

## FOLK MEDICINAL USES OF VERBENACEAE FAMILY PLANTS IN BANGLADESH

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## Abstract

Folk medicinal practitioners form the first tier of primary health-care providers to most of the rural population of Bangladesh. They are known locally as Kavirajes and rely almost solely on oral or topical administration of whole plants or plant parts for treatment of various ailments. Also about 2% of the total population of Bangladesh are scattered among more than twenty tribes residing within the country's borders. The various tribes have their own tribal practitioners, who use medicinal plants for treatment of diseases. The objective of the present survey was to conduct an ethnomedicinal survey among the Kavirajes and tribal practitioners to determine which species of plants belonging to the Verbenaceae family are used by the practitioners. The Verbenaceae family plants are well known for constituents having important bio-active properties. The present survey indicated that 13 species belonging to 8 genera are used by the folk and tribal medicinal practitioners of Bangladesh. A comparison of their folk medicinal uses along with published reports in the scientific literature suggests that the Verbenaceae family plants used in Bangladesh can potentially be important sources of lead compounds or novel drugs for treatment of difficult to cure debilitating diseases like malaria and rheumatoid arthritis.

**Key words:** Verbenaceae, folk medicine, Bangladesh, medicinal plants

## Introduction

The Verbenaceae family of plants, which is also commonly known as the verbena or vervain family consists of trees, shrubs and herbs. They are mainly flowering plants found in the tropical regions of the world. The family includes some 35 genera and around 1,200 species.

The Verbenaceae family plants are well known for their uses in the traditional medicinal systems of various countries. Quite a number of the plants have been reported to contain bio-active phytochemicals with important pharmacological effects. To cite only a few recent publications, abietane diterpenoids having anti-microbial and anti-parasitic (anti-leishmanial, anti-malarial) properties have been isolated from the roots of *Clerodendrum eriophyllum* Gürke (Machumi *et al.*, 2010). Ethanolic extract of *Premna corymbosa* (Burm.f.) Rottl. & Willd. leaves reportedly suppressed the development of chronic arthritis in rats induced by Complete Freund's Adjuvant (Karthikeyan and Deepa, 2010).

Essential oil obtained from leaves of *Lippia gracilis* Schauer reportedly possessed antinociceptive and anti-inflammatory activities. Notably the plant is used by folk medicine practitioners of the Caatinga region of Northeastern Brazil for these properties (Mendes *et al.*, 2010). Essential oil obtained from *Lippia graveolens* Kunth reportedly inhibited the growth of *Giardia lamblia*, the causative agent for the diarrheal disease, giardiasis (Machado *et al.*, 2010). Anti-oxidant and cytotoxic activity of essential oil from leaves and fine stems of *Lippia schomburgkiana* Schauer (main constituents 1,8-cineole and  $\alpha$ -terpineol) has been demonstrated (da Silva *et al.*, 2009). Essential oils obtained from *Lippia turbinata* Griseb. and *Lippia polystachya* Griseb. reportedly demonstrated lethal effects against mosquito larvae of *Culex quinquefasciatus*, where ambulation speed and total time of ambulation was significantly decreased (Kembro *et al.*, 2009). Essential oil of *Lippia sidoides* Cham. has been shown to have anthelmintic activity against sheep gastrointestinal nematodes (Camurça-Vasconcelos *et al.*, 2007; Camurça-Vasconcelos *et al.*, 2008). Anti-spasmodic activity has been reported for essential oil from *Lippia dulcis* Trev., a plant used in traditional medicine of Central America for cough, colds, bronchitis, asthma, and colic (Görnemann *et al.*, 2008).

A new anthraquinone, named tectone (3,8-dihydroxy-2-methyl anthraquinone) with anti-hyperglycemic properties has been isolated from leaves of *Tectona grandis* L.f. (Shukla *et al.*, 2010). Essential oils obtained by hydrodistillation of *Aloysia polystachya* (Griseb.) Moldenke and *Aloysia citriodora* Ortega ex. Pers. have been reported to have ovicidal activity against eggs and second instar nymphs of the soybean pest *Nezara viridula* (Hemiptera: Pentatomidae). The major components in the oil were carvone for *A. polystachya*, and citronellal and sabinene for *A. citriodora* (Werdin González *et al.*, 2010). Pro-apoptotic activity of essential oil from *Verbena officinalis* L., and its main component citral has been reported in experiments conducted with lymphocytes collected from patients with chronic lymphocytic leukemia (De Martino *et al.*, 2009). Anti-oxidant and anti-fungal properties have been shown of various solvent extracts of leaves of *V. officinalis* (Casanova *et al.*, 2008).

Ethanol extract of *Stachytarpheta jamaicensis* (L.) Vahl reportedly demonstrated anti-inflammatory properties in animal models of nociception and inflammation (Sulaiman et al., 2009). Anti-inflammatory phenylpropanoid glycosides have been reported from leaves of *Clerodendron trichotomum* Thunberg (Kim et al., 2009). The plant, *Clerodendrum umbellatum* Poir is used in the traditional medicinal system of Cameroon for treatment of intestinal helminthiasis; aqueous extract of leaves have been shown to demonstrate schistosomicidal properties in *Schistosoma mansoni* mice model (Jatsa et al., 2009). Another plant, *Acantholippia deserticola* (Phil.) Moldenke, used in traditional northern Chilean medicine, has been shown to have anti-oxidant properties (Morales et al., 2008).

