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## Ethnomedicinal and ethnobotanical uses of aquatic flora by local inhabitants of Gopalganj District, Bangladesh

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### Abstract

The current work was intended to carry out ethnomedicinal research of aquatic flora or hydrophytes in Gopalganj district, Bangladesh in order to gather evidence of its therapeutic benefits through conversations with the local residents and practitioners. Extensive empirical surveys were conducted on frequently to gather samples of aquatic plants and interviews with local inhabitants and herbalists were accomplished during November 2022 – November 2023. Documentation was done on the fundamentals of traditional applications of medicinal plant as well as their various ethnobotanical purposes. An aggregate of 60 plant species belonging to 33 families were identified as having ethnomedical uses in the treatment of various human illnesses and ailments, including skin conditions, asthma, gonorrhoea, ulcers, stomach pain, and piles. These hydrophytes were found to play vital functions in material culture, agricultural purposes and ritual manners. Wetland resources, particularly those with ethnomedicinal and ethnobotanical significance require care because the existence of these natural wetlands species is in jeopardy.

**Keywords:** Ethnomedicinal, ethnobotanical, hydrophytes, traditional knowledge

### 1. Introduction

Bangladesh is surrounded by the Buriganga river which is a tide-influenced river forming the western and southern boundaries of Dhaka City. It is home to a vast expanse of wetlands, which include freshwater lakes, marshes, rivers, streams, flooded agricultural fields, estuarine systems with large mangrove swamps, haors, baors, and beels. Moreover, a district of Bangladesh called Gopalganj is part of the Dhaka Division<sup>[1]</sup>. This district is situated at 23°00'47.67" N 89°49'21.41" and located alongside the Madhumati river. It is 1,490 km<sup>2</sup> in size and residence to 1,172,415 people<sup>[2]</sup>. This area lies in southern part of Bangladesh which is also blessed with a plenty of freshwater wetlands such as riverine, lacustrine and palustrine along with man-made wetlands. These wetlands are rich in hydrophytes, which make up one of the most abundant natural vegetation types.

Hydrophytes also known as aquatic macrophytes, are plants that are visible to the naked eye and have the ability to grow and survive both on the surface and beneath the water bodies. These plants have pigments called chlorophylls so that hydrophytes are able to synthesize food for themselves<sup>[3]</sup>. Hydrophytes play a crucial role in the ecosystem of wetlands, preserving species diversity and providing food, shelter, and traditional treatments for a variety of aquatic and waterfowl species<sup>[4]</sup>.

Almost 80% of the world population depends on the traditional system for health care<sup>[5]</sup>. The people from rural communities depends on traditional remedies for ailments such as cough, cold, fever, headache, dysentery etc. without any adverse effects. The local community of Gopalganj district has gathered knowledge about the ethnobotanical and ethnomedicinal use of aquatic plants through observations, intuition, and experimentation. They enriched the knowledge through selection and rejection and transferred it from generation to generation through various channels such as talks, documents and teaching.

Numerous authors have emphasized the potential of aquatic plants as food and feed<sup>[6, 7]</sup>. In addition, aquatic plants are an intriguing source of a variety of biologically active compounds with anticancer, antimicrobial, antifungal, antiviral, anti-inflammatory properties along with novel functional food ingredients<sup>[8]</sup>. Several authors have thoroughly recorded observations on the aquatic and marsh plants of Bangladesh<sup>[9, 10, 11]</sup>.

But in this region, aquatic plants and their ethnobotanical and ethnomedicinal studies were not enough documented. Comprehending the conventional uses of aquatic plants by the people of Gopalganj district for ethnobotanical and ethnomedicinal purposes is essential not only for the preservation of traditional systems of knowledge but also for exploring possible pharmacological applications and sustainable utilization of natural resources.

Therefore, the major objectives of this study are to identify and to document aquatic flora as well as to preserve traditional herbal knowledge of this research territory, Gopalganj before any of them are lost forever. It is especially alarming because the water bodies of this region are at risk and the diversity of aquatic plants is disappearing due to expanding urbanization.

## 2. Materials and Methods

### 2.1 Surveys and collection of plant materials

For the study, several sites in Gopalganj district, including the wetlands of Kashiyan, Mokshudpur, Kotalipara, Ghonapara, Gobra, Mollarhat and Tungipara were surveyed throughout November 2022 - November 2023. The hydrophytes were collected from the wetlands such as slow-running water, ponds, sides of stagnant ponds, paddy fields, monsoon rainy waterways, marshy lands, bogs, small water bodies as well as surrounding regions of Madhumati river. The collected samples of hydrophytes were identified with the help of literature i.e. encyclopedia and flora books etc. [12, 13].

