Ethnopharmacological Survey of Medicinal Plants Used by Traditional Health Practitioners and Indigenous People in Chittagong Hill Tracts, Bangladesh for the Treatment of Dysentery

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ABSTRACT: Dysentery is frequently associated with high morbidity and mortality and is found in young children and mainly affects those in developing nations. Rural people across the world trust on herbal remedies and homeopathic medicines for their primary health care on account of their easy accessibility, efficacy and exceptionally cost ampleness in relation to modern drugs. The purpose of the present study was to compile knowledge of traditional healers and indigenous people in Chittagong hill tracts, Bangladesh, including Rangamati, Bandarban and Khagrachari for the treatment of dysentery. The ethnomedicinal data was gathered from January 2019 to January 2020 through open and focused group discussions and individual meetings utilizing semi-structured questionnaire. An aggregate of 75 people were interviewed, including traditional health practitioners. Frequency and percentage were utilized to sum up the data. Relative frequency of citation (RFC) was determined and inclination positioning activities were led to appraise the significance of the revealed medicinal plants. An aggregate of 90 medicinal plants from 52 families and 79 genera were recorded during the survey. Leaves were discovered to be the most largely used plant part (35%) followed by root (19%) and herbs (40%) were the essential wellspring of medicinal plants, followed by trees (20%). The major mode of preparation is juice (68%) followed by paste (11%) and cooked form (7%). *Centella asiatica* scored the highest RFC value (0.773). The survey addresses the preliminary information of certain medicinal plants having anti-dysenteric property. However, further phytochemical investigation, validation and clinical trial sought to be conducted, with need given to those that scored the most elevated RFC values prior to utilizing these plants as an option in contrast to modern medicine.

Key words: Bangladesh, ethnobotanical survey, dysentery, medicinal plants, traditional healers.

INTRODUCTION

Dysentery, which is characterized as an acute bout of diarrhea lasting less than or equal to l4 days with apparent blood in one or more stools, is an intestinal inflammation. Not all stools in dysenteric disease may contain apparent blood, while most stools contain bodily fluid. The infection can be transmitted by the fecal-oral course through contaminated food, water and different drinks, poor hand washing by infected individuals, swimming in contaminated water and individual to-individual contact. A few groups may have no noticeable symptoms yet can in any case transmit the organisms to others. It is assessed that there are in any event 80 million instances of bloody diarrhea and 700,000 related deaths every year around the world, with roughly 99% of cases happening in developing nations.[1,2] Notwithstanding the amazing improvement

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of sanitation and education during the past decade, dysentery is a significant reason for high childhood morbidity and mortality in developing nations as they have an effective immune response to *Shigella* infections than grown-ups.[3]

There are four *Shigella* serogroups, each with multiple serotypes: A (*S. dysenteriae*, 12 serotypes); B (*S. flexneri*, six serotypes); C (*S. boydii*, 18 serotypes); and D (*S. sonnei*, one serotype). *S. flexneri* overwhelms in non-industrial nations, while *S. sonneiis* normally detailed in developed countries.[3-5] Most dysentery cases in the tropics are caused by *Shigella*,[6,7] bloody diarrhea has additionally been accounted for in infections with *amoebiasis*, *Campylobacter* enteritis, enteroinvasive *E. Coli*, and enterohaemorrhagic *E. coli*;[8] though a study focusing on eight Asian countries found that *S. flexneri* (50%) and *S. sonnei* (45%) were predominantly identified among 98 *Shigella* isolates.[9] Extra basic manifestations include abdominal cramps or pain, nausea, vomiting, fever of 100.4 °F (38 °C) or higher and dehydration, which can be life-threatening whenever left untreated.

The most important diagnostic test is a single stool culture (a cheap, rapid and simple diagnostic test) from diarrhea cases and should regularly handle the sample for the major causes of dysentery including *Shigella, Campylobacter, Salmonella* and in industrialized areas, Shiga toxin-producing *E. coli*. When dysentery develops more than 72 h, *C. difficile* should be tested.[10] Multiplex polymerase chain reaction platforms for identification of *Shigella* are likewise commercially accessible, however are restricted in their accessibility in most medical service settings. Other causes of dysentery should be sought based on other epidemiologic information.

While fluid and electrolytes therapy are fundamental to treat intense looseness of the bowels, antimicrobial specialists assume, antimicrobial agents play a significant role in the treatment of dysentery although antibiotics may increase the risk of complications in a minority of patients as is seen for those infected with Shiga toxin-producing *E. coli*. According to Traa[11] treatments with one of the three WHO-recommended antibiotics ciprofloxacin, ceftriaxone and pivmecillinam are successful in reducing the clinical and bacteriological signs and symptoms of dysentery and consequently can be relied upon to decrease diarrhea mortality attributable to dysentery. On the other hand, when two distinct antibiotics (pivmecillinam and ciprofloxacin) were utilized, it brought about 82% reduction in clinical failure. While pivmecillinam, ciprofloxacin and ceftriaxone reported 96% decrease in bacteriological failure[12] Bangladesh followed the WHO suggestion to utilize antibiotics only for dysentery and suspected cholera cases with severe dehydration.[13]

Ethnopharmacological survey is significant for the preservation and usage of biological resources since medicinal uses of plants have been recorded in approximately 10,000 to 15,000 of world's plants and about 150-200 have been incorporated in western medicine and it is at present assessed that roughly 420,000 plant species exist in nature.[14,15] Secondary metabolites or phytochemicals are naturally occurring and biologically active plant compounds that have potential disease inhibiting capabilities just as believed to be effective in combating or preventing disease because of their antioxidant effect.[16] Many studies have shown that a good number of medicinal plants used by the herbalists have found support from modern scientific research when tested for relevant pharmacological activities. The far-reaching utilization of traditional medicine in communities of Bangladesh could be ascribed to cultural acceptability, efficacy, physical accessibility, and economic affordability when contrasted with modern medicine.

Several ethnobotanical investigations have been carried out at different parts of the world to explore the medical remedies of some medicinal plants to cure dysentery. In any case, there are not many ethnobotanical surveys carried out in Bangladesh to explore the medicinal plants utilized here in the treatment of dysentery. Undoubtedly, it is vital to transform this traditional knowledge into scientific knowledge in order to revalue it, top reserve it and use it rationally. The current study was led to archive

the traditional knowledge of the medicinal plants used by the traditional healers of Bangladesh for treating dysentery.

