

AN ETHNOBOTANICAL SURVEY OF MEDICINAL PLANTS FOCUSING ON CARDIOVASCULAR DISEASES USED BY THE LOCAL PEOPLE IN AND AROUND DINAJPUR DISTRICT, BANGLADESH

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Abstract

This study aimed to document the medicinal plants through semi-structured interviews, key informant discussions, and informal conversations with local people in and around the Dinajpur district, Bangladesh. A total of 109 medicinal plant species distributed in 60 families with 210 formularies to treat 55 ailments were recorded. The most frequently utilized plant populations were herbs, followed by trees, shrubs, and climbers. Oral consumption was the main mode of treatment in the study area and was followed by external application. The highest factor of informant consensus (Fic) values was found in heart disease, followed by diabetes, gastrointestinal disorders, skin disease, respiratory disorders, sexual disease, and cuts and wounds. In the present survey, eight species have attained a fidelity level of 100 percent (Fl). Among the plants, 25 species have been used to treat cardiovascular diseases. The most cited medicinal plants for cardiac management are *Terminalia arjuna* (Roxb. ex DC.) Wight & Arn., *Baccaurea ramiflora* Lour., *Dillenia indica* L., *Allium sativum* L., *Tamarindus indica* L., *Rauvolfia serpentina* (L.) Benth. ex Kurz., *Terminalia chebula* Retz., *Phyllanthus emblica* L., *Averrhoa carambola* L. and *Spondias pinnata* (L. f.) Kurz. The ethnobotanical uses of the documented plants provide basic data, and further investigation focusing on pharmacological research is essential to confirm the results. Numerous threats to medicinal plants were identified during the ethnobotanical survey in the study area. Some recommendations are provided to mitigate the threats and the conservation of medicinal plants.

Key words: Ethnobotanical survey, Medicinal plants, Dinajpur District, Cardiovascular disease, Threats, Conservation.

Introduction

Ethnobotanical studies are significant for discovering modern drugs from native medicinal plant resources. There are appropriate sources of information about useful medicinal plant species, which can be targeted for management and domestication

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(Njoroge *et al.*, 2004; Mahmood *et al.*, 2013). Dinajpur is the largest district among all sixteen northern districts of the Rangpur division of Bangladesh. It is famous for producing rice, lychee, and wheat and is highly rich in natural resources like coal. Recently, according to the Geological Survey of Bangladesh (GSB), the presence of iron reserves in the form of magnetite was found at Isabpur village in Hakimpur Upazila of the district (GSB, 2019). Bangladesh is divided into distinct, culturally diverse areas. Dinajpur is such one area where ethnic communities such as Santals, Oraon, Mahali, Malpahari, and Kol live (Bangladesh Population Census, 2001). Cardiovascular diseases (CVDs) are problems with the heart or blood vessels (Uddin *et al.*, 2019; Olorunnisola *et al.*, 2011). CVDs are a variety of diseases, including peripheral vascular diseases, coronary heart disease (CHD), heart failure, heart attack (myocardial infarction), stroke, cardiomyopathies, dyslipidemias, and hypertension (Reiner *et al.*, 2019). According to the World Health Organization (WHO, 2017), an estimated 17.9 million people died from CVDs in 2016, representing 31% of all global deaths. Of these deaths, 85% were due to heart attacks and strokes. Bangladeshis had the highest prevalence of CVD risk factors among five South Asian countries, with a prevalence of self-reported history of hypertension (14.3%), abdominal obesity (43.3%), and current and former smoking (59.9%) (Uddin *et al.*, 2019; Joshi *et al.*, 2007).

From the beginning of society, humans relied on plants to create a new field for discovering of plant-derived drugs. These drugs effectively cure certain diseases and have drawn attention to herbal medicines in a new way. Medicinal herbs continue to be an alternative treatment approach for several diseases, including CVD (Shaito *et al.*, 2020). It is estimated that about 30% of pharmaceuticals are prepared from plant derivatives (Leta *et al.*, 2002; Gillman *et al.*, 1995). Several research studies have been conducted to discover the plants and natural food sources, the supplements of which have antithrombotic (anticoagulant and antiplatelet) effects, and there is an indication that consuming such foods leads to the prevention of coronary events and stroke (Ratnasooriya *et al.*, 2008; Joshipura *et al.*, 1999; Liu *et al.*, 2000).

In Bangladesh, a number of plants are known to possess cardioprotective properties, resulting in their use by traditional healers for the treatment of chest complaints, high cholesterol, high blood pressure, and general heart problems, which are the most common symptoms of cardiovascular diseases. Although the beneficial effects of thrombolytic therapy are now well established (Collen, 1996), the biochemical mechanisms of thrombolytic therapy have been explained. The search for alternative therapies continues because of availability, affordability, diversity, and easy access to natural resources. Due

to their biological activities, plants may serve as alternative sources for developing new anticoagulant agents (Uddin *et al.*, 2019).

Ethnobotanical knowledge of medicinal plants needs proper documentation and evaluation before declining from the natural source of the study area. To protect such knowledge, documentation of ethnobotanical plants has already been started. In Bangladesh, a number of research has been done in this field, focusing mainly on a particular community or particular diseases or particular areas, such as Mia and Haque (1988); Hassan and Khan (1986, 1996); Alam (1992); Alam *et al.*, (1996); Uddin *et al.*, (2001, 2006, 2012, 2017); Khan *et al.*, (2002); Ghani (2003); Uddin and Hassan (2004); Yusuf and Uddin (2006); Yosuf (2006); Uddin and Roy (2007); Roy *et al.*, (2008); Emily *et al.*, (2010); Uddin (2013); Haque *et al.*,(2014); Uddin *et al.* (2015a,b). But there is no record of ethnobotanical plant species useful for cardiovascular diseases in and around the Dinajpur district. In order to document and corroborate ethnobotanical plant species for cardiovascular diseases in and around Dinajpur district, an attempt was made to achieve the following objectives: to record, assimilate, and document all scattered distribution of traditional healthcare knowledge of medicinal plants, along with discovering any threats to medicinal plants in the study area, and to focus the traditional knowledge of medicinal plants for cardiovascular diseases.

