

PEOPLE CONSENSUS IN THE USE OF ETHNOMEDICINAL PLANTS FOR CONSERVATION IN AND AROUND PURBACHAL MODERN TOWN, DHAKA

MOHAMMAD ZASHIM UDDIN¹, TAHMINA HAQUE, TAHMINA SULTANA JUTHI,
FAHMIDA RAHMAN, ABULAIS SHOMRAT, EVANA AKTER AND MD. TARIKUL ISLAM

Department of Botany, University of Dhaka, Dhaka-1000, Bangladesh

Keywords: Consensus, Ethnomedicinal plants, Conservation, Purbachal modern town, Dhaka

Abstract

The present study aims to determine the consensus on the use of ethnomedicinal plants available in and around the Purbachal modern town area for conservation. The data were collected through nine field trips during the year 2023 using a semi-structured questionnaire, followed by interviews showing plants, mentioning checklists, field interviews, a market survey, and participant observations. The study recorded 185 medicinal plant species under 78 families, which have been used through 673 formularies to treat 48 complaints in 13 disease categories. Among the medicinal plants, trees were 49%, herbs 27%, shrubs 16%, and climbers 8%. Leaf (31%) is the major plant part used, followed by fruit (19%), bark (6%), stem (11%), root (6%), seed (9%), whole plant (5%), flower (3%), and others. Cuts and wounds attained the highest FIC value and were treated by 18 medicinal plant species. Among the most cited species are *Cynodon dactylon* (L.) Pers. and *Cissus quadrangularis* L.. According to FI value, *Ocimum tenuiflorum* L. is a culture-bound species because it has been used for respiratory tract complaints only. The most commonly cited species of medicinal plants are *Ocimum tenuiflorum* L., *Cynodon dactylon* (L.) Pers., *Justicia adhatoda* L., *Terminalia arjuna* (Roxb. ex DC.) Wight & Arn. and *Coccinia grandis* (L.) Voigt. Based on observations and interviews with local people, a good number of threats were detected for medicinal plant species. To conserve medicinal plants in Purbachal modern town, plantations in each sector should have some native medicinal trees including *Terminalia arjuna* (Roxb. ex DC.) Wight & Arn., *Azadirachta indica* A. Juss., *Phyllanthus emblica* L., *Litsea glutinosa* (Lour.) Robinson, *Syzygium cumini* (L.) Skeels, *Sterculia villosa* Roxb. ex Sm., *Terminalia bellirica* (Gaertn.) Roxb., *Alstonia scholaris* (L.) R.Br., *Moringa oleifera* Lamk., *Holarrhena pubescens* Wall. ex G.Don, *Bombax ceiba* L., *Aegle marmelos* (L.) Corr., *Tamarindus indica* L., *Zanthoxylum rhetsa* (Roxb.) DC., *Toona ciliata* M. Roem., *Cassia fistula* L., *Flacourtia jangomus* (Lour.) Raesch., *Garcinia cowa* Roxb., *Baccaurea ramiflora* Lour., *Ficus racemosa* L., *Ficus benghalensis* L., *Aphanamixis polystachya* (Wall.) R.N. Parker, *Milliusa velutina* (DC.) Hook.f. & Thomson, *Spondias pinnata* (L.f.) Kurz, *Oroxylum indicum* (L.) Benth. ex Kurz, *Neolamarckia kadamba* (Roxb.) Bosser, and *Elaeocarpus serratus* L., so that town dwellers can find them easily.

Introduction

Determination of people's consensus in the use of ethnomedicinal plants is one of the important tools to identify the important medicinal plants. Understanding the most cited and most useful medicinal plants in any area is crucial for the conservation and sustainable development of natural resources. However, there is a knowledge gap about medicinal plants that are useful for the primary healthcare management of smart city dwellers in the newly developed Purbachal new town. Globally, 80% of local people rely on ethnomedicinal plants for their primary healthcare needs, as reported by Farnsworth *et al.* (1985) and Ekor (2014). Ethnomedicinal plants provide economic benefits, protect human health and safety, and offer recreational or aesthetic enjoyment. Currently, ethnomedicinal plants are vulnerable because of rapid urbanization, population growth, pollution, global climate change, habitat destruction, over-exploitation, and biological invasion.

¹ Author for correspondence: <zashim01@gmail.com>.

For the sustainable management of ethnomedicinal plants, a database on different aspects of such plants is very essential. Otherwise, ethnomedicinal plants will be lost before documentation of medicinal and economic evaluation.