MATERIALS AND METHODS

Study area. The Chittagong area, an extraordinary geological and social scene of Bangladesh, situated in the southeast of the country, has three managerial locales: Rangamati, Bandarban and Khagrachari (Figure 1). Around 13,300 km^2 space of the locale covers 8% of the all-out land region in the country. The Chittagong area is a remarkable topographical and social scene of Bangladesh, situated in the southeast locale lined by Assam and Tripura territories of India on the upper east, Arakan territory of Myanmar toward the southeast and Cox's Bazar region in the southwest.[17]

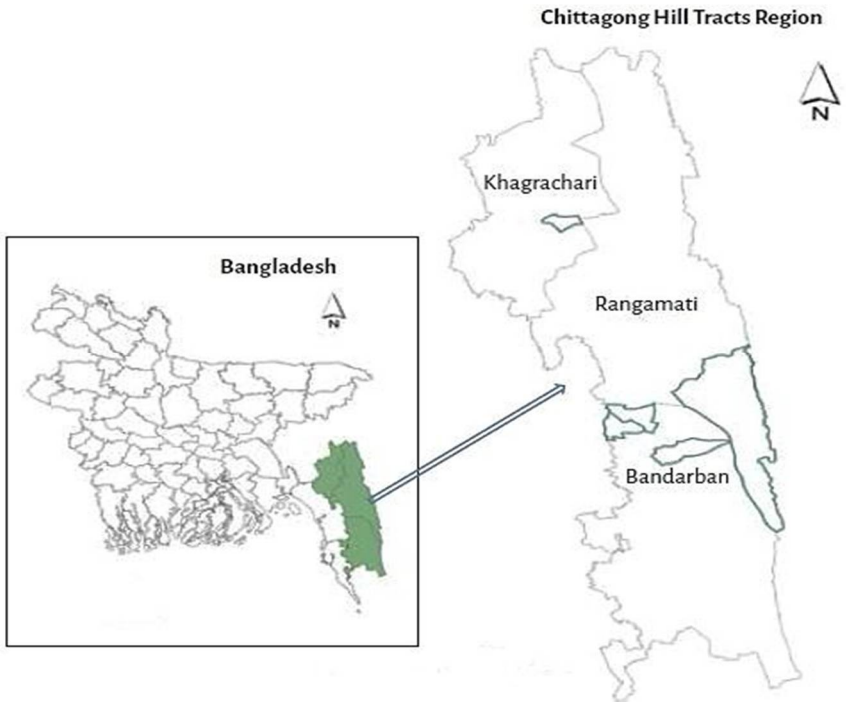

Figure 1. Geographical location of Chittagong hill tracts, Bangladesh.[17]

Informants and ethnomedicinal data collection. The survey was directed in the authority language of Bangladesh, Bengali language, from January 2019 to January 2020. Targets of the study were disclosed to the neighborhood networks during get-togethers masterminded by nearby individuals acquainted with notable traditional health practitioners (THPs). While meeting with indigenous populations who had mother language unique in relation to the state language, help from nearby bilingual interpreter was taken. Prior to beginning the overview, general data was gathered about the investigation region just as THPs and general individuals. The information was gathered observing the standard rules of ethnobotanical data collection.[18,19] A sum of 75 individuals participated in interviews including THPs and learned individuals from the three communities. All were lasting inhabitants of the investigation region. Respondents were chosen based on whether they furnished a certifiable response when gotten some information about their medicinal plant knowledge. Following a certifiable answer, detailed interviews were directed with the respondents where they examined their insight on medicinal plants and showed the plants. During the study time frame, the ethnomedicinal

information was gathered through the open-ended, semi-structured interviews as per Cotton[20] and Bruni.[21] The data of each plant was archived alongside the local name, nature of the plant, plant part utilized, therapeutic uses, method of preparation, routes of administration and level of shortage around here. A reasonable agreement was made with individuals overviewed that their protected innovation rights regarding the data provided won't be disregarded if the outcomes lead to any financial advantages for us. Voucher specimens of antidysenteric plants were collected, which were affirmed by experts in the field and the specimens of the plants were stored in Bangladesh National Herbarium, Dhaka.

Data analysis. Every one of the plant species was recorded in alphabetical order by their scientific name, local name, family, plant type, plants parts used, mode of preparation. All the data, for example, frequency distributions, were determined by utilizing SPSS 16.0. Local significance of each plant species was controlled by computing relative frequency of citation (RFC),[22] utilizing the formula, RFC = FC/N, where, FC is the quantity of witnesses who referenced the utilization of the species and N is the complete number of informants. Preference positioning activity was directed with 10 sources, haphazardly chosen from the 75 knowledgeable informants participated in the interviews, to rank seven most often cited medicinal plants used to treat dysentery dependent on talk with results following the methodology of Martin.[23]

RESULTS AND DISCUSSION

Informants. In order to assess the demographic data of informant's different parameters were considered in the present study, namely gender, religion, age, education, working experience and profession (Table 1). Among the 75 interviewee, major informants were male (53, 70.67%) and 22 (29.33%) informants were female, with an age range of 20 to >60 years. Among the respondents' majority of them were from Islamic religion (58.67%) followed by Hinduism (25.33). As per the age, the greater part of the informants (54.67 %) were 51-60 years of age followed by informants (22.67 %) who were 41-50 years of age and just one (1.33 %) witness was over 60 years (Table 1). The analysis of the data obtained from table 1 reveals that, the majority of informants (38.67%) has 5 years of education profile, with only 7 person (9.33%) and two person (2.67%) holding graduate and postgraduate degrees respectively. Among 75 THPs and indigenous people, 28% had 11-20 years of involvement with ethnomedicinal practice in their current region though 37.33% were THPs and 62.67% were indigenous people.

Table 1. Demographic information of informants.

Variable	Categories	Frequency (n= 75)	Percentage
Gender	Male	53	70.67 %
	Female	22	29.33 %
Religion	Islam	44	58.67 %
	Hinduism	19	25.33 %
	Buddhism	12	16 %
Age (years)	20-30	7	9.33 %
	30-40	9	12 %
	41-50	17	22.67 %
	51-60	41	54.67 %
	>60	1	1.33 %
Education (years)[Ψ]	5	29	38.67 %
	8	15	20 %
	10	13	17.33 %
	12	9	12%
	16	7	9.33 %
	18	2	2.67 %
Experience (years)[§]	<2	14	18.67 %
	2-5	18	24 %
	6-10	16	21.33 %
	11-20	21	28%
	>20	6	8 %
Profession[¥]	Traditional health practitioners	28	37.33 %
	Indigenous people	47	62.67 %

[Ψ]Year completed through formal educational institution; [§]relevant to treating people; [¥] people who acquired medicinal knowledge by themselves and are usually involved in profession not relevant to medicine

Plant using in the treatment of dysentery and other relevant information. It was observed that, a total of 90 plants belongs to 52 families were being used by the THPs and native individuals of Chittagong hill tracts for the treatment of dysentery (Figure 2). The Fabaceae family contributed the most with 8 species followed by Amaranthaceae (5 species), Euphorbiaceae (4 species) and Malvaceae (4 species). Leaves were discovered to be the generally utilized plant part (35%) in the ethnomoedicinal practice of Chittagong Hill Tracts, followed by root (19%), bark (13%), fruit (11%) and whole plant (10%) respectively (Figure 3). Our current study shows (Figure 4) that, among the recorded 90 medicinal plant species, the most elevated number of plant species utilized by THPs and indigenous people are herbs (40%) followed by trees (20%) and shrubs (16%). In Chittagong hill tracts the most common method of medicinal plant preparation for oral consumption (Figure 5) is juice (68%) followed by paste (11%) and cooked form (7%).