### 2.2 Interviews with local residents

The data on aquatic plants with ethnomedicinal and ethnobotanical significance were documented by interviewing through a questionnaire with 50 local informants, including 25 males and 25 females (Table 1). During the field work, the common village dwellers (middle aged and older aged), farmers, traditional healers, vegetables salesmen, fishermen and boatmen were interviewed because of their interest and knowledge about medicinal properties and ethnobotanical uses of local aquatic flora. The data were obtained on a variety of aspects by inquiring about the aquatic plants, their medicinal and ethnobotanical uses, their local names, used parts and how these parts were used and for which disorders they were used to cure. The informants were asked questions in Bangla language so that the villagers could easily understand and respond. The questionnaires were designed using a semi-structural interviewing technique, which combines an open-ended question set with the option for the interviewer to go deeper into specific answers.

### 2.3 Data analysis

All the data obtained from the survey was statistically analyzed using SPSS version 2021 software (SPSS Inc.) and graphs were prepared using OriginPro software and Microsoft Excel Worksheet.

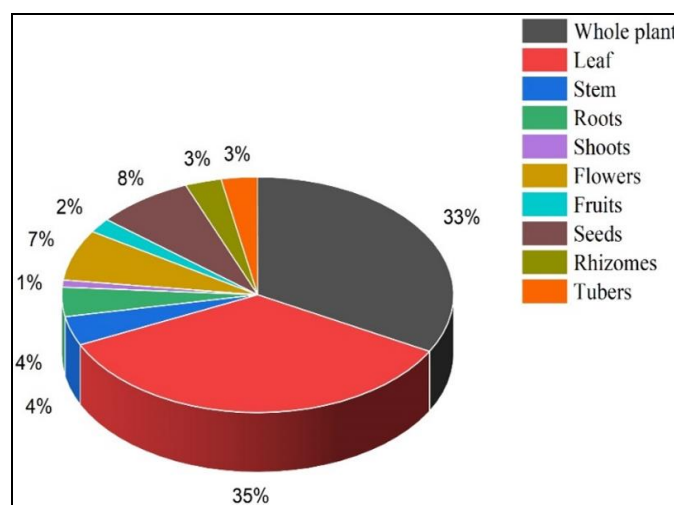
**Table 1:** Interviews with local residents of Gopalganj district, Dhaka division, Bangladesh

Number of informants	Age groups (year)
25 males	40-55
25 females	45-65
Total: 50	-

## 3. Results

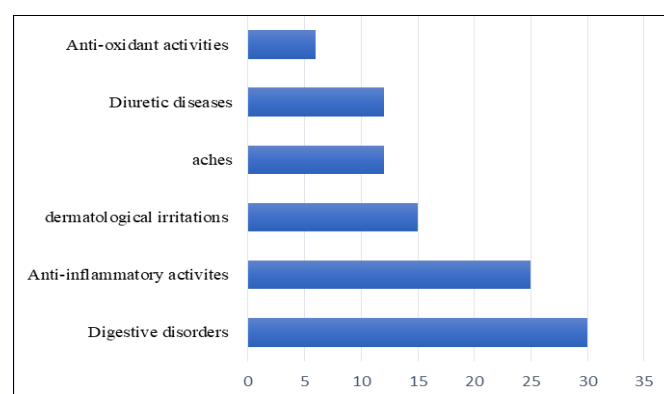
The comprehensive investigation on wetland and marsh flora available in Gopalganj revealed the identification and documentation of 60 species of plants distributed in 54 genera

belonging to 33 families frequently utilized by local folklore medicinal practitioners and indigenous people in the study area (Table 2). Amongst the taxonomic families, Asteraceae (6 plant species) followed by Araceae (4 plant species), Cyperaceae (3 plant species), Scrophulariaceae (3 plant species) and Poaceae (2 plant species) were found to be utilized frequently as traditional remedies, nutritional support as well as for other various commercial and agricultural purposes by ethnic communities of Gopalganj district (Table 2). Different vegetative and reproductive parts of hydrophytes such as leaves, stems, petioles, seeds, roots, flowers and fruits were found in use for the preparation of indigenous medications, human food and fodder for domestic animals as well as fish and poultry feed. This ethnobotanical survey showed that leaves occupied the major plant part used (35%) followed by whole plant (33%), seeds (8%) and flower (7%) (Figure 1). Even sometimes underground plant parts such as tubers, rhizomes and roots were also reported to be utilized for the preparation of herbal medicines by traditional healers (Table 2).

