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RESEARCH PAPER

Evaluation of Pharmacognostical, Phytochemical, Antioxidant activity, and Chemical composition emphasizing traditional uses of *Blumea lanceolaria* (Roxb.) Druce (Asteraceae)

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Abstract
Blumea lanceolaria (Roxb.) Druce is a perennial herb of the genus *Blumea* under the Asteraceae family native to Asia's tropical and sub-tropical regions, particularly the Indian Subcontinent and Southeast Asia. It is a traditionally used medicinal plant in India. The present study aimed to assess the importance of pharmacognostic, phytochemical constituents, antioxidant activity, and GC–MS analysis, of leaves of *B. lanceolaria*. Standard protocols were followed to study macroscopic, microscopic, organoleptic, powder microscopy, and phytochemical studies. Biologically active compounds in leaf extract were identified using Gas chromatography-mass spectrometry (GC–MS). The microscopic study of the leaf revealed hypostomatic leaf surface, i.e. stomata restricted on the lower surface and multicellular trichomes have been observed on the lower surface of the leaf. Phytochemical studies determined the presence of different secondary metabolites like alkaloid, flavonoid, terpenoid, protein, phenol, tannin, carbohydrates, and glycosides and showed a good concentration amount of alkaloid, flavonoid, and terpenoid contents. From GC–MS analysis, we found Dodecanoic acid was the major volatile compound with the highest percentage of peak area (6.279%) in methanol extract. In petroleum ether extract, Chloroacetic acid, Tetradecyl ester was the major compound with the highest percentage of peak area (16.355%). IC_{50} values of methanol and petroleum ether leaf extract exhibited 28.82 ± 1.35 µg/mL and 35.84 ± 0.40 µg/mL respectively indicating good concentrations of antioxidant properties. Therefore, the present study will be helpful for the identification and standardization of the species as well as beneficial for pharmaceutical industries.

Keywords *B. lanceolaria* · Pharmacognosy · Phytochemical · Antioxidant · GC–MS

Introduction

Since the beginning of the period, people have used plants to heal a wide range of human and animal illnesses. A vast array of medicinally valuable plants can be found in India. People from all walks of life used these plants extensively, either directly for traditional medicine purposes or indirectly to prepare pharmaceuticals for contemporary medicine (Chaachouay and Zidane 2024). Pharmacognosy deals with the biological, biochemical, and economic features of natural drugs including both crude pharmaceuticals and their natural compounds (Sarker 2012). Phytoconstituents such as Alkaloids, flavonoids, steroids, tannin, terpenoids, phenol, and other chemical compounds can be found in any part of plants that possess significant biological activities that help humans from various diseases (Brahma and Baruah 2023; Brahma et al. 2024). Phytochemical screening is a preliminary test that detects secondary metabolites in plants. This includes detecting bioactive components such as tannins, alkaloids, polysaccharides, steroids, flavonoids, and terpenoids (Chaudhary et al. 2023). Pharmacognostic and phytochemical research are two examples of the various approaches and methodologies we might employ to gradually accomplish the objective of the standardization process of plants (Akbar et al. 2014).

Blumea lanceolaria (Roxb.) Druce is a perennial herb with woody stems that reach heights of 1–2.5 m. The species belongs to the genus *Blumea* under the Asteraceae

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family native to Asia's tropical and sub-tropical regions, particularly the Indian Subcontinent and Southeast Asia (Lalmuanthanga et al. 2019). The plant is native to India, Bangladesh, Cambodia, China, Myanmar, Philippines, Sri Lanka, Indonesia, Taiwan, Thailand, and Vietnam (POWO 2024). The species thrives in damp, shaded regions along stream banks at elevations of up to 1500 m. The flower blooms from January to April and has dark green leaves with channeled. An earlier study revealed that the different parts of *B. lanceolaria* were used to cure cancer and inflammatory diseases (Do et al. 2022). The species exhibits important phytoconstituents including flavonoids, triterpenoids, xanthene, diterpenes, and essential oils and also possesses strong antioxidant, antimicrobial, and antibacterial properties, making it a valuable plant for the treatment of a range of illnesses (Mishra et al. 2015).

The plant is used in the traditional medicinal system to treat various diseases including hemorrhoids, bronchitis, sores, wound healing, etc. (Lalmuanthanga et al. 2019). Thus, the present work has been undertaken to evaluate pharmacognostical study, phytochemical, antioxidant, and chemical composition emphasizing traditional knowledge of *B. lanceolaria* as a potent medicinal plant.

Materials and Methods

Plant Material

The leaves of *Blumea lanceolaria* (Roxb.) Druce were collected in February 2024 from the Debargaon area of Kokrajhar district, Assam at a latitude of 26° 24′ 16.1964" N and a longitude of 90° 16′ 23.1672" E. The voucher specimen was deposited at the Bodoland University Botanical Herbarium (BUBH). Identification was carried out by concerning some literature and online taxonomic databases such as IPNI and WFO (IPNI 2024; WHO 2024). During the collection, the ethnobotanical uses of the plant were also consulted through interactions with local people in the collected area.

Pharmacognostical Study

Macroscopic study and Organoleptic Study

The fresh and healthy specimen was studied macroscopically. A simple microscope was used to examine and measure the distinct morphological characters of plant material. The taste, colour, odour, texture, and size of the plant and powder species were recorded (Brahma et al. 2024).

Microscopic Study

Transverse Section of Stem The transverse section of the stem was cut by free hand section and dehydrated with a graded ethanol series, i.e., 30, 50, 70, 90, 100%. Then the section was stained with safranin and observed under a light microscope (Brahma et al. 2024).