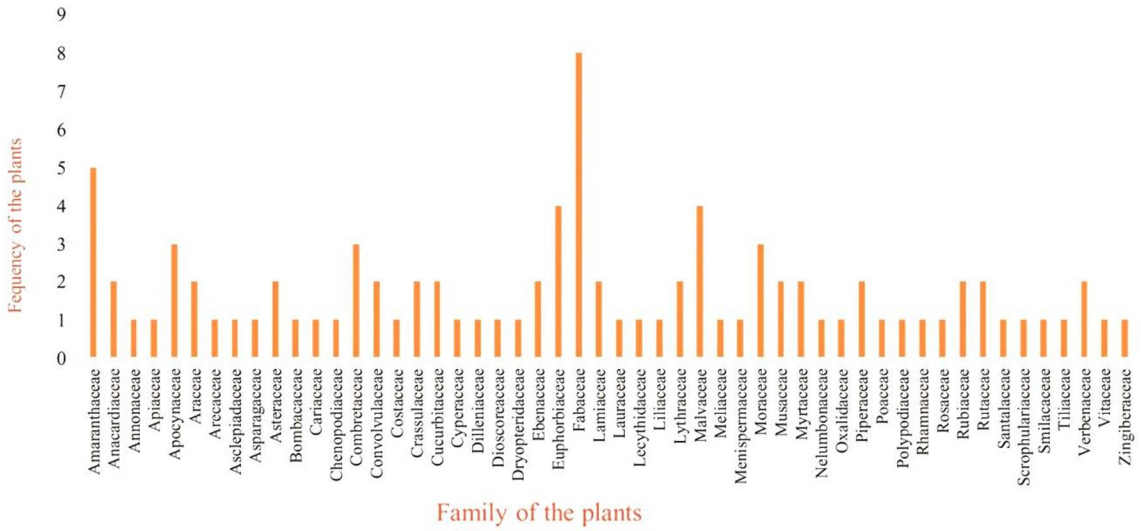

Figure 2. Family of the plants with their frequencies.

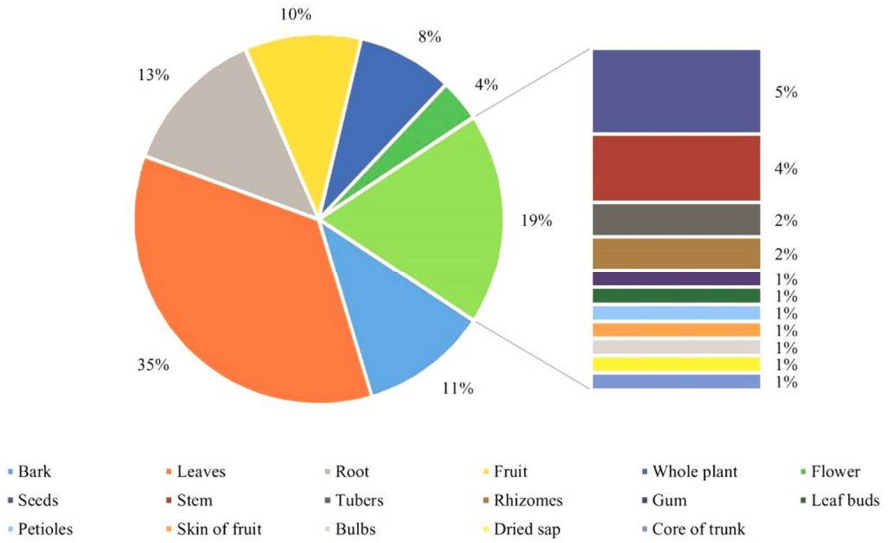

Figure 3. Percentage uses of various plant parts in traditional practice.

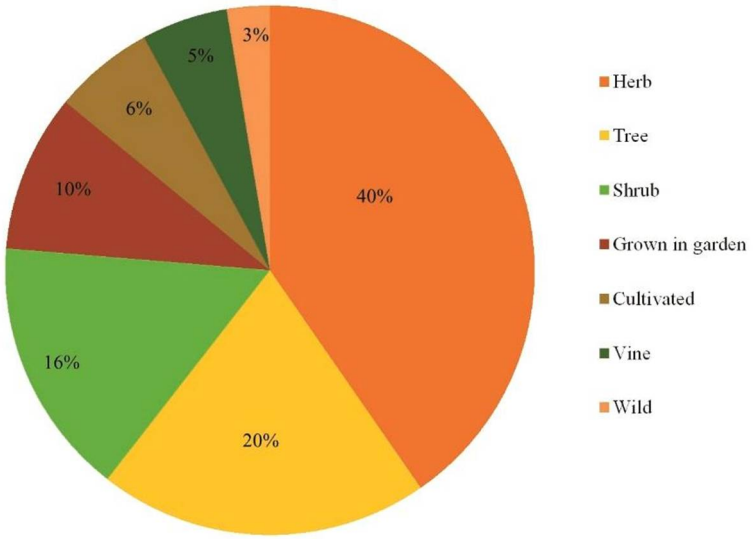

Figure 4. Type of plants used in traditional medicines of Chittagong hill tracts.

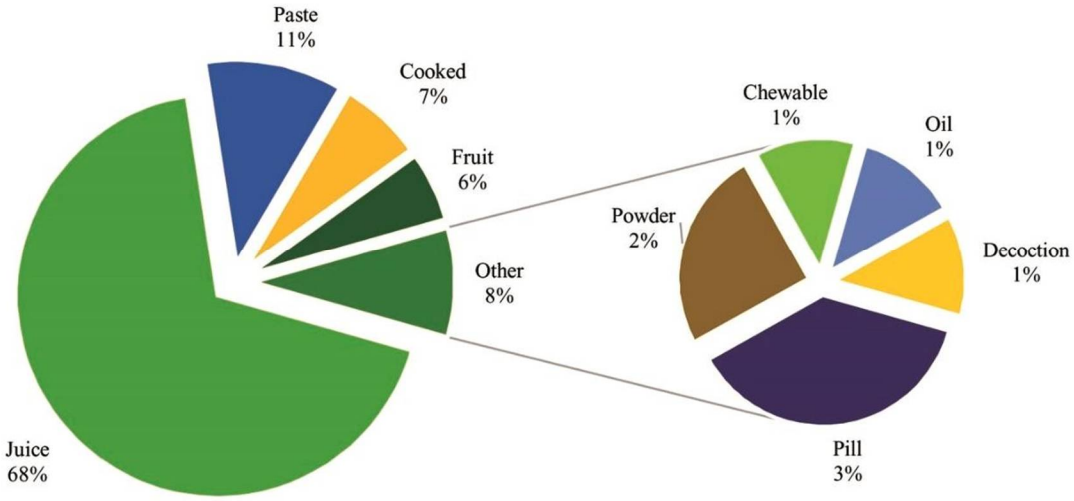

Figure 5. Percentage of mode of preparation.