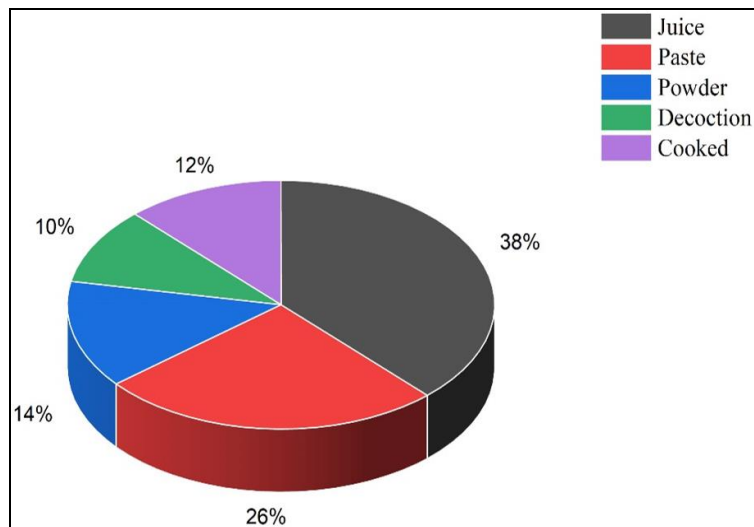


**Fig 1:** Percentage of different plant parts of ethnomedicinal hydrophytes utilized by folks for treating various ailments.

Moreover, the majority of aquatic weeds were recounted to cure various diseases including digestive issues, chronic skin problems, diabetes and aching of human body parts (Figure 2). The herbal medicines were prepared in a variety of ways including paste, powder, decoction, juice and cooked. During conducting the survey, it was confirmed that the bulk of herbal cures were made as juice (38%), with the remaining percentages being prepared as paste (26%), powder (14%), cooked (12%), decoction (10%) and paste (8%) (Figure 3).



**Fig 2:** Percentages of the most treated ailments using hydrophytes by traditional healers.



**Fig 3:** Percentages of mode of preparation of ethnomedicines through hydrophytes.



**Fig 4:** One of the interviewers was enquiring about the uses of *Sesbania sesban* (L.) Merr. and *Mikania micrantha* Kunth in a personal interview with local people of the study area.



**Fig 5:** *Enhydra fluctuans* Lour. was being sold at market of Gopalganj, a vegetable vendor was caught in camera selling hydrophytes which are edible as leafy vegetables.

Along with the ethnomedicinal functions, local hydrophytes were found to have enormous demand in agricultural purposes, pollution management and in various commercial and economic fields as these are sold as vegetables in local markets by traditional dealers (Figure 5). The folk people of Gopalganj have adopted indigenous wetland farming, locally

known as 'Vasoman Chash'- meaning floating cultivation on floating bed. This age-old traditional practice of floating seed bed is used for seedling production of many vegetables such as tomato, cauliflower, okra, amaranth, spinach, chili, bottle gourd and brinjal etc. (Figure 6).



**Fig 6:** A floating seed bed composed of *Eichhornia crassipes* for the cultivation of cauliflower.

**Table 2:** List of ethnomedicinal uses of the hydrophytes along with their ethnobotanical purposes available in Gopalganj district, Bangladesh.