Studies of ethnomedicinal plants in Bangladesh are in a progress. Some of the articles published in this field included Khan *et al.* 2002, Uddin *et al.* 2006, Uddin and Roy 2007, Roy *et al.* 2008, Uddin *et al.* 2009, Islam *et al.* 2010, Uddin *et al.* 2012, Haque *et al.* 2014, Uddin *et al.* 2014, Uddin and Hassan 2014, Haque *et al.* 2017, Uddin *et al.* 2017, Shethi and Uddin 2018, Uddin and Haque 2018, Uddin *et al.* 2019, Uddin *et al.* 2021, Haque *et al.* 2022, Mitu *et al.* 2022, Rifat *et al.* 2022, Sajeeb *et al.* 2022, Uddin and Islam 2022 and Uddin *et al.* 2023. All such articles listed a good number of medicinal plants from particular communities or areas and for particular diseases. Unfortunately, no such works have covered the documentation of ethnomedicinal plants of people living in and around Purbachal modern town, Dhaka. Once, the Purbachal area was full of both terrestrial and aquatic vegetation. Due to the development of model town, evacuation of the local population, destruction of vegetation, wetland filling and habitat shifting, maximum vegetation were lost. In the present study, an attempt was made to record ethnomedicinal plants with uses; to determine consensus in the use of ethnomedicinal plants; to find the threats to ethnomedicinal plants and to suggest measures for conservation.

Materials and Methods

Purbachal is the largest preplanned township project in Bangladesh, near the north-eastern side of Dhaka city. The total area of the project is about 6213 acres (RAJUK 2023). The project area is located between the Shitalkhya and Balu rivers at Rupgonj Thana in Narayanganj district and Kaligonj Thana in Gazipur district, 16 km apart from the zero point of Dhaka city. The project has 30 sectors, and the work started in 1995 and is supposed to be finished in 2024. The project has allotted 6.6% for greening and 7.1% for lakes and canals (RAJUK 2023). Due to the project, the area has lost a huge amount of plant diversity, medicinal plants, and part of the sal forest. Soil properties include filling sand, clay, and sand mixtures, which make up the majority of the soils in Purbachal, like Dhaka city. Occasionally, an extra clay layer has been noticed. The climate of Purbachal (as like as Dhaka) is tropical, hot, humid, and rainy. A distinct monsoonal season occurs in the city, with an average yearly temperature of 27.5 °C. About 2000 mm of rain fall on the city each year, with over 80% of that falling between June and September during the monsoon season (Dewan and Yamaguchi 2009). The vegetation of Purbachal is now planted with mostly exotic plants, as was observed by Uddin *et al.* (2021) for Dhaka. Plantation activities have regularly been conducted by the owners of plots in Purbachal, RAJUK, and enthusiastic people from Dhaka city. The most common tree species planted are *Samanea saman* (Jacq.) Merr., *Swietenia mahagoni* (L.) Jacq., *Polyalthia longifolia* (Sonn.) Thwaites, *Mimusops elengi* L., *Acacia auriculiformis* A.Cunn. ex Benth., *Albizia richardiana* King & Prain, *Eucalyptus camaldulensis* Dehnh., *Borassus flabellifer* L., *Khaya anthotheca* (Welw.) C.DC., *Terminalia mantaly* H.Perrier, *Leucaena leucocephala* (Lam.) de Wit, *Mangifera indica* L., and *Artocarpus heterophyllus* Lam.. A good number of exotic ornamental plants are also planted in the beautification of modern cities. The area also contained 146 acres of remnant of Sal Forest, which is dominated by Sal trees, and many associated tree species are available in threatened condition.

Purbachal modern town and its surrounding areas were visited through nine field trips in different seasons of the year 2023. Ethnomedicinal data were collected through participatory rural appraisal (PRA), which was based on interaction with local people and direct observation in the field (Chambers 1994, Martin 1995). The data were recorded through semi-structured interviews, key informant discussions, and informal conversations with local people and herbal practitioners

(Alexiades 1996). For more information on medicinal plants, field interviews, plant interviews, checklist interviews, and market surveys were also conducted (Alexiades 1996). The local plant name, part(s) used, ailment to be treated, mode of use, and citation number were collected in the data sheets. A total of 240 informants were interviewed. They were mostly male, and their ages ranged from 20 to 84 years old. The education levels of the informants ranged from illiterate to masters' degrees. Professionally, they were mostly day labors, rickshaw pullers, small vendors, government employees, housewives and others. During the field survey, threats to medicinal plants and their local knowledge, as well as observations on the population status of medicinal plants and local perceptions of conservation strategies, were noted. For the calculation of consensus knowledge of medicinal plant uses, all cited ailments were grouped into certain disease categories (Heinrich *et al.* 1998). Voucher specimens or images for each medicinal plant were collected and processed using standard herbarium techniques (Hyland 1972, Alexiades 1996). Most of the medicinal plant species were identified in the field. In cases of confusion, the specimens or color images were identified by consulting standard literature (Siddiqui *et al.* 2007, Ahmed *et al.* 2008, 2009). Specimens available at the Dhaka University Salar Khan Herbarium (DUSH) and Bangladesh National Herbarium were consulted in identifying the collected plant specimens or images of plants. The updated nomenclature of the species was followed (Siddiqui *et al.* 2007, Ahmed *et al.* 2008, 2009, "The Plant List IPINI, Tropics" websites). Voucher specimens or color images were deposited at DUSH. The factor of informant consensus (FIC) of local people in the use of ethnomedicinal plants was calculated (Heinrich *et al.* 1998). To determine the most cited medicinal plant species, the Citation Frequency (Cf) formula was used (Friedman *et al.* 1986). To determine the most popular medicinal plant species to treat certain ailments in society, the Fidelity Level (Fl) formula was used (Friedman *et al.* 1986).

