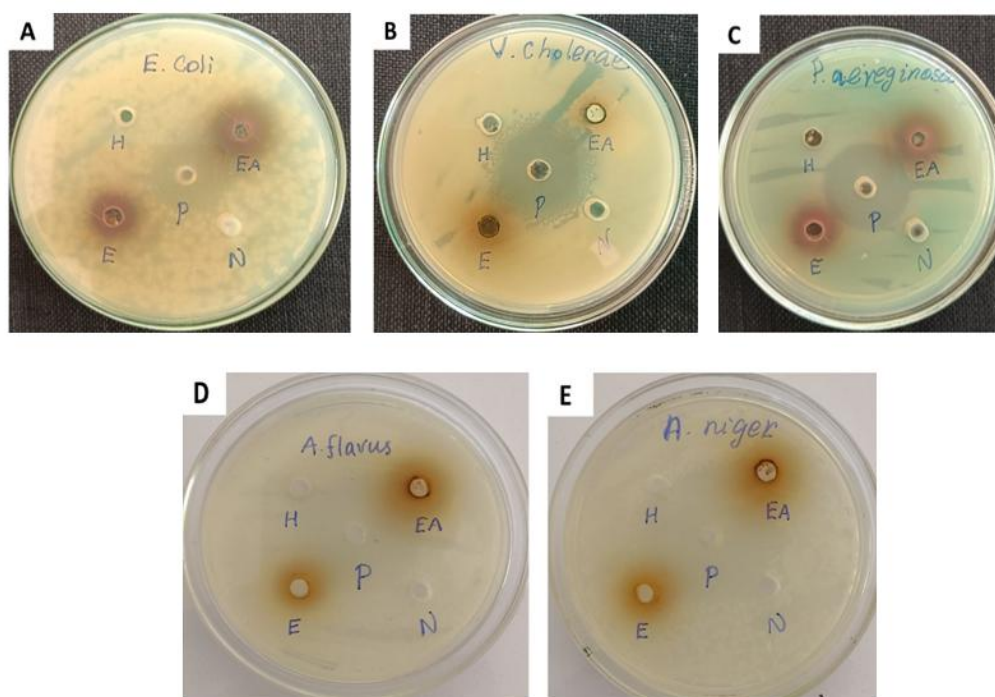


Figure 2. Determination of the antimicrobial activity of *D. esculenta* tuber extract against bacterial and fungal strains

The MIC values of *Dioscorea esculenta* tuber extracts against selected pathogens are presented in Figure 3. The ethanol extract demonstrated the lowest MIC values, recording 1250 ± 433 $\mu\text{g/ml}$ against *E. coli* and *P. aeruginosa*, and 1667 ± 289 $\mu\text{g/ml}$ against *V. cholerae*, *A. niger*, and *A. flavus*, indicating superior broad-spectrum antimicrobial potency (Table 3). The ethyl acetate extract

showed moderate MIC values ranging from 1667 ± 289 to 2333 ± 763 $\mu\text{g/ml}$ across all tested organisms, while the hexane extract exhibited the weakest activity, limited to *E. coli* and *P. aeruginosa* (2500 ± 866 $\mu\text{g/ml}$), with no inhibition recorded against *V. cholerae*, *A. niger*, and *A. flavus*. Overall, the ethanol extract consistently demonstrated the most favourable MIC profile.

Table 3. MIC of the *D. esculenta* tuber extract.