Materials and Methods

Study area: The total area of Dinajpur district is 3437.98 km², located between 25°10' and 26°04' north latitudes and 88°23' and 89°18' east longitudes. It is bounded by Thakurgaon and Panchagarh districts in the north, Gaibandha and Joypurhat districts in the south, Nilphamari and Rangpur districts in the east, and the state of West Bengal, India in the west. There are 13 Upazillas in the study area, where Birganj is the biggest and Hakimpur is the smallest. The Singra Shal forest in Birganj Upazila has a vast collection of plant resources. It is also a protected area in Bangladesh as a National Park.

Data collection: The study area was visited five times in different seasons from July 2018 to April 2019. Each field trip lasted five to eight days. Data on medicinal plants was recorded in three ways, i.e., semi-structured interviews, key informant interviews, and informal conversations with local people, including herbal practitioners. A total of 300 informants were interviewed using a questionnaire. Among them, 57% were male and the rest, 43%, were female (Fig. 1). age ranged from 21 to 70 years old (Fig. 2).

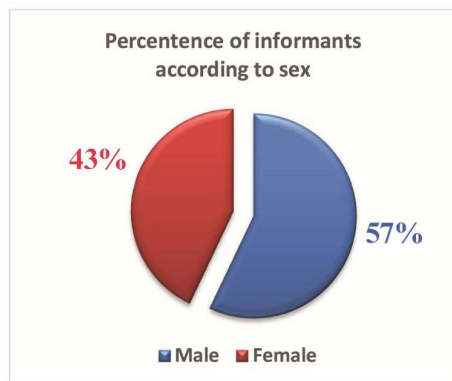


Fig. 1. Percentage of informants according to sex.

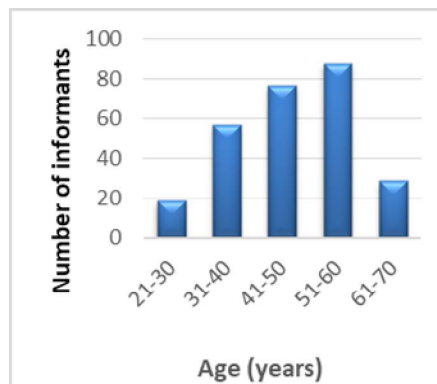


Fig. 2. Number of informants in each age group.

Key questions about medicinal plants were on the local name of a medicinal plant, particularly, types of disease treated, mode of treatment and method of preparation for remedy, plant parts used, fresh or dry plant parts used, mode of administration, and requirement for doses.

Collection and identification of the plant materials: According to the list, medicinal plants were collected from fields, gardens, forests, and the habits of these plants were documented. The collected plant specimens were pressed, dried, poisoned, mounted, and processed using standard herbarium techniques (Hyland, 1972; Alexiades, 1996).

Data analysis: The factor of informant consensus (Fic) was calculated using the following equation: $Fic = N_{ur} - N_{taxa} / N_{ur} - 1$, where N_{ur} is the number of use reports in each category and N_{taxa} is the number of species in each category (Heinrich *et al.*, 1998). The fidelity level was calculated following the equation: $Fl (\%) = (N_p / N) 100$, where N_p is the number of informants who claim to have used a plant species to treat a specific disease and N is the number of informants who use the plants as medicine to treat any given disease (Friedman *et al.*, 1986). Cf values of medicinal plants were estimated by Friedman *et al.* in 1986. Using a Microsoft Office Excel sheet, the data were summarized. Descriptive statistical methods were applied for analyzing and summarizing the ethnobotanical data, such as frequency and percentage.

Results and Discussion

The study has resulted in the recording of 109 medicinal plant species belonging to 60 families. The local people use these species to treat 55 ailments through 210 formularies

in and around the Dinajpur district. For each species, scientific name, local name, family, habit, part used, ailment, and treatment mode are provided (Table 1).

Table 1. Ethnobotanical data on medicinal plants and uses in the study area (S=Shrub, C=Climber, H=Herb, T=Tree).

Scientific name	Local name	Family	Habit	Parts use	Ailments	Treatment mode
<i>Abroma augustum</i> (L.) L. f.	Ulotkombal	Sterculiaceae	S	Leaf	Jaundice	Leaf juice is taken
<i>Justicia adhatoda</i> L.	Basak	Acanthaceae	S	Leaf	Dysentery	Juice is taken
					Cold treatment	Leaf is chewed
<i>Aegle marmelos</i> (L.) Corr.	Bel	Rutaceae	T	Fruit	Bronchitis	Leaf juice is taken with ginger and honey
					Dysentery	Juice is taken twice per day
<i>Albizia procera</i> (Roxb.) Benth.	Koroi	Mimosaceae	T	Stomach problem	Juice is taken	
				Leaf	Diarrhoea	Leaf juice is taken
<i>Allium cepa</i> L.	Piaz	Liliaceae	H	Leaf	Skin disease	Leaf paste is applied to the affected area
<i>Allium sativum</i> L.	Rosun	Liliaceae	H	Bulb	Flu	Juice is taken
<i>Alocasia cucullata</i> (Lour.) G. Don	Biskachu	Araceae	H	Rhizome	Blood pressure	Clove is eaten raw
					Heart disease	2-3 cloves are eaten
<i>Aloe vera</i> (L.) Burm. f.	Aloevera	Aloaceae	H	Leaf	Body ache	Cooked rhizome is taken
					Rheumatic pain	Cooked rhizome is taken
<i>Alstonia scholaris</i> (L.) R. Br.	Chatim	Apocynaceae	T	Latex	Stomachache	Leaf juice is taken
					Weight loss	Juice is taken
<i>Amaranthus tricolor</i> L.	Lalsak	Amaranthaceae	H	Leaf	Hair treatment	Latex paste is applied to hair
					Ringworm	Latex is applied to the affected area
<i>Amorphophallus paeoniifolius</i> (Dennst.) Nicolson	Olkachu	Araceae	H	Rhizome	Blood purifier	Cooked leaf is taken
					Blood pressure	Cooked leaf is taken
<i>Anacardium occidentale</i> L.	Bhela	Anacardiaceae	T	Fruit	Rheumatic pain	Cooked rhizome is taken
<i>Andrographis paniculata</i> (Burm.f.) Nees	Kalomegh	Acanthaceae	H	Leaf	Antiseptic	Fruit juice is applied to the affected area
					Cold treatment	Leaf is chewed

Table 1 contd.

