Advances in Natural and Applied Sciences, 4(3): 236-253, 2010
ISSN 1995-0748
This is a refereed journal and all articles are professionally screened and reviewed

ORIGINAL ARTICLE

An Ethnomedicinal, Pharmacological and Phytochemical Review of Some Bignoniaceae Family Plants and a Description of Bignoniaceae Plants in Folk Medicinal Uses in Bangladesh

[1]Mohammed Rahmatullah, [2]Walied Samarrai, [1]Rownak Jahan, [1]Shahnaz Rahman, [1]Nasima Sharmin, [1]Z.U.M. Emdad Ullah Miajee, [2]Majeedul H. Chowdhury, [3]Sazzadul Bari, [1]Farhana Jamal, [1]A.B.M. Anwarul Bashar, [1]A.K. Azad, [1]Shamima Ahsan

[1]Faculty of Life Sciences, University of Development Alternative, Dhanmondi, Dhaka-1205, Bangladesh.
[2]Present address: New York City College of Technology The City University of New York 300 Jay Street, Brooklyn, NY 11201, USA.
[3]MonicoPharma Ltd. House No. 89/1, Road No. 12A, Dhanmondi, Dhaka-1209, Bangladesh.

Mohammed Rahmatullah, Walied Samarrai, Rownak Jahan, Shahnaz Rahman, Nasima Sharmin, Z.U.M. Emdad Ullah Miajee, Majeedul H. Chowdhury, Sazzadul Bari, Farhana Jamal, A.B.M. Anwarul Bashar, A.K. Azad, Shamima Ahsan; An ethnomedicinal, pharmacological and phytochemical review of some Bignoniaceae family plants and a description of Bignoniaceae plants in folk medicinal uses in Bangladesh

ABSTRACT

The Bignoniaceae family comprising of about 110 genera and 650 species is a family of flowering plants, commonly known as the Trumpet Creeper family, Jacaranda family, Bignonia family, or the Catalpa family. Plant species belonging to this family are distributed worldwide, but most of them occur in the tropical and sub-tropical countries. However, a number of temperate species also grow in North America and East Asia. Although the family is small, the Bignoniaceae plants are important for their reported bio-active constituents and diverse pharmacological activities. Bignoniaceae family plants are also widely used in traditional medicinal systems of a number of countries, including Bangladesh, where folk and tribal medicinal practitioners use a number of species for treatment of diverse ailments. Since folk medicinal practitioners form the first tier of primary health care in Bangladesh, the objective of the present study was to conduct a review of reported bio-active constituents from this family and compare the traditional medicinal uses of Bignoniaceae family plants in various countries of the world including Bangladesh. Accordingly, a survey was conducted among traditional medicinal practitioners of Bangladesh, which included folk medicinal practitioners (catering to the mainstream population and otherwise known as Kavirajes) as well as tribal medicinal practitioners of various tribes residing within the country. It was observed that the traditional medicinal practitioners use a total of seven Bignoniaceae family species for treatment of ailments like cancer, snake bite, skin disorders, gastrointestinal disorders, respiratory tract disorders, gynecological disorders, hepatic disorders, epilepsy, cholera, pain, urinary problems, malaria, heart problems, and sexually transmitted diseases. The seven species of Bignoniaceae family plants in use were *Crescentia cujete*, *Heterophragma adenophyllum*, *Oroxylum indicum*, *Stereospermum suaveolens*, *Tabebuia argentea*, *Tecoma gaudichaudi*, and *Tecoma stans*. Since the available scientific literature validates the use of a number of these plants for the ailments they are prescribed for by the Kavirajes and tribal medicinal practitioners, the plants present excellent potential for further scientific studies, which may result in discovery of novel compounds of therapeutic interest.