Transverse Section of Midrib To get a transverse section of the leaves, the thin section was cut and hydrated in a graded ethanol series, i.e., 30, 50, 70, 90, 100% using double staining with safranin and fast green, inspected under a light microscope (Brahma et al. 2024).

Transverse Section of Petiole The petiole was cut into thin sections with a sharp blade and hydrated in a graded alcohol. Before observing through the light microscope, the sample was stained with safranin (Brahma et al. 2024).

Leaf Epidermis Fresh leaves were cut and steeped in 30% nitric acid, then boiled with 2.0 gm of potassium chloride in a test tube for 1–2 min. The skin is then peeled off and immersed in a 60% potassium hydroxide solution for around 1–2 h. The epidermis was then suspended in lactic acid on a glass slide and examined under light microscopy (Munir et al. 2011).

The stomatal Index is determined by the formula-

$$\text{Stomatal Index (SI)}\ \% = S/S + E \times 100.$$

Where, S = Number of stomata per vision.

E = Number of epidermal cells per vision.

Study of the Foliar Leaf Epidermis using Field Emission Scanning Electron Microscopy (FESEM) A field emission scanning electron microscope (Model: EVO 10 FESEM, ZEISS) was used to analyze the foliar leaf epidermal layer on both adaxial and abaxial surfaces. To examine the dried leaf specimen under FESEM, a tiny slice was cut from both surfaces, mounted on stubs with double adhesive tape, and coated with gold–palladium (Brahma and Baruah 2024).

Powder Microscopy The powder microscopy of *B. lanceolaria* was studied by staining with safranin or applying directly the aqueous solution and observed through a light microscope (Brahma et al. 2024).

Phytochemical Study

Preparation of Plant Extract

The collected fresh leaves were washed properly and dried in the shade for 2 weeks until they became fully dry. Then the dried leaves were ground by using an electric grinder

and kept in an airtight bottle. Then by maceration method, 10 gm of coarse powder was soaked in 100 ml of methanol solvent for 3–4 days. The same procedure was repeated for petroleum ether solvent. Then the extract was filtered by using Whatman no.1 filter paper. After filtration, the filtrate extract was evaporated with a vacuum rotary evaporator. The final residue was taken for various phytochemical studies (Brahma and Baruah 2023).

Qualitative Phytochemical Test

To establish the presence of several phytocompounds, preliminary phytochemical tests were undertaken on a crude extract of *B. lanceolaria* leaves.

Test for Alkaloids

Mayer's Test 1 mL of extract with 2 mL of 1% hydrochloric acid were mixed and heated. After heating, a few drops of Mayer's reagent were added. The formation of yellow precipitates indicated the presence of alkaloids (Brahma and Baruah 2023).

Wagner's Test The mixture of 1 mL of extract and 2 mL of 1% hydrochloric acid was heated with a few drops of Wagner's reagent added. The resulting reddish-brown precipitate verified the presence of alkaloids (Brahma and Baruah 2023)**.**

Dragendorff's Test To 1 mL of extract 2 drops of Dragendorff's reagent were added. The occurrence of yellow precipitate confirmed the presence of alkaloids (Brahma and Baruah 2023).

Test for Carbohydrates

Fehling's Test 1 mL each of Fehling's A and B reagents was combined with 1 mL of extract. For a short while, the solution was brought to a boil in a water bath. The test was considered positive when the red colour precipitate appeared (Brahma et al. 2024).

Molisch's Test A small amount of extract was combined with a few drops of Molisch's reagent. The mixture was mixed thoroughly. The concentrated sulfuric acid (2 mL) was gently added from the side of the test tube. A purple or violet colour indicated the presence of carbohydrates (Brahma et al. 2024).

Iodine Test Adding 2 mL of iodine solution to crude extract results in purple colour, indicating the presence of carbohydrates (Raaman 2006).

Test for Phenolic Compounds

Ferric Chloride Test 2 mL of leaf extract treated with ferric chloride droplets yielded a bluish-green colour, indicating the presence of phenol (Raaman 2006).

Lead Acetate Test A 10% lead acetate solution was combined with a few drops of extract. A white precipitate proved the presence of phenolic chemicals (Raaman 2006).

Test for Flavonoids

Alkaline Reagent Test Plant extract was combined with 2 mL of 2% sodium hydroxide. When a few drops of diluted hydrochloric acid were added, the mixture's colour changed to colourless, indicating the presence of flavonoids (Raaman 2006).

Test for Saponin A small amount of extract was combined with a small amount of distilled water and then shaken briskly. The formation of foam suggested the presence of saponin (Brahma and Baruah 2023).

Quantitative Phytochemical Test

A quantitative phytochemical study was carried out to determine total alkaloid, flavonoid, and terpenoid contents.

Total Alkaloid Content

After measuring 2.50 gm of powder, 200 mL of 10% acetic acid in ethanol was added and left for 4 h. to rest. The filtrate was heated in a water bath following filtering. Concentrated ammonium hydroxide was used to complete the precipitation process. The sample was washed with 20 mL of 0.1 M ammonium hydroxide and filtered. The residue was dried in an oven and weighed using an electronic balance (Brahma and Baruah 2023).

The formula to calculate alkaloid content is as follows-

Alkaloid content (%) = Final weight of the extract residue/ Initial weight of the powder × 100.

Total Flavonoid Content

Weighed 2.5 gm of powder into a 250 ml beaker, poured 100 mL of 80% aqueous methanol, and stored at room temperature for 24 h. The extract was filtered using Whatman filter paper no. 1. After extraction, 80% ethanol was added to the sample and filtered using Whatman filter paper no. 1. The extract was collected (Brahma and Baruah 2023).