Bangladesh has a rich tradition of alternative medicinal practices, which include homeopathy, Ayurvedic, Unani, and folk medicine. The latter is practiced by folk medicinal practitioners known commonly as Kavirajes, who rely almost exclusively on medicinal plants for treatment of various ailments. The mode of plant usage is simple, being decoctions, pastes or macerations of whole plant or plant parts followed by topical or oral administration. The Kavirajes tend to keep the knowledge within the family and which is passed from generation to generation. As a result, the Kavirajes over hundreds of years have accumulated considerable knowledge on medicinal plants of Bangladesh. Almost every Kaviraj has his unique repertoire of medicinal plants, and as such, the use of medicinal plants for treatment of a given ailment may differ between Kavirajes of even adjoining villages. Villages form the primary unit of human habitation in the country and almost every village has one or two practicing Kavirajes, who in turn form the primary health-care providers to the inhabitants. This is more so because the villagers not only lack modern medicinal facilities but also most of the time, they cannot afford the price of modern allopathic drugs. Moreover, since the Kavirajes reside within the village, the rural people feel more comfortable to discuss with the Kavirajes their health problems.

About 2% of the population of Bangladesh are scattered among more than twenty tribes within the country. The tribal medicinal practitioners also rely on medicinal plants for treatment of various diseases. Even as of this date, the tribal people obtain primary health-care from their own practitioners instead of visiting allopathic doctors, who are in reality absent from most of the tribal villages.

We had been conducting ethnomedicinal surveys in numerous villages and among various tribes of Bangladesh over the last few years (Hossan et al., 2010; Mollik et al., 2010; Rahman et al., 2010; Rahmatullah et al., 2010 a-i). In our ethnomedicinal surveys we noticed that Verbenaceae family plants hold considerable importance with the Kavirajes for treatment of a considerable number of ailments. The objective of this review is to describe the use of Verbenaceae family plants by the Kavirajes and tribal practitioners of Bangladesh.

#### Materials and methods

The population of Bangladesh is quite homogenous with about 98% of the people speaking the Bengali language. The majority of the population resides in the 86,000 villages and small towns of the country. The number of large cities is only four with only two cities, namely Dhaka and Chittagong, which can be considered as major cities with modern health care facilities and a sizeable number of allopathic doctors. About 2% of the total population are scattered among the various tribal populations of the country, who reside mainly in the south-eastern, north-eastern, and northern regions of the country. Ethnomedicinal surveys were conducted among the Kavirajes, randomly selected from various villages of the 64 districts of Bangladesh. Surveys were further conducted among the major and some minor tribes of the country, which included the Garos, Santals, Manipuris, Chakmas, Marmas, Chaks, Tonchongas, Rakhains, Murongs, Tripuras, and the Khasias.

All surveys were conducted with the help of a semi-structured questionnaire and the guided field-walk method as described by Martin (1995) and Maundu (1995). Briefly, informed consent was first obtained from the Kavirajes and tribal medicinal practitioners. The objective of the survey was explained and consent obtained that the results may be disseminated nationally and internationally. Where tribes were concerned, actual surveys were conducted through an interpreter, who usually happened to be the Headman of the tribe and conversant in both the tribal language as well as Bengali. Kavirajes took the interviewers in field-walks to places from where they collected their medicinal plants, pointed out the plants and described their uses. All plant specimens were collected on the spot, dried and later brought back to the Bangladesh National Herbarium at Dhaka for proper identification. Occasionally, we relied on Mr. Manzurul Kadir Mia, ex-Principal Scientific Officer and Curator of the Bangladesh National Herbarium for plant identification. Information obtained from the Kavirajes and tribal medicinal practitioners during daytime field-walks were cross-checked in evening meetings with the practitioners and any other interested person of the village present at those meetings.

#### Results

The various surveys conducted among Kavirajes and different tribes of Bangladesh indicated that altogether 13 species distributed into 8 genera of Verbenaceae family plants are used by the folk medicinal and tribal medicinal practitioners within the country. Four plants belonged to the *Clerodendrum* genus, while two plants belonged to the *Lippia* genus. From the number of ailments treated and citations by the Kavirajes, *Clerodendrum viscosum* was the most frequently used plant followed by *Clerodendrum indicum* and *Nyctanthes arbor tristis*. Rheumatoid arthritis and skin diseases appeared to be the ailments for which the *Clerodendrum* genus was used for treatment. The results are summarized in Table 1.