Assessment of the importance of antidysenteric plants. RFC value was calculated to get an assessment of the significance of certain antidysenteric plants of Chittagong hill tracts, Bangladesh. *Centella asiatica* (RFC = 0.773), *Musa paradisiaca* (RFC = 0.693), *Asparagus racemosus* (RFC = 0.613) and *Spondias pinnata* (RFC = 0.507) were found to score the most elevated RCF values (Table 2). *C. asiatica* got the most noteworthy score in inclination positioning activities led on five anti-dysenteric plants, followed by *A. racemosus, M. paradisiaca, S. pinnata* and *P. granatum* (Table 3).

According to the gender, major informants were male (70.67%), which confirm the consequences of other ethnobotanical work completed in Bangladesh.[24,25] Among the participants, it was seen that the greater part of the sources were 51-60 years of age. The most noteworthy age respondents give more dependable data since they hold a significant part of the genealogical information that is essential for the oral tradition.[26] As a general rule, THPs do not disclose the plant name or the formula of their preparation to other people; notwithstanding, they gave this data to us after legitimate clarification.

Table 2. List of medicinal plants of Chittagong hill tracts, reported by THPs and indigenous people.

Sl. no.	Scientific name and voucher specimen	Bengali name	Family	Plant type	Parts used	Formulation	RCF
01	*Abroma augusta* L. f. DACB-1219	Ulatkambal	Malvaceae	S	P	Aqueous extract of petiole is taken orally.	0.120
02	*Acacia catechu* (L.) Willd. DACB-1220	Khoyer	Fabaceae	T	DrS	200 gm dried sap is mixed with 400 ml water and dissolved by applying heat then the solution is taken at 1 hour intervals for 24 hours.	0.040
03	*Acacia farnesiana* L. DACB-127	Babla	Fabaceae	S	B	20 gm dried bark is soaked in 500 ml water overnight and taken 2 hours before breakfast. Treatment continued for 2 months if dysentery persists.	0.080
04	*Achyranthes aspera* L. DACB-1221	Apang	Amaranthaceae	H	R	Paste obtained from the root with small amount of sugar is taken on an empty stomach.	0.213
05	*Aegle marmelos* (L.) Corr. DACB-1225	Bael	Rutaceae	T	Fr	Ripe fruits are eaten.	0.333
06	*Albizia odoratissima* L. DACB-1169	Koroi	Fabaceae	T	B	From crushed bark, marble size pills are made and one pill is taken trice daily for 7 days.	0.093
07	*Alium sativum* L. DACB-1145	Deshi roshun	Liliaceae	C, H	Bu	Bulbs are fried in mustard oil and eaten.	0.147
08	*Alstonia scholaris* (L.) R. Br. DACB-110	Chattim	Apocynaceae	S, T	B	Dried and powdered bark is orally taken.	0.093
09	*Alternanthera sessilis* (L.) DC DACB-2143	Sanchi shak	Amaranthaceae	H	Wp, L	Whole plant and leaves are cooked as vegetable and eaten for 3 days.	0.200
10	*Amaranthus spinosus* L. DACB-43	Kantanotya	Amaranthaceae	H	R	Paste obtained raw root is eaten directly with small amount of sugar.	0.080
11	*Amaranthus viridis* Pall. DACB-1639	Notey shak	Amaranthaceae	H	Wp	Juice of crushed leaves is taken orally once for two days.	0.200
12	*Amorphophallus campanulatus* (Roxb.) DACB-1146	Ol kochu	Araceae	H	Tu	Tubers are cooked and eaten as vegetable.	0.187
13	*Anisomeles heyneana* Benth.	Gobura	Lamiaceae	H	Wp	Whole plant and leaves are cooked as vegetable and eaten for 3 days.	0.040
14	*Areca catechu* L. DACB-2108	Supari gach	Arecaceae	T	R	East side of the plant roots are crushed to obtain juice and taken daily with honey for five days.	0.026
15	*Asparagus racemosus* Willd. DACB-79	Shotomuli	Asparagaceae	H	Wp	Whole plant juice is taken orally with milk for 7 days.	0.613
16	*Azadirachta indica* A. Juss. DACB-1204	Neem	Meliaceae	T	L	Juice obtained from crushed leaves is taken orally.	0.280
17	*Barringtonia acutangula* L. DACB-2133	Hijol	Lecythidaceae	S	L	Crushed leaves are mixed with water and taken twice daily.	0.147
18	*Blumea lacera* DC DACB-1186	Hial mutra	Asteraceae	H	L	Leaves are boiled in water and taken orally.	0.067
19	*Bombax ceiba* L. DACB-190	Shimul	Bombacaceae	T	R	Smashed bark is cooked with *Wallago attu* and eaten for three consecutive Fridays.	0.253

Table 2 Contd.