The total flavonoid content was determined quantitatively as-

Flavonoid (%) = Final weight of extract residue/Initial weight of powder × 100.

Total Terpenoid Content

50 mL of alcohol was added to 2 gm of the sample's dry powder, which was then placed in a beaker and agitated for a full day before filtering. The filtrate extract was combined with 10 mL of petroleum ether and filtered once more (Brahma and Baruah 2023).

The following formula was used to get the total terpenoid content-

Terpenoid (%) = Final weight of extract residue/Initial weight of powder × 100.

Gas Chromatography-Mass Spectrometry (GC–MS) Analysis

A methanolic and petroleum ether extract of *B lanceolaria* leaves were analyzed using a Perkin Elmer Clarus 680 GC and amplifier with Turbo Mass Ver 6.1.2 software. The peaks and chemical components in the mass spectrum were identified using NIST-2014 software (Brahma and Baruah 2023).

DPPH Free Radical Scavenging Assay

A methanolic extract and petroleum ether extract of *B. lanceolaria* (Roxb.) Druce was evaluated for antioxidant activity using DPPH (2,2-Dipheny-1-picryl-hydrazyl-hydrate) assay (Brahma and Baruah 2023). In the absence of light, 1 mL of methanolic extract solutions (10–50 µg/mL) were mixed with 3 mL of DPPH solution and at 37 °C incubated for 30 min. The blank was made with 3 mL of methanol, whereas the control was made with 2 mL of methanol and 1 mL of DPPH solution. After that extracts' absorbance at 517 nm was measured using a UV–Vis spectrophotometer and compared to equal amounts of normal ascorbic acid.

The DPPH radical scavenging assay was evaluated using the following formula:

$$\% \text{ of inhibition} = (\text{Absorbance of control} - \text{Absorbance of the sample extract or standard})/\text{Absorbance of control} \times 100$$

Results

Macroscopic Study

B. lanceolaria is a perennialherb. Stems are herbaceous, woody at the base, hairy, branched above. Leaves are simple, alternate, oblanceolate or lanceolate, 0.3 – 9.5 cm long, apex acuminate, margins minutely serrate-dentate, glabrous and dark green. Capitula numerous, 0.9 – 1 cm × 0.5 – 0.6 cm. Involucre bracts are pubescent; phyllaries in 2–3 series, outer one is shorter, lanceolate to linear, 0.3 – 0.9 cm × 0.3 – 0.5 cm. Florets are yellow, 0.7 – – 0.8 cm. Achenes are oblong, 0.1 cm. Pappus 0.5 cm.

Organoleptic Study

The organoleptic observation resulting the aromatic smell, spicy or slightly astringent taste, and the texture of the leaves and stem rough and hairy. The stem is cylindrical, green to purplish colour and leaves green in colour with serrate to dentate. The leaf powder gives an aromatic smell, smooth in texture and green in colour.

Microscopic Study

Transverse Section of Stem

The cuticle is thick and the epidermis consists of tiny, single-layered cells with deposits. Multicellular trichomes were present in the stem. The cortex is divided into three areas: hypodermis, middle cortex, and inner cortex. There are numerous vascular bundles. The phloem is composed of sieve cells, companion cells, fibres, and parenchyma. Xylem is classified as metaxylem and protoxylem. Pith is composed of big, thin-walled parenchymatous cells with intercellular gaps (Fig. 1).

Transverse Section of Leaf

The epidermis is composed of single-layered, tiny, thick-walled cells with thick cuticles. The leaves include multicellular epidermal hairs. Mesophyll is divided into palisade and spongy tissue. The midrib area has a small number of vascular bundles. Vascular bundles consist of both xylem and phloem. Xylem is divided into metaxylem and protoxylem vessels (Fig. 1).

Transverse Section of Petiole

The cuticle is thick and the epidermis is single-layered, composed of small parenchyma cells. The scattered vascular bundle composed of xylem and phloem were observed (Fig. 1).

Foliar Epidermal Study Through Light Microscopy (LM) and FESEM (Field Emission Scanning Electron Microscopy)

The leaves of *B. lanceolaria* are hypostomatic. Anisocytic, anomocytic, dicytic and paracytic types of stomata are observed in the lower surface of leaves. The maximum