The various plant parts used for treatment included whole plants, leaves, roots, stems, barks, meristems, flowers, fruits, and seeds. Of the various plant parts used, leaves constituted the majority of uses (26.7% of total uses), followed by whole plants (15.6%), roots and stems (13.3% each), barks and flowers (11.1% each), fruits (4.4%), seeds and meristems (2.2%). Whole plant, individual plant parts, as well as a combination of plant parts were observed to be used for treatment of various ailments. For instance, whole plants of *Clerodendrum indicum* were used for treatment of coughs, rheumatoid arthritis, jaundice, skin diseases,

**Table 1:** Verbenaceae family plants used by the Kavirajes and tribal medicinal practitioners of Bangladesh.

Serial number	Botanical name	Local name(s)	Plant part(s) used	Ailment(s) treated and plant part(s) used
1	<i>Callicarpa japonica</i> Thunb. ex Murray	Rakabbory	Leaf	Dyspepsia, heart burn ( <b>leaf</b> ).
2	<i>Callicarpa macrophylla</i> Vahl.	Jama-thoi (Tripura tribe) <sup>1</sup> , Kanili-shar	Whole plant, root	Tonic, dermatitis, cancer, antidote to poison ( <b>whole plant</b> ). Heart palpitations, frequent diarrhea (Tripura tribe) ( <b>root</b> ).
3	<i>Clerodendrum indicum</i> (L.) Kuntze	Brahmon-hati, Bamon hati, Bamon-haki, Dibjja phool, Raaz-biit, vamot gach, Vamut, Bine josthi, Biaich gach (Tripura tribe), Bamus gach (Garo tribe), Meremmo (Rakhain tribe)	Whole plant, leaf, root, bark, stem	Cough, rheumatoid arthritis, jaundice, skin diseases, edema, sedative, cancer, diabetes, boils, asthma ( <b>whole plant</b> ). Skin lesions on children's throat, measles in children, to remove spots or scars from face and body (Tripura tribe), skin rash (Garo tribe), whooping cough, allergy, abscess ( <b>leaf</b> ). Eczema, itches, toothache (Rakhain tribe) ( <b>stem</b> ). Cold, asthma, respiratory problems, bloating, tuberculosis ( <b>root</b> ). Diseases of the fetus, excessive menstrual bleeding ( <b>leaf + root</b> ). Skin disorders (Rakhain tribe) ( <b>leaf + bark</b> ). Gastrointestinal problems, respiratory problems like cough, asthma, swellings in any portion of the body (Rakhain tribe) ( <b>leaf + root or leaf + bark or root + bark</b> ). Respiratory distress, herpes, skin and soft tissue infections ( <b>leaf + stem + root</b> ). Syphilis, edema, rheumatoid arthritis, asthma, colic ( <b>leaf + root + bark</b> ).
4	<i>Clerodendrum inerme</i> (L.) Gaertn.	Vana-jhai	Leaf, flower	Night blindness, pneumonia, colic, rheumatoid arthritis ( <b>leaf + flower</b> ).
5	<i>Clerodendrum trichotomum</i> Thunb. ex Murray	Chapa-genda	Leaf, stem, flower	Heart diseases, rheumatoid arthritis, skin diseases ( <b>leaf + stem + flower</b> ).
6	<i>Clerodendrum viscosum</i> Vent.	Viti, Bhat pata, Bhati, Vaita, Foksha, Bandi gach, Baad-bagora, Veter gach, Bite gach or Kung-sroi-ma (Tripura tribe), Oli-phang (Chak tribe), Ghatho or Tikto-bhat (Santal tribe), vati or Bhat or Baita gach or Shamtakari-phang (Garo tribe), Bite gach (Manipuri tribe), Wakk-ram (Murong tribe), Gomokha (Rakhain tribe)	Whole plant, leaf, stem, meristem, root, flower, fruit	Giddiness, typhus, colic in cattle, diabetes, fever, cold, aphrodisiac, malaria, helminthiasis, insect repellent, itches, coughs, infections, tonic, gastritis, dermatitis, dysentery ( <b>whole plant</b> ). Stomach ache, acidity, bloating (Chak tribe), frequent fever, muscle ache, joint ache, gastrointestinal discomfort (Garo tribe), stomach ache (Marma tribe), stomach ache (Manipuri tribe), jaundice, toothache, helminthiasis, spinal pain, fracture or strain, fever, diabetes, coughs, asthma, skin diseases, snake bite, stomach pain, acidity, stimulation of appetite, diarrhea in cattle, lesions within the ear, toothache, malaria fever, typhoid, rheumatic fever, dengue fever, head lice, infections from scorpion bites, nausea, vomiting, puerperal fever, frequent urination ( <b>leaf</b> ). Blood dysentery, dysentery ( <b>stem</b> ). Feeling of weakness during time of menstruation (Tripura tribe), gonorrhoea, low semen count, leukorrhoea, pain, allergy ( <b>root</b> ). Redness of eye ( <b>meristem</b> ). Acidity, diabetes, jaundice, peptic ulcer, dysentery, fever in children, toothache, gum ache ( <b>leaf + stem</b> ).