Microbial strains	Hexane extract MIC ($\mu\text{g/ml}$)	Ethyl acetate extract MIC ($\mu\text{g/ml}$)	Ethanol extract MIC ($\mu\text{g/ml}$)
<i>E. coli</i>	2500 ± 866	2333 ± 763	1250 ± 433
<i>V. cholerae</i>	0	2167 ± 577	1667 ± 289
<i>P. aeruginosa</i>	2500 ± 866	1667 ± 289	1250 ± 433
<i>A. niger</i>	0	2267 ± 750	1667 ± 289
<i>A. flavus</i>	0	2167 ± 577	1667 ± 289

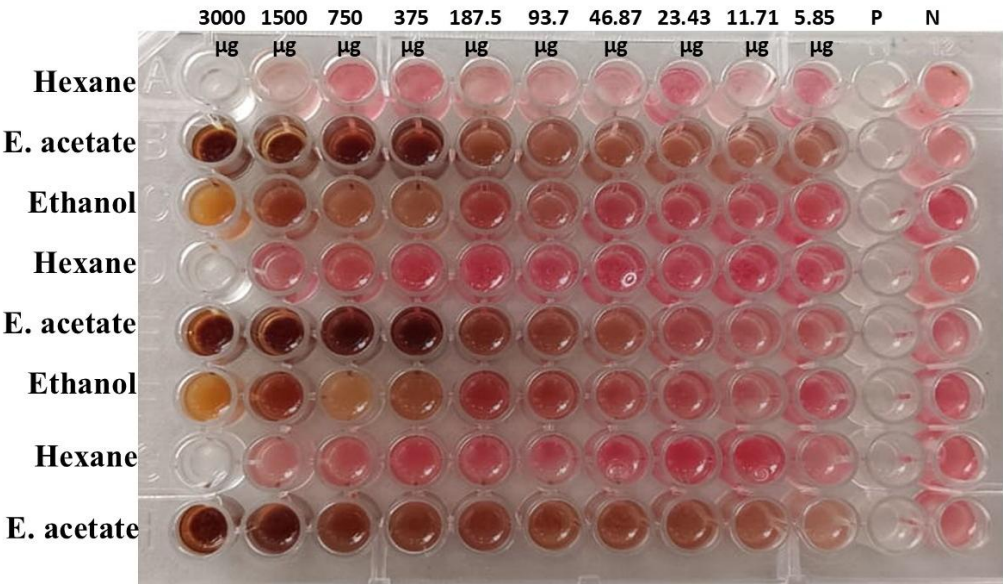


Figure 3. Determination of the MIC values for the *D. esculenta* different solvent extracts against antimicrobial strains.

The antioxidant activity of *Dioscorea esculenta* ethanol extract was evaluated using the DPPH free radical scavenging assay, with ascorbic acid as the positive control. The results are presented in Figure 4. The ethanol extract demonstrated concentration-dependent scavenging activity across all tested concentrations (1.0–1000 μg/ml). At the lowest concentration (1.0 μg/ml), the extract recorded $11.98 \pm 0.12\%$ inhibition, surpassing ascorbic acid ($1.41 \pm 2.44\%$) at the same concentration. Scavenging activity

progressively increased with concentration, reaching a peak of $90.51 \pm 0.09\%$ at 800 μg/mL, comparable to that of ascorbic acid ($94.05 \pm 0.04\%$) at the same concentration. The IC₅₀ value of the ethanol extract was 47.65 μg/mL, compared to 28.19 μg/mL for ascorbic acid, indicating moderate but promising antioxidant potential. The observed activity may be attributed to the presence of steroids and tannins, which are well recognized for their hydrogen-donating and free radical scavenging capabilities.