Sl. no.	Scientific name and voucher specimen	Bengali name	Family	Plant type	Parts used	Formulation	RCF
20	*Bryophyllum pinnatum* (Lam.) DACB-2242	Pathorkuchi	Crassulaceae	G, H	L	Juice obtained from crushed leaves is taken orally.	0.107
21	*Calotropis gigantea* L. DACB-169	Akondo	Asclepiadaceae	H	Fl	2 gm powder of dried flower is mixed with tablespoon of water and taken once daily for three days.	0.107
22	*Carica papaya* L. DACB-1245	Pepe	Cariaceae	G, H	Fr	400 gm fruit juice is taken once daily for five days.	0.293
23	*Cayratia trifolia* L. DACB-1118	Golta	Vitaceae	W	L	Crushed leaves are mixed with water and taken twice daily.	0.027
24	*Centella asiatica* (L.) Urb. DACB-1250	Thankuni	Apiaceae	G, H	Wp, L	Juice obtained from crushed whole plant taken orally in the morning an evening for 7 days on an empty stomach.	0.773
25	*Chenopodium ambrosioides* L. DACB-1148	Bathu sag	Chenopodiaceae	H	L, St	Juice obtained from crushed leaves and stems is taken with honey for twenty days.	0.133
26	*Citrus aurantium* L.	Komola	Rutaceae	G, T	FrS	Crushed fruit skin is taken orally.	0.240
27	*Clerodendrum viscosum* Vent. DACB-207	Bhant	Verbenaceae	S, T	L	Juice obtained from crushed leaves is taken orally.	0.093
28	*Coccinia cordifolia* L. DACB-1261	Telakucha	Cucurbitaceae	V	L	100 gm leaves are squeezed in 250 ml water and 125 ml taken twice daily in an empty stomach till cure.	0.173
29	*Coccinia grandis* L. DACB-39526	Telakucha	Cucurbitaceae	V	L	100 gm leaves are squeezed in 250 ml water and 125 ml taken twice daily till cure.	0.200
30	*Corchorus capsularis* L. DACB-1154	Paat gach	Tiliaceae	C, H	Wp	Whole plants are cooked and eaten as vegetable.	0.267
31	*Costus speciosus* DACB-62	Ketaki	Costaceae	G, H	R	Root juice is mixed with 0.5 liter water and strained through a piece of cloth and 250 ml mixture is taken once daily in the morning for 10 days.	0.067
32	*Cuscuta reflexa* Roxb. DACB-1268	Shorno Lota	Convolvulaceae	V	L	Juice obtained from crushed leaves is taken orally.	0.293
33	*Cynodon dactylon* L. Pers. DACB-1269	Dubla gash	Poaceae	H	L	Juice obtained from crushed leaf is taken orally to keep healthy body.	0.173
34	*Cyperus rotundus* L. DACB-25	Mutha	Cyperaceae	H	Tu	Macerated tuber is dried in sun and taken with water.	0.347
35	*Dillenia indica* L. DACB-1273	Chalta	Dilleniaceae	H	L, Fr	Juice from crushed leaves and fruit is taken orally.	0.373
36	*Dioscorea bulbifera* L. DACB-2046	Banalu	Dioscoreaceae	V, W	Fr	Boiled fruits are mixed with salt and boiled rice to make marble size pill and one pill is taken trice daily.	0.027
37	*Diospyros blancoi* A. DC. DACB-1408	Gab	Ebenaceae	G, T	Fr, B	Ripe fruits and powdered bark of young tree are taken orally.	0.213
38	*Diospyros peregrina* (Gaertn.) Gurke. DACB-1275	Bilati gab	Ebenaceae	S	Fr	Fruit is eaten.	0.227
39	*Drynaria quercifolia* L. DACB-1409	Ponkhi raj	Polypodiaceae	H, W	Rh	Juice obtained from crushed rhizomes is taken thrice daily for 10 days.	0.227
40	*Evolvulus nummularius* DACB-2146	Bhumisusni	Convolvulaceae	H, W	Wp	Whole plant is boiled, smashed and taken orally.	0.027

Table 2 Contd.

Sl. no.	Scientific name and voucher specimen	Bengali name	Family	Plant type	Parts used	Formulation	RCF
41	*Ficus benghalensis* L. DACB-2235	Botia	Moraceae	T	Lb	Juice obtained from squeezed leaf buds is taken orally with water.	0.080
42	*Ficus hispida* L. DACB-303	Jogdumur	Moraceae	H, T	Fr	Fruit is eaten.	0.120
43	*Hemidesmus indicus* L. R. Br. DACB-218	Kapuri	Apocynaceae	H	R	Paste prepared from a mixture of gum of *Streblus asper* and root of *H. indicus* is taken for 4 days.	0.227
44	*Hibiscus mutabilis* L. DACB-1410	Sthol padma	Malvaceae	H	L	Leaves are soaked and crushed in water after which sap emerges from the leaves then the mixture is orally taken with sugar prepared from sap of *Borassus flabellifer*.	0.147
45	*Hibiscus rosa-sinensis* L. DACB-1284	Rokto joba	Malvaceae	G, H	Fl	Juice obtained from macerated flowers petals is taken with water.	0.040
46	*Holarrhena antidysenterica* L. DACB-14	kurchi	Apocynaceae	H	B, Se	Juice obtained macerated bark and seeds is taken twice daily with honey until cure.	0.013
47	*Ixora athroantha* Bremek. DACB-1415	Ludi choilla	Rubiaceae	S	B	Macerated bark is dried in sun and taken with cold water.	0.227
48	*Ixora coccinea* L. DACB-1286	Rangon	Rubiaceae	S	R	Juice obtained from crushed roots is taken thrice daily for five days.	0.227
49	*Jatropha curcas* L. DACB-1420	Bagbherenda	Euphorbiaceae	S	L	Juice comes out from leaf mixed with small amount of sugar is taken trice daily for 5 days.	0.253
50	*Kalanchoe pinnata* (Lam.) Pers. DACB-1288	Pathorkuchi	Crassulaceae	H	L	3-4 leaves are chewed daily till cure.	0.173
51	*Lawsonia inermis* L. DACB-1290	Mehedi	Lythraceae	S	L	Juice obtained from crushed leaves is taken orally	0.093
52	*Lippia alba* (Mill.) DACB-1530	Gondo pata	Verbenaceae	S	L	Juice of crushed leaves is taken orally once for five days.	0.227
53	*Litsea monopetala* Roxb. DACB-1445	Shul pata	Lauraceae	S, T	L	Leaves are soaked in water followed by drinking the water once daily for 2-3 days	0.067
54	*Mangifera indica* L. DACB-1291	Aam gach	Anacardiaceae	G, T	Se	Crushed inner pulp of seed of *M .indica* and *Zizyphus mauritiana* bark are taken orally.	0.253
55	*Mentha arvensis* L. DACB-1532	Pudina	Lamiaceae	G, H	L	Juice obtained from crushed leaves is taken thrice daily for one week.	0.347
56	*Mimosa pudica* L. DACB-94	Lojjaboti	Fabaceae	H	Wp	Whole plant is boiled in water and taken as remedy.	0.213
57	*Mucuna pruriens* L. DACB-60	Akolchi	Fabaceae	H	L	Juices obtained from macerated fruits of *Phyllanthus emblica, Terminalia belerica, Terminalia chebula* are mixed with macerated leaves of *M. pruriens* and administered orally.	0.173
58	*Musa paradisiaca* L. DACB-2080	Bichi kola	Musaceae	C, H	CoTr	Core of trunk is cut into small pieces and squeezed in water and taken 1-3 times daily.	0.693
59	*Musa sapientum* L. DACB-1531	Shabri kola	Musaceae	C, H	L	Juice from crushed young leaf is taken orally.	0.400

Table 2 Contd.