Results and Discussion

The study recorded 185 medicinal plant species under 78 families, which have been used through 673 formularies to treat 48 complaints in 13 disease categories. For each species, the scientific name, local name, family, habit, part(s) used, ailments, and treatment modes were recorded. Among the ethnomedicinal plant species, the most cited 48 species are presented in Table 1. The present results are an indication of the high diversity of medicinal plants and their rich knowledge of primary healthcare in the study area of Purbachal. Though the study area is located near Dhaka city, cultural practices are quite different from Dhaka city. The people of Dhaka city come from different parts of the country and they practice almost a common culture in the city. They used to use modern medicines. Old people in the study area still practice their own cultural heritage and in most cases, they rely on medicinal plants for their primary healthcare. In the case of young people, they are in transition to modern culture. They do not like to practice the system of their forefathers of healthcare using medicinal plants. Similar types of researches have recorded a total of 109 medicinal plant species from Dinajpur district (Rifat *et al.* 2022). Likewise, 102 medicinal plant species were reported from Thakurgaon district (Mitu *et al.* 2022). From Manikganj district, 131 medicinal species were reported (Juthi *et al.* 2024). The present record of medicinal plant species from Purbachal modern town was greater than all previous reports of medicinal plant species which proves the rich knowledge bank of the area.

Habits analysis of medicinal plant species showed that trees were represented by 49%, herbs by 27%, shrubs by 16%, and climbers by 8% (Fig. 1). Trees were the abundant habit groups of medicinal plants in Thakurgaon district (Mitu *et al.* 2022). On the other hand, herbs were the most abundant group of medicinal plants in Dinajpur district (Rifat *et al.* 2022). Likewise, the study in Manikganj district also showed that herbs were the most abundant group of medicinal plants (Juthi *et al.* 2024). The present habit groups of medicinal plant species were similar to the medicinal

plants of Thakurgaon district (Mitu *et al.* 2022). In the case of part (s) used, leaves (31%) were the major plant part used, followed by fruit (19%), bark (6%), stem (11%), root (6%), seed (9%), whole plant (5%), flower (3%), and others (Fig. 2). Leaves were the leading parts used by medicinal plants and were recorded from Thakurgaon district, Dinazpur district, Manikganj district, and Lawachara national park (Uddin *et al.* 2012, Mitu *et al.* 2022, Rifat *et al.* 2022 and Juthi *et al.* 2024). The present result, in which leading parts used leaves, was similar to all the studies mentioned above. Leading parts used leaves mean the sustainable use of medicinal plants. Roots and bark pose huge threats to medicinal plants because of overharvesting. Sometimes people do not care about sustainable harvesting techniques for medicinal plant collections.

Table 1. Most cited ethnomedicinal plant species in the study area. (C = Climber, H = Herb, S = Shrub, T = Tree)

Scientific name	Local name	Family	Habit	Part used	Ailments	Treatment mode
<i>Acmella calva</i> (DC.) R.K.Jansen	Surjokonna	Asteraceae	H	Flower	Toothache	Flower is chewed
<i>Aegle marmelos</i> (L.) Corr.	Bel	Rutaceae	T	Fruit	Dysentery	Dried fruit pulp is taken
<i>Allium sativum</i> L.	Rosun	Amaryllidaceae	H	Bulb	Heart problem	1 piece regularly
<i>Aloe vera</i> (L.) Burm.f.	Alovera	Aloaceae	H	Leaf	Calcium Deficiency, Skin care	Leaf juice taken; Leaf paste applied
<i>Ananas comosus</i> (L.) Merr.	Anaros	Bromeliaceae	H	Fruit	Fever	Ripe fruit taken
<i>Ananas comosus</i> (L.) Merr.	Anaros	Bromeliaceae	H	Leaf	Worms	Leaf juice taken in empty stomach
<i>Andrographis paniculata</i> (Burm.f.) Nees	Kolfonath	Acanthaceae	H	Leaf	Cold/ corona	Leaf juice taken
<i>Asparagus racemosus</i> Willd.	Sotomuli	Liliaceae	C	Root	Impotency / Male weakness	Raw root crushed and juice taken
<i>Azadirachta indica</i> A. Juss.	Neem	Meliaceae	T	Leaf, Stem	Itching, Diabetes, Worms, Teeth and gum problem, Skin problem, Blood purifier, Stomach ache	Leaf juice mixed with water and take bath; Leaf juice taken; Used as brush; Neem leaf with turmeric pasted and applied; Leaf juice taken
<i>Bombax ceiba</i> L.	Simul	Bombacaceae	T	Young root, Matured root	Constipation, Semen increase	Young root taken; Young root taken
<i>Borassus flabellifer</i> L.	Tal	Arecaceae	S	Stem	Cold and cough	Warm juice taken
<i>Cajanus cajan</i> (L.) Millsp.	Arhar, Arol	Fabaceae	S	Leaf	Jaundice	Leaf juice taken
<i>Calotropis gigantea</i> (L.) W.T.Aiton.	Akondo	Asclepiadaceae	S	Leaf, Latex	Body pain, Insect bite	Latex applied
<i>Carica papaya</i> L.	Pepe	Caricaceae	S	Fruit	Gastritis	Young fruit taken in the morning
<i>Centella asiatica</i> (L.) Urban	Thankuni	Apiaceae	H	Leaf	Dysentery, Diarrhoea, Upset stomach, Corona, Cold and cough	Leaf juice taken; Leaf chewed and taken; 3 leaf chewed and taken at midnight; Leaf chewed and taken