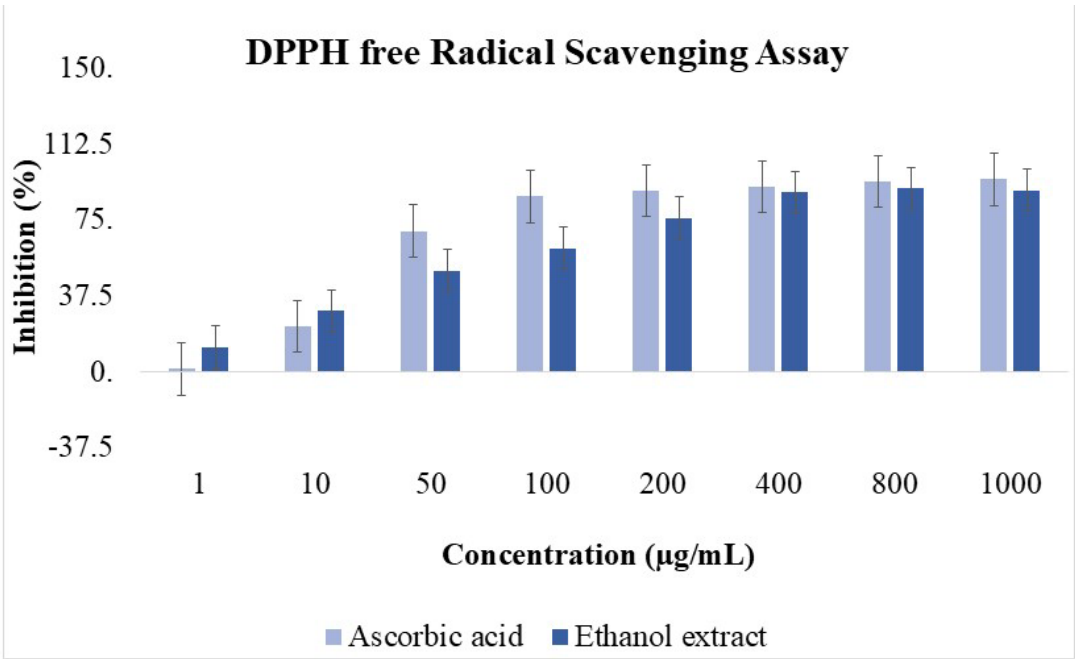


Figure 4. Antioxidant activity by the DPPH method of *Dioscorea esculenta* ethanol extract

The toxicity of *Dioscorea esculenta* tuber extracts against *Artemia salina* nauplii was evaluated across concentrations ranging from 10 to 2000 mg/L (Figure 5). No mortality was recorded at 10 mg/L for any of the three extracts. With increasing concentration, a progressive dose-dependent rise in lethality was observed. At 2000 mg/L, the hexane, ethyl acetate, and ethanol extracts caused maximum mortalities of $86.67 \pm 3.33\%$, $80.00 \pm 3.33\%$, and $63.33 \pm 3.33\%$, respectively. The calculated LC50 values were 1153.8 mg/L (hexane), 1307.7 mg/L (ethyl acetate), and 1727

mg/L (ethanol). All three extracts are considered non-toxic, as their LC50 values exceeded 1000 mg/L. Nevertheless, among the extracts, the hexane fraction showed comparatively higher lethality, while the ethanol extract showed the least, reflecting differences in the polarity and composition of their bioactive constituents. Overall, these findings suggest that the tuber extracts of *D. esculenta* possess a favorable safety profile at the concentrations tested.