				Gastritis, jaundice, diabetes, skin eruptions, fever, dysentery, diarrhea or wound in cattle (Santal tribe), malaria, dermatitis, myopathic spasm, boils on the head or body of children, scabies, eczema, urinary problems, gastrointestinal tract problems, malaria, helminthiasis, coughs, typhus, hepatitis, pain, fever (leaf + root). Scorpion sting, jaundice, skin diseases, stomach disease ( <b>leaf + flower</b> ). Helminthiasis, diarrhea ( <b>leaf + fruit</b> ).
7	<i>Duranta repens</i> L.	Kata-mehandi, Kata-mehendhe (Garo tribe)	Whole plant, leaf, fruit, bark	Insect repellent, itches, infertility, fever, pneumonia, antidote to poisoning, neuralgic disorder, malaria ( <b>whole plant</b> ). Malarial fever (Garo tribe) ( <b>bark</b> ). Malarial fever (Garo tribe) ( <b>leaf + fruit</b> ).
8	<i>Lantana camara</i> L.	Chaturaangi, Jangoli-janglog	Whole plant, leaf, root, flower	Cough, mental diseases, fever, boils ( <b>whole plant</b> ). Tuberculosis, malaria, small pox, fistula, tetanus, tumor ( <b>leaf + root + flower</b> ).
9	<i>Lippia alba</i> (Mill.) N.E.Br. ex Britton & P. Wilson	Khuria	Leaf	Cuts and wounds ( <b>leaf</b> ).
10	<i>Lippia nodiflora</i> (L.) Michx.	Bhumi-okra, Saitta okra, Okra pata, Khoi-upra, Horinga lota	Whole plant, leaf, stem, bark	Constipation, eczema, heat stroke, rheumatoid arthritis, nervous disorders, gonorrhea, fever, boils, pain, spasms ( <b>whole plant</b> ). Headache, fever, dizziness ( <b>leaf + stem</b> ). Pain due to working or falling down, pain in back or waist due to rheumatism ( <b>leaf + stem + bark</b> ).
11	<i>Nyctanthes arbor tristis</i> L.	Shefali, Sheuli, Sheuly-phang (Garo tribe)	Whole plant, leaf, stem, root, bark, flower, seed	Influenza, dandruff, helminthiasis ( <b>whole plant</b> ). Fever, coughs, mucus, rheumatism, hypertension, diabetes, obesity, dandruff, migraine, malaria ( <b>leaf</b> ). Constipation in children ( <b>flower</b> ). Constipation in children ( <b>seed</b> ). Expectorant ( <b>leaf + bark</b> ). Arthritis, malaria, expectorant ( <b>leaf + bark of root</b> ). Fever, coughs ( <b>leaf + flower</b> ). Dog bite, cancer, ebolic, flatulency ( <b>leaf + stem + flower</b> ). Bacterial infections, fungal infections, inflammation, helminthiasis, biliary problems, obstinate remittent fever, constipation in children, sciatica, rheumatoid arthritis, alopecia ( <b>leaf + bark + flower + seed</b> ).
12	<i>Premna integrifolia</i> L.	Goniari	Leaf, bark, root	Fever ( <b>leaf</b> ). Fever, energy stimulant ( <b>leaf + bark + root</b> ).
13	<i>Stachytarpheta indica</i> (L.) Vahl.	Supang	Leaf, stem	Leukorrhoea ( <b>leaf + stem</b> ).

<sup>1</sup>All local names are in Bengali language unless a specific tribe is mentioned.

Table 2. Some reported bio-activities of Verbenaceae family plants used by folk and tribal medicinal practitioners of Bangladesh.

