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RESEARCH ARTICLE

PHYTOCHEMICAL STUDIES ON TRIBALLY USED AQUATIC MEDICINAL PLANTS OF LALBAGH BLOCK OF MURSHIDABAD DISTRICT, WEST BENGAL, INDIA

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Abstract: Since ancient times, plants have been utilized to treat a wide range of ailments. Conventional medical practices, such as Homeopathy, Ayurveda, and Unani, utilize the understanding of ethnomedicinal plants to address human health problems. Among tribal communities, these plants continue to be used for various traditional healthcare practices. Plants possess a multitude of bioactive chemicals that serve as the foundation for medical care; known as Secondary metabolites. The present study deals with the phytochemical screening and ethnomedicinal documentation of aquatic plants used by the tribal people of Lalbagh block of Murshidabad district. Fourteen aquatic and semi-aquatic plant species belonging to different families have been documented through field surveys and interviews, highlighting their medicinal importance. Each species then subjected to phytochemical screening using aqueous and organic solvent extracts to detect the different secondary metabolites. Results confirmed the presence of alkaloids, flavonoids, tannins, saponins, terpenoids, phenol etc. These secondary metabolites are associated with specific pharmacological activities that validate the indigenous therapeutic claims. This study aims towards detailed documentation of tribally used ethnomedicinally important aquatic plants with their potential reservoirs of bioactive compounds for future drug development and sustainable healthcare approaches.

Keywords: Phytochemical screening, Secondary metabolites, Tribal ethnomedicinal profiles, Murshidabad

INTRODUCTION

The present study aims to document and evaluate the phytochemical composition of aquatic and semi-aquatic medicinal plants traditionally utilized by the tribal communities of the Lalbagh block of Murshidabad district, West Bengal. Medicinal plants have been used since ancient times as a primary source of healthcare across different cultures, owing to their diverse bioactive constituents known as secondary metabolites. Aquatic and semi-aquatic plants, although less explored than terrestrial plants, represent an important group of medicinal flora with immense pharmacological potential. These plants thrive under unique ecological conditions, often resulting in the synthesis of distinctive secondary metabolites with antioxidant, antimicrobial, anti-inflammatory, and neuroprotective properties (Arya *et al*., 2022).

Ethnobotanical research conducted across different regions of India indicates that indigenous and tribal communities possess extensive and well-structured traditional knowledge related to the use of medicinal plants, including aquatic and semi-aquatic species, for treating a wide range of health-related issues. This knowledge system, which is largely transmitted verbally from one generation to the next, plays a vital role in primary healthcare practices and reflects long-term empirical observations of plant efficacy. Such indigenous wisdom forms a crucial foundation for contemporary ethnopharmacological research, aiding in the scientific validation of traditional remedies and the identification of potential bioactive compounds (Sharma, Thakur, & Uniyal, 2019). Recent reviews highlight that aquatic and semi-aquatic medicinal plants are rich sources of alkaloids, flavonoids, tannins, saponins, terpenoids, glycosides, phenols, and steroids, which contribute significantly to their therapeutic efficacy (Ochatt *et al.*, 2022). These compounds play crucial roles in plant defense and exhibit strong biological activities beneficial to human health. Few Studies focusing on hydrophytes have demonstrated that phenolic compounds and flavonoids are among the most dominant metabolites, imparting antioxidant, antimicrobial, antiparasitic, and anticancer activities (Alharthi *et al.*, 2024). This highlights the pharmaceutical relevance of wetland plants and supports their traditional medicinal usage. In India, wetlands serve as biodiversity-rich ecosystems supporting numerous medicinal aquatic plants. Ethnobotanical surveys conducted in different regions of the country have documented extensive use of aquatic macrophytes by tribal communities for traditional healthcare practices (Behera, 2006).

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However, scientific validation of these medicinal claims through phytochemical screening remains inadequate for many species.