S.N.	Scientific Name	Common Name	Local Name	Family	Parts Used	Ethnomedicinal use(s)	Ethnobotanical use(s)
1	<i>Acmella paniculata</i> (DC.) R.K. Jansen	Toothache plant, Electric daisy	Current ful, Nak ful	Asteraceae	Leaves, Flowers	Used for healing toothache.	-
2	<i>Ageratum conyzoides</i> L.	Goat weed	Fulkuri, Ochunti	Asteraceae	Whole plant	Used for wound dressing, curing skin infections, dysentery, diarrhea and killing lice.	Used as insecticide.
3	<i>Alocasia macrorrhizos</i> (L.) G.Don	Giant Taro	Mankochu	Araceae	Rhizome, Petiole, Leaf	-	Edible as leafy vegetable.
4	<i>Alternanthera philoxeroides</i> (Mart.) Griseb.	Alligator weed	Malancha Shak	Amaranthaceae	Tender shoots	Used as haemostat in cut wounds, stomach and liver problems.	Used as leafy vegetable.
5	<i>Alternanthera sessilis</i> (L.) DC.	Sessile Joy weed	Malancha Shak	Amaranthaceae	Whole plant	Used for the treatment of cough, skin and eye irritation and act as diuretic.	Edible as leafy vegetable.
6	<i>Ammannia baccifera</i> L.	Monarch redstem	Daadmari, Jongli-mendi	Lythraceae	Leaves	Used for the treatment of typhoid, skin itching.	-
7	<i>Azolla pinnata</i> R.Br.	Mosquito ferns	Kutipana	Azollaceae	Whole plant	-	Used as fish and poultry food, as biofertilizer.
8	<i>Bacopa monnieri</i> (L.) Pennell	Water hyssop	Brahmi lota	Scrophulariaceae	Whole plant	Used for the treatment of constipation, epilepsy, cough, cataract and act as brain tonic.	Edible as leafy vegetable.
9	<i>Centella asiatica</i> (L.) Urban	Asiatic pennywort	Thankuni	Apiaceae	Shoots	Used for the treatment of dysentery.	Edible as leafy vegetable.
10	<i>Ceratophyllum demersum</i> L.	Coontail	Kata-jhanjhi	Ceratophyllaceae	Whole plant	Used for the treatment of scorpion sting and biliousness.	Used as fodder.
11	<i>Chara</i> sp.	Stonewort	Pat-sheola	Characeae	Whole plant	-	Food and cover for fishes.
12	<i>Colocasia esculenta</i> (L.) Schott.	Arum	Kochu	Araceae	Rhizome, Petiole, Leaves	Used for the treatment of iron deficiency.	Edible as vegetables.
13	<i>Commelina benghalensis</i> L.	Benghal dayflower	Kanashira, Dholpata, Kanaibashi	Commelinaceae	Leaves	Used for the treatment of earache, leprosy, skin inflammations and rheumatic pain.	Edible as leafy vegetable and fodder.
14	<i>Cyperus rotundus</i> L.	Purple nut sedge	Mutha ghash	Cyperaceae	Root tubers	Used as brain tonic and for digestive problems.	Used in religious rituals and perfumery.
15	<i>Eclipta prostrata</i> (L.) L.	False daisy	Kalokeshi, Bhringaraj	Asteraceae	Leaves	Used for the treatment of liver disorder, scorpion sting and eczema.	Used for hair growth and as hair dye for black color.
16	<i>Eichhornia crassipes</i> (Mart.) Solms-Laub.	Water hyacinth	Kochuripana	Pontederiaceae	Whole plant, Flower	Sap of flowers is used to treat eczema and skin irritations.	Used as fish feed, biofertilizer, water purifier and medium for floating seed bed and Flowers are fried and eaten as snacks.
17	<i>Eleocharis palustris</i> (L.) Roem. & Schult.	Common spike-rush	Pani-chech	Cyperaceae	Root and Stem	Used in abdominal problems.	Edible as curry.
18	<i>Enhydra fluctuans</i> Lour.	Water Spinach, Water cress	Helencha shak	Asteraceae	Leaves	Used for the treatment of dysentery.	Edible as leafy vegetable.