Scientific name	Local name	Family	Habit	Parts use	Ailments	Treatment mode
					Constipation	Leaf juice is taken
					Ulcer	Leaf juice is taken.
<i>Annona squamosa</i> L.	Sharifa	Annonaceae	T	Fruit	Anthelmintics	Juice is taken
<i>Arachis hypogaea</i> L.	Badam	Fabaceae	H	Fruit	Heart disease	Fruit is taken
<i>Areca catechu</i> L.	Supari	Areaceae	T	Fruit	Stomachache	Crushed fruit is taken
<i>Aristolochia indica</i> L.	Iswarmul	Aristolochiaceae	C	Root	Dysentery	Root juice is taken
<i>Artocarpus heterophyllus</i> Lamk.	Kathal	Moraceae	T	Fruit	Nutritive	Fruit is eaten
				Leaf	Skin disease	Paste is applied
<i>Asparagus racemosus</i> Willd.	Satamuli	Asparagaceae	C	Root	Gastric	powdered root is taken
<i>Averrhoa carambola</i> L.	Kamranga	Oxalidaceae	T	Fruit	Cold treatment	Fruit is taken
					Heart disease	Fruit juice is taken
<i>Azadirachta indica</i> A. Juss.	Neem	Meliaceae	T	Leaf	Diabetes	Juice is taken
					Skin disease	Leaf boiled water is applied affected to the area
					Jaundice	Juice is taken
<i>Baccaurea ramiflora</i> Lour.	Lotkon	Euphorbiaceae	T	Fruit	Heart disease	Fruit juice is taken
					Anti-oxidant	Fruit juice is taken
<i>Bambusa tulda</i> Roxb.	Talla bash	Poaceae	T	Stem	Impotence	Cooked stem is taken
<i>Basella alba</i> L.	Puisak	Basellaceae	C	Leaf	Wound	Leaf paste is applied to the affected area
<i>Bombax ceiba</i> L.	Shimul	Bombacaceae	T	Root	Impotence	Root juice is taken
<i>Borassus flabellifer</i> L.	Tal	Areaceae	T	Young apex	Cough	Juice is taken
<i>Bryophyllum pinnatum</i> (Lamk.) Oken	Pathorkuchi	Crassulaceae	H	Leaf	Diabetes	Juice is taken
					Cold treatment	Juice is taken
					Cuts & wounds	Paste is applied
					Blood dysentery	Juice is taken
<i>Cajanus cajan</i> (L.) Millsp.	Orhor	Fabaceae	S	Leaf	Jaundice	Leaf juice is taken
<i>Calotropis procera</i> (Ait.) R. Br.	Akanda	Asclepiadaceae	S	Leaf	Ringworm	Leaf paste is applied over affected area
<i>Careya arborea</i> Roxb.	Kumbhi	Lecythidaceae	T	Bark	Weakness	Bark juice is taken

Table 1 contd.

Scientific name	Local name	Family	Habit	Parts use	Ailments	Treatment mode
<i>Carica papaya</i> L.	Pepe	Caricaceae	S	Fruit	Gastric pain	Boiled fruit is taken
					Constipation	Cooked fruit is taken
<i>Cassia fistula</i> L.	Sonalu	Caesalpiniaceae	T	Leaf	Ringworm	Leaf paste is applied to the affected area
					Fruit	Laxative
<i>Catharanthus roseus</i> (L.) G. Don	Noyontara	Apocynaceae	H	Leaf	Diabetes	Leaf juice is taken twice per day
				Leaf	Diabetes	Leaf is chewed in empty stomach
				Flower	Diabetes	Flower chewed early in the morning
<i>Centella asiatica</i> (L.) Urban	Thankuni	Apiaceae	H	Leaf	Brain tonic	Leaf chewed
				Leaf	Skin disease	Leaf paste is applied to the applied area
				Leaf	Constipation	Leaf paste is taken
<i>Cinnamomum tamala</i> Nees & Eberm.	Tejpata	Lauraceae	T	Leaf	Asthma	Bud is eaten
					Digestion	Bud is eaten raw
					Cold treatment	Bud is boiled with tea & then taken
<i>Citrus aurantifolia</i> (Christm. & Panzer) Swingle	Kagojilebu	Rutaceae	S	Fruit	Vomiting	Juice is taken.
					Vomiting	Juice is taken
<i>Citrus limon</i> (L.) Burm. f.	Lebu	Rutaceae	S	Fruit	Toothache	Juice is taken
<i>Clerodendrum viscosum</i> Pers.	Vat	Verbenaceae	S	Leaf	Jaundice	Juice is taken
					Dysentery	Leaf paste is taken
				Root	Daud	Root blended with Zinger then the paste is applied to the affected area
<i>Coccinia grandis</i> (L.) Voigt	Telakucha	Cucurbitaceae	C	Leaf	Diabetes	Leaf paste is taken
					Constipation	Leaf juice taken with black cumin
					Diabetes	4 to 5 leaves are chewed in empty stomach in the morning

Table 1 contd.