Sl. no.	Scientific name and voucher specimen	Bengali name	Family	Plant type	Parts used	Formulation	RCF
60	*Nelumbo nucifera* DACB-2016	Shada poddo	Nelumbonaceae	H	Wp	Whole plant of *N. nucifera* and leaves of *Tinospora cordifolia* are macerated together and taken orally twice daily after meals for three days.	0.107
61	*Oxalis corniculata* L. DACB-32	Amrul shak	Oxalidaceae	G, H	Wp	Whole plants are cooked and eaten as vegetable.	0.213
62	*Phyllanthus reticulatus* DACB-1499	Bhui amla	Euphorbiaceae	S	L, R	Juice collected from leaves and roots is taken once daily for 15 days.	0.173
63	*Piper longum* L. DACB-2058	Pepul	Piperaceae	V	St, R	Stem and root are crushed with black peppers to obtain juice and 1 teaspoon of slightly warm juice taken trice daily.	0.280
64	*Piper nigrum* L. DACB-181	Gol morich	Piperaceae	C, H	Se	Seeds are crushed with small amount of sugar to obtain juice and 1 teaspoon of slightly warm juice taken trice daily.	0.147
65	*Polyalthia longifolia* (Somm.) DACB-2127	Debdaru	Annonaceae	T	B	Decoction made from powdered bark is taken twice daily with honey for 5 days.	0.226
66	*Pongamia pinnata* L. DACB-2017	Karanj	Fabaceae	T	L	3 gm of leaves are squeezed in 2 liter water followed by straining the water taken orally once daily till cure	0.280
67	*Psidium guajava* L. DACB-2095	Peyara	Myrtaceae	C, T	Fr	Fruit is eaten.	0.387
68	*Punica granatum* L. DACB-1303	Dalim	Lythraceae	S	L	Juice obtained from crushed leaves is taken orally	0.413
69	*Ricinus communis* L. DACB-2167	Bherenda	Euphorbiaceae	C, H	L, Se	Juice obtained from crushed leaf and seed is taken orally.	0.253
70	*Rubus fruticosus* L. DACB-2018	Blackberry	Rosaceae	S	L, R	Paste of leaves and roots are taken once daily.	0.373
71	Santalum album L. DACB-2020	Chondon	Santalaceae	H	L, St	Juice obtained from crushed leaves and stems is taken with honey for forteen days.	0.120
72	*Saraca indica* L. DACB-1111	Ashok	Fabaceae	T	B	Juice obtained from macerated bark is taken orally.	0.213
73	*Scoparia dulcis* L. DACB-1304	Modhu maloti	Scrophulariaceae	H, S	L	Leaves are soaked in water followed by drinking the water once daily for 2-3 days	0.280
74	*Sida cordifolia* L. DACB-191	Bon methi	Malvaceae	H	L, R	Juice collected from leaves and roots is taken once daily for 10 days.	0.333
75	*Smilax zeylanica* L. DACB-1579	Koaria mul	Smilacaceae	S	R	Root juice is taken orally.	0.280
76	*Spondias pinnata* DACB-320	Amra	Anacardiaceae	T	B	Juice obtained from macerated bark is taken orally.	0.507
77	*Stephania japonica* DACB-317	Akandi	Menispermaceae	V	L	Juice obtained from crushed leaves is taken orally	0.227
78	*Streblus asper* DACB-117	Shora	Moraceae	H	G	Paste prepared from a mixture of gum of *S. asper* and root of *Hemidesmus indicus* is taken for four days.	0.080
79	*Syzygium cumini* (L.) Skeels DACB-1314	Jaam	Myrtaceae	T	L, B, Se	Juice of leaf, bark, seeds of plant are taken trice daily (150 ml).	0.307
80	*Tagetes erecta* L. DACB-408	Gada phool	Asteraceae	G, H	L, Fl	Juice collected from leaves and roots is taken once daily for three days.	0.013
81	*Tamarindus indica* L. DACB-1315	Tetul	Fabaceae	T	L	Leaves are boiled in water and taken orally.	0.120

Table 2 Contd.

Sl. no.	Scientific name and voucher specimen	Bengali name	Family	Plant type	Parts used	Formulation	RCF
82	*Tectaria heterosora* DACB-305	Baidya nath	Dryopteridaceae	H	R	One teaspoon of boiled roots is taken twice daily.	0.027
83	*Telanthera ficoidea* (Lam.) DACB-406	Chorchora	Amaranthaceae	H	R	Paste obtained from the root is taken on an empty stomach.	0.067
84	*Terminalia arjuna* DACB-1316	Arjun	Combretaceae	T	B	Juice obtained from macerated bark is taken orally.	0.307
85	*Terminalia belerica* Roxb. DACB-582	Bohera	Combretaceae	H	Fr	Juice obtained from macerated fruits is taken orally.	0.280
86	*Terminalia chebula* Retz. DACB-1319	Hortoki	Combretaceae	H	Fr	Juice obtained from macerated fruits of *Phyllanthus emblica*, *Terminalia belerica* and *Terminalia chebula* is mixed with macerated leaves of *Mucuna pruriens* and administered orally.	0.307
87	*Trewia polycarpa* Benth. DACB-1771	Pitali	Euphorbiaceae	T	L, Fl, Fr	Crushed leaves, flower and fruits are taken twice daily.	0.013
88	*Typhonium trilobatum* (L.) Schott DACB-2207	Ghat Kochu	Araceae	H	L, St	Juice obtained from crushed leaves and stems is taken with honey for five days.	0.280
89	*Zingiber officinale* Roscoe DACB-1320	Ada	Zingiberaceae	C, H	Rh	Pills prepared from macerated roots of *Evolvulus nummularius*, rhizomes of *Z. officinale* and roots of *Alternanthera sessilis* are taken thrice daily.	0.093
90	*Z. mauritiana* Lam. DACB-1322	Kul	Rhamnaceae	S	B	Crushed inner pulp of seed of *M. indica* and *Z. mauritiana* bark are taken orally.	0.120

THPs = traditional health practitioners; plant type: T = tree, V = vine, G = grown in the garden, H = herb, C = cultivated, S = shrub, W = wild; parts used: B = bark, L = leaves, Se = seeds, P = petioles, Wp = whole plant, Fr = fruit, Fl = flower, St = stem, R = root, DrS = dried sap, CoTr = core of trunk, Tu = tubers, FrS = skin of fruit, Bu = bulbs, Rh = rhizome, G = gum, Lb = leaf buds; RFC = relative frequency of citation.

Table 3. Comparison of top five antidysenteric plants reported by randomly selected participants (N =10).

Antidysenteric plants	Participants labeled A-J										Total score	Rank
	A	B	C	D	E	F	G	H	I	J		
C. asiatica (L.) Urb.	4	5	2	5	3	5	4	5	5	5	43	1
A. racemosus Willd.	5	2	3	3	4	3	5	3	4	3	35	2
M. paradisiaca L.	3	4	5	4	2	4	3	2	2	2	31	3
S. pinnata	1	1	4	2	5	1	2	4	1	4	25	4
P. granatum L.	2	3	1	1	1	2	1	1	3	1	16	5