Plant	Scientific literature on bio-activity studies
<i>Callicarpa japonica</i> Thunb. ex Murray	Free radical scavenging activity reported for lignan glycosides isolated from stems of the plant (Ono <i>et al.</i> , 2009). Insect repellent terpenoids – callicarpenal and intermedeol reported from leaves (Chen <i>et al.</i> , 2008); isolation of <i>Aedes aegypti</i> and <i>Anopheles stephensi</i> mosquito bite deterrent terpenoids – $\alpha$ -humulene, humulene epoxide II, intermedeol, and spathulenol from the plant (Cantrell <i>et al.</i> , 2005). Anti-bacterial activities reported against <i>Bacillus cereus</i> and <i>Salmonella typhimurium</i> for volatile constituents (1-octen-3-ol, 2-hexenal) isolated from the plant (Kim and Shin, 2004). Anti-viral activity reported for a flavone isolated from the plant – 5,6,7-trimethoxyflavone against herpes simplex virus type 1, human cytomegalovirus, and poliovirus (Hayashi <i>et al.</i> , 1997).
<i>Callicarpa macrophylla</i> Vahl.	Betulinic acid has been reported from the plant (Pan <i>et al.</i> , 2008), which is known to have anti-plasmodial properties (Steele <i>et al.</i> , 1999). Extract of bark shown to inhibit lipid peroxidation in biological membranes (Kumar and Müller, 1999);
<i>Clerodendrum inerme</i> (L.) Gaertn.	Significant antinociceptive activity reported for alcoholic and aqueous extracts of leaves (Parveen <i>et al.</i> , 2010). Hepatoprotective activity demonstrated by ethanolic extract of leaves against carbon tetrachloride-induced liver damage in Swiss albino rats (Gopal and Sengottuvelu, 2008). An anti-plasmodial compound, betulinic acid reportedly present in the plant (Pandey <i>et al.</i> , 2007). Chemopreventive and anti-lipidperoxidative properties reported for ethanolic extract of leaves against 7,12-dimethylbenz(a)anthracene-induced skin carcinogenesis in Swiss albino mice (Renju <i>et al.</i> , 2007), and hamster buccal pouch carcinogenesis (Manoharan <i>et al.</i> , 2006).
<i>Clerodendrum trichotomum</i> Thunb. ex Murray	Anti-inflammatory phenylpropanoid glycosides reported from leaves (Kim <i>et al.</i> , 2009); leaf extract shown to provide anti-inflammatory effects through inhibiting pro-inflammatory gene expression in lipopolysaccharide-stimulated RAW 264.7 macrophages by suppressing NF- $\kappa$ B activation (Park and Kim, 2007); anti-oxidative phenylpropanoid glycoside, trichotomoside reported from the plant with radical scavenging property and ability to protect viability of Chinese hamster lung fibroblasts (V79-4) cells exposed to hydrogen peroxide and $\gamma$ -irradiation (Chae <i>et al.</i> , 2006); reported anti-inflammatory property of acteoside, a phenylpropanoid glycoside isolated from the plant, as demonstrated by inhibition of arachidonic acid release and prostaglandin E2 production induced by mellitin in RBL-2H3 mast cells (Lee <i>et al.</i> , 2006); anti-oxidant activity reported for jionoside D, a constituent of the plant (Chae <i>et al.</i> , 2004); anti-inflammatory properties reported for methanol extract of leaves in rats, mice, and RAW 264.7 cells (Choi <i>et al.</i> , 2004); anti-oxidant activity reported for isoacteoside, a constituent isolated from the plant (Chae <i>et al.</i> , 2005). Reported inhibition of oesophagitis and gastritis in rats by apigenin-7-O- $\beta$ -D-glucuronopyranoside, a constituent of leaves of the plant (Min <i>et al.</i> , 2005). Phenylpropanoid glycosides – acteoside, leucosceptoside A, martynoside, acteoside isomer, and isomartynoside isolated from ethyl acetate extract of the plant with anti-hypertensive effects as demonstrated by significant inhibition of angiotensin converting enzyme (Kang <i>et al.</i> , 2003).
<i>Duranta repens</i> L.	Mosquitocidal triterpenes, $\beta$ -amyryn and 12-oleane 3 $\beta$ , 21 $\beta$ -diol, which have larvicidal properties against larvae of <i>Culex quinquefasciatus</i> have been isolated from stems (Nikkon <i>et al.</i> , 2010); flavonoid glycosides demonstrating anti-plasmodial activity against chloroquine-sensitive (D6) and chloroquine-resistant (W2) strains of <i>Plasmodium falciparum</i> reported from chloroform soluble