Comparative phytochemical studies have clearly demonstrated that solvent polarity plays a crucial role in the extraction of secondary metabolites from plant materials. Organic solvents such as methanol and ethanol are generally more efficient than aqueous solvents in extracting a wider range of bioactive compounds due to their ability to dissolve both polar and moderately non-polar phytochemicals. Such solvent-based evaluations are therefore essential for understanding metabolite solubility patterns and optimizing extraction efficiency in phytochemical investigations (Tiwari et al., 2011). Systematic ethnobotanical studies from West Bengal indicate that aquatic and semi-aquatic medicinal plants continue to be widely used in rural and tribal healthcare systems, yet many remain unexplored scientifically. Documentation efforts in different districts have recorded extensive traditional uses of wetland and local flora for treating diverse ailments, emphasizing the need for phytochemical and pharmacological validation of these species (Chakraborty, Mondal, & Mukherjee, 2016).

Statistical evaluation will further assess the efficiency of different solvents in extracting these compounds and highlight metabolite richness across species (Kumar & Bhat, 2022). By correlating ethnomedicinal claims with laboratory-based phytochemical profiles, the study intends to identify potential candidate plants for pharmacological exploration, drug discovery, and sustainable healthcare practices (WHO, 2013). Ultimately, this research underscores the importance of conserving indigenous medicinal plant resources and promoting their sustainable use in the context of biodiversity preservation and traditional knowledge systems, thereby contributing to both scientific advancement and community-based healthcare resilience.

METHODOLOGY

The present study deals with the ethnobotanical knowledge related to medicinal uses of aquatic and semi aquatic plants used by tribal as well as local people of Lalbagh block of Murshidabad district (24.17590^{o} N, 88.28020^{o} E), West Bengal. The district Murshidabad is one of the important districts in West Bengal that is full of rivers and wetlands. Generally, two types of interviews were conducted- firstly, of individuals and secondly of groups. Of individuals, people were selected randomly from the knowledgeable and for groups more than one person is approached. They talk about the plants and their local collection side as well. Plants were then collected and identified with the help of different Floras and standard literatures. For every plant species, the appropriate morphology and other important traits were meticulously recorded. A documentation table was created to store the detailed knowledge of tribal folk medicine of Lalbagh block of Murshidabad District showing the plants scientific name as well as local name with their medicinal uses. Which parts of the plants and how those parts are used are also documented.

To check the medicinal properties of those plants, phytochemical screening of secondary metabolites has been performed. Firstly, fresh leaves are collected from each plant sample and crushed thoroughly using a mortar pestle with aqueous, methanol &ethanol as the solvent. The obtained crude extracts then taken into centrifuge tubes and centrifuged for 12-15 minutes. Supernatant is taken and filtration was done using filter paper. Lastly, the final filtered supernatants are taken in the fresh test tubes and labeled properly for various qualitative phytochemical tests, (Ochatt *et al.,* 2022).

Qualitative Test

- **A. Test for Alkaloids:** 2ml 1% HCl is added to the crude extract. Then the mixture is heated and then Mayer's reagent and Wagner's reagent are added and if precipitate is formed then it shows the presence of alkaloids. (Mandal *et al.,* 2023)
- **B. Test for Flavonoids:** Alkaline reagent test is performed; 1 ml of crude extract is taken to it 3 ml of 2% NaOH solution is added. Dark yellow is developed and then if a few drops of diluted acid are added the color disappears. This confirms the presence of flavonoids in the sample. (Mandal *et al.,* 2023)
- **C. Test for Tannins:** 3 ml of the crude extract is taken obtained from the plant samples and to it, 1 ml of distilled water is added to it. To this mixture of the solution, 1ml of 5% Ferric chloride solution is added. If black is formed, then it indicates the presence of tannins. (Mandal *et al.*, 2023)
- **D. Test for Saponins:** 1 ml of the crude extract and 5 ml of distilled water was taken and shaken vigorously; the constant foam formation indicated the presence of saponin. (Mandal et al., 2023)
- **E. Test for Terpenoids:**1 ml of the crude extract was taken, and 2 ml of conc. sulfuric acid (H_2SO_4) was added to it. If reddish-brown coloration at the interface appeared, indicates terpenoids.
- **F. Test for Glycosides:** Keller-Kilani test, 1 ml of the crude extract was taken and mixed with 2ml of Glacial acetic acid. 1 ml of 2% Ferric chloride solution is used. Then to the mixture 2 ml of conc. H_2SO_4 is added. A brown ring is formed at the interface which gives a positive result for the Glycosides. (Mandal *et al*., 2023)
- **G. Test for Phenols:** 2 ml of alcohol and 1 ml of Ferric chloride solution is added to 1 ml of crude extract. If blue, green, or black color is developed, it shows the presence of phenols in the sample. (Mandal *et al.*, 2023)