Scientific name	Local name	Family	Habit	Parts use	Ailments	Treatment mode
					Diabetes	Paste taken with boiled rice
					Dysentery	1 glass of leaf juice is taken
					Jaundice	1 cup of juice is taken
					Constipation	Leaf juice taken with black cumin
<i>Cocos nucifera</i> L.	Narikel	Arecaceae	T	Fruit	Jaundice	Water is taken
<i>Colocasia esculenta</i> (L.) Schott	Kochu	Araceae	H	Leaf	Brain tonic	Cooked and taken
				Stem	Brain tonic	Cooked stem is taken
<i>Coriandrum sativum</i> L.	Dhonia	Apiaceae	H	Seed	Reducing cholesterol	Soaked in water then water is taken
<i>Crinum asiaticum</i> L.	Birpiaj	Liliaceae	H	Root	Ring worm	Root paste is applied to the affected area
<i>Cucurbita siceraria</i> Molina	Lau	Cucurbitaceae	C	Fruit	Toothache	Cooked fruit is taken
<i>Curcuma longa</i> L.	Halood	Zingiberaceae	H	Rhizome	Blood purifier	Juice is taken
					Skin disease	Paste is applied to the affected area
<i>Cuscuta reflexa</i> Roxb.	Swarnalota	Cuscutaceae	C	Stem	Jaundice	Juice is taken
					Deworming	Juice is taken
<i>Cyperus rotundus</i> L.	Gandhavadlu	Cyperaceae	H	Leaf	Diarrhoea	Cooked leaf is taken
<i>Dalbergia sissoo</i> Roxb.	Shishu	Fabaceae	T	Leaf	Dysentery	Leaf juice is taken
<i>Datura metel</i> L.	Dhatura	Solanaceae	S	Leaf	Paralysis	Dried crushed leaf is applied to the affected area
					Skin disease	Leaf paste is applied to the affected area
					Skin disease	Cooked leaf is taken
<i>Daucus carota</i> L.	Carot	Apiaceae	H	Root	Heart disease	Root juice is taken
<i>Dillenia indica</i> L.	Chalta	Dilleniaceae	T	Leaf	Diarrhoea	Leaf paste is applied to the affected area
					Headache	Paste is applied to the affected area
				Leaf	Tumor	Paste is applied to the affected area
				Fruit	Heart disease	Fruit juice is taken
<i>Diospyros malabarica</i> (Desr.) Kostel.	Gab	Ebenaceae	T	Leaf	Headache	Leaf paste is applied to the affected area

Table 1 contd.

Scientific name	Local name	Family	Habit	Parts use	Ailments	Treatment mode
<i>Bacopa momieri</i> (L.) Pennell	Brammi	Scrophulariaceae	H	Leaf	Hair treatment	Juice applied to hair for hair growth
<i>Eclipta prostrata</i> (L.) Mant.	Keshoraj	Asteraceae	H	Leaf	Hair treatment	Leaf paste is applied to hair
<i>Enhydra fluctuans</i> Lour.	Helencha	Asteraceae	H	Leaf	Jaundice	Juice is taken
					Ulcer	Leaf juice is taken
					Anti-oxidant	Cooked leaf is taken
					Eye treatment	Cooked leaf is taken
<i>Ficus racemosa</i> L.	Jogdumur	Moraceae	T	Leaf	Diabetes	Cooked leaf is taken
<i>Glinus oppositifolius</i> (L.) A. DC.	Gemashak	Molluginaceae	H	Leaf	Blood pressure	Dried leaf is taken
<i>Gloriosa superba</i> L.	Ulotchandal	Lilliaceae	C	Root	Stomachache	Juice is taken
				Leaf	Head lice	Paste is applied
<i>Glycosmis pentaphylla</i> (Retz.) A. DC.	Motkilla	Rutaceae	S	Leaf	Diarrhea	Juice is taken
				Stem	Toothache	Stem used as brushing teeth
				Root	Skin disease	Paste is applied to the affected area
					Eczema	Paste is applied to the affected area
<i>Hibiscus rosasinensis</i> L.	Joba	Malvaceae	S	Leaf	Dysentery	Leaf juice is taken internally twice a day
					Liver disease	Leaf soaked in water at night then taken in the next morning
					Hair tonic	Leaf paste is boiled with oil and then applied over hair
				Flower	Hair fall	Flower paste is applied over head
					Weakness	Flower buds are taken
<i>Hyptis suaveolens</i> (L.) Poit.	Tokma	Lamiaceae	H	Seed	Blood pressure	Seed is taken
					Constipation	Seed is taken
<i>Ipomoea aquatica</i> Forssk.	Kalmisak	Convolvulaceae	H	Leaf	Eye treatment	Leaf is cooked
<i>Lawsonia inermis</i> L.	Mehedi	Lythraceae	S	Leaf	Hair treatment	Leaf paste is applied to the affected area
<i>Leucas aspera</i> (Willd.) Link	Dondokolosh	Lamiaceae	H	Leaf	Cold treatment	Juice is taken
<i>Litsea glutinosa</i> (Lour.) Robinson	Menda	Lauraceae	T	Leaf	Diarrhoea	Leaf juice is taken
				Bark	Dysentery	Bark soaked in water is taken

Table 1 contd.

Scientific name	Local name	Family	Habit	Parts use	Ailments	Treatment mode
<i>Lycopersicon esculentum</i> Mill.	Tomato	Solanaceae	H	Fruit	Heart disease	Juice is taken
<i>Mangifera indica</i> L.	Aam	Anacardiaceae	T	Fruit	Stomach problem	Fruit juice is taken
				Seed	Reducing cholesterol	Crushed seed is taken
				Leaf	Teeth ache Dysentery	Chewed leaves Grinded and taken in empty stomach once per day
					Heart disease	Young leaves are eaten in empty stomach
					Diarrhoea	Grinded and taken in empty stomach once per day
				Stem	Weakness	Stem soaked water is taken
<i>Mentha arvensis</i> L.	Pudina	Lamiaceae	H	Leaf	cold treatment	Leaf juice is taken
<i>Mikania cordata</i> (Burm. f.) Robinson	Assamilata	Asteraceae	C	Leaf	Cuts & wounds Diarrhoea	Leaf paste is applied to the affected area Leaf juice is taken
<i>Mimosa pudica</i> L.	Lajjaboti	Mimosaceae	H	Whole plant	Blood purifier	Decoction of the whole plant is taken
				Root	Fistula	Juice is taken
				Leaf	Toothache	juice is taken
<i>Moringa oleifera</i> Lamk.	Sajna	Moringaceae	T	Bark	Gastric	Crushed bark is taken
					Body ache	Juice is taken
					Ulcer	Bark paste is taken
<i>Murraya paniculata</i> (L.) Jack	Kamini	Rutaceae	T	Leaf	Toothache	Leaf paste is applied
<i>Musa acuminata</i> Colla	Kola	Musaceae	H	Latex	Skin disease	Latex is applied to the affected area
				Fruit	Digestion	Fruit is eaten
				Flower	Heart disease	Paste is taken
<i>Neolamarckia cadamba</i> (Roxb.) Bosser	Kadam	Rubiaceae	T	Leaf	Rheumatic pain	Heated leaf is applied to the affected area
<i>Nicotiana plumbaginifolia</i> Viv.	Tamak	Solanaceae	H	Leaf	Cuts & wounds	Leaf paste is applied
<i>Nigella sativa</i> L.	Kalajira	Ranunculaceae	H	Seed	Liver control	Crushed seed is taken internally
<i>Ocimum gratissimum</i> L.	Raamtulsi	Lamiaceae	S	Leaf	Asthma	Leaf juice is taken

Table 1 contd.