19	<i>Equisetum debile</i> Roxb.	Horsetail	Not known	Equisetaceae	Whole plant	-	Used as bath-rub of cattle.
20	<i>Grangea maderaspatana</i> (L.) Poir.	Madras carpet	Namuti ful, Agnikumari	Asteraceae	Whole plant	Used for the treatment of menstrual and stomach disorders.	-
21	<i>Heliotropium indicum</i> L.	Indian heliotrope	Hatishur	Boraginaceae	Leaves	Used for the treatment of cataract and conjunctivitis and act as antiseptic in cut wounds.	-
22	<i>Hydrilla verticillata</i> (L.f.) Royle	Waterthyme	Kutkute jhanjhi.	Hydrocharitaceae	Whole plant	Applied to treat boils, wounds and abscesses. Improvement of digestion.	Used as organic fertilizer and nutritional supplement.
23	<i>Hydrocotyle sibthorpioides</i> Lamk.	Coin plant	Poisha lily	Apiaceae	Whole plant	Used to treat sun burnt skin.	Used as ornamental plants.
24	<i>Hygrophila difformis</i> (L.f.) Blume	Water Wisteria	Kulekhara	Acanthaceae	Whole plant	-	Used in aquaculture and natural water purifier.
25	<i>Hygrophila auriculata</i> (Schumach) Heine	Marsh barbel	Kulekhara	Acanthaceae	Leaves, Seeds	Used for the treatment of anemia and impotency.	-
26	<i>Hygroryza aristata</i> (Retz.) Nees ex Wright & Arn	Asian watergrass	Pani ghash, Jolojo ghash	Poaceae	Leaves	Used for the treatment of urinary tract and biliousness.	Used in aquaculture and natural water purifier.
27	<i>Ipomoea aquatica</i> Forssk.	Water spinach	Kolmi shak	Convolvulaceae	Leaves	Used to treat snake bite, gonorrhoea, ear-ache and act as blood purifier.	Edible as leafy vegetable.
28	<i>Ipomoea carnea</i> Jacq.	Bush morning glory	Dhol kolmi	Convolvulaceae	Leaves, Stems	Leaves are applied on skin abscesses.	Stems are used as fuel and fence.
29	<i>Lemna minor</i> L.	Duckweed	Khudipana	Lemnaceae	Whole plant	Used for the treatment of measles and nasal polyps.	Used as organic fertilizer, fish food, water purifier.
30	<i>Limnophila sessiliflora</i>	Asian marshweed	Bamon-keshori	Scrophulariaceae	Leaves	Used for the quick healing of cut wounds.	-
31	<i>Lippia alba</i> (Mill.) N.E.Br.	Bushy matgrass	Motmotia	Verbenaceae	Leaves	Used as herbal tea to treat cold, cough, throat irritations and asthma.	Used during fishing.
32	<i>Ludwigia adscendens</i> (L.) H. Hara	Water primrose	Keshorbadam	Onagraceae	Whole plant	Used for the treatment of ulcers and skin diseases, gum ache, act as antiseptic.	Edible as vegetable.
33	<i>Ludwigia perennis</i> L.	Perennial Water Primrose	Bon lobongo	Onagraceae	Whole plant	Used for the treatment of fever.	-
34	<i>Ludwigia octalvis</i> L.	Perennial Water Primrose	Lal Bon lobongo	Onagraceae	Whole plant	Used for the treatment of fever.	-
35	<i>Marsilea quadrifolia</i> L.	Water clove	Shushni shak	Marsileaceae	Leaves, Seeds and Root	Applied on boils and taken as curry to cure biliousness.	Edible as vegetable.
36	<i>Mentha spicata</i> L.	Spearmint	Pudina	Lamiaceae	Leaves	Used to treat digestive problems.	Edible as salad and used as an ingredient of beverage.
37	<i>Mikania micrantha</i> kunth	Bitter vine	Josshor lota, Tufani lota	Asteraceae	Leaves	Applied on cut wounds to stop bleeding, excessive menstrual bleeding, healing snake bite, external sores and itching.	-
38	<i>Monochoria hastata</i> (L.) Solms	Arrow leaf pondweed	Boronukha, Khojutti.	Pontederiaceae	Flower, Root	Roots are chewed to cure toothache.	Flowers are fried and eaten as snack. Used as biofertilizer and in floating bed.
39	<i>Nelumbo nucifera</i> Gaertn.	Lotus	Padma ful	Nymphaeaceae	Flower, Seeds, Root	Used to treat diarrhea, jaundice, headache and piles.	Seeds are dried and eaten as snacks, flowers are used in Sanatan rituals.
40	<i>Nicotiana glauca</i> (L.) Viv.	Tex-mex tobacco	Bon Tamak	Solanaceae	Leaves	Applied on cut wounds and used to cure toothache and swelling of gum.	-
41	<i>Nymphaea nouchali</i> Burm. f.	Water lily	Shapla	Nymphaeaceae	Fruits, Petiole, Rhizome	Used to treat diarrhea, intestinal problems, diabetes, gastric and jaundice.	Petioles and fruits are edible as vegetable.
42	<i>Nymphaea pubescens</i> Willd.	White water lily	Shada shapla	Nymphaeaceae	Whole plant	Used to cure irregular menstruations.	Long tender pedicles used as vegetable.
43	<i>Nymphoides</i>	crested floating-	Chand mala	Menyanthaceae	Leaves	Leaf juice is applied to treat	-