RESULTS AND DISCUSSIONS

The survey conducted in the wetland and adjoining rural areas of the Lalbagh block, Murshidabad district, revealed a rich diversity of aquatic and semi-aquatic medicinal plants traditionally used by local and tribal communities for primary healthcare. Information regarding vernacular names, plant parts used, modes of preparation, and therapeutic applications was systematically documented through field observations and interactions with traditional healers and elderly informants. A total of 14 aquatic medicinal plant species belonging to 13 families were recorded, reflecting the strong dependence of indigenous communities on wetland flora for treating a wide range of ailments.

These plants are primarily utilized in the form of fresh pastes, decoctions, infusions, indicating simple yet effective traditional processing methods (Tomar, 2022). Leaves and whole plants were the most frequently used parts, which may be attributed to their easy availability and higher concentration of bioactive compounds. The recorded medicinal uses ranged from treatment of skin disorders, wounds, and inflammation to neurological, digestive, and metabolic conditions. Such medicinal practices are consistent with earlier reports from wetland-rich regions of eastern India, highlighting the therapeutic significance of aquatic plant resources.

Based on documented information on medicinally important plants, subsequent phytochemical evaluation and comparative analysis of secondary metabolites are conducted. The list of traditionally used aquatic medicinal plants recorded from the study area, along with their botanical identity, family, parts used, method of use, and medicinal importance, is presented in Table 1.

Table 1: Shows the list of tribally used aquatic medicinal plants of Lalbagh block of Murshidabad district

Sl. No	Common Name	Botanical Name	Family	Parts Used	Method Used	Medicinal Importance
1	**Thankuni**	*Centella asiatica* (L.) Urb.	Apiaceae	Leaves, whole plant	Crushed or boiled to make herbal tea or paste	Memory enhancement, wound healing, skin issues
2	**Brahmi Shak**	*Bacopa monnieri* (L.) Wettst.	Plantaginaceae	Whole plant	Made into decoction or paste for oral use	Nervine tonic, epilepsy, anti-anxiety
3	**Bhringraj**	*Eclipta prostrata* (L.) L.	Asteraceae	Leaves, whole plant	Leaf juice applied topically or taken orally	Liver tonic, hair growth promoter, skin problems
4	**Kolmi Shak**	*Ipomoea aquatica*Forssk.	Convolvulaceae	Stems and leaves	Cooked as vegetable, leaf juice used	Anti-inflammatory, detoxification, jaundice remedy
5	**Sushni Shak**	*Marsilea quadrifolia* L.	Marsileaceae	Leaves	Boiled or juiced, sometimes dried	Anticonvulsant, febrifuge, urinary relief
6	**Water Lily**	*Nymphaea nouchali* Burm.f.	Nymphaeaceae	Flowers, roots	Flower extracts used in decoctions	Cooling agent, astringent, promotes fertility
7	**Lotus**	*Nelumbo nucifera*Gaertn.	Nelumbonaceae	Flowers, seeds, rhizomes	Seeds eaten, petals used in infusions	Cardiac tonic, anti-diarrheal, wound healing
8	**Water Hyacinth**	*Eichhornia crassipes* (Mart.) Solms	Pontederiaceae	Leaves, roots	Crushed into poultice or paste	Skin diseases, inflammation (used cautiously)
9	**Water Lettuce**	*Pistia stratiotes* L.	Araceae	Whole plant	Crushed for topical use	Rheumatism, skin disorders (folk application)