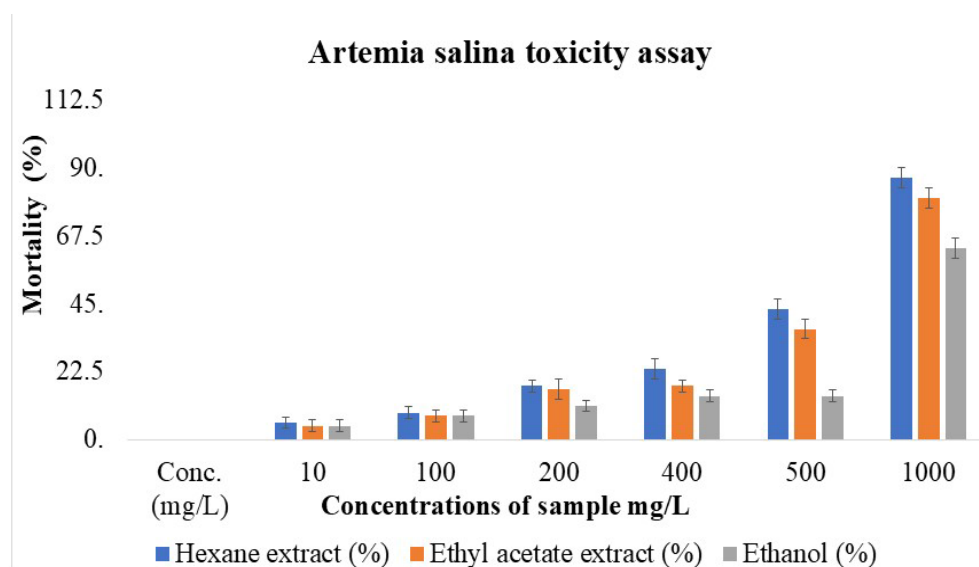


Figure 5. Toxicity of *Artemia salina* at different concentrations of *D. esculenta* extract

Dioscorea esculenta (lesser yam) is widely cultivated across South and Southeast Asia, including India, where it serves both as a nutritious staple food and a folk remedy for numerous ailments (Kumar *et al.*, 2017; Padhan *et al.*, 2020). The tuber is a recognised source of bioactive phytoconstituents responsible for its antioxidant, anti-inflammatory, anti-diabetic, and antimicrobial activities (Wang *et al.*, 2025). Qualitative phytochemical screening in the present study revealed cardiac glycosides, phenols, flavonoids, tannins, and steroids across the ethyl acetate and ethanol extracts. These secondary metabolites are well established as key contributors to the biological activities of medicinal plants (Agidew, 2022). Tannins identified in the ethanol extract are widely reported for their therapeutic value in rheumatism, asthma, skin infections, and inflammatory conditions (Mlozi, 2022), and flavonoids are recognised for their antioxidant, anti-inflammatory, and antimicrobial properties (Swain *et al.*, 2021). The detection of cardiac glycosides across multiple solvent fractions indicates a broad solubility profile and potential pharmacological relevance, consistent with reports on related species such as *D. bulbifera*, *D. delicata*, and *D. pentaphylla* (Ponce *et al.*, 2025; Titova *et al.*, 2021). GC-MS analysis of the ethanol extract further identified four major compounds (3 β)-tetradecanoate (38.88%), providing

a biochemical basis for the observed bioactivities and corroborating earlier phytochemical investigations on *Dioscorea* species (Duraishwamy *et al.*, 2018). The superior antimicrobial efficacy of the ethanol extract of *Dioscorea alata* against all tested pathogens, including *P. aeruginosa*, *A. niger*, and *A. flavus*, is consistent with the well-documented abundance of polar phytochemicals particularly tannins, flavonoids, and steroids characteristic of the genus (Prajapati *et al.*, 2025). The limited activity of the hexane extract, restricted to *E. coli* and *P. aeruginosa*, corroborates findings from related *Dioscorea* studies indicating that non-polar fractions contribute minimally to antimicrobial potency, reinforcing solvent polarity as a critical determinant of bioactivity in *Dioscorea*-derived extracts. The MIC values obtained for the ethanol extract are consistent with the broad-spectrum inhibitory capacity previously reported for *D. esculenta* mucilage extract against *E. coli*, *P. aeruginosa*, and *S. aureus* (Yoon and Park 2023), lending further credibility to the antimicrobial potential of this species. The susceptibility of *P. aeruginosa*, widely recognised as an antimicrobial-resistant pathogen observed in the present study, is particularly noteworthy, as it suggests that *D. esculenta* phytochemicals may overcome conventional resistance mechanisms. Comparable inhibitory profiles against *A. niger* and *P.*

aeruginosa have been reported for *Colocasia esculenta* tuber peel, with activity attributed to flavonoids, phenols, tannins, and saponins (Terngu *et al.*, 2024), consistent with the phytochemical classes identified in the present study. Mierza *et al.* (2020) similarly documented inhibition zones against *E. coli* and *S. aureus* by *D. pyriformis* tuber extracts containing glycosides, alkaloids, and tannins. A maximum inhibition zone of 17.16 mm against *Shigella dysenteriae* at 500 µg/disc was previously reported for *D. esculenta* tuber extract (Prajapati *et al.*, 2025), in close agreement with the present results. The antimicrobial efficacy is primarily attributed to tannins, which inhibit bacterial protein synthesis by irreversibly binding proline-rich proteins (Farha *et al.*, 2020), alongside the membrane-disrupting effects of phenols and flavonoids.