Scientific name	Local name	Family	Habit	Parts use	Ailments	Treatment mode
<i>Ocimum sanctum</i> L.	Tulshi	Lamiaceae	H	Leaf	Cold treatment	Leaf is chewed
					Cold treatment	Leaf is boiled with tea and then taken
					Constipation	Dried crushed leaf is taken with raw honey
					Ringworm	Leaf paste is applied to the affected area
<i>Oryza sativa</i> L.	Dhan	Poaceae	H	Seed	Tuberculosis	Leaf juice is taken
					Diarrhoea	Powder is taken after meal twice per day
<i>Paederia foetida</i> L.	Gandhaveduli	Rubiaceae	C	Leaf	Diarrhoea	Leaf juice is taken
<i>Persicaria hydropiper</i> (L.) Spach	Biskatali	Polygonaceae	H	Leaf	Skin disease	Leaf paste is applied to the affected area
<i>Phyllanthus emblica</i> L.	Amloki	Euphorbiaceae	T	Fruit	Toothache	Fruit juice is taken
					Hair problem	Paste is applied on hair
					Hair tonic	Fruit juice is boiled with oil and then applied on hair
					Heart disease	Fruit juice is taken
<i>Senna alata</i> (L.) Roxb.	Dadmardan	Caesalpiniaceae	H	Leaf	Ring worm	Paste is applied to the affected area
					Skin disease	Paste is taken
<i>Piper betle</i> L.	Pan	Piperaceae	C	Leaf	Bone ache	Leaf paste applied to the affected area
<i>Psidium guajava</i> L.	Peyara	Myrtaceae	T	Leaf	Dysentery	Young leaves are eaten
				Fruit	Nutritive	Fruit is taken
<i>Punica granatum</i> L.	Dalim	Punicaceae	S	Fruit	Heart disease	Juice is taken
<i>Rauvolfia serpentina</i> (L.) Benth. ex Kurz	Sarpagandha	Apocynaceae	S	Root	Heart disease	Powder is taken after meal twice per day
					Blood purifier	Paste is taken
<i>Ricinus communis</i> L.	Verenda	Euphorbiaceae	S	Seed	Constipation	Seed oil is used
<i>Saccharum officinarum</i> L.	Akh	Poaceae	H	Stem	Jaundice	Juice is taken
<i>Saraca asoca</i> (Roxb.) de Wild.	Ashok	Caesalpiniaceae	T	Bark	Anti-leukemia	Bark soaked in water then taken in empty stomach
<i>Scoparia dulcis</i> L.	Chinipata	Scrophulariaceae	H	Leaf	Diabetes	Juice is taken
					Dysentery	Juice is taken
					Diarrhoea	Leaf juice is taken

Table 1 contd.

Scientific name	Local name	Family	Habit	Parts use	Ailments	Treatment mode
<i>Sesamum indicum</i> L.	Til	Pedaliaceae	H	Seed	Skin disease	Oil is applied
<i>Smilax macrophylla</i> Roxb.	Kumarilata	Smilacaceae	C	Leaf	Stomach ache	Leaf juice is taken
<i>Solanum melongena</i> L.	Begun	Solanaceae	S	Fruit	Reducing cholesterol	Boiled fruit eaten internally.
<i>Solanum tuberosum</i> L.	Alu	Solanaceae	H	Tuber	Cuts & wounds	Paste is applied
<i>Spondias pinnata</i> (L. f.) Kurz	Amra	Anacardiaceae	T	Fruit	Blood pressure	Fruit juice is taken
<i>Syzygium cumini</i> (L.) Skeels	Kalojam	Myrtaceae	T	Seed	Diabetes	Seed powder is taken
				Bark	Dysentery Toothache	Seed powder is taken Decoction of bark is taken
<i>Syzygium samarangense</i> (Blume) Merr. & Perry	Jamrul	Myrtaceae	T	Seed Leaf	Diabetes Stomachache	Seed paste is taken Juice is taken
<i>Tagetes erecta</i> L.	Gada	Asteraceae	H	Leaf	Cut	Juice is applied to the affected area.
				Flower	Dysentery	Flower is taken
<i>Tamarindus indica</i> L.	Tetul	Caesalpiniaceae	T	Fruit	Blood pressure	Fruit juice is taken
<i>Terminalia arjuna</i> (Roxb. ex DC.) Wight & Arn.	Arjun	Combretaceae	T	Bark	Heart disease	Bark soaked water is taken in empty stomach
					Heart disease	Powdered bark is taken in empty stomach early in the morning
					Heart disease	Bark mixed with Amloki, Horitoki and Bohera and then taken in empty stomach
					Gastric pain	Bark soaked water is taken in empty stomach
<i>Terminalia bellirica</i> (Gaertn.) Roxb.	Bohera	Combretaceae	T	Seed	Chest pain Skin disease	Bark juice is taken Seed oil is used
				Fruit	Diabetes	Juice is taken
<i>Terminalia chebula</i> Retz.	Haritaki	Combretaceae	T	Fruit	Blood purifier	Fruit soaked water is taken
					Gastro intestinal disorders	Fruit soaked water is taken

Table 1 contd.

Scientific name	Local name	Family	Habit	Parts use	Ailments	Treatment mode
<i>Tinospora crispa</i> (L.) Hook. f. & Thoms.	Gulancha	Menispermaceae	C	Stem	Diabetes	Fruit juice is taken
					Dysentery	Unripe fruit is taken
<i>Streblus asper</i> Lour.	Sheora	Moraceae	T	Leaf	Diabetes	Leaf juice is taken
<i>Vitex negundo</i> L.	Nishinda	Verbenaceae	S	Leaf	Insomnia	Leaf is kept under pillow
<i>Zingiber officinale</i> Rosc.	Ada	Zingiberaceae	H	Rhizome	Cold treatment	Boiled with tea then taken
					Digestion	Taken with salt before meal
<i>Ziziphus mauritiana</i> Lamk.	Boroi	Rhamnaceae	T	Leaf	Gastric	Juice taken with salt.
					Cuts & wounds	Boiled water is applied to the affected area.