	<p>fraction of whole plant (Ijaz <i>et al.</i>, 2010); triterpene saponins with significant cytotoxic activity against HepG2 cell line reported (Ahmed <i>et al.</i>, 2009), along with oleanolic acid, which reportedly possess anti-plasmodial activity (Moon <i>et al.</i>, 2007; van Baren <i>et al.</i>, 2006); anti-malarial effects noted for ethyl acetate and aqueous extracts of fruits against <i>Plasmodium berghei</i> (Castro <i>et al.</i>, 1996). Anti-oxidative coumarinolignoids, repenins A-D reported from chloroform soluble fraction of whole plant (Ahmad <i>et al.</i>, 2009); presence of acteoside reported in the plant, which has anti-oxidant activity (Shahat <i>et al.</i>, 2005). Report of <math>\alpha</math>-glucosidase inhibitory constituents from the plant, suggesting the plant's anti-diabetic potential (Iqbal <i>et al.</i>, 2004).</p>
<p><i>Lantana camara</i> L.</p>	<p>Oleanolic acid has been isolated from the plant, which besides having anti-inflammatory, anti-cancer and hepatoprotective effects (Ghosh <i>et al.</i>, 2010; Misra <i>et al.</i>, 1997; Pan <i>et al.</i>, 1993) also possess anti-plasmodial properties (Moon <i>et al.</i>, 2007); adulticidal activity of essential oil from leaves of the plant (major constituents – caryophyllene, eucalyptol, <math>\alpha</math>-humulene, and germacrene) reported against mosquito species – <i>Aedes aegypti</i>, <i>Culex quinquefasciatus</i>, <i>Anopheles culicifacies</i>, <i>Anopheles fluviatilis</i>, and <i>Anopheles stephensi</i> (Dua <i>et al.</i>, 2010); <i>in vitro</i> anti-plasmodial activity reported for dichloromethane leaves extract against 3D7 and W2 strain of <i>Plasmodium falciparum</i> (Jonville <i>et al.</i>, 2008); ursolic acid reported from aerial part of the plant (Begum <i>et al.</i>, 2008a), a compound reported for its anti-plasmodial activity (van Baren <i>et al.</i>, 2006); reported use of the plant as a repellent for mosquitoes by people of Moshi in Kilimanjaro region in north-eastern Tanzania (Kweka <i>et al.</i>, 2008); plant reportedly used for malaria treatment in traditional medicinal practices of Budiope county, Uganda (Tabuti, 2008); repellency effect demonstrated for flower extract against <i>Aedes albopictus</i> and <i>Aedes aegypti</i> (Dua <i>et al.</i>, 1996); <i>in vitro</i> anti-malarial activity demonstrated against multidrug resistant K1 strain of <i>Plasmodium falciparum</i> by extract of rootbark (Weenen <i>et al.</i>, 1990).</p> <p>Anti-bacterial activity against the microorganisms – <i>Arthrobacter protophormiae</i>, <i>Micrococcus luteus</i>, <i>Rhodococcus rhodochrous</i>, and <i>Staphylococcus aureus</i> demonstrated by essential oil from the plant (containing as major constituents – 3,7,11-trimethyl-1,6,10-dodecatriene, <math>\beta</math>-caryophellene, zingiberene, <math>\gamma</math>-curcumene, and <math>\alpha</math>-humulene) (Kurade <i>et al.</i>, 2010); anti-bacterial activity reported against <i>Staphylococcus aureus</i> by extract of leaves (Cheruiyot <i>et al.</i>, 2009); anti-microbial efficacy of plant constituents reported against <i>Escherichia coli</i>, <i>Proteus mirabilis</i>, <i>Staphylococcus aureus</i>, <i>Candida albicans</i>, and <i>Trichophyton mentagrophytes</i> (Sharma and Kumar, 2009); reported anti-microbial activity of extract of plant (Dabur <i>et al.</i>, 2007; Kumar <i>et al.</i>, 2006); anti-microbial activity reported for essential oil (Deena and Thoppil, 2000); anti-microbial activity against <i>Staphylococcus aureus</i> and <i>Salmonella typhi</i> demonstrated by 22<math>\beta</math>-acetoxylantic acid, isolated from the plant (Barre <i>et al.</i>, 1997); anti-mycobacterial activity of chloroform and methanol extracts of the plant reported against three strains (H37Rv, rifampicin-resistant TMC-331, and wild strain 28-25271) of <i>Mycobacterium tuberculosis</i>, notably the plant is used to treat tuberculosis in traditional medicine of Uganda (Kirimuhuzya <i>et al.</i>, 2009); anti-mycobacterial activity reported for flavonoids isolated from the plant, namely linarioside, lantanoside, and their common acetyl derivative against <i>Mycobacterium tuberculosis</i> (Begum <i>et al.</i>, 2008b).</p> <p>Reported wound healing activity for excision wounds by leaf extract in rats (Nayak <i>et al.</i>, 2009).</p> <p>Used for treatment of gastrointestinal diseases by the village population of Zapotitlán de las Salinas, Mexico, conformation of anti-microbial effects against 14 bacterial strains causing common gastrointestinal disorders (Hernández <i>et al.</i>, 2003).</p> <p>Reported efficacy of treatment by ointment made from ethanolic extract of leaves for bovine dermatophilosis (Ali-Emmanuel <i>et al.</i>, 2003).</p> <p>Cytotoxic constituents (pentacyclic triterpenoids) active against various cancer cell lines reported from leaves (Litaudon <i>et al.</i>, 2009); pentacyclic triterpenoids (lantadenes and their esters) present in the plant reportedly demonstrated <i>in vivo</i> tumor inhibitory potential on squamous cell carcinogenesis in Swiss albino mice induced by 7,12-dimethylbenz[a]anthracene (DMBA) and promoted by 12-<i>O</i>-tetradecanoylphorbol-13-acetate (TPA) (Sharma <i>et al.</i>, 2008; Kaur <i>et al.</i>, 2008); anti-tumor component verbascoside isolated from the plant, which has been attributed to inhibition of protein kinase C from rat brain (Herbert <i>et al.</i>, 1991).</p> <p>Plant extract reported to be efficacious in controlling cattle ticks (Moyo <i>et al.</i>, 2009).</p> <p>Nematicidal activity demonstrated against root-knot nematode <i>Meloidogyne incognita</i> by various pentacyclic triterpenoids obtained from aerial parts of the plant – pomolic acid, lantanolic acid, lantoic acid, camarin, lantacin, camarinin, and ursolic acid (Begum <i>et al.</i>, 2008); nematicidal properties demonstrated for lantanilic acid, camaric acid, and oleanolic acid isolated from methanolic extract of aerial parts of the plant, notably the last compound also has anti-plasmodial properties (Qamar <i>et al.</i>, 2005); nematicidal properties demonstrated for lantanoside, linarioside, and camarinic acid isolated from aerial parts (Begum <i>et al.</i>, 2000).</p>