The ethanol extract exhibited potent concentration-dependent DPPH radical scavenging activity, reaching $90.51 \pm 0.09\%$ inhibition at 800 µg/mL, closely comparable to ascorbic acid ($94.05 \pm 0.04\%$), with an IC_{50} of 47.65 µg/mL versus 28.19 µg/mL for ascorbic acid. Antioxidant activity has been reported across several *Dioscorea* species including *D. alata*, *D. bulbifera*, *D. oppositifolia*, and *D. hispida* (Murugan *et al.*, 2012). The present findings align with Narzary *et al.* (2025), who reported 79.3% DPPH scavenging at 1000 µg/mL for *D. esculenta*, with an IC_{50} of 38.33 µg/mL, attributing the activity to its high steroid and tannin content. The IC_{50} of 47.65 µg/mL recorded in this study compares favourably with *D. bulbifera*, which achieved only 69.4% inhibition at 5000 µg/mL (Swain *et al.*, 2021), and *D. alata* leaves and stems with $IC_{50} \approx 531$ µg/mL (Mondal *et al.*, 2025), indicating superior antioxidant potency of *D. esculenta* tubers. The activity is attributed to the hydrogen-donating capacity of phenolics and flavonoids (Prayoga *et al.*, 2025), consistent with reports on *D. alata* underground tubers, where phenols, flavonoids, tannins, and diosgenin were identified as key contributors (Mondal *et al.*, 2025).

The *Artemia salina* brine shrimp lethality assay classified all three extracts as non-toxic, with LC_{50} values of 1153.8 mg/L (hexane), 1307.7 mg/L (ethyl acetate), and 1727 mg/L (ethanol), all exceeding the 1000 mg/L safety threshold. The ethanol extract produced no abnormal behavioural changes, mortality, or morbidity in *Artemia* nauplii at 2000 ppm, consistent with Suharyanisa *et al.* (2025), who attributed the lower lethality of polar extracts to greater distribution of bioactive compounds within the solvent. The comparatively higher lethality of the hexane extract is attributed to non-polar steroids and cardiac glycosides known to disrupt *Artemia* cell membranes (Kalalinggi *et al.*, 2023); cardenolides in particular are highly toxic with a therapeutic dose approximating 60% of the lethal dose (Nagorny & Cichowicz, 2016). These results are in agreement with the non-toxic profile reported for *D. esculenta* by Wang *et al.* (2024). Collectively, the favourable safety profile, combined with the potent antimicrobial and antioxidant activities of *D. esculenta* tuber extracts, supports their further investigation as

candidates for pharmaceutical and nutraceutical applications.

CONCLUSION

The present study demonstrated that *Dioscorea esculenta* tuber extracts contain diverse phytochemicals, including tannins, flavonoids, saponins, phenols, and steroids. Among the tested extracts, the ethanol extract showed the strongest antimicrobial activity, with MIC values as low as 1250 µg/mL, and antioxidant activity (IC_{50} : 47.65 µg/mL). GC–MS analysis identified several bioactive compounds that may contribute to the observed biological effects. Toxicity evaluation using the *Artemia salina* lethality assay showed LC_{50} values above 1000 mg/L, indicating low toxicity of the extracts. Although *Dioscorea esculenta* is widely consumed as an edible yam, the present study highlights its potential as a valuable source of bioactive compounds with possible pharmaceutical applications. Further studies are required to isolate the active constituents and evaluate their therapeutic potential.

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CONFLICT OF INTERESTS

The authors declare no conflict of interest

ETHICS APPROVAL

Not applicable

FUNDING

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AI TOOL DECLARATION

The authors declare that no AI and related tools are used to write the scientific content of this manuscript.

DATA AVAILABILITY

Data will be available on request

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