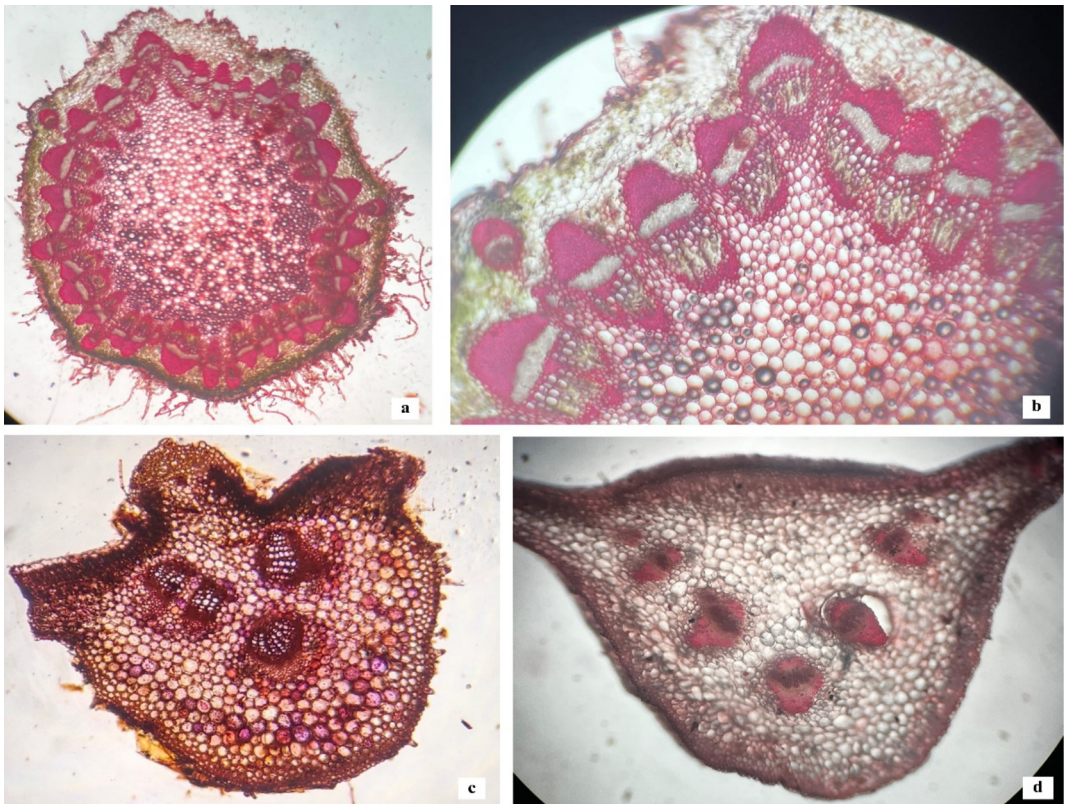

Fig. 1 Transverse section (T. S.) of different parts of *B. lanceolaria*: **a**–**b** T.S. of stem (10X, 40X), **c** T.S. of leaf (10X), **d** T.S. of petiole (10X)

length of the stomata is 32.76–42.28 µm and breadth is 12.57–22.89 µm. The stomatal index on the lower surface is 19.13%. In the upper surface of the leaf, the epidermal cells are wavy, pentagonal, and hexagonal and in the lower surface, the epidermal cells are polygonal type. Multicellular trichomes are observed on the lower surface of the leaf (Fig. 2).

Powder Microscopic Study

Leaf powder microscopy revealed epidermal cells with different types of stomata and uniseriate multicellular trichomes (Fig. 3).

Qualitative Phytochemical Analysis

Qualitative phytochemical screening of methanol and petroleum ether leaf extract indicated the presence of the secondary metabolites which are represented in Table 1.

Here, "−" indicates absent and "+" indicates present; "ppt" for precipitate.

Quantitative Phytochemical Analysis

Quantitative analysis of total alkaloid, flavonoid and terpenoid contents are presented in Table 2.

Results were analyzed in triplicate experiments (mean ± SD).

GC–MS Analysis

Figures 4 and 5 depicted the GC–MS chromatogram in *B. lanceolaria* methanol and petroleum leaf extracts. The volatile compounds in the leaf extract were determined using the NIST library. The retention time, molecular weight, molecular formula, percentage of peak area, and biological activities of identified compounds were determined in Table 3 and 4 respectively. In the methanol leaf extract, the identified compounds were 2,2-Dimethyl-1, 3-butanediol, N-Decanoic