	<i>hydrophylla</i> (Lour.) Kuntze	heart		e		snake bites.	
44	<i>Nymphoides indica</i> (L.) Kuntze	Water snowflake	Chand mala	Menyanthaceae	Leaves	Used to cure scabies.	-
45	<i>Phragmites karka</i> (Retz.) Steud.	Tall Reed	Nol Khagra	Poaceae	Stems, Inflorescences	-	Used to manufacture paper, making mats, broom and baskets, stem is given shape as pen known as 'khager kolom' to utilize with ink.
46	<i>Phyla nodiflora</i> (L.) Greene	Turkey tangle frogfruit	Vui Okra	Verbenaceae	Whole plant	Applied to treat urine infection.	-
47	<i>Pistia stratiotes</i> L.	Water lettuce	Golap-pana, Topa-pana	Araceae	Leaves	Used to treat ring worm, skin diseases, leprosy and eczema and old wounds.	Used as water purifier.
48	<i>Polygonum barbatum</i> L.	Knotgrass	Bishkatali	Polygonaceae	Leaves	Used to treat skin and urination problems.	Young shoots are cattle fodder.
49	<i>Sagittaria sagittifolia</i> L.	Arrowhead	Chotokut	Alismataceae	Tubers	-	Consumed as vegetable.
50	<i>Salvinia cucullata</i> Roxb. ex Bory	Asian watermoss	Indur-kani, Chela	Salviniaceae	Whole plant	Used as anti-bacterial agent.	Used as biofertilizer, water purifier and medium for floating seed bed.
51	<i>Scirpus mucronatus</i> L.	Ricefield Bulrush	Chechra	Cyperaceae	Seeds	Used to treat diarrhea.	-
52	<i>Scoparia dulcis</i> L.	Sweet Broomweed	Bon-dhoniya, Chinigura	Scrophulariaceae	Leaves	Used for the treatment of diabetes.	-
53	<i>Sesbania sesban</i> (L.) Merr.	Riverhemp	Joyintig ach, Dhonche gach	Fabaceae	Leaves, Stems	-	Used as green manure and fence.
54	<i>Setaria punctata</i> (Burm.f.) Veldkamp	Riceweeds, Arrow-leaved sida	Sheyal lenja	Poaceae	Seeds	-	Used as cattle fodder.
55	<i>Spirodela polyrrhiza</i> (L.) Sch.	Giant duckweed	Khudi-pana	Lemnaceae	Whole plant	Used as antibiotics and antioxidant.	Water purifier, duck and fish feed.
56	<i>Typha elephantina</i> Roxb.	Broad leaf cattail	Hogla	Typhaceae	Seeds, Leaves, Roots	Seeds are used as antidiuretic agent.	Leaves are used to make mat, hut and fences. Seeds are boiled in milk and eaten as desert.
57	<i>Typhonium trilobatum</i> (L.) Schott	Bengal arum	Ghet kochu, Ghet Oal	Araceae	Tuber, Leaves	Used to treat breast tumor, liver infections and leukemia.	Edible as vegetable.
58	<i>Urena lobata</i> L.	Ceaser weed	Bon okra	Malvaceae	Leaves	Used to treat diabetes, gonorrhea, malaria, dysentery, abdominal colic, nausea, rheumatism, and edema.	-
59	<i>Utricularia aurea</i> Lour.	The golden bladderwort	Pata-jhajhi, Jhangi	Lentibulariaceae	Flowers	-	Used as nutritional supplement.
60	<i>Vallisneria spiralis</i> L.	Eel grass	Bicha, Baicha, Patsheola	Hydrocharitaceae	Whole plant	-	As organic fertilizer and prevent eutrophication of wetlands.

\*All the information were gathered from literature and personal interviews

#### 4. Discussions

The goal of the current study was to record the traditional knowledge about medicinally, economically, ethnobotanically significant as well as nutrient rich plants obtainable in several wetlands of Gopalganj district. The national flower, *Nymphaea nouchali* Burm. f. and other water plants are major food sources for the indigenous people living in Gopalganj. Tender shoots, petioles and leaves of these plants are cooked with cooking oil and consumed as leafy vegetables in human diet. The young shoots of *Alternanthera philoxeroides* (Mart.) Griseb., *Bacopa monnieri* (L.) Pennell, *Centella asiatica* (L.) Urban, *Colocasia esculenta* (L.) Schott., *Enhydra fluctuans* Lour., *Ipomoea aquatica* Forssk., *Marsilea quadrifolia* L., *Nymphaea nouchali* Burm. f. and the tuber and rhizomes of *Alocasia* sp. *Colocasia* sp. *Eleocharis* sp. and *Typhonium trilobatum* (L.) Schott are eaten as leafy vegetables or curry. As well as, the dry-fried seeds of *Nelumbo nucifera* Gaertn.

and *Nymphaea nouchali* Burm. f. are incredibly tasty snacks for folks. Still, only a small number of species have been properly investigated to ascertain their true nutritional value [14]. The hydrophytes are rich in macro- and micronutrients as well as vitamins, despite the fact that their nutritional worth has not been thoroughly investigated. *Eichhornia crassipes* (Mart.) Solms-Laub. and *Ceratophyllum demersum* L. are examples of wild edible hydrophytes that have the largest quantities of nutrients such as Na, Ca, Mg, N, K and C along with the carbohydrates as well as proteins [15]. Another hydrophyte that is well-liked for its remarkable nutritional qualities is *Hydrilla verticillata* (L.f.) Royle, a submerged aquatic plant. *Hydrilla* is high in two important minerals i.e. zinc (Zn) and selenium (Se) as well as vitamin B12. It is also brimming with antioxidants making it a potent immunity booster for humans. It is known that calcium strengthens the skeletal system of the human body and helps cleanse the

digestive tract by eliminating waste particles [16]. In Gopalganj, *Bacopa monnieri* (L.) Pennell. is consumed as leafy vegetable and root tuber of *Cyperus rotundus* L. is taken as curry to improve memory power.