Table 1 Contd.

Scientific name	Local name	Family	Habit	Part used	Ailments	Treatment mode
<i>Chromolaena odorata</i> (L.) R.M.King & H.Rob.	Ujaru Lota	Asteraceae	S	Leaf	Stop bleeding	Leaf juice given to the wounded place
<i>Cissus Quadrangularis</i> L.	Harvanga	Vitaceae	C	Stem	Fracture	Stem paste applied on broken bone
<i>Citrus aurantifolia</i> (Christm. & Panzer) Swingle	Lebu	Rutaceae	S	Fruit	Cold/corona, Tooth problem	Fruit juice taken; Fruit juice taken with water or tea
<i>Clerodendrum infortunatum</i> L.	Vat	Verbenaceae	S	Leaf	Stomach problem	Leaf juice taken
<i>Coccinia grandis</i> (L.) Voigt	Telakucha	Cucurbitaceae	C	Leaf	Diabetes, Jaundice, Body burning, Head cooling	Leaf juice taken; Cooked and taken
<i>Colocasia esculenta</i> (L.) Schott	Kochu	Araceae	H	Stem	Blood purifier	Cooked and taken
<i>Curcuma longa</i> L.	Holud	Zingiberaceae	H	Rhizome	Blood purifier	Raw rhizome taken in the morning
<i>Cuscuta reflexa</i> Roxb.	Sornolota	Cuscutaceae	C	Stem	Worm	Juice used
<i>Cynodon dactylon</i> (L.) Pers.	Durba	Poaceae	H	Leaf, Whole plant	Stop bleeding, Wound healing	Leaf juice given to the wounded place; Crushed and paste applied on the wounded place
<i>Eclipta alba</i> (L.) Hassk.	Keshraj, Kalokeshi, Kalakucha	Asteraceae	H	Whole plant	Hair fall, stop bleeding	Paste applied on head; Paste applied on wounded part
<i>Hyptis suaveolens</i> (L.) Poit.	Tokma	Lamiaceae	H	Seed	Constipation	Seed mixed with water and then taken
<i>Justicia adhatoda</i> L.	Basok	Acanthaceae	S	Leaf	Cold and cough	Leaf juice taken
<i>Lawsonia inermis</i> L.	Mehedi	Lythraceae	S	Leaf	Hair fall, Head cool	Leaf juice applied on head; Paste applied on head
<i>Leucas aspera</i> (Willd.) Link	Dondo Kolosh	Lamiaceae	H	Leaf	Cold and cough	Leaf cooked and taken
<i>Litsea glutinosa</i> (Lour.) Robinson	Menda	Lauraceae	T	Leaf, Bark	Dysentery, Constipation	Leaf soaked in water and then water taken; Leaf soaked in water and then water taken
<i>Mangifera indica</i> L.	Amm	Anacardiaceae	T	Leaf, Bark	Gastritis, Dysentery	Leaf juice taken on empty stomach; bark juice taken
<i>Mentha arvensis</i> L.	Pudina	Lamiaceae	H	Leaf	Cold and cough	Leaf warm juice taken
<i>Mikania scandens</i> B.L.Rob.	Asamlota, German lota, Refugee lota	Asteraceae	C	Leaf	Wound healing, Gastritis	Leaf juice applied on the wounded place; Leaf juice taken
<i>Momordica charantia</i> L.	Korola	Cucurbitaceae	C	Fruit	Diabetes	Fruit juice taken; Cooked and taken
<i>Moringa oleifera</i> Lamk.	Sajna	Moringaceae	T	Leaf	Rheumatic pain	Leaf juice taken

Table 1 Contd.