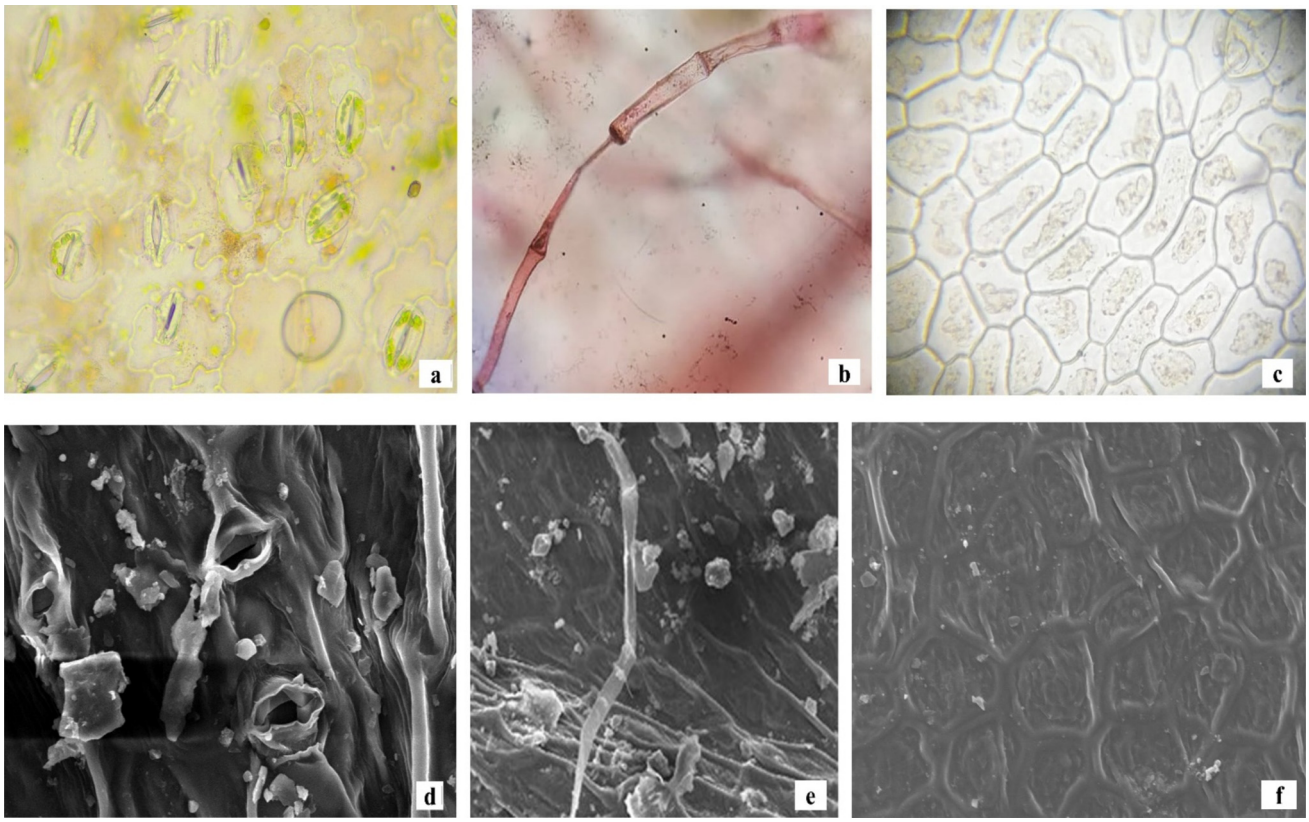

Fig. 2 Light microscopy of leaf epidermis of *B. lanceolaria*: **a** Lower surface of leaf showing stomata (40X), **b** Trichome on lower surface (40X), **c** Upper surface of leaf (40X), Field Emission Scanning Electron Microscopy of leaf epidermis of *B. lanceolaria*: **d** Lower surface of leaf showing stomata, **e** Trichome on lower surface, **f** Upper surface of leaf

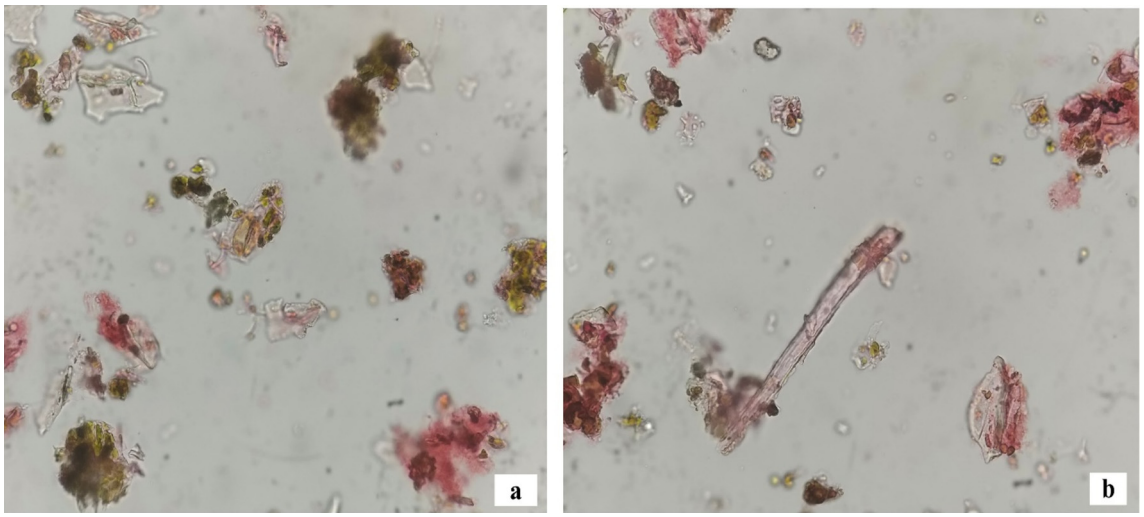

Fig. 3 Powder microscopy of leaf of *B. lanceolaria*: **a**–**b** Powder microscopy showing stomata and trichome (40X)

acid, Chloroacetic acid, Tetradecyl ester, Cis-2-methyl-4-N-buthylthiane, S, S- Dioxide, Dodecanoic acid, Diethyl phthalate, AR-Turmerone. Caryophyllene, Hexanedioic acid, bis (2-ethyl hexyl) ester, Tricosanal, Chloroacetic acid, Tetradecyl ester, and 1-Hexadecanol were identified compounds in the petroleum ether leaf extract.

Table 1 Qualitative phytochemical study of methanolic and petroleum ether leaf extract of *B. lanceolaria*

Parameters	Test	Results	Methanolic extract	Petroleum ether extract
Alkaloid test	Dragendorff's test	Yellowish ppt	+	+
	Mayer's test	Yellowish ppt	−	+
	Wagner's test	Reddish-brown ppt	−	+
Carbohydrates	Fehling's test	Red ppt	−	−
	Iodine test	Purple colour	−	+
	Molisch's test	Purple or violet colour	−	−
Saponin test	Foam test	Foam	+	+
Protein test	Millon's test	White ppt	−	+
	Ninhydrin test	Violet colour	−	−
Phenols	Lead acetate test	White ppt	−	+
	Ferric chloride test	Bluish-green	+	+
Test for flavonoids	Alkaline reagent test	Colourless	−	+

Table 2 Quantitative estimation of total alkaloid, flavonoid and terpenoid contents of leaves of *B. lanceolaria*

Parameters	Results (% yield)
Total alkaloid content	11.97 ± 0.05
Total flavonoid content	7.49 ± 0.23
Total terpenoid content	2.27 ± 0.26

DPPH Free Radical Scavenging Assay

The DPPH assay was used to evaluate the antioxidant properties of the leaf extract of *B. lanceolaria*. The % inhibition concentration against the standard, methanolic, and petroleum ether sample extract of DPPH assay were presented in Fig. 6. Concentrations were taken ranging from 10 to 50 µg/mL and the percentage inhibition of methanol and petroleum ether leaf extract compared to standard ascorbic acid were represented in Table 5. At 50 µg/mL concentration, methanol and petroleum ether leaf extract showed inhibition of 72.47 ± 1.19% and 26.77 ± 2.65% respectively while ascorbic acid showed inhibition of 37.02 ± 4.19%. IC_{50} values of methanol and petroleum ether leaf extract exhibited 28.82 ± 1.35 µg/mL and 35.84 ± 0.40 µg/mL respectively while standard exhibited 42.20 ± 4.38 µg/mL that indicated good concentrations of antioxidant properties.