Sl. No	Common Name	Botanical Name	Family	Parts Used	Method Used	Medicinal Importance
10	**Arrowhead**	*Sagittaria trifolia* L.	Alismataceae	Tuber, leaves	Tubers boiled or ground for pastes	Antibacterial, healing wounds, edible
11	**Rice Paddy Herb**	*Limnophila indica* (L.) Druce	Plantaginaceae	Whole plant	Used as infusion or in fresh paste form	Cough suppressant, expectorant, used in fever & indigestion
12	**Water Fern**	*Salvinia molesta* D.S. Mitch.	Salviniaceae	Whole plant	Dried or used in aqueous extracts	Antioxidant, anti-inflammatory, reported antimicrobial
13	**Water Smartweed**	*Polygonum glabrum* Willd.	Polygonaceae	Leaves, stem	Crushed paste or decoction	Antimicrobial, wound healing, anti-inflammatory
14	**Matsyaakshi**	*Alternanthera sessilis* (L.) R.Br. ex DC.	Amaranthaceae	Whole plant	Eaten raw/cooked, used in infusions	Improves eyesight, skin ailments, blood purifier

To validate the ethnomedicinal relevance of the recorded aquatic plant species, a preliminary qualitative phytochemical screening was carried out to detect the presence of major secondary metabolites responsible for therapeutic activity. Extracts of each plant species were prepared using three solvents of varying polarity—aqueous, ethanol, and methanol—in order to assess solvent efficiency and metabolite solubility. The use of multiple solvent systems is essential, as different classes of phytochemicals exhibit differential extractability depending on solvent polarity.

The screening focused on seven important groups of secondary metabolites, namely alkaloids, flavonoids, tannins, saponins, terpenoids, glycosides, and phenols, which are widely reported for their pharmacological properties such as antioxidant, antimicrobial, anti-inflammatory, and neuroprotective activities. Qualitative tests were performed following standard phytochemical protocols, and the results were recorded based on the intensity of colour development or precipitate formation, categorized as present (+), weakly present (±), or absent (−).

The comparative phytochemical profiles obtained across different solvent extracts provide insights into the metabolite richness of individual species and highlight the superiority of alcoholic solvents over aqueous extracts in extracting a broader spectrum of bioactive compounds. The detailed qualitative phytochemical screening results of the 14 aquatic medicinal plants at different solvent fronts are presented in Table 2.

Table 2: Shows Phytochemical Screening of Secondary Metabolites at Different Solvent Fronts

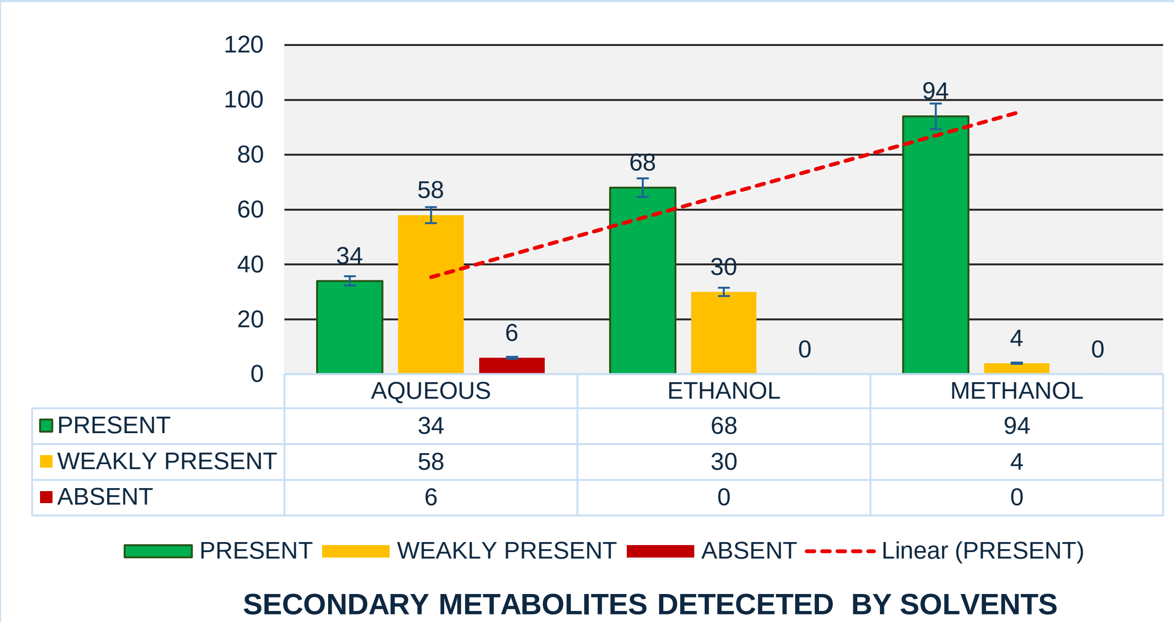
SL NO	BOTANICALNAME	SOLVENT	A	B	C	D	E	F	G
1	*Centella asiatica*	Aqueous	+	+	+	+	±	+	+
		Ethanol	+	+	+	±	+	+	+
		Methanol	+	+	+	+	+	+	+
2	*Bacopa monnieri*	Aqueous	±	+	+	+	±	+	+
		Ethanol	+	+	+	±	+	+	+
		Methanol	+	+	+	+	+	+	+
3	*Eclipta prostrata*	Aqueous	+	±	+	+	±	+	+
		Ethanol	+	+	+	±	+	+	+
		Methanol	+	+	+	+	+	+	+
4	*Ipomoea aquatica*	Aqueous	±	+	±	+	±	±	±