Key words: Bignoniaceae, folk medicine, Bangladesh, constituents

Corresponding Author: Professor Dr. Mohammed Rahmatullah, Pro-Vice Chancellor and Dean, Faculty of Life Sciences University of Development Alternative House No. 78, Road No. 11A (new) Dhanmondi, Dhaka-1205 Bangladesh
Telephone: +88-01715032621 Fax: +88-02-815739
E-mail: rahamatm@hotmail.com

Introduction

Human beings have been aware of medicinal plants possibly as long ago as 3,000 BC [Sofowara, 1982]. Virtually every indigenous culture in the world uses medicinal plants in some form or other for treatment of ailments. The actual knowledge of medicinal plants is possessed by a select group of practitioners, who determine the nature of the ailments and then prescribe remedies. Although indigenous cultures possess a holistic view of ailments and their cure, medicinal plants do form a major part of indigenous medicinal or traditional medicinal practices. Since the advent of modern or allopathic medicine, traditional medicine lost quite a bit of ground, being determined to be somewhat akin to superstitious beliefs or even quackery by allopathic doctors. However, in recent periods, traditional medicine has made a major come-back. It has been realized that a number of important modern pharmaceuticals have been derived from, or are plants used by indigenous people [Balick and Cox, 1996]. A number of modern drugs like aspirin, atropine, ephedrine, digoxin, morphine, quinine, reserpine and tubocurarine are examples, which were originally discovered through observations of traditional cure methods of indigenous peoples [Gilani and Rahman, 2005].

The Indian sub-continent comprising of the countries India, Pakistan, and Bangladesh form one of the richest sources of traditional medicinal practices in the whole world. Overall, the alternative medicinal systems of India uses more than 7500 plant species [Mukherjee and Wahile, 2006]. The various traditional medicinal systems practiced in the above countries are the well known homeopathic, Ayurvedic, Unani, and the Siddha systems of medicine with their well-defined formulations and selection of medicinal plants. What is not so well known is another system of medicine, which can best be referred to as folk medicine. In Bangladesh, the folk medicinal practitioners, known otherwise as Kavirajes or Vaidyas form the first tier of primary health care for a substantial segment of the rural and urban population of the country. The Kavirajes each have their unique repertoire of medicinal plants for treatment of ailments, a knowledge which is closely guarded and usually passed on from generation to generation. The distinctive feature of treatment of ailments by the Kavirajes is that unlike the other systems of traditional medicine, the Kavirajes rely almost exclusively on simple preparations of medicinal plants or plant parts in their treatments.

In our ethnomedicinal surveys among the various Kavirajes spread throughout the country and the tribal medicinal practitioners of various tribes [Hanif *et al*., 2009; Hossan *et al*, 2009, 2010; Mollik *et al*, 2010; Rahmatullah *et al*., 2009a-e; Rahmatullah *et al*., 2010 a,b], we have observed considerable variations about the plant species selected by any individual Kaviraj for treatment of a specific ailment. Quite naturally, this variation extended to families of plants. A plant family that is not often used by the folk medicinal or tribal medicinal practitioners (henceforth both will be referred to as folk medicinal practitioners or Kavirajes unless necessary otherwise) in Bangladesh is the Bignoniaceae family. Yet this family, although containing worldwide a relatively small number of genera (about 110) and species (about 650) is important on account of the considerable scientific literature present on bio-active constituents and pharmacological activities in Bignoniaceae family plant species. The objective of the present study was to conduct a review of reported bio-active constituents from some important plants belonging to this family along with reported pharmacological activities in the scientific literature and compare the traditional medicinal uses of this family in various countries of the world including Bangladesh.

Materials and Methods

Reports of ethnomedicinal studies, bio-active phytochemical constituents and pharmacological activity studies on Bignoniaceae family plants were obtained from existing scientific data bases. Interviews of folk medicinal practitioners within Bangladesh were conducted with the help of a semi-structured questionnaire and the guided-field walk method as described previously [Martin, 1995; Maundu, 1995]. Briefly, in this method, the folk medicinal practitioners took the interviewers in guided field-walks during daytime through the areas from where they collected their medicinal plants, pointed out the plants, and gave their local name(s) with a description of their uses. Prior permission was obtained from all folk medicinal practitioners before the interview and the guided field-walks. The informants were specifically told that the information obtained may be disseminated in both national as well as international publications. All information was cross-checked with the folk medicinal practitioners in later evening sessions. Interviews were conducted in the Bengali language when Kavirajes practicing within the mainstream population were interviewed and in the corresponding tribal language when tribal medicinal practitioners were interviewed. In the latter case, the tribal Headman acted as the interpreter, the Headman being conversant in both Bengali as well as the language of his tribe. Plant specimens were collected and dried in the field and later identified by the Bangladesh National Herbarium.