Ethnobotanical Uses of B. lanceolaria

Ethnobotanical uses of *B. lanceolaria* were done by consulting the local people of the specimen collected area, represented in Table 6. *B. lanceolaria* has been used

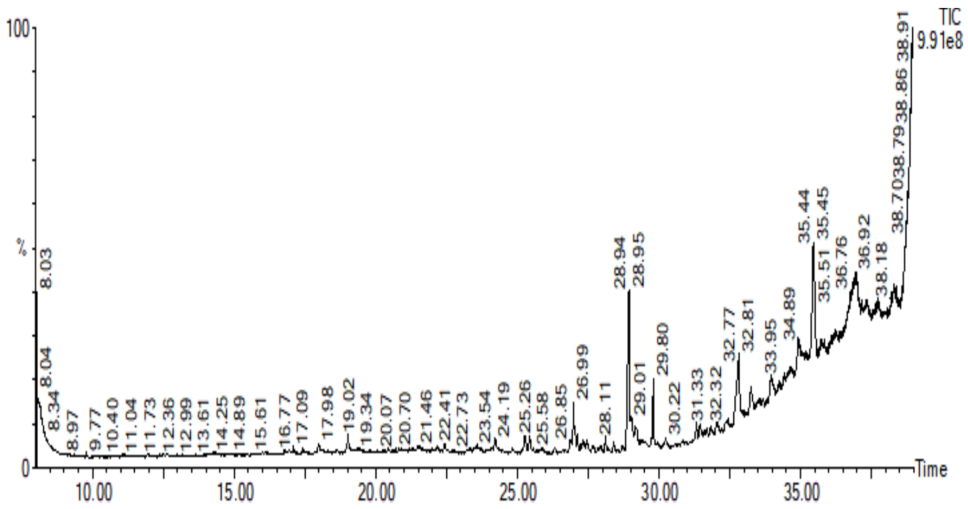

Fig. 4 Chromatogram of methanolic leaf extract of *B. lanceolaria*

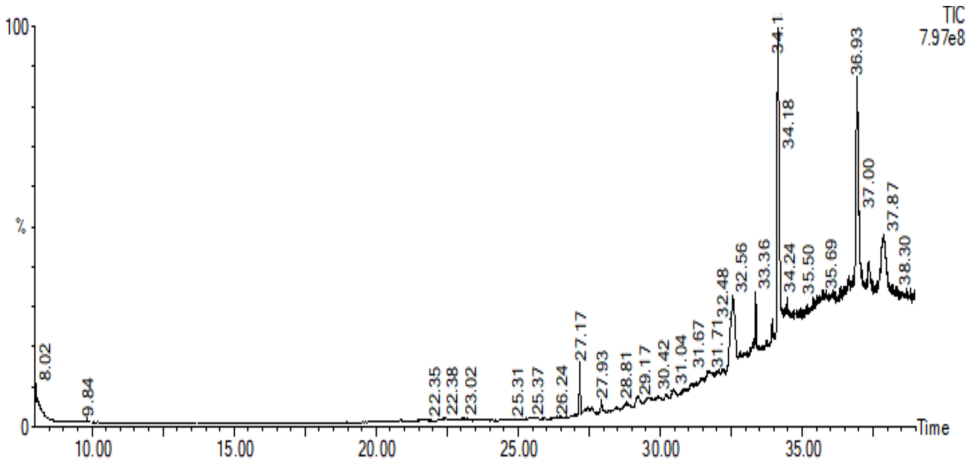

Fig. 5 Chromatogram of petroleum ether leaf extract of *B. lanceolaria*

Table 3 Identified phytocompounds and their biological activity of methanol leaf extract of *B. lanceolaria* by using GC–MS

Retention time	Area%	Compound name	Molecular formula	Molecular weight	Biological activity
19.023	0.687	2,2-Dimethyl-1,3- Butanediol	$C_6H_{14}O_2$	118	Antibacterial, anticancer (Brahma and Baruah 2024)
24.225	0.601	N-Decanoic acid	$C_{10}H_{20}O_2$	172	Antibacterial, anti-inflammatory, antimicrobial, antifungal, antitumor (Ahmad et al. 2018; Shen et al. 2021; Yang et al. 2023)
25.280	0.745	Chloroacetic acid, Tetradecyl ester	$C_{16}H_{31}ClO_2$	290	Antibacteriocide, antioxidant, antimicrobial, anti-inflammatory (Ralte et al. 2022)
25.445	0.546	Cis-2-Methyl-4-n- Butylthiane, S, S-Dioxide	$C_{10}H_{20}O_2S$	204	Antifungal, antimicrobial, antioxidant, antibacterial, anti-inflammatory (Mohiuddin et al. 2022)
28.947	6.279	Dodecanoic acid	$C_{12}H_{24}O_2$	200	Antibacterial, antimicrobial, antitumor, anti-inflammatory (Anzaku et al. 2017; Ameena et al. 2024)
29.798	1.594	Diethyl phthalate	$C_{12}H_{14}O_4$	222	Antimicrobial, acetylcholinesterase, neurotoxic activity (Dubey et al. 2014)
31.328	0.459	AR-Turmerone	$C_{15}H_{20}O$	216	Antitumor, antioxidant, anti-inflammatory, antibacterial (Orellna-Paucar and Machando-Orellana 2022)

traditionally for medicine, mainly in Northeast India. Especially the Bodo tribe of Assam used the plant to cure a common cold, cough, pneumonia, and wound healing. The Bodo communities of Assam also add leaves of *B. lanceolaria* in the preparation of 'Gwkha Gwkhwi' (bitter sour), mixed wild vegetables during the primary or seasonal festival of Assam i.e., 'Bwisagu' (beginning of New Year in Assam). There is a belief among the Bodo tribes of Assam that if we eat these mixed wild vegetables during the Bwisagu festival, then all our diseases from the body will vanish.