SL NO	BOTANICALNAME	SOLVENT	A	B	C	D	E	F	G
		Ethanol	+	+	+	±	±	+	+
		Methanol	+	+	+	+	+	+	+
5	*Marsilea quadrifolia*	Aqueous	±	±	+	+	±	-	±
		Ethanol	+	+	+	±	±	±	+
		Methanol	+	+	+	+	+	+	+
6	*Nymphaea nouchali*	Aqueous	±	+	+	+	±	±	±
		Ethanol	+	+	+	±	±	+	+
		Methanol	+	+	+	+	+	+	+
7	*Nelumbo nucifera*	Aqueous	+	±	+	±	±	±	±
		Ethanol	+	+	+	±	+	+	+
		Methanol	+	+	+	+	+	+	+
8	*Eichhornia crassipes*	Aqueous	±	±	±	±	-	-	±
		Ethanol	+	+	+	±	±	±	+
		Methanol	+	+	+	+	+	+	+
9	*Pistia stratiotes*	Aqueous	-	±	±	±	±	-	±
		Ethanol	±	+	+	±	±	±	+
		Methanol	+	+	+	+	+	±	+
10	*Sagittaria trifolia*	Aqueous	±	±	±	±	±	±	±
		Ethanol	+	+	+	±	±	±	+
		Methanol	+	+	+	+	+	+	+
11	*Limnophila indica*	Aqueous	±	+	+	±	±	+	+
		Ethanol	+	+	+	±	+	+	+
		Methanol	+	+	+	+	+	+	+
12	*Salvinia molesta*	Aqueous	±	±	+	±	±	±	±
		Ethanol	±	+	+	±	+	±	+
		Methanol	+	+	+	±	+	±	+
13	*Polygonum glabrum*	Aqueous	±	+	+	±	±	±	+
		Ethanol	+	+	+	±	+	+	+
		Methanol	+	+	+	+	+	+	+
14	*Alternanthera sessilis*	Aqueous	±	±	±	+	±	-	±
		Ethanol	±	+	+	±	+	+	+
		Methanol	+	+	+	+	+	+	+

Legends: A: Alkaloids, **B:** Flavonoids, **C:** Tannins, **D:** Saponins, **E:** Terpenoids, **F:** Glycosides, **G:** Phenols. (**+**)**:** Present, (**-**)**:** Absent, (**±**)**:** Weakly Present