Results and Discussion

Bignoniaceae family plants are widely used in traditional medicinal systems of many countries as shown in Table 1. A notable number of bioactive compounds have been reported from Bignoniaceae family plants. These compounds reportedly demonstrated a number of important activities, which are beneficial to human beings. The various activities included molluscicidal, trypanocidal, mosquito larvicidal, anti-oxidant, anti-diabetic, anti-plasmodial, anti-inflammatory, immunostimulant, anti-microbial, anti-depressant, anti-snake venom, anti-cancer, antinociceptive, and neurotrophic activities. The findings from published studies are summarized in Table 1. It is to be noted that Table 1 does not cover all plants of the Bignoniaceae family but only several important plants.

Among the various bio-active constituents reported from Bignoniaceae family plantsand reviewed in the present study, some of the more common but pharmacologically important compounds are ursolic acid, oleanolic acid, a- and b-lapachone, lapachol, verbascoside, corymboside, lupeol, quercitrin, apigenin, pomolic acid, and isoacteoside. Although a comprehensive evaluation of the activities of these compounds is beyond the scope of the present study, a brief review of some of the most recent literature on these compounds shall be presented.

The anti-trypanocidal activity of ursolic acid has already been mentioned in Table 1. The compound has been shown to ameliorate thymic atrophy and hyperglycemia in streptozotocin-nicotinamide-induced diabetic mice (Lee *et al*., 2010). Inhibition of early lesions of diabetic nephropathy in streptozotocin-induced diabetic mice has also been reported (Zhou *et al*., 2010). Anti-diabetic activity has further been demonstrated by enhancement of the cellular immune system and pancreatic b-cell function in streptozotocin-induced diabetic mice fed a high-fat diet (Jang *et al*., 2009). Anti-cancer activity has also been demonstrated through report of the compound's inducing apoptosis in human hepatoma cell line SMMC-7721 (Yu *et al*., 2010). Both ursolic acid and oleanolic acid (constituents reported from Bignoniaceae family plants) demonstrated anti-cancer activity by inducing apoptosis in four human liver cancer cell lines, HepG2, Hep3B, Huh7 and HA22T (Yan *et al*., 2010). Notably, the compound also demonstrated protective effects against oxidative DNA damage, which included enhancement of DNA repair in Caco-2 cells (Ramos *et al*., 2010). It reportedly also attenuated oxidative stress-mediated hepatocellular carcinoma induction by diethylnitrosamine in male Wistar rats (Gayathri *et al*., 2009). The compound potentially can be used to treat obesity as demonstrated by its stimulation of lipolysis in primary-cultured rat adipocytes (Li *et al*., 2010). Anti-nematicidal activity has been reported for both ursolic and pomolic acids (the latter also being present in Bignoniaceae family plants) against root-knot nematode *Meloidogyne incognita* (Begum *et al*., 2008). Anti-arthritic effect has been reported for ursolic acid in zymosan-induced acute inflammation and adjuvant-induced chronic arthritis in rodent models (Kang *et al*., 2008). Ursolic and oleanolic acid reportedly demonstrated anti-oxidative and anti-inflammatory protection in PC12 cells against hydrogen peroxide- or 1-methyl-4-phenylpyridinium ion-induced cell injury (Tsai and Yin, 2008). Anti-fungal activity has also been reported for ursolic acid (Shai *et al*., 2008).

Ursolic acid, present in methanol extract of *Satureja parvifolia* (Phil.) Epling (Lamiaceae) reportedly gave an IC_{50} value of 4.9 mg/ml against *Plasmodium falciparum* K1 strain and was also active against *P. falciparum* 3D7 strain (van Baren *et al*., 2006). The anti-plasmodial activity of ursolic acid isolated from hydromethanol extract of *Mitragyna inermis* (Willd.) O Ktze. (Rubiaceae) have also been reported (Traore-Keita *et al*., 2000). Extract of *Baccharis dracunculifolia* DC (Asteraceae), containing ursolic acid, also demonstrated anti-plasmodial activity against *P. falciparum* (IC_{50} value of about 20 mg/ml, da Silva Filho *et al*., 2009).

Oleanolic acid, together with ursolic acid reportedly showed inhibitory activities against amastigote forms of *Leishmania amazonensis* and *Leishmania braziliensis* (Passero *et al*., 2010). A synergistic anti-hyperglycemic effect has been reported between *Syzygium cordatum*-derived oleanolic acid and insulin in streptozotocin-induced diabetic rats (Musabayane *et al*., 2010). The compound reportedly increased urinary Na^+ outputs and creatinine clearance of streptozotocin-induced diabetic rats (Mapanga *et al*., 2009).