Scientific name	Local name	Family	Habit	Part used	Ailments	Treatment mode
<i>Musa paradisiaca</i> L.	Kola	Musaceae	H	Fruit	Dysentery	Unripe fruit crushed with sugar and taken
<i>Nigella sativa</i> L.	Kalojira	Ranunculaceae	H	Seed	Corona, Cold and cough	Seed paste taken regularly
<i>Ocimum tenuiflorum</i> L.	Tulshi	Lamiaceae	S	Leaf	Cold and cough, Corona	Leaf juice taken; Leaf chewed and taken; Leaf boiled with tea and taken with honey; Leaf chewed and taken
<i>Phyllanthus emblica</i> L.	Amloki	Phyllanthaceae	T	Fruit	Gastritis	Amloki fruit crushed with bohera and horitoki fruits and taken after drying
<i>Plantago ovata</i> Forssk.	Esobgul	Plantaginaceae	S	Seed coat	Constipation	Seed coat powder mixed with water and taken
<i>Psidium guajava</i> L.	Peyara	Myrtaceae	T	Leaf	Toothache	Young leaf chewed
<i>Sterculia villosa</i> Roxb. ex Sm.	Udal	Sterculiaceae	T	Stem	Strength	Young stem soaked in water and taken
<i>Swietenia macrophylla</i> King	Mehogoni	Meliaceae	T	Seed	Diabetes	Taken raw
<i>Syzygium cumini</i> (L.) Skeels	Kaloram	Myrtaceae	T	Seed	Diabetes	Seed powder taken regularly
<i>Tagetes erecta</i> L.	Gada	Asteraceae	H	Leaf	Stop bleeding	Leaf juice given to the wounded place
<i>Tamarindus indica</i> L.	Tetul	Caesalpiniaceae	T	Fruit	High pressure	Fruit taken
<i>Terminalia arjuna</i> (Roxb. ex DC.) Wight & Arn.	Arjun	Combretaceae	T	Stem bark	Gastritis	Bark powder soaked in water and then taken; Bark powder soaked in water and then taken; Bark powder soaked in water and then taken
<i>Zingiber officinale</i> Rosc.	Ada	Zingiberaceae	H	Rhizome	Cold and cough, Corona, Gastritis and stomach pain	Rhizome boiled with tea and drunk, Raw rhizome taken, Raw rhizome taken with salt, Raw rhizome taken with salt

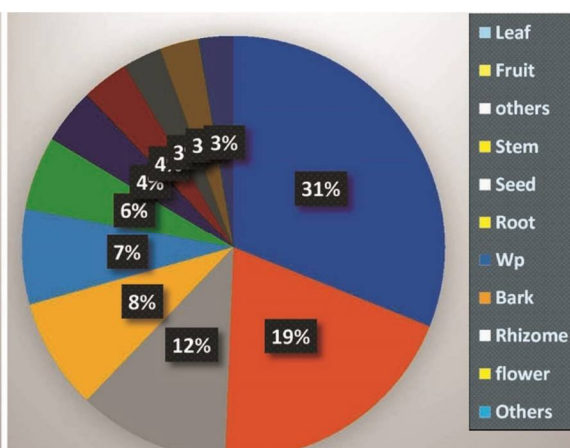
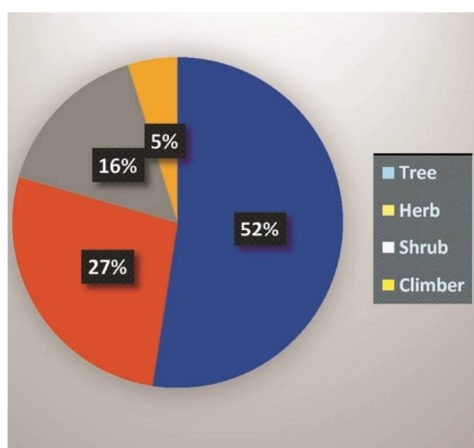


Fig.1. Habits categories.

Fig. 2. Part (s) used categories.

The consensus of local people in the use of ethnomedicinal plants is one of the important tools to identify species for further phytochemical research and natural resource conservation. The ailments mentioned by the informants during data collection were grouped into thirteen medically known disease categories, and the calculated informant's consensus factor (FIC) values are presented in Table 2. Cuts and wounds attained the highest FIC value and were treated by 18 medicinal plant species. The most cited species in this category are *Cynodon dactylon* and *Cissus quadrangularis*. Maximum values of Factor of Informant Consensus (FIC) were obtained in the cases of heart diseases (0.92) and (0.93) from Thakurgaon and Dinajpur districts (Mitu *et al.* 2022), whereas cuts and wounds showed a maximum fic value (0.93) from other studies from Bangladesh (Uddin *et al.* 2014). The present result of highest fic values in cuts and wounds was similar to Uddin *et al.* (2014). *Cynodon dactylon* is used to reduce inflammation, one of the early signs of diabetes, and prevent complications in patients with diabetes by accelerating wound healing (Porushottam *et al.* 2024). Diabetes and respiratory disorders showed the second highest FIC values, and the most cited species for diabetes were *Coccinia grandis* and *Azadirachta indica*. *Ocimum tenuiflorum* is the most cited species for respiratory disorders. The FIC values were found to be less than 0.80 in the other ten disease categories. That means local people were not well agreed upon in the use of medicinal plants to treat such categories.

Table 2. Informants consensus values (FIC) of major diseases categories.