It was observed that medicinal plants recorded in the study area belonged to 60 families. Among them, the maximum number of species belonged to 40 families and other species to the families Fabaceae, Rutaceae, Araceae, Asteraceae, Apiaceae, Solanaceae, Cucurbitaceae, Combretaceae, Myrterceae, and Euphorbiaceae (Fig. 3).

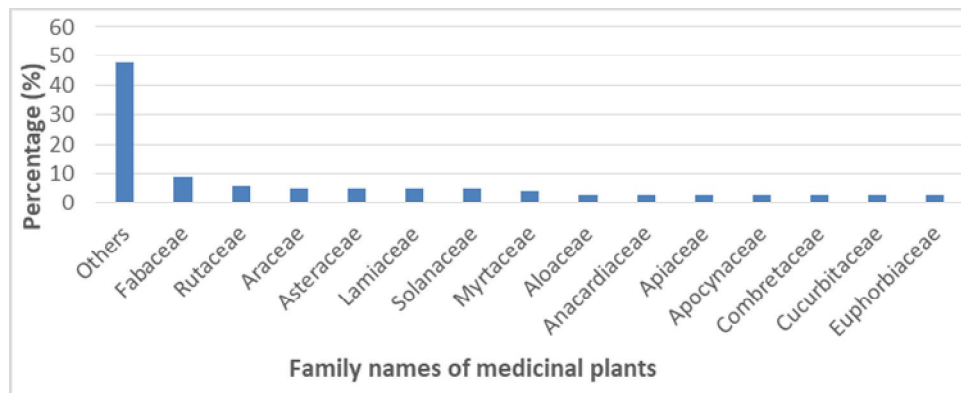


Fig. 3. Medicinal plants used for medicinal purposes.

Leaves were the most commonly utilized plant part with 43% application in traditional medicinal recipes, followed by fruit (18%), root (7%), seed (7%), stem (5%), bark (4%), rhizome (4%), latex (3%), flower (3%) and others (flower bud, bulb, clove, tuber, whole plant, young apex) 1% (Fig. 4).

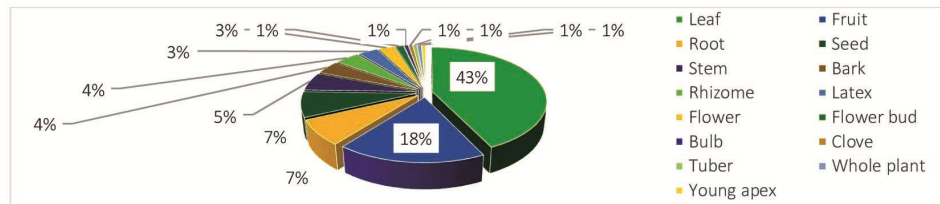


Fig. 4. Plant parts used for medicinal purposes

Plant species were classified into four groups based on their habitat: herbs (37%), trees (36%), shrubs (16%), and climbers (11%) (Fig. 5). It was observed that local healers use herbs more than trees, shrubs, and climbers to cure different kinds of diseases; it may be due to their easy accessibility, collection, fewer side effects, and abundance in the area. Local inhabitants of the study area use different methods, i.e., juice, paste, crushed, decoction, cooked, etc., to prepare a recipe for the treatment of various ailments. Out of 210 formularies, 71% were internal applications, and the rest (29% were external) (Fig. 6).

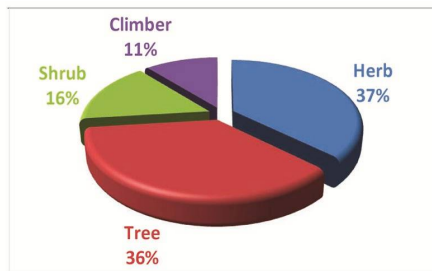


Fig. 5. Vegetation analysis of medicinal plants based on habit.

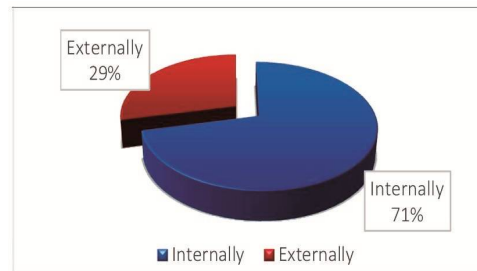


Fig. 6. Application mode of medicinal plants.

The informant consensus factor (Fic): To calculate Fic, the reported ailments were first classified into 8 different disease categories based on their usage reports. Among the

major disease categories, heart disease (more than 0.93) attained the highest Fic value (Table 2).

Table 2. Values of the factor of informant consensus in the uses of medicinal plants among the informants.

Disease category	Ailments	Most cited plants	N _{ur}	N _{taxa}	Fic value
1	Heart disease	<i>Terminalia arjuna</i> (Roxb. ex DC.) Wight & Arn., <i>Baccaurea ramiflora</i> Lour., <i>Dillenia indica</i> L., <i>Allium sativum</i> L., <i>Tamarindus indica</i> L., <i>Rauwolfia serpentina</i> (L.) Benth. ex Kurz., <i>Terminalia chebula</i> Retz., <i>Phyllanthus emblica</i> L., <i>Averrhoa carambola</i> L., <i>Spondias pinnata</i> (L. f.) Kurz	424	25	0.943
2	Diabetes	<i>Coccinia grandis</i> (L.) Voigt	117	12	0.905
3	Gastro-intestinal disorders	<i>Agle marmelos</i> (L.) Correa	237	46	0.809
4	Skin disease	<i>Azadirachta indica</i> A. Juss.	189	27	0.862
5	Respiratory disorder	<i>Justicia adhatoda</i> L.	136	22	0.844
6	Impotence	<i>Bombax ceiba</i> L.	30	3	0.931
7	Cuts & wounds	<i>Bryophyllum pinnatum</i> (Lamk.) Oken	19	7	0.667
8	Others	<i>Centella asiatica</i> (L.) Urban	172	32	0.819

N_{ur}= The number of use reports in each category; N_{taxa} =The number of species in each category; Fic= Factor of informant consensus.