Oleanolic acid has also been reported to have anti-plasmodial activity. Bioactivity guided fractionation of whole plant of *Viola verecunda* A. Gray (Violaceae) led to the isolation of epi-oleanolic acid with high anti-plasmodial activity against chloroquine-resistant FcB1 strain of *P. falciparum* with an IC_{50} value of 0.18 mg/ml (Moon *et al*., 2007). Oleanolic acid has been isolated from the methanol extract of *Satureja parvifolia* (Phil.) Epling (Benth.) Briq. (Lamiaceae). The IC_{50} value against *P. falciparum* K1 strain has been reported to be 9.3 mg/ml (van Baren *et al*., 2006). A moderate *in vitro* anti-plasmodial effect has been observed with extract of *Salvia hydrangea* DC. ex Bentham (Lamiaceae) flowers, which has been attributed to presence of oleanolic acid. The observed effect has been attributed to incorporation of oleanolic acid into the erythrocyte membrane thus adversely affecting the growth of *P. falciparum* (Sairafianpour *et al*., 2003).

Table 1: A pharmacological, phytochemical and ethnomedicinal evaluation of Bignoniaceae family plants.

Botanical name	Reported phytochemical constituents and pharmacological activities
Adenocalymma comosum (Cham.) A.P. DC.	Molluscicidal activity against *Biomphalaria glabrata* reported for ethanolic extract of whole plant (Silva *et al*., 2007).
Anemopaegma arvense (Vell.) Stelff. Ex Souza	Antioxidant activities reported for flavan-3-ol-phenylpropanoid conjugates, catuabin A, cinchonain Ia, cinchonain Iia, and kandelin A1 isolated from ethyl acetate fraction of stem bark (Tabanca *et al*., 2007).
Arrabidaea chica Verlot	Used in Brazilian traditional medicine as wound healing agent; leaf extract demonstrated wound healing properties as exhibited by stimulation of fibroblast growth and collagen synthesis both *in vitro* and *in vivo* (Jorge *et al*., 2008).
Arrabidaea triplinervia H. Baill.	Ursolic acid, oleanolic acid, pomolic acid, and alpinetine has been reported from ethanol extract of leaves; the first two compounds demonstrated trypanocidal activity against trypomastigotes of *Trypanosoma cruzi*, which causes Chagas disease (Leite *et al*., 2006).
Arrabidaea parviflora Bureau & K.Schum.	Molluscicidal activity against *Biomphalaria glabrata* reported for ethanolic extract of whole plant (Silva *et al*., 2007).
Campsis grandiflora K. Schum.	Extract from the flower has been shown to contain oleanolic acid, ursolic acid, ursolic aldehyde, maslinic acid, corosolic acid, 23-hydroxyursolic acid, and arjunolic acid, of which the last four components reportedly demonstrated high human acyl-CoA:cholesterol acyltransferase inhibitory activities (Kim *et al*., 2005).
Catalpa bignonioides Walt.	Anti-oxidant activity reported for methanolic extracts from inflorescence rachises, corollas, calyxes, leaves, valves of capsules and hypertrophied placenta (Dvorská *et al*., 2007).
Catalpa ovata G. Don.	Isolation from methyl chloride-soluble fractions of stems a naphthoquinone, 4-hydroxy-2-(2-methoxy-3-hydroxy-3-methyl-but-1-enyl)-4-hydro-1H-naphthalen-1-one as well as catalponol, catalponone, catalpalactone, a-lapachone, 9-hydroxy-a-lapachone, 4,9-dihydroxy-a-lapachone, 9-methoxy-a-lapachone, 4-oxo-a-lapachone, and 9-methoxy-4-oxo-a-lapachone of which catapalactone, 9-hydroxy-a-lapachone, and 4,9-dihydroxy-a-lapachone exhibited potent inhibitory effects on lipopolysaccharide-induced NO synthesis in RAW 264.7 cells (Park *et al*., 2010). Chemopreventive effect of seed oil against azoxymethane-induced colonic aberrant crypt foci in male F344 rats (Suzuki *et al*., 2006). Compounds isolated from stem bark, namely 8-methoxydehydroiso-a-lapachone, 9-methoxy-4-oxo-a-lapachone, (4S, 4aR, 10R, 10aR)-4,10-dihydroxy-2,2,-dimethyl-2,3,4,4a,10,10a-hexahydrobenzo[g]chromen-5-one, 3-hydroxydehydroiso-a-lapachone, 4,9-dihydroxy-a-lapachone, 4-hydroxy-a-lapachone, 9-methoxy-a-lapachone, and catalpalactone exhibited significant inhibitory activity against 12-*O*-tetradecanoylphorbol 13-acetate-induced Epstein-Barr virus early antigen activation in Raji cells (Fujiwara *et al*., 1998).