Discussion

Establishing pharmacognostic standards, ensuring quality, and correct identification are all crucial aspects of medicinal plants and the first stage in determining the identity and the characteristics of a medicinal plant is to examine its macroscopic and microscopic characteristics (Pandey and Tripathi 2014). For accurate drug identification and raw material assurance, microscopic evaluation is one of the least expensive techniques (Akbar et al. 2014). A study of powdered microscopy revealed the structural information of the raw drugs (Majid et al. 2021).

Table 4 Identified phytocompounds and their biological activity of petroleum ether leaf extract of *B. lanceolaria* by using GC–MS

Retention Time	Area%	Compound name	Molecular formula	Molecular weight	Biological activity
27.171	1.429	Caryophyllene	$C_{15}H_{24}$	204	Anti-inflammatory, antimicrobial, antioxidant, anticancer, antibacterial (Dahham et al. 2015; Moo et al. 2020)
32.828	1.079	Hexanedioic acid, bis(2-ethylhexyl) ester	$C_{22}H_{44}O_4$	370	Antifungal (Ferdosi et al. 2021)
33.359	1.559	Tricosanal	$C_{23}H_{46}O$	338	No activity reported
34.134	16.355	Chloroacetic acid, Tetradecyl ester	$C_{16}H_{31}ClO_2$	290	Antibacteriocide, antioxidant, antimicrobial, anti-inflammatory (Ralte et al. 2022)
34.139	0.475	1-Hexadecanol	$C_{16}H_{34}O$	242	Antioxidant, anti-inflammatory, antimicrobial (Amudha et al. 2018; Vedhanayaki and Ramkumar 2019)

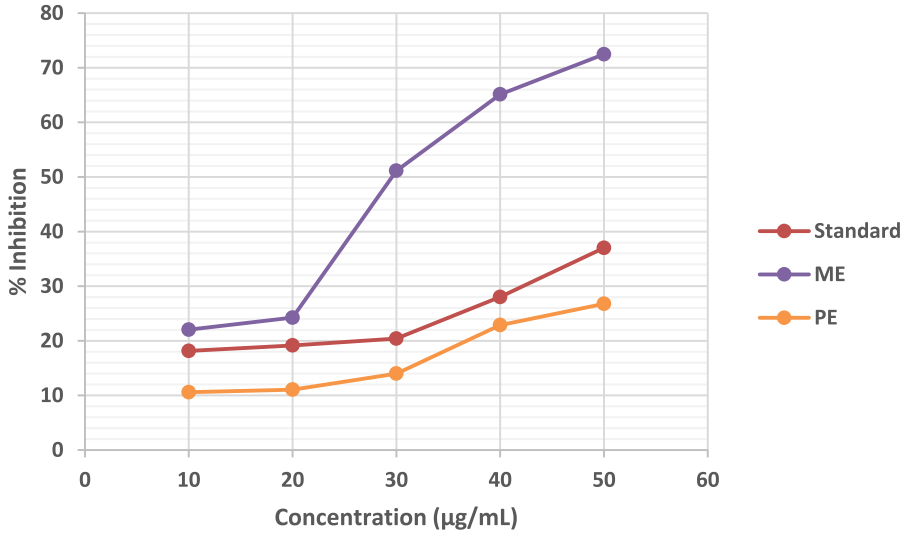

Fig. 6 Graphical comparison showing the % inhibition concentration against standard, methanolic and petroleum ether sample extract of DPPH assay

Table 5 DPPH assay of methanolic and petroleum ether extract of *B. lanceolaria* and ascorbic acid

Concentration (µg/mL)	% inhibition of methanol extract	% inhibition of petroleum extract	% inhibition of ascorbic acid (Standard)
10	22.04 ± 6.77	10.59 ± 7.56	18.15 ± 11.26
20	24.25 ± 5.98	11.06 ± 8.08	19.76 ± 2.16
30	51.14 ± 7.30	13.99 ± 5.06	20.41 ± 3.18
40	65.12 ± 16.23	22.88 ± 10.11	28.20 ± 1.72
50	72.47 ± 1.19	26.77 ± 2.65	37.02 ± 4.19
IC_{50} (µg/mL)	28.82 ± 1.35	35.84 ± 0.40	42.20 ± 4.38

Taxonomically, *B. lanceolaria* of the family Asteraceae can be identified by its head and capitulum inflorescence, the presence of phyllaries, florets, and achenes with pappus. The plant is well known for its ethnomedicinal value. Macroscopic study revealed the importance of the morphological characteristics of the plant.