Additionally, hydrophytes bear a large number of therapeutical properties which helps to cure several diseases. So that, aquatic weeds have gained popularity amongst the traditional healers of Gopalganj as wellsprings for herbal medications. Fresh leaves and flowers of *Acmella paniculata* are chewed directly or paste of leaves or flowers is hold in mouth to mend toothache as this plant has local anesthetic effect [17]. As well as, *Monochoria* sp. and *Nicotiana* sp. are also used against toothache and swelling of gums. Boils and wounds are treated with the leaf decoction of *Hydrilla verticillata* and the use of dried leaf powder speeds up the healing process [18]. Similarly, leaves of *Polygonum barbatum* (Wild.) M. Gómez and *Lemna minor* L. are used to treat skin and urine issues as well as lessen colic pain [19]. Leaf decoction of *Phyla nodiflora* (L.) Greene is very efficient to treat urinary bladder problems as well [20]. Leaf paste of *Pistia stratiotes* L., *Ammania baccifera* L., *Commelina benghalensis* L. and *Eclipta prostrata* (L.) L. are suggested by traditional healers to treat a variety of chronic skin conditions including syphilis, eczema, ulcers, piles and leprosy. It has been reported that leaf paste of *Pistia stratiotes* L. is utilized for treating eczema, leprosy and syphilis [18, 21]. The decoction or infusion of the leaves of *Nelumbo nucifera* Gaertn., *Ageratum conyzoides* L., *Centella asiatica* (L.) Urban, and *Hygroryza aristata* (Retz.) Nees are utilized in stomach ailments such as dysentery, diarrhea and vomiting [18, 22, 23, 24]. The seeds of *Nelumbo nucifera* Gaertn. and *Scirpus mucronatus* L. are suggested by indigenous herbalist to cure jaundice [25]. Leaf juice of *Bacopa monnieri* (L.) Pennell, *Alternanthera sessilis* (L.) DC. and *Heliotropium indicum* L. is used as eye drop to cure cataract, conjunctivitis or any other eye irritations [21]. Leaf paste of *Scoparia dulcis* L., *Alternanthera sessilis* (L.) DC., *Urena lobata* L. and seeds of *Typha elephantina* Roxb. are taken orally with honey for the treatment of diabetes. The potentiality of *Scoparia dulcis* L. has been proved to reduce blood glucose significantly which is also prescribed by traditional healers of the study area [26]. *Urena lobata* L. is utilized as traditional remedy in Gopalganj for the treatment of diabetes, gonorrhoea, malaria, dysentery, nausea and edema [27]. Leaf paste of *Ageratum conyzoides* L. *Mikania micrantha* kunth, *Salvinia cucullata* L. *Ludwigia adscendens* L. *Heliotropium indicum* L. and *Spirodela polyrrhiza* L. own enormous anti-oxidant, anti-septic, anti-bacterial and anti-inflammatory properties. Besides, these plants also help to stop bleeding, excessive menstrual bleeding, healing snake bite, external sores and itching. The potency of the leaf extract of *Mikania micrantha* kunth as antimicrobial and antiseptic agent was reported in a study [28]. Similar to this, *Eichhornia crassipes* (Mart.) Solms-Laub. is a strong source of antioxidant compounds and *Ceratophyllum demersum* L. is utilized as a cardiac tonic [29]. Furthermore, hydrophytes are cooked as curry and taken as popular human diet as brain tonic. Leaf juice of *Bacopa monnieri* (L.) Pennell along with honey is taken orally for the treatment of epilepsy [21]. Paste of whole plant of *Grangea maderaspatana* (L.) Poir. is orally taken with milk or honey to cure menstrual irregularities and to relief from stomach ailments [21]. *Mentha spicata* L. has enormous demand amongst folks in Gopalganj as an ingredient of a beverage called "Borhani" usually taken to get rid of digestive problems. According to Ikram, the leaves of *Mentha spicata* and *Eclipta alba* are used to treat wounds,