Disease categories	No. of species	Use report	FIC values	Most cited species
Cuts and Wounds	18	165	0.896341463	<i>Cynodon dactylon</i> (L.) Pers., <i>Cissus quadrangularis</i>
Diabetes	31	156	0.806451613	<i>Coccinia grandis</i> (L.) Voigt, <i>Azadirachta indica</i> A. Juss.
Respiratory disorder	73	364	0.801652893	<i>Ocimum tenuiflorum</i> L.
Cardiovascular and Circulatory Problem	37	153	0.763157895	<i>Terminalia arjuna</i> (Roxb. ex DC.) Wight & Arn.
Gastrointestinal disorder	171	459	0.628820961	<i>Listea glutinosa</i> , <i>Achyranthes aspera</i> L.
Dermatological Disorders	78	198	0.609137056	<i>Azadirachta indica</i> A. Juss.
Mouth and Dental Problems	46	107	0.575471698	<i>Psidium guajava</i> L.
Gastro-liver	36	79	0.551282051	<i>Andrographis paniculata</i> (Burm.f.) Nees
Analgesic and Antipyretic	57	121	0.533333333	<i>Azadirachta indica</i> A. Juss., <i>Calotropis gigantea</i> (L.) W.T.Aiton.
Food and nutrition	30	59	0.5	<i>Aloe vera</i> (L.) Burm.f.
Kidney disease	10	18	0.470588235	<i>Kalanchoe pinnata</i> (Lam.) Pers.
Gynaecological or Sexual Disorders	50	92	0.461538462	<i>Lawsonia inermis</i> L.
Neurological	21	28	0.259259259	<i>Datura metel</i> L.

Culturally bound medicinals can be detected by the fidelity index (FL) value. Among the most commonly cited medicinal plant species, *Ocimum tenuiflorum* showed a 100% FL value (Table 3). That means people in the cultural group used *Ocimum tenuiflorum* for respiratory disorders, and they have no other choice of medicinal plants for respiratory disorders. Other 21 species have shown more than one use to treat disease categories. That's why FL values were low. Neem has been used to treat a number of diseases. The low value for neem showed diversity of uses in the cultural groups. *Terminalia arjuna*, *Baccaurea ramiflora*, *Dillenia indica*, *Lycopersicon*

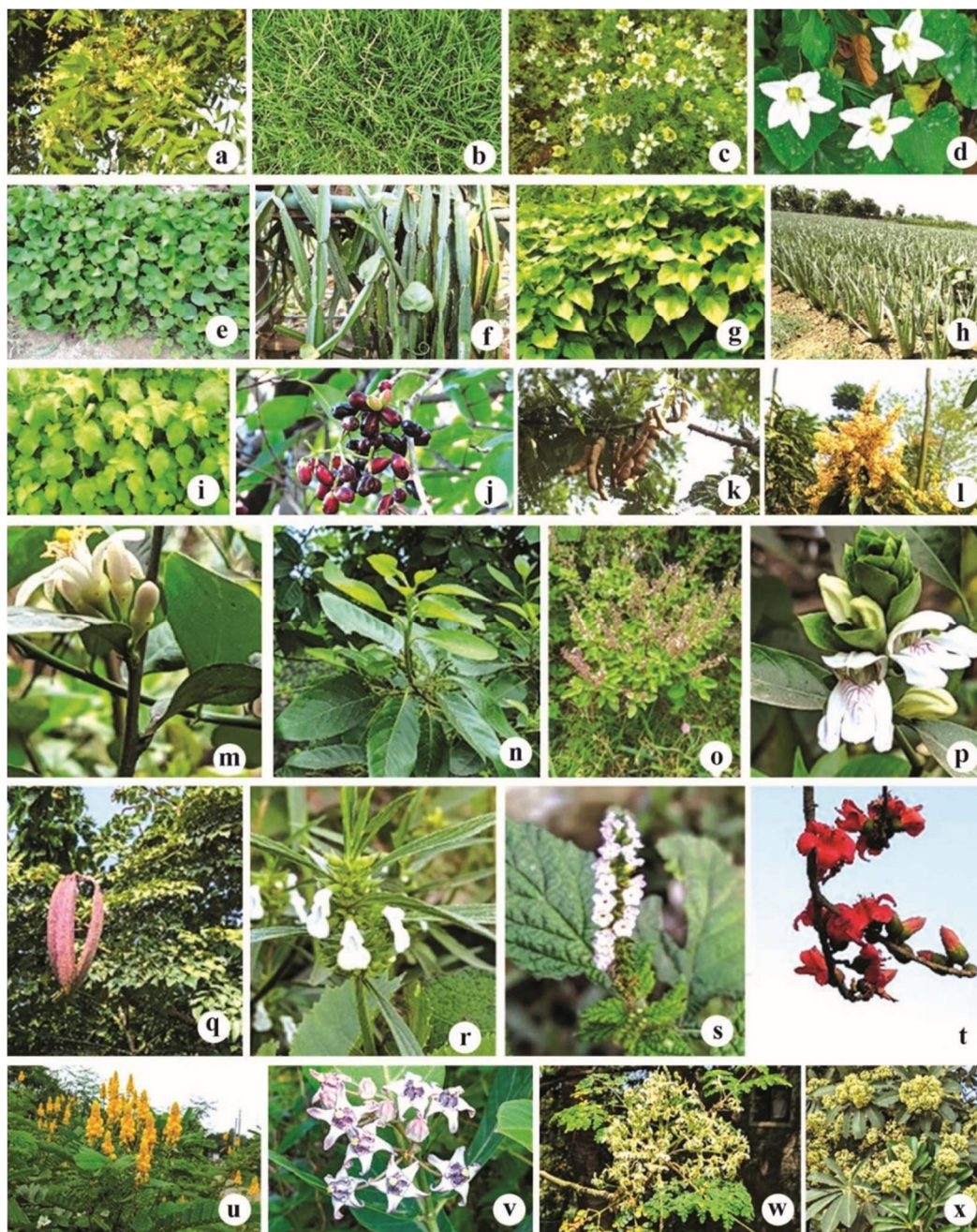
lycopersicum, *Tamarindus indica*, *Lawsonia inermis*, *Azadirachta indica*, and *Nigella sativa* were reported as culturally bound tree species from Dinajpur district and attained 100% FI values (Rifat *et al.* 2022). In the other study from Thakurgaon, *Allium sativum*, *Spondias pinnata*, *Cynodon dactylon*, *Lawsonia inermis*, *Zingiber officinale*, *Saccharum officinarum*, *Tagetes erecta*, and *Baccaurea ramiflora* showed 100% FI values (Mitu *et al.* 2022). The present result of FI values was not in accordance with the previous report.