	<p>Anti-filarial activity demonstrated by stem extract against human lymphatic filariid <i>Brugia malayi</i> and rodent filariid <i>Acanthocheilonema viteae</i> (Misra <i>et al.</i>, 2007).</p> <p>Insecticidal activity reported of volatile oils from leaves and flowers (Abdel-Hady <i>et al.</i>, 2005).</p>
<i>Lippia alba</i> (Mill.) N.E.Br. ex Britton & P. Wilson	<p>Anti-viral activity against dengue virus serotypes replication reported for essential oil (Ocazonez <i>et al.</i>, 2010); Anti-protozoal activity of essential oil against <i>Trypanosoma cruzi</i> epimastigites and intracellular amastigotes (Escobar <i>et al.</i>, 2010); inhibitory effect of essential oil reported against yellow fever virus replication <i>in vitro</i> (Meneses <i>et al.</i>, 2009); reported n-butanol extract of the plant demonstration of anti-viral activity against herpes simplex virus type 1 (HSV-1) and poliovirus type 2 (PV-2) (Andrighetti-Fröhner <i>et al.</i>, 2005).</p> <p>Reported hypotensive and vasorelaxant effects of citronellol, a monoterpene alcohol obtained from essential oil (Bastos <i>et al.</i>, 2010). Cytotoxic effect (against HeLa cells) and anti-fungal effects described for the citral chemotype essential oil obtained from the plant (Mesa-Arango <i>et al.</i>, 2009); anti-fungal effect described for essential oil against legume-contaminating fungi (Shukla <i>et al.</i>, 2009); <i>in vitro</i> anti-microbial and cytotoxic activities described for leaves and flower extracts (Ara <i>et al.</i>, 2009); anti-<i>Candida albicans</i> activity reported for essential oil (Duarte <i>et al.</i>, 2005); anti-bacterial activity reported for bacteria causing respiratory infections – <i>Staphylococcus aureus</i>, <i>Streptococcus pneumoniae</i>, and <i>Streptococcus pyogenes</i> (Caceres <i>et al.</i>, 1991); cytostatic activity of aqueous, alcoholic and ketonic extract of the plant has been reported (Lopez Abraham <i>et al.</i>, 1979).</p> <p>Ethnobotanical uses of the plant described as used against digestive and respiratory ailments, and as a sedative and hypertensive remedy (Hennebelle <i>et al.</i>, 2008a); anti-oxidant and neurosedative properties reported for polyphenols and iridoids from the plant (Hennebelle <i>et al.</i>, 2008b); reported ethnopharmacological use in Brazilian traditional medicine system as a sedative (Oliveira <i>et al.</i>, 2006); constituents of essential oil – citral, myrcene, and limonene shown to have sedative as well as motor relaxant effects in mice (do Vale <i>et al.</i>, 2002); leaves reported to be used in Guatemalan traditional medicine for stomach problems, dysentery, colds and cough, febrifuge, as well as a sedative and in spasmolytic remedies, oral administration of the plant reported to prevent gastric ulceration induced by indomethacin in rats (Pascual <i>et al.</i>, 2001); anti-convulsant activity reported for essential oil with indications that three constituents of the oil, namely citral, <math>\beta</math>-myrcene, and limonene are the active compounds (Viana <i>et al.</i>, 2000).</p> <p>Aqueous extract of the plant shown to provoke significant cardiac rate in isolated rat hearts (Gazola <i>et al.</i>, 2004).</p> <p>Analgesic effects described in mice for 50% aqueous ethanol extract of the plant as demonstrated by writhing and tail flick methods (Costa <i>et al.</i>, 1989).</p>
<i>Lippia nodiflora</i> (L.) Michx.	<p>Anti-inflammatory property exhibited by cyclo-pentano phenanthrenol isolated from the plant (Balakrishnan <i>et al.</i>, 2010); anti-inflammatory and antinociceptive activities reported for methanolic extract of leaves (Ahmed <i>et al.</i>, 2004).</p> <p>The plant is one of the components of the Indian drug, Anna Pavala Sindhooram, used in traditional Indian medicine for the prevention and reversal of the atherosclerotic disease process (Shanmugasundaram <i>et al.</i>, 1983).</p>
<i>Nyctanthes arbor tristis</i> L.	<p>Larvicidal activity of leaves and flowers extracts demonstrated against the mosquito species – <i>Aedes aegypti</i>, <i>Culex quinquefasciatus</i>, and <i>Anopheles stephensi</i> (Mathew <i>et al.</i>, 2009).</p> <p>Reported tranquilizing, anti-histaminic and purgative activity of leaf extract, notably a decoction of leaves is used in Ayurvedic system of medicine for treatment of sciatica, arthritis, fevers, painful conditions, and as laxative (Saxena <i>et al.</i>, 2002).</p> <p>Anti-bacterial and cytotoxic activity reported for extracts of flowers (Khatune <i>et al.</i>, 2001).</p> <p>Immunostimulant activity reported for 50% ethanolic extract of seeds, flowers, and leaves, which are likely to play roles in the plants' traditional uses as an anti-amoebic, anti-leishmanial, and anti-viral agent (Puri <i>et al.</i>, 1994).</p> <p>Analgesic and anti-pyretic activity reported for leaf extract (Saxena <i>et al.</i>, 1987); anti-inflammatory activity reported for leaf extract against inflammatory edema produced by different phlogistic agents like carrageenin, formalin, histamine, 5-hydroxytryptamine and hyaluronidase (Saxena <i>et al.</i>, 1984).</p>
<i>Premna integrifolia</i> L.	<p>Hypoglycemic activity reported of 95% ethanolic extracts of plants in alloxan-diabetic rats (Kar <i>et al.</i>, 2003); hypoglycemic activity reported for plant extract in streptozotocin-induced type 1 and type 2 diabetic rats (Alamgir <i>et al.</i>, 2001).</p>

edema, cancer, diabetes, and boils, while leaves were used for treatment of skin lesions on children's throat, to remove scars from face and body, skin rash, whooping cough, allergy, and abscesses. The stems of the same plant were used for treatment of eczema, itches, and toothache. A combination of leaves and roots was used for treatment of diseases of the fetus, while a combination of leaves and bark was used for treatment of skin disorders.