However, when someone is interested in such information, native people frequently share their wisdom.[24] Fabaceae family has recently been accounted as a major medicinal plant group of Chittagong hill tracts[25,27] and it has the most elevated number of species than some other plant families on the planet.[28-30] The inclination of leaves was because of its simple accessibility, effortlessness in remedy preparation. Metabolically the most active part of the plant, leaves are known to synthesize a wide scope of secondary metabolites.[26] Leaves were the most generally utilized plant parts utilized by THPs and native individuals of Chittagong hill tracts in the preparation of antidysenteric remedies. Contrasted with the current investigation comparative discoveries demonstrated leaf as a significant

prevailing plant part for herbal medicine preparation.[26,31-34] Trees and herbs attribute a higher utilization in ethnomedicinal practice on account of their more prominent accessibility.[24,25,35] Compared to the current study, similar findings indicated that majority of remedies are prepared in the form of juice.[36] When fruits were used as medication, patients were advised to consume the fruit directly. Use of combination of plants was also reported to be used in the present study to treat dysentery. Sometimes different plant parts of different plants are combined to treat ailment, e.g., acerated roots of *E. nummularius,* rhizomes of *Z. officinale* and roots of *A. sessilis* are mixed properly to make pills. A combination of plant parts of the same plant was also observed to be used for treatment, e.g., leaf, bark and seeds *S. cumini* are used to prepare juice. The utilization of numerous plant remedies might be illustrated by the phenomenon of synergistic actions where at least two plants produce an effect more noteworthy than their individual effect[28] and without a doubt this might be the future bearing in the development of efficacious, safe and cost effective phytopharmacotherapeutics world over.[37] Inclination positioning activities directed on five medicinal plants that scored the most elevated RFC values for their use against dysentery revealed *C. asiatica* as the most preferred plant, which may demonstrate its better adequacy in the treatment of dysentery. Most of the THPs and indigenous people participated in the current study also mentioned that *C. asiatica* has likewise been utilized in conventional medication for the treatment of skin problems, dysentery, indigestion, cataract, gonorrhea, low semen, leucorrhea, diabetes, anemia, vomiting, stomach pain and jaundice.

A review of the overall similar investigations of cited plants of current survey is displayed in table 4. From the 90 plant species got in the current study, 66 plant species have all the earmarks of being widely utilized by folk and ancestral medicinal practitioners in different nations barring Bangladesh as decided from the different ethnomedicinal uses of those plant species revealed in the published literature.

Once infected, all *Shigella* species multiply and cause acute bloody diarrhea by invading the colonic epithelium where favorable to provocative cytokines are delivered and the subsequent inflammatory reaction obliterates the epithelial cells covering the gut mucosa, considering further direct invasion by *Shigella*. Phytochemical investigation of plant preparations and the distinguishing proof of active components in that is likewise useful to clarify the mechanism of antidiarrheal activity[88] followed by dysentery. For example, polyphenols and tannins provide strength to intestinal mucosa, decrease intestinal secretion and advance equilibrium in water transportation across the mucosal cells[89] because of their astringent properties. Flavonoids and saponins inhibit the release of prostaglandins, autacoids and contractions brought about by spasmogens as well as motility and hydroelectrolytic secretions.[90] A wide range of secondary metabolites were accounted for to be available in various antidysenteric, antidiarrheal and other medicinal plants.[91-95] On the other hand, significant antimicrobial activity especially against *E. Coli, Shigella, V. cholerae* and *Salmonella* were reported by different antidysenteric medicinal plants.[96-104]

Earlier studies have shown that the anti-dysenteric and antidiarrheal activities of different medicinal plants were because of tannins, alkaloids, saponins, flavonoids, steroids, terpenes and glycosides contained in them.[91,105] As indicated by Raj.[106] the methanol bark extract of *A. catechu* exhibited significant antidiarrheal activity against GI motility. Extracts of *A. farnesiana* showed antidysenteric activity (MIC 100-200 µg/mL).[39] The effectiveness of *A. marmelos* fruit in diarrhea and dysentery has brought about its entrance into the British Pharmacopoeia and as per Chopra[107] it is effective in chronic cases of diarrhea because of the presence of large quantities of mucilage, which acts as a demulcent. The methanol leaf extract of *A. scholaris* showed broad-spectrum antibacterial activity against *Bacillus subtilis* followed by *E. coli* and *Staphylococcus aureus.* Steroidal saponin, isoflavenoids and polysachharides are some of the significant components found in this plant which are

liable for its antidiarrheal and antidysenteric properties.[108] According to Imam.[109] the crude methanol extracts of *B. acutangula* leaves and seeds showed a dose-dependent reduction in fecal droppings in both castor oil- and magnesium sulphate-induced diarrhea. Methanol extracts of *B. ceiba, C. grandis,* and *S. zeylanica* experimentally demonstrated to restrain the looseness of the bowels causing bacteria.[110] From literature review it was observed that the hydroethanolic root extract of *C. gigantea* showed a significant and dose dependent antidiarrheal property.[111] Alcoholic extracts of the epicarp, endocarp, roots and seeds from ripe and unripe papaya fruit have antidiarrheic, antidysenteric and antibacterial properties.[112,113] Methanol and hexane extracts of *C. asiatica* and *C. rotundus* showed significant antibacterial activity against dysentery causing bacteria *E. coli*.[114,115] Methanolic extract of *F. hispida* leaves significantly reduced the gastro-intestinal motility and inhibit the level of diarrhea.[116] Antidiarrheal effect of methanol extract of *H. indicus* against *S. typhimurium, E. coli* and *S. flexneri* has been accounted for an experimentally-induced diarrhea in rats.[117] The alcoholic extracts of seeds and barks of *H. antidysenterica* show antidysenteric, antibacterial, astringent, anthelmintic, stomachic and febrifugal properties.[118] The pseudostem ethanol extract of *M. paradisiaca* showed moderate anti-dysentery activity.[119] Methanolic extracts of peel and pulp of *M. sapientum* fruits displayed strong antibacterial effect against diarrhea and dysentery caused by *S. dysenteriae* and *E. coli*.[120] The crude extract as well as chloroform and n-butanol soluble fractions of *Oxalis corniculata* showed excellent activities against *E. coli* and *S. dysenteriae.*[121] Karsha and Laxmi[122] reported antibacterial activity of black pepper (*P. nigrum* Linn.) with unique reference to its method of activity on bacteria and tracked down that excellent inhibition on the growth of gram-negative bacteria like *P. aeruginosa* was more susceptible followed by *S. typhi* and *E. coli*. *P. guajava* leaf aqueous extract (50-400 mg/kg p.o.) produced dose-dependent and significant ($p<0.05$-0.01) protection of rats and mice against castor oil-induced diarrhea, inhibited intestinal transit and delayed gastric emptying.[123] The aqueous extract of *P. granatum* peels caused a dose-dependent decrease of gastrointestinal transit and markedly protected rats against castor oil–induced diarrhea enteropooling.[124] Methanol extracts of *Z. mauritiana, B. orellana, S. album, S. japonica, S. asper* and ethanol extract of *S. dulcis* showed significant anti-diarrheal activity against castor oil-induced diarrhea.[125-130] Aqueous extract of *T. lucida* showed antispasmodic activity in segments of the guinea pig ileum precontracted with KCl (83.7 ± 1.9%) and ACh (77.2 ± 5.3%) at the maximal concentration.[131] The bioactive compounds from tamarind seeds present valuable anti-diarrheal activity.[132] Aqueous and ethanolic extracts *T. belerica* showed significant anti-diarrheal activity against castor oil-induced diarrhea.[133] According to Sheng[134] aqueous extract and its soluble fractions of *C. fructus* (*T. chebula* fruits) possessed anti diarrheal property and the ethyl acetate fraction was its main active fraction. Ethanolic leaf extract of *T. trilobatum* significantly decreased the frequency of defecation and increased the mean latent period ($p<0.01$) in castor oil-induced diarrheal model mice at the doses of 250 and 500 mg/kg body weight.[103]