Table 3. Fidelity index values of most cited medicinal plants.

Plant Species	No. of Species	Use report	FI Values
<i>Ocimum tenuiflorum</i> L.	120	120	100
<i>Justicia adhatoda</i> L.	52	55	94.54545455
<i>Tagetes erecta</i> L.	13	14	92.85714286
<i>Cajanus cajan</i> (L.) Millsp.	10	11	90.90909091
<i>Cissus Quadrangularis</i> L.	20	22	90.90909091
<i>Tamarindus indica</i> L.	15	18	83.33333333
<i>Cynodon dactylon</i> (L.) Pers.	70	86	81.39534884
<i>Chromolaena odorata</i> (L.) R.M.King & H.Rob.	11	14	78.57142857
<i>Allium sativum</i> L.	14	18	77.77777778
<i>Zingiber officinale</i> Rosc.	32	50	64
<i>Mikania scandens</i> B.L.Rob.	17	27	62.96296296
<i>Terminalia arjuna</i> (Roxb. ex DC.) Wight & Arn.	49	78	62.82051282
<i>Syzygium cumini</i> (L.) Skeels	11	20	55
<i>Nigella sativa</i> L.	22	42	52.38095238
<i>Calotropis gigantea</i> (L.) W.T. Aiton.	15	29	51.72413793
<i>Hyptis suaveolens</i> (L.) Poit.	14	28	50
<i>Aloe vera</i> (L.) Burm.f.	21	45	46.66666667
<i>Coccinia grandis</i> (L.) Voigt	38	84	45.23809524
<i>Citrus aurantifolia</i> (Christm. & Panzer) Swingle	10	27	37.03703704
<i>Litsea glutinosa</i> (Lour.) Robinson	19	61	31.14754098
<i>Centella asiatica</i> (L.) Urban	32	104	30.76923077
<i>Azadirachta indica</i> A. Juss.	32	115	27.82608696

For the better understanding and recognition of most cited medicinal plants, color images were taken during field work, and some of them are presented in the Plate 1.

Through field observations and discussion with local people in the study area, a number of threats to ethnomedicinal plants were identified. Once, the area was a part of Sal Forest, with a diversity of plant species, some of which were medicinally important and used in the primary healthcare of local people. Due to urbanization and town development, a number of such plants have been eliminated from nature. According to the informants, the availability of modern medicines near their hands, local people do not bother about medicinal plants and even do not realize their potential values for future conservation. They also mentioned that lack of awareness among the dwellers about medicinal plants also posed threats. Some people noticed that overharvesting of some demanding medicinal plants, including *Centella asiatica*, *Coccinia grandis*, *Eclipta prostrata*, *Holarrhena pubescens*, *Litsea glutinosa*, *Terminalia arjuna*, *Andrographis paniculata* and *Azadirachta indica* showed another threat. Observation confirmed that water pollution from industries is another threat to medicinal herbs in the study area. The



Plat. 1. Medicinal plant species a. *Azadirachta indica* b. *Cynodon dactylon* c. *Nigella sativa* d. *Coccinia grandis* e. *Centella asiatica* f. *Cissus quadrangularis* g. *Mikania scandens* h. *Aloe vera* i. *Hyptis suaveolens* j. *Syzygium cumini* k. *Tamarindus indica* l. *Mangifera indica* m. *Citrus aurantifolia* n. *Litsea glutinosa*, o. *Ocimum tenuiflorum* p. *Justicia adhatoda* q. *Oroxylum indicum* r. *Leucas lavandulifolia* s. *Heliotropium indicum* t. *Bombax ceiba* u. *Senna alata* v. *Calotropis gigantea* w. *Moringa oleifera* x. *Alstonia scholaris*.