Although only 13 Verbenaceae family plants were used by the folk medicinal practitioners, a wide variety of diseases were treated. Among the most frequent diseases treated were skin diseases, gastrointestinal disorders, respiratory tract disorders, rheumatoid arthritis, fever, hepatic disorders like jaundice, sexually transmitted diseases, malaria, helminthiasis, and nerve disorders. Other diseases treated with Verbenaceae family plants included heart problems, cancer, edema, measles, allergy, pain, tuberculosis, menstrual problems, herpes, night blindness, sexual disorders, hypertension, cuts and wounds, fracture or sprain, snake bite, scorpion bite, dog bite, rheumatic fever, dengue fever, head lice, nausea, vomiting, urinary tract problems, leukorrhea, hepatitis, fistula, and tetanus. Of the 13 Verbenaceae family plants used, 8 plants were used to treat skin diseases, 7 plants for treatment of gastrointestinal disorders, and 5 plants each for treatment of respiratory tract infections, rheumatoid arthritis, fever, and malaria. A plant may be used for treatment of both human and cattle diseases, e.g. *Clerodendrum viscosum*, which while used for treatment of various human ailments was also used for treatment of colic in cattle.

Regarding tribal usage, *Clerodendrum viscosum* was the most frequently used plant by various tribes, including the Chak, Garo, Manipuri, Marma, Santal, and Tripura tribes. The plant next most frequently used by various tribes was *Clerodendrum indicum*, which was used by the Garo, Rakhain, and Tripura tribes. The ailment(s) treated by any tribe with a particular plant was not necessarily the same as other tribes or the Kavirajes belonging to the mainstream population. To cite just one example, *Clerodendrum indicum* was used by the Garo tribe for skin rashes, but used by the Rakhain tribe for eczema, itches, and toothache. While it may be argued that skin rashes, itches and eczema are all skin disorders, nevertheless the use of the plant for treatment of toothache was unique to the Rakhain tribe. The Rakhain tribe also used the plant for treatment of gastrointestinal problems, respiratory problems like coughs and asthma, as well as swellings in any portion of the body. Notably the mainstream Kavirajes used the same plant or plant parts for treatment of ailments like cold, asthma, respiratory problems, bloating, tuberculosis, diseases of the fetus, excessive menstrual bleeding, sexually transmitted diseases, skin and soft tissue infections, edema, and rheumatoid arthritis. Thus while a common feature may be noted in the treatment by various tribal practitioners and Kavirajes in the treatment of skin-related disorders, overall there were more varieties in diseases treated than common uses of the plant. *Duranta repens* was another plant used for treatment of malaria by tribal practitioners as well as mainstream Kavirajes. But while the Garo tribal medicinal practitioners used the plant exclusively for treatment of malarial fever, mainstream Kavirajes utilized the plant as an insect repellent, and for the treatment of itches, infertility, fever, and pneumonia besides treatment of malaria.

### Discussion

A number of the Verbenaceae family plants have reported bio-active properties, which validate their use in the folk medicinal system of Bangladesh. *Clerodendrum inerme* has been reported to have significant antinociceptive activity (Parveen *et al.*, 2010), which might explain its use for rheumatoid arthritis, which has quite intensive pain as one of its symptoms. Anti-inflammatory properties has also been reported for *Clerodendrum trichotomum* (Kim *et al.*, 2009), which again can justify its folk medicinal use in Bangladesh for treatment of rheumatoid arthritis. The plant, *Lippia nodiflora* also reportedly has anti-inflammatory and antinociceptive effects (Ahmed *et al.*, 2004), which can be useful in the treatment of rheumatoid arthritis for which purpose the plant is used locally.

Mosquitocidal triterpenes as well as anti-plasmodial activity have been reported for *Duranta repens* (Nikken *et al.*, 2010; Ijaz *et al.*, 2010), justifying its use as insect repellent and for treatment of malarial fever in Bangladesh. Oleanolic acid has been isolated from *Lantana camara*, a compound reported to have anti-plasmodial properties (Moon *et al.*, 2007). Notably the plant is used as an anti-malarial by folk medicinal practitioners of Bangladesh. The essential oil of the plant also reportedly has anti-bacterial properties (Kurade *et al.*, 2010), which can justify its local use for coughs, and anti-mycobacterial properties (Kirimuhuzya *et al.*, 2009) justifying its use for treatment of tuberculosis.

*Nyctanthes arbor tristis* is used in Bangladesh for treatment of fever, bacterial infections, and rheumatism as well as other ailments. Validation of the plant's use can be found in the scientific literature, which describes anti-pyretic and analgesic effects of the plant (Saxena *et al.*, 1987), as well as anti-bacterial properties of its flowers (Khatune *et al.*, 2001).

Overall, the Verbenaceae family plants used in Bangladesh appear to have constituents with pharmacological properties, which can be useful in the treatment of bacterial and fungal infections, malaria, and pain arising from various causes including rheumatoid arthritis. The plants merit detailed studies which can prove useful in the discovery of lead compounds leading to novel and more efficacious drugs. The importance of the plants used in Bangladesh lies more so in their potential for treatment of malaria and rheumatoid arthritis, two of the most debilitating diseases affecting millions of people throughout the world.

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