To further elucidate the comparative efficiency of different solvent systems in extracting secondary metabolites, the qualitative phytochemical screening results were consolidated and expressed as total counts of metabolites detected under each solvent category. Summarization of the results into present, weakly present, and absent classes allows a clearer comparison of extraction performance among aqueous, ethanolic, and methanolic solvents. This solvent-wise quantification highlights overall trends in metabolite recovery and provides a visual and numerical basis for evaluating solvent polarity in relation to phytochemical solubility. Such comparative assessment is essential for identifying the most suitable solvent system for comprehensive phytochemical investigation of aquatic medicinal plants. The total number of secondary metabolites detected by each solvent system, along with their distribution pattern, is presented in Table 3 and illustrated graphically for better interpretation.

Table 3: Total number of secondary metabolites detected by solvents



To gain a comprehensive understanding of the distribution and prevalence of individual secondary metabolites across all studied aquatic medicinal plants, a frequency-based analysis was carried out. While solvent-wise screening highlights extraction efficiency, frequency analysis allows assessment of how commonly each class of secondary metabolite occurs irrespective of plant species or solvent system. This approach provides valuable insight into the dominant and least abundant phytochemical groups present in the flora investigated.

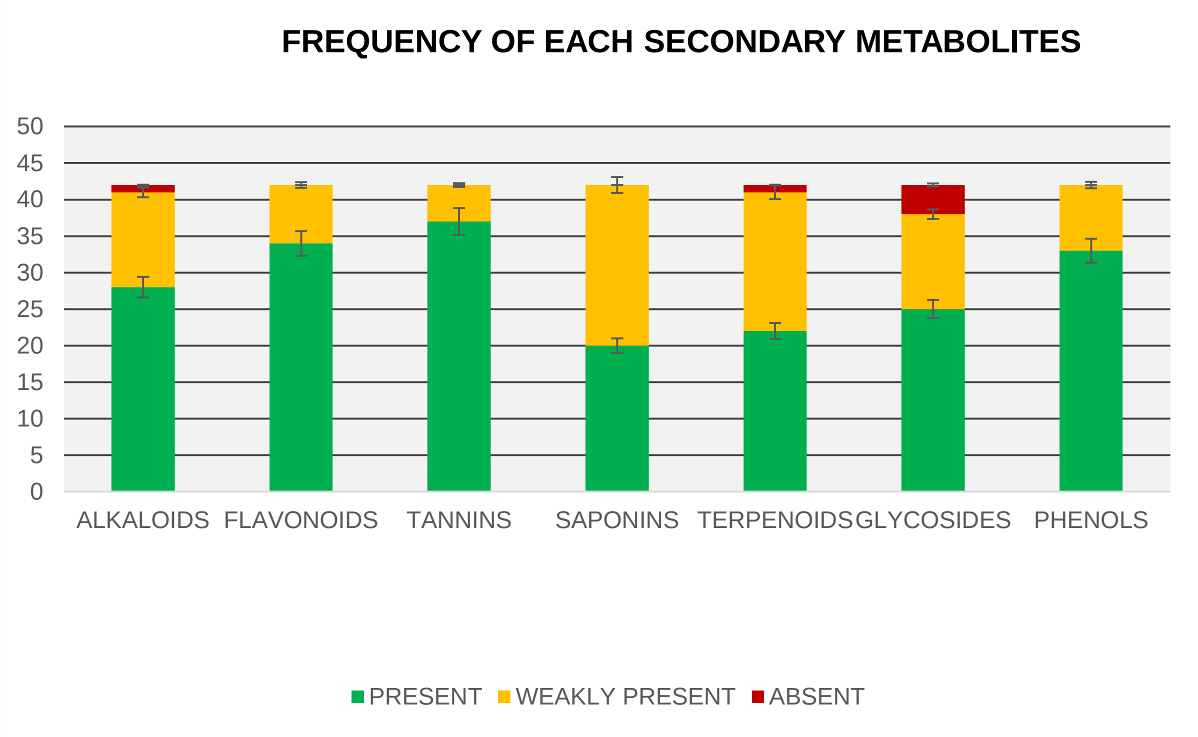
The frequency of each secondary metabolite was determined by compiling the qualitative screening results obtained from all plant–solvent combinations and categorizing them as present, weakly present, or absent. Such an analysis helps to identify metabolite groups that are widely distributed and potentially responsible for the broad therapeutic applications reported in ethnomedicinal practices. Moreover, it facilitates comparison among different classes of compounds in terms of consistency and intensity of occurrence.