The fidelity level (FI) of the 21 most important plant species ranged from 35% to 100%. *Terminalia arjuna* (Roxb. ex DC.) Wight & Arn., *Baccaurea ramiflora* Lour., *Dillenia indica* L., *Lycopersicon esculentum* Mill., *Tamarindus indica* L., *Lawsonia inermis* L., *Azadirachta indica* A. Juss., *Nigella sativa* L. indicated 100% FI against heart disease, blood pressure, hair treatment, skin disease, and liver control respectively (Table 3).

Citation frequency values varied from species to species, as indicated in Table 4. *Terminalia arjuna* (Roxb. ex DC.) Wight & Arn. scored the highest Cf% value, meaning that such species are very popular in the study and used to treat heart disease. *Allium sativum* L., *Dillenia indica* L., *Baccaurea ramiflora* Lour., *Tamarindus indica* L., *Spondias pinnata* (L. f.) Kurz, *Rauwolfia serpentina* (L.) Benth. ex Kurz, *Terminalia chebula* Retz., *Phyllanthus emblica* L., and *Averrhoa carambola* L. were the most cited species in the study area.

The therapeutic potential of herbs in the healthcare system is well known worldwide, whether for a diseased state or for proper health maintenance (Malik, 2007). Herbs for cardiovascular diseases such as congestive heart failure, systolic hypertension, angina

pectoris, atherosclerosis, cerebral insufficiency, and arrhythmia have been prevalent since ancient times (Ray and Saini 2021; Mashour *et al.*, 1988).

Table 3. Fidelity level (FI) values of the frequently reported plants and their major uses.

Species	Ailments	Np	N	FI(%)
<i>Terminalia arjuna</i> (Roxb. ex DC.) Wight & Arn.	Heart disease	97	97	100
<i>Baccaurea ramiflora</i> Lour.	Heart disease	21	21	100
<i>Dillenia indica</i> L.	Heart disease	23	23	100
<i>Lycopersicon esculentum</i> Mill.	Heart disease	13	13	100
<i>Tamarindus indica</i> L.	Blood pressure	21	21	100
<i>Lawsonia inermis</i> L.	Hair treatment	17	17	100
<i>Azadirachta indica</i> A. Juss.	Skin disease	22	22	100
<i>Nigella sativa</i> L.	Liver control	18	18	100
<i>Averrhoa carambola</i> L.	Heart disease	16	17	94.118
<i>Catharanthus roseus</i> L.	Diabetes	23	27	85.185
<i>Coccinia grandis</i> (L.) Voigt	Diabetes	16	20	80
<i>Ocimum sanctum</i> L.	Cold treatment	22	31	70.968
<i>Syzygium cumini</i> (L.) Skeel.	Diabetes	11	18	61.111
<i>Centella asiatica</i> (L.) Urban	Brain tonic	14	24	58.333
<i>Allium sativum</i> L.	Blood pressure	27	49	55.102
<i>Rauwolfia serpentina</i> (L.) Benth. ex Kurz	Blood pressure	19	36	52.778
<i>Phyllanthus emblica</i> L.	Heart disease	16	31	51.613

Np= The number of informants who claim to have used a plant species to treat a specific disease; N= The number of informants who use the plants as medicine to treat any given disease.

Table 4. Citation frequency of most cited medicinal plants.

Scientific name	Local name	Citation	Citation frequency (Cf %)
<i>Terminalia arjuna</i> (Roxb. ex DC.) Wight & Arn.	Arjun	45	15
<i>Allium sativum</i> L.	Rosun	27	9
<i>Dillenia indica</i> L.	Chalta	23	7.667
<i>Baccaurea ramiflora</i> Lour.	Lotkon	21	7
<i>Tamarindus indica</i> L.	Tetul	21	7
<i>Spondias pinnata</i> (L. f.) Kurz	Amra	19	6.333
<i>Rauwolfia serpentina</i> (L.) Benth. ex Kurz	Sarpagandha	17	5.667
<i>Terminalia chebula</i> Retz.	Haritaki	16	5.333
<i>Phyllanthus emblica</i> L.	Amloki	16	5.333
<i>Averrhoa carambola</i> L.	Kamranga	16	5.333

Many ethnobotanical surveys have been carried out in the Dinajpur district of Bangladesh (Rahmatullah *et al.*, 2010, 2009; Rahman 2015, 2012; Jamal *et al.*, 2012; Uddin *et al.*, 2006). None of these focused on ethnobotanical research in connection with the cardiovascular plant. In Bangladesh, several plants are reputed to possess cardioprotective properties, resulting in their use by traditional healers to treat chest complaints, high cholesterol, high and low blood pressure, and general heart problems (Uddin *et al.*, 2019). There is compelling scientific evidence demonstrating that consuming dietary anticoagulants or phytochemicals with anticoagulant properties can ultimately reduce or eliminate the risks of thromboembolic diseases (Uddin *et al.*, 2019; Kumar *et al.*, 2011; Lee *et al.*, 2012; Manicam *et al.*, 2010).

The present study revealed that 109 medicinal plant species were used for 55 ailments, with 210 formularies by the local people of the study area. Among them, 25 species have been used to treat cardiovascular diseases. These are *Terminalia arjuna* (Roxb. ex DC.) Wight & Arn., *Baccaurea ramiflora* Lour., *Rauwolfia serpentina* (L.) Benth. ex Kurz, *Hyptis suaveolens* (L.) Poit., *Phyllanthus embelica* L., *Averrhoa carambola* L., *Amaranthus tricolor* L., *Glinus oppositifolius* (L.) Aug.DC., *Enhydra flactuans* Lour., *Spondias pinnata* (L. f.) Kurz, *Amaranthus tricolor* L., *Daucus carota* L., *Lycopersicon esculentum* Mill., *Solanum melongena* L., *Musa acuminata* Colla, *Mimosa pudica* L., *Arachis hypogaea* L., *Mangifera indica* (L.), *Curcuma longa* L., *Cuminum cyminum* L. and *Punica granatum* L. The most cited medicinal plant species for cardiac management are *Terminalia arjuna* (Roxb. ex DC.) Wight & Arn., *Baccaurea ramiflora* Lour., *Dillenia indica* L., *Allium sativum* L., *Tamarindus indica* L., *Rauwolfia serpentina* (L.) Benth. ex Kurz., *Terminalia chebula* Retz., *Phyllanthus emblica* L., *Averrhoa carambola* L.