introduction of exotic trees in the study area is one of the new threats to medicinal plants, according to local perceptions. Plot owners, those living outside the country, do not like to plant native fruits or medicinal or ornamental trees in their lands; rather, they prepare to plant exotic tree species like *Samanea saman*, *Eucalyptus camaldulensis*, *Swietenia mahagoni*, *Terminalia mantaly*, and *Khaya anthotheca* in their plots, which is another intentional threat to medicinal plants. During field work, we observed invasive plants, including *Parthenium hysterophorus*, *Eichhornia crassipes*, *Wedelia trilobata*, *Eupatorium odoratum* and *Mikania cordata* in the study area, and they formed a pure colony, did not socialize with native plant species in habitats, and posed great threats to native plants. The scarcity of native plant seedlings in nurseries is one of the great challenges of native medicinal plant restoration. A number of nurseries were visited during the field work in and around the study area. According to nurseries, owners noticed that they were not much aware of native plants; rather, they sell seedlings, which are demanding to customers. Fruit and ornamental trees were much more demanding in the nurseries.

Medicinal plant management in nature is one of the great challenges. A number of possible recommendations are suggested here for medicinal plant conservation in the in the Purbachal new town area. Initially, all threats to medicinal plants should be reduced as much as possible. The most cited medicinal species should be included in the future plantation plan in the study area. The distribution of important medicinal species should be mapped to determine their population status in nature. A park or garden should have one corner with medicinal plants to which people can get access whenever they need to collect medicinal parts. An integrated approach based on local knowledge should be followed to make policies and plans for the conservation of native medicinal plants. Strong awareness programs should be implemented to provide people with an understanding of the importance of medicinal plants. Plantations in each sector should have with some native medicinal trees, including *Terminalia arjuna*, *Azadirachta indica*, *Phyllanthus emblica*, *Litsea glutinosa*, *Syzygium cumini*, *Sterculia villosa*, *Terminalia bellirica*, *Alstonia scholaris*, *Moringa oleifera*, *Holarrhena pubescens*, *Bombax ceiba*, *Aegle marmelos*, *Tamarindus indica*, *Zanthoxylum rhetsa*, *Toona ciliata*, *Cassia fistula*, *Flacourtia jangomus*, *Garcinia cowa*, *Baccaurea ramiflora*, *Ficus racemosa*, *Ficus benghalensis*, *Aphanamixis polystachya*, *Milliusa valutina*, *Spondias pinnata*, *Oroxylum indicum*, *Neolamarckia kadamba*, and *Elaeocarpus serratus*, so that dwellers can find them easily. Nurseries nearby should have to ensure the supply of native medicinal plants. School going children could be involved in the conservation activities of medicinal plants through outreach programs in Friday or Saturday.

The study recorded 185 medicinal plant species under 78 families, which have been used through 673 formularies to treat 48 complaints in 13 disease categories. These results are the indication of diversity of medicinal plants and their use diversity in the study area. Cuts and wounds attained the highest FIC value and were treated by 18 medicinal plant species. Among them most cited species are *Cynodon dactylon* and *Cissus quadrangularis*. According to FI value, *Ocimum tenuiflorum* is the culture bound species because it has been used for respiratory tract diseases treatment only. The most commonly cited species of medicinal plants are *Ocimum tenuiflorum*, *Cynodon dactylon*, *Justicia adhatoda*, *Terminalia arjuna*, *Coccinia grandis*, *Centella asiatica*, *Azadirachta indica*, *Nigella sativa*, *Aloe vera*, *Zingiber officinale*, *Cissus quadrangularis*, *Litsea glutinosa*, *Mangifera indica*, *Mikania scandens*, *Calotropis gigantea*, *Tamarindus indica*, *Hyptis suaveolens*, *Tagetes erecta*, *Syzygium cumini*, *Chromolaena odorata*, *Cajanus cajan*, and *Citrus aurantifolia*. Based on observations and interviews with local people, a good number of threats have been detected for medicinal plant species, including urbanization, globalization, pollution, habitat loss, introduction of exotic trees, invasive species, plot owners living outside countries who don't want to grow native fruits or medicinal tree species, industrialization, lack of policy for native species conservation, lack of awareness, unwillingness to practice, and lack of

documentation. To conserve medicinal plants in and around the Purbachal modern town area, management plan should be adopted with expert bodies based on local knowledge, native medicinal plants and their uses.

Acknowledgement

The authors greatly acknowledge the Advanced Studies in Biological Sciences, University of Dhaka, for the financial support. They also acknowledge the contributions of local informants who provided data during the field work.

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(Manuscript received on 30 August, 2024; revised on 18 September, 2024)