The summarized frequency distribution of alkaloids, flavonoids, tannins, saponins, terpenoids, glycosides, phenols, and steroids across all plant species and solvent extracts is presented in Table 4 (A)&4(B).

Table 4 (A): Frequency of each secondary metabolites across all plants & solvents

CODE	NAME OF THE SECONDARY METABOLITES	TOTAL PRESENT	TOTAL WEAKLY-PRESENT	TOTAL ABSENT
A	ALKALOIDS	28	13	01
B	FLAVONOIDS	34	08	00
C	TANNINS	37	05	00
D	SAPONINS	20	22	00
E	TERPENOIDS	22	19	01
F	GLYCOSIDES	25	13	04
G	PHENOLS	33	09	00

Table 4 (B): Frequency of each secondary metabolites across all plants & solvents



To compare the relative phytochemical richness of the investigated aquatic medicinal plants, a plant-wise quantitative assessment was performed based on the total number of positive (+) reactions obtained during qualitative phytochemical screening. The total '+' count represents the cumulative presence of secondary metabolites detected across all solvent extracts and metabolite classes for each plant species. This approach enables identification of species by exhibiting a higher diversity of bioactive constituents.

Plant-wise comparison of metabolite occurrence is important for prioritizing species with greater therapeutic potential and for selecting suitable candidates for further quantitative, pharmacological, and bioactivity-guided studies. Species showing higher total '+' counts are considered metabolite-rich and may contribute significantly to the ethnomedicinal efficacy reported by local communities. The plant-wise distribution of total positive phytochemical reactions is presented in the following table 5(A)& 5(B).