The microscopic study revealed the important characteristics of the stem, midrib, petiole, and leaf. The leaves were hypostomatic i.e., the stomata were restricted only to lower the surface of the leaf. Mainly four different types of stomata have been observed i.e., paracytic, anomocytic, anisocytic, and dicytic. The upper epidermal cell surface

Table 6 Ethnobotanical uses of both primary and secondary sources *B. lanceolaria*

Species name	Parts used	Ethnobotanical uses	
		Primary source	Secondary source
B. lanceolaria	Leaf	Used as a curry or soup to treat the common cold, cough, pneumonia, and wound healing. Especially the Bodo tribe used to prepare 'Gwkha Gwkhwi', a distinctive Bodo dish during the primary festival i.e., 'Bwisagu'. Oil extracted from the leaf is also used as a massage oil to cure inflammation of limbs	Eaten as vegetables, used as medicine for cough, antipyretic, anti-inflammatory, analgesic, wound healing, diuretic, skin infection, asthma, ulcer, dysentery and relief from urinary problems (Lalmuanthanga et al. 2019; Victoria et al. 2012; Ralte et al. 2024)

was wavy and polygonal hexagonal but only polygonal type was observed on the lower surface. Uniseriate multicellular trichomes were observed on the lower surface of the leaf. These characteristics will help the identification of different plant parts for drug evaluation.

Preliminary qualitative phytochemical studies confirmed the presence of different secondary metabolites such as alkaloids, carbohydrates, flavonoids, saponin, protein, and phenol. Phytochemical screening revealed more significance in petroleum ether extract than methanolic extract. The quantitative phytochemical study (Fig. 7) resulting the highest percentage yield of alkaloid content (11.97 ± 0.05) followed by flavonoid (7.49 ± 0.23) and terpenoid (2.27 ± 0.26).

The major compounds of methanolic extract of *B. lanceolaria* recorded from GC–MS analysis are 2,2-Dimethyl-1, 3-butanediol (area% = 0.687, RT = 19.023), N-Decanoic acid (area% = 0.601, RT = 24.225), Chloroacetic acid, Tetradecyl ester (area% = 0.745, RT = 25.280), Cis-2-methyl-4-n-buthylthiane, S, S-dioxide (area% = 0.546, RT = 25.445), Dodecanoic acid (area% = 6.279, RT = 28.947), Diethyl phthalate (area% = 1.594, RT = 29.798), AR-Turmerone (area% = 0.459, RT = 31.328). Previous work suggested that Dodecanoic acid exhibitted antibacterial, antimicrobial, antitumor and anti-inflammatory activities (Table 3) and bioactive compounds identified from petroleum ether extract showed Caryophyllene (area% = 1.429, RT = 27.171), Hexanedioic acid, bis (2-ethyl hexyl) ester (area% = 1.079, RT = 32.828), Tricosanal (area% = 1.559, RT = 33.359), 1-Hexadecanol (area% = 0.475, RT = 34.139) Chloroacetic acid, tetradecyl ester (area% = 16.355 RT = 34.134). The highest percentage peak area is 16.355% with the major identified compound Chloroacetic acid, Tetradecyl ester and earlier research suggested that the compound exhibited different pharmacological activities such as antibacteriocide, antioxidant, antimicrobial, and anti-inflammatory properties (Table 4).

The DPPH free radical scavenging assay was performed to evaluate antioxidant activity. The lowest IC_{50} value indicates the most effective antioxidant action. The lowest IC_{50} value is observed in methanolic extract (28.82 ± 1.35 µg/mL) compared to petroleum ether extract (35.84 ± 0.40 µg/mL) and standard (42.20 ± 4.38 µg/mL).

The ethnobotanical study revealed that *B. lanceolaria* is used in traditional medicine for wound healing, chronic ulcers and dysentery prevention, pneumonia, common cold, cough and also leaves are used to treat asthma, bronchitis, hemorrhoids, astringents, anthelmintic, and febrifuges.

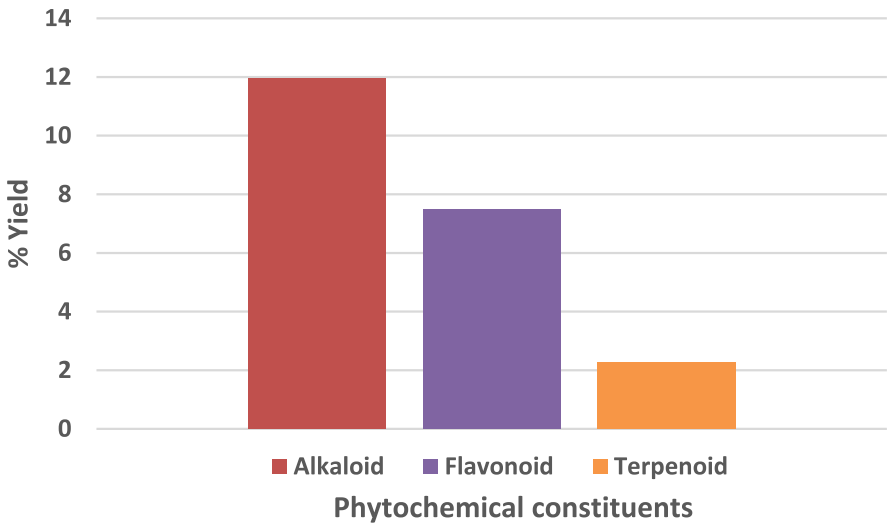

Fig. 7 Graphical comparison showing the % yield of total alkaloid, flavonoid, and terpenoid contents

Conclusion

The present study offers a detailed pharmacognostical, phytochemical study, and the importance of antioxidant activity and GC–MS analysis in association with traditional uses of *B. lanceolaria*. The study revealed the plant has a rich medicinal property used to treat several ailments such as wound healing, cough, asthma, bronchitis, pneumonia, etc. Leaves extract indicated having various phytochemical constituents and chemical compounds with antioxidantproperties. Hence, the outcomes of the present study will be helpful for the correct identification and standardization of the species assisting in the establishment of drug purity assurance and quality control standards.

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Declarations

Conflict of interest Authors declare that they have no conflict of interest.

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