Terminalia arjuna (Roxb. ex DC.) Wight & Arn. was used to treat heartache in the study area. It is used for the same purpose (Uddin *et al.*, 2021, 2012; Uddin and Hassan, 2014) and is also used for stomachaches, coughs, diabetes, menstruation, gastric pain, and dysentery (Uddin *et al.*, 2006, 2012, 2017; Islam *et al.*, 2014; Uddin *et al.*, 2015a, b) reported from the different area from Bangladesh. *Baccaurea ramiflora* Lour. was used for the treatment of heart disease and as an antioxidant. It has been shown to have antioxidant properties (Uddin *et al.*, 2021; Goyal *et al.*, 2013; Ullah *et al.*, 2012). The plant was used for diarrhea, flatulence, gastric ulcer, ureterolithiasis, and jaundice (Uddin, 2006). *Dillenia indica* L. was used to treat heart disease, diarrhoea, headaches, and tumors. This plant was also used for jaundice, hair tonic, constipation, dysentery, food poisoning, and cardiac weakness an general weakness (Uddin and Hassan, 2014; Uddin *et al.*, 2012; Uddin *et al.*, 2015; Uddin, 2006). It has been reported for antioxidant

(Abdille *et al.*, 2005), antihyperlipidemic, and anti-diabetic (Kumar *et al.*, 2011) activities. *Allium sativum* L. has been used to treat heart disease, gastric problems, colds, fevers, chest pain, high blood pressure, and ringworm (Uddin *et al.*, 2015, 2017, 2019). *Tamarindus indica* L. has been used to treat high blood pressure, diarrhea, dysentery, appetizer, constipation, impotence, abscess, and jaundice (Uddin *et al.*, 2012, 2015, 2017; Khan *et al.*, 2002). *Rauwolfia serpentina* (L.) Benth. *ex* Kurz. was used to treat high blood pressure, hypertension, mental illness, stomach aches, and gastric ulcers (Islam *et al.*, 2014; Roy *et al.*, 2008; Uddin *et al.*, 2004). *Terminalia chebula* Retz. has been shown to have antioxidant, antimicrobial, antidiabetic, hepatoprotective, anti-inflammatory, antimutagenic, antiproliferative, radioprotective, cardioprotective, antiarthritic, anticaries, gastrointestinal motility, and wound healing activity (Bag *et al.*, 2013). *Phyllanthus emblica* L. was used for heart disease (Uddin *et al.*, 2021, 2019; Khatun and Rahman, 2018). Muthu *et al.* (2016) discovered that *Averrhoa carambola* L. has antioxidant properties. *Amaranthus gangeticus* L. was used as a blood purifier (Uddin *et al.*, 2015). *Curcuma longa* L. has been reported as a blood purifier (Uddin *et al.*, 2006). Sujarwo and Keim 2019 reported that *Spondias pinnata* (L. f.) Kurz has a high antioxidant capacity.

Furthermore, *Amaranthus gangeticus* L., *Glinus oppositifolius* (L) Aug. DC., *Musa acuminata* Colla, *Mimosa pudica* L., *Arachis hypogaea* L., *Mangifera indica* (L), *Cuminum cyminum* L., *Punica granatum* L., *Amaranthus tricolor* L., *Daucus carota* L., *Lycopersicon esculentum* Mill., and *Solanum melongena* L. are also reported as medicinal plants for the cardiovascular diseases in the study area by the local people.

In the course of the study, traditional healers such as Kabiraj (Medicine men) showed their knowledge of the medicinal properties of plant species. The knowledge accumulated by the tribal people, such as the Santal community and the local population, about disease ailments is crucial to discover the latest drugs that can benefit human health. Also, dosages and administration should be standardized with the latest scientific methods. Currently, various developmental activities such as coal mining and stone lifting in Phulbari Upazila are great threats to medicinal plants and their habitats (Uddin *et al.* 2006). The tribals like the Santal community have already converted themselves to other religions, mostly Christianity, because of missionary activities. It gave them opportunities to use modern medicine rather than traditional ones. Sometimes, many medicine men are reluctant to go back to their roots.

From the observations, a variety of dangers to ethnomedicinal plants have been found via field interviews and discussions with local people. The study area's surrounding plantations of exotic timber species, including *Dalbergia sissoo* Roxb. and *Eucalyptus*

camadulensis Dehnh, pose the greatest dangers. Another danger to locally grown medicinal plants is the clearing of forests for constructing exotic monoculture plantations in Phulbari Upazila. Several natural forest sections of the Upazila, Sal Forest and allied species were replaced by *Acacia* spp. and *Eucalyptus* spp. plantations. Due to fragmentation, edge effects, agricultural encroachment, and development activities, the remaining Sal patches are in serious jeopardy.

Moreover, people are not particularly careful in cultivating resources, and care more for ornamental, timber or fruit trees than important medicinal plants. They are starting to take care of the plants in their roof gardens and even balconies. The availability of modern medicine that encourages the local people to use it rather than herbal medicines found in the study area is an additional threat to the medicinal plant. People who are elderly and know herbs are not inclined to share their knowledge with children. In the event of the sudden death of these individuals, the knowledge of herbal remedies in the area will disappear forever.

The present work in the Dinajpur district is very preliminary. The record of these medicinal plant species indicate rich ethnobotanical knowledge among the locals in and around the Dinajpur district. This research could provide an immediate and efficient strategy to investigate the effect of clot lysis on newly developed and known drugs. The results currently reported by medicinal plants are fundamental, and further lengthy studies are essential to verify these results. When conducting the study within the study area, a number of dangers to medicinal plants were discovered and a few suggestions were made to protect beneficial plants within the Dinajpur district. The latest scientific discoveries for further study of bioactive components that could lead to the development of new treatment options for cardiovascular diseases. Along with that, we must cultivate awareness of the importance of medicinal plants among residents, developers, and policymakers.

Acknowledgment

The authors are grateful to the Ministry of Science and Technology, Government of the People's Republic of Bangladesh, for financial support for the research project and to the informants, along with people, for their support during the field work in and around Dinajpur district for the research.

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(Revised copy received on 06.11.2022)