Preclinical studies have shown that *A. marmelos* leaf extract was effective in hindering the development of leukemic K562, T-lymphoid Jurkat, B-lymphoid Raji, erythroleukemic HEL, melanoma Colo38, breast cancer cell lines MCF7 and MDA-MB-231.[135] The *in vivo* hepatoprotective activity of the methanolic extract of *A. sessilis* at the dose of 250 mg/kg body weight was profoundly successful in controlling SGPT, SGOT, ALP, serum cholesterol and serum bilirubin level when contrasted with silymarin just as fundamentally brought down the lipid profile caused by CCl_4.[136] Ayoka[137] concluded that aqueous extract of *A. viridis* might be effective in patients with CP-induced neuro-endocrine dysfunction and reproductive toxicity. Nimbolide, a limonoid from *A. indica* leaves and flowers, restrains the expansion and incites apoptosis in human choriocarcinoma (BeWo) cells.[138] β-boswellic acid isolated from the flowers of *Calotropis gigantean* showed cytotoxic activity against A431 (human

vulval-derived epidermoid carcinoma) cell line when compared with standard drug doxorubicin.[139] Mullick[140] reported that the crude methanolic extract of *E. nummularius* appeared to be toxic towards human RBCs and female genital tract epithelial cells. The anticancer principles of *S. asper* have been recognized as strebloside and mansonin, which showed significant activity in KB cell culture system[141] and the volatile oil from the fresh leaves has additionally shown significant anti-cancer activity.[142] From literature review, it was observed that the extracts of *A. scholaris*, *S. japonica*, *D.*

Table 4. Overall similar investigations of cited plants of current survey.

Sl. no.	Scientific name	Country	References
01	*A. catechu* (L.) Willd.	India	38
02	*A. farnesiana* L.	Mexico	39
03	*A. aspera* L.	India, Pakistan	40, 41
04	*A. marmelos* (L.) Corr.	India	42, 43
05	*A. odoratissima* L.	India	44
06	*A. scholaris* (L.) R. Br.	Myanmar	45
07	*A. sessilis* (L.) DC	Myanmar	45
08	*A. spinosus* L.	Nigeria	46
09	*Amaranthus viridis* Pall.	India	47
10	*A. campanulatus* (Roxb.)	India	48
11	*A. catechu* L.	Indonesia	49
12	*A. racemosus* Willd.	India	40, 42, 50
13	*A. indica* A. Juss.	India	40, 50
14	*B. acutangula* L.	India	51
15	*B. ceiba* L.	India	38, 50, 52, 53
16	*C. gigantea* L.	Myanmar	45
17	*C. papaya* L.	India	42
18	*C. asiatica*(L.) Urb.	India, Myanmar	45, 50
19	*C. aurantium* L.	China, Pakistan	41, 54, 55
20	*C. grandis* L.	Sri Lanka	56
21	*C. speciosus*	India	57
22	*C. dactylon* L. Pers.	India, Pakistan	40, 41, 43
23	*C. rotundus* L.	India	43
24	*D. indica* L.	India	58
25	*D. bulbifera* L.	Africa	59
26	*D. peregrina* (Gaertn.) Gurke.	India	60
27	*E. nummularius*	India	40
28	*F. benghalensis* L.	India, Pakistan	38, 41
29	*F. hispida* L.	China, Myanmar	45, 61
30	*H. indicus* L. R. Br.	India	62
31	*H. mutabilis* L.	Philippine	63
32	*H. antidysenterica* L.	Myanmar	45
33	*I. coccinea* L.	India, Myanmar	45, 64
34	*J. curcas* L.	India	65
35	*K. pinnata* (Lam.) Pers.	Myanmar	45
36	*L. inermis* L.	India	66
37	*M. indica* L.	India	67, 68
38	*M. pudica* L.	India	38, 47
39	*M. pruriens* L.	Myanmar	45
40	*M. paradisiaca* L.	Madagascar, India	69, 70
41	*M. sapientum* L.	India	71
42	*N. nucifera*	Nepal	72
43	*O. corniculata* L.	Pakistan, India	47, 73
44	*P. longum* L.	India	74
45	*P. nigrum* L.	China	75
46	*P. longifolia* (Somm.)	India	76
47	*P. guajava* L.	Madagascar, India	50, 60
48	*P. granatum* L.	India, Algeria	42, 77
49	*R. communis* L.	Myanmar	45
50	*R. fruticosus* L.	India	78
51	*S. album L.*	China	79
52	*S. indica* L.	India	42
53	*S. dulcis* L.	India	40
54	*S. cordifolia* L.	India	42
55	*S. zeylanica* L.	India	47
56	*S. pinnata*	India	38, 45
57	*S. japonica*	India	40
58	*S. asper*	India	42
59	*S. cumini* (L.) Skeels	India	38
60	*T. erecta* L.	Iran	80
61	*T. indica* L.	India	43
62	*T. arjuna*	India	38, 81, 82
63	*T. belerica* Roxb.	India	83, 84
64	*T. chebula* Retz.	India	85, 86
65	*T. trilobatum* (L.) Schott	India	42
66	*Z. mauritiana* Lam.	India	68, 87

indica, D. bulbifera, H. rosa-sinesis, N. nucifera, S. album, T. indica and T. erecta showed significant toxicity.[143-151] According to Jafari[152] administration of the highest dose (2754.43 mg/kg) of hydroalcoholic extract of *T. chebula* caused pathological changes in kidney, liver and heart tissues, which might be due to the presence of undeniable degree of phenolic content in the extract.

However, it is not only important to investigate the herbals to establish their efficacy, but also equally important to investigate their toxic effects. A major challenge to the use of traditional phyto remedies is lack of proper standardization, safety measures, quality control as well as adulteration with conventional medicines.[153,154] It is suggested that all phytochemical substances be scientifically validated for their guaranteed efficacy, safety and toxicity.[153]

CONCLUSION

In light of literature studies and results of this investigation, one potential way to deal with discovering novel and helpful antidysenteric therapeutic agents and products, is to screen herbal medicines that are broadly utilized by THPs and native individuals to treat dysentery and other related diseases. However, more investigations are required to isolate the active components of plants and molecular interactions of their compounds for analysis of their healing properties.

Conflict of interest

We announce that we have no conflict of interests.

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