Table 5 (A): Metabolites richness per plant

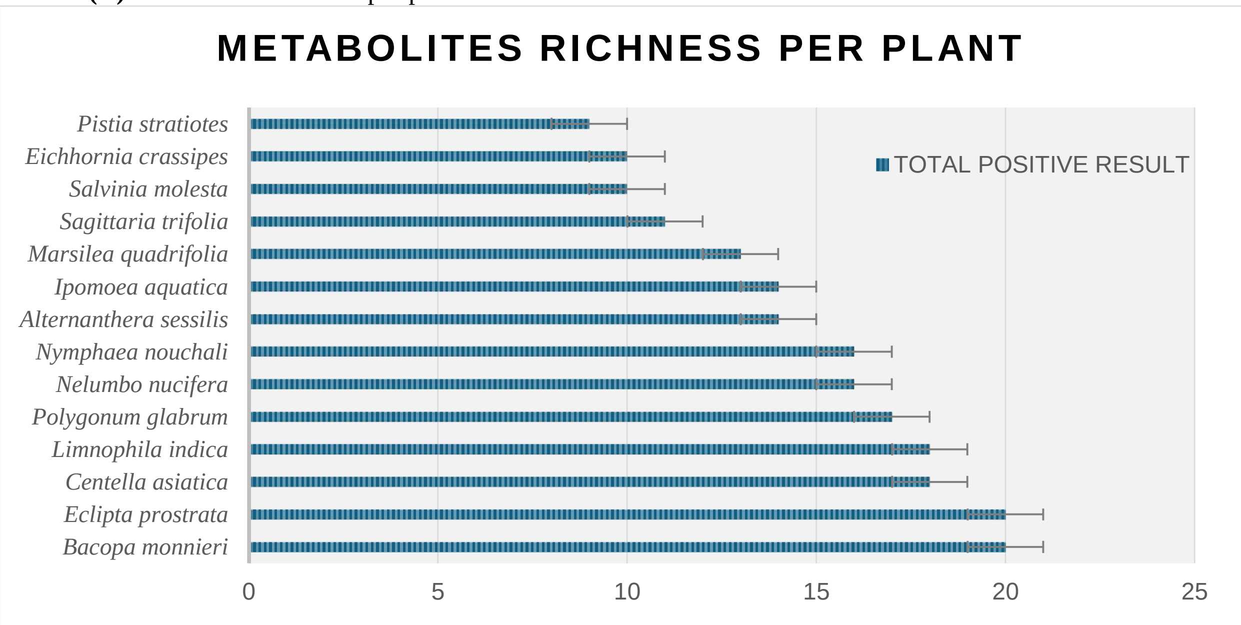


Table 5 (B): Metabolites richness per plant

SL NO	NAME OF THE PLANT	TOTAL '+' COUNTS
1	*Bacopa monnieri*	20
2	*Eclipta prostrata*	20
3	*Centella asiatica*	18
4	*Limnophila indica*	18
5	*Polygonum glabrum*	17
6	*Nelumbo nucifera*	16
7	*Nymphaea nouchali*	16
8	*Alternanthera sessilis*	14
9	*Ipomoea aquatica*	14
10	*Marsilea quadrifolia*	13
11	*Sagittaria trifolia*	11
12	*Salvinia molesta*	10
13	*Eichhornia crassipes*	10
14	*Pistia stratiotes*	09

CONCLUSIONS

The present investigation provides a comprehensive account of tribally used aquatic and semi-aquatic medicinal plants from the Lalbagh block of Murshidabad district, West Bengal, integrating ethnomedicinal knowledge with preliminary phytochemical validation. A total of fourteen aquatic plant species belonging to thirteen families were documented through systematic field surveys, reflecting the continued reliance of indigenous and local communities on wetland flora for primary healthcare. The medicinal uses record ranging from treatment of neurological disorders, skin ailments, digestive problems, inflammation, and wound healing—highlight the therapeutic significance of these plants and the depth of traditional knowledge preserved among tribal communities.

Qualitative phytochemical screening revealed the widespread occurrence of major secondary metabolites such as alkaloids, flavonoids, tannins, saponins, terpenoids, glycosides, and phenols across the investigated species. The presence of these bioactive compounds provides scientific support for many of the traditional medicinal claims documented during the ethnobotanical survey. Among the different solvent systems employed, methanolic extracts consistently showed superior efficiency in extracting a broader spectrum of secondary metabolites compared to ethanolic and aqueous extracts. This observation underscores the importance of solvent polarity in phytochemical investigations and supports the preferential use of organic solvents for comprehensive metabolite profiling.

Plant-wise comparative analysis indicated that *Bacopa monnieri*, *Eclipta prostrata*, *Centella asiatica*, *Limnophila indica*, and *Polygonum glabrum* exhibited higher metabolite richness, suggesting their potential as promising candidates for further pharmacological and bioactivity-guided studies. The dominance of phenols, flavonoids, and tannins across most species highlights the antioxidant and anti-inflammatory potential of aquatic medicinal plants, which may play a key role in their therapeutic efficacy. Furthermore, the frequent use of leaves and whole plants by tribal communities aligns with the higher concentration of secondary metabolites typically found in these plant parts.

Overall, the findings of this study emphasize that aquatic and semi-aquatic plants of the wetland ecosystems of Murshidabad constitute an important yet underexplored reservoir of medicinally valuable bioactive compounds. The correlation between traditional ethnomedicinal knowledge and phytochemical evidence reinforces the relevance of indigenous healthcare practices and validates their scientific basis. However, as the present study is limited to qualitative screening, further investigations involving quantitative phytochemical estimation, in vitro and in vivo pharmacological assays, toxicity evaluation, and compound isolation are necessary to fully elucidate the therapeutic potential of these species.

In conclusion, this study not only contributes valuable baseline data on ethnomedicinally important aquatic plants of eastern India but also highlights the need for conservation of wetland ecosystems and preservation of traditional knowledge systems. Sustainable utilization and scientific exploration of these aquatic medicinal plants may play a crucial role in future drug discovery programs and community-based healthcare strategies.

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