allergies, injuries and stomach issues [30]. *Mentha spicata* has been employing to treat common ailments like hypoglycemia, flatulence relief, antispasmodic, vermifuge and diuretic [31]. As well as, the leaves of *Lippia alba* (Mill.) N. E. Br are boiled in water to make herbal tea which is suggested to take for the treatment of cough, cold along with asthma by folk healers of Gopalganj. Interestingly, this marsh plant, *Lippia alba* has a distinctive application by local fishermen of Gopalganj with their special fishing technique. In this technique, the leaves are rubbed on fishing net or line as a track during fishing. As a result, they get able to catch more fishes compared to other usual fish tracks. It has been scientifically proved that essential oil of *Lippia alba* has sedative properties which act as an anesthetic for fish without harm to consumers [32]. Hence, this plant helps the fishermen with this unique property. Ultimately, it could be state that the significance of herbal treatments cannot be ignored since they have no known adverse effects. It is essential to mention that the hydrophytic species have extensive uses in both the economy and the ecology. For example, *Hydrilla verticillata* is utilized as fish food in Lake Phewa and Lake Rupa (Nepal) and in certain other nations [33]. According to Shahjahan *et al.*, the result of utilizing aquatic weeds such as *Azolla*, *Spirodela* in poultry feed as protein augmentation was found to be very satisfactory in Bangladesh [34]. On the contrary, *Lemna* manifested effective result in relation to its uses as fish food along with *Eichhornia crassipes*, *Pistia stratiotes* and *Azolla pinnata* [35]. Similarly, these hydrophytes such as *Azolla pinnata*, *Spirodela polyrrhiza*, *Eichhornia crassipes* and *Pistia stratiotes* L. were ascertained to be employed in poultry and fish feed by local inhabitants of Gopalganj. Moreover, a wide range of hydrophytes were detected during the survey to have enormous demand as fodder for cattle. For example, *Ceratophyllum demersum*, *Commelina benghalensis*, *Polygonum barbatum*, *P. glabrum* and *Setaria punctata* were reported to be in frequent use as fodder by rural livestock managers in this area.

Notably, hydrophytes play a critical role in pollution control by reducing the amount of heavy metal contamination in wetlands, which can cause fishes and other aquatic organism varieties to decline due to biomagnifications. A variety of aquatic plants such as *Eichhornia crassipes*, *Hygrophila difformis*, *Hygroryza aristata*, *Lemna minor*, *Pistia stratiotes*, *Salvinia cucullata*, *S. molesta*, *S. minima*, *Spirodela polyrrhiza* and *Vallisneria spiralis* are allowed to grow as natural water purifier in the study area as these are capable of excluding chemical contaminants from water. These submerged, emergent and floating wetland floras were reported to own hyperaccumulating ability to revitalize water [36, 37, 38, 39, 40].

During the survey, aquatic weeds were found to be utilized for mulching the agricultural land and also used as biofertilizer for the cultivation of tomatoes and red amaranths by local farmers of Gopalganj. Moreover, a unique aqua-farming on floating bed is being popular amongst the local farmers of this study area day by day to cultivate tomato, chili, cauliflower and several leafy vegetables. This technique is known as 'vashoman chash', meaning floating cultivation technique [41]. For the construction of the floating bed which floats on wetlands or marshy area requires a floating mat made up of bamboos, paddy straw, coconut husk and various aquatic plants such as water hyacinths (*Eichhornia crassipes*), water lettuce (*Pistia stratiotes*), duckweed (*Najas graminea*), *Salvinia* spp. and *Potamogeton alpinus* [42].

Wetland regions faced primary risks from fishing, harvesting

edible insects and the conversion of wetlands to rice fields<sup>[43]</sup>. The overexploitation of aquatic weeds either as herbal medicines, human diet or as material culture or ritual agent, may lead them to the margin of extinction. The majority of the population of this rural area relies on these medicinal plants to treat a variety of illnesses and ailments as there are insufficient basic healthcare facilities. It has been noted that older people are more likely to use traditional medicinal plants as their primary source of healthcare. With luck, this ethnobotanical survey on hydrophytes will be helpful to record the especial utilizations of different hydrophytes by the tribes and rural communities of Gopalganj, Bangladesh. This survey may lead to find any novel and unique way of utilizing hydrophytes which could be beneficial for other people of the country or science such as ethno-medicines, economy, agriculture or environmental management. Due to this, protecting these resources is urgently needed that are essential to the survival of humankind.

## 5. Conclusion

Hydrophytes are an essential component of the ecosystem since they are essential to human survival as food, medicine, and other necessities. Since there haven't been any ethnomedical and ethnobotanical investigations on hydrophytes in this study area, therefore, it is necessary to compile a database of aquatic plants and traditional herbal knowledge before any one of them is extinct forever unrecognized. It is also concerning that the aquatic plant diversity in this area of Gopalganj is being adversely impacted by the fast urbanization that is putting the water bodies in danger. In order to ensure the sustainable development of our nation, these natural resources must be preserved for the benefit of humankind.

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