Clytostoma binatum (Thunb.) Sandw.	Molluscicidal activity against *Biomphalaria glabrata* reported for ethanolic extract of whole plant (Silva *et al*., 2007).
Crescentia cujete L.	A number of compounds have been reported from the plant, all compound showing activity toward DNA-repair-deficient yeast mutants; the compounds are (2S,3S)-3-hydroxy-5,6-dimethoxydehydroiso-a-lapachone, (2R)-5,6-dimethoxydehydroiso-a-lapachone, (2R)-5-methoxydehydroiso-a-lapachone, 2-(1-hydroxyethyl)naphtho[2,3-b]furan-4,9-dione, 5-hydroxy-2-(1-hydroxyethyl)naphtho[2,3-b]furan-4,9-dione, 2-isopropenylnaphtho[2,3-b]furan-4,9-dione, and 5-hydroxydehydroiso-a-lapachone (Hetzel *et al*., 1993).
Cuspidaria argentea (Wawra) Sandw.	Molluscicidal activity against *Biomphalaria glabrata* reported for ethanolic extract of whole plant (Silva *et al*., 2007).
Cybistax antisyphilitica (Mart.) Mart.	Larvicidal activity reported for stem wood hexane extract against *Aedes aegypti* larvae, which bio-activity guided fractionation indicated the active component to be lapachol (Rodrigues *et al*., 2005).
Dolichandrone falcata (Wall. ex DC.) Seem.	Dolichandroside-A, a-lapachone, lapachol, aloesaponarin II, 8-hydroxydehydroiso-a-lapachone, b-sitosterol, 3,8-dihydroxydehydroiso-a-lapachone and verbascoside reported from ethyl acetate soluble extract of heartwood; a-glucosidase inhibitory activity observed with verbascoside and aloesaponarin II, a-glucosidase inhibitory and free radical scavenging activity observed with dolichandroside A (Aparna *et al*., 2009).
Incarvillea arguta (Royle) Royle	Five components have been reported from alcohol extract of plant, namely, plantarenaloside, 5-hydroxy-4 ,6,7-trimethoxyflavone, 4 ,5-dihydroxy-6,7-dimethoxyflavone, 4 ,5-dihydroxy-7-methoxyflavone, and 5-dydroxy-4 ,7-dimethoxyflavone, of which plantarenaloside has been shown to have neurotrophic activity for PC-12 cell (Yu *et al*., 2005).
Jacaranda acutifolia Humb. & Bonpl.	In ethnomedicine of South America, bark extract considered as astringent and diuretic (Roth and Lindorf, 2002) and used for treatment of wounds; ground bark used against venereal diseases, rheumatism, and sciatica (Correa and Bernal, 1989; quoted in Gachet and Schühly, 2009). Constituents isolated from bark include 7,2 ,3 ,4 -tetrahydroxyflavone 3-*O*-neohesperidoside (Ferguson and Lien, 1982).

Table 1: Continue

Jacaranda caerulea (L.) Juss.	Leafy branches used in Camaguey for eczema and pimples; leaves used to treat skin cancer and other skin disorders (Morten, 1981; quoted in Gachet and Schühly, 2009)
Jacaranda caroba D.C.	In some regions of Brazil, leaves used for treatment of infections, syphilis, and ulcer (Di Stasi and Hiruma-Lima, 2002; Botion *et al*., 2005). Hydroethanolic extract of the plant is one of the constituents of a Brazilian phytopharmaceutical product, 'Ierobina' used for treatment of dyspepsia, which has been validated in rat models (Botion *et al*., 2005).
Jacaranda caucana Pittier	Leaves and bark reported to be used in traditional medicine for treatment of venereal disease (Gentry, 1992); reported to be used in Colombia for treatment of rheumatism, colds and skin diseases (Weniger *et al*., 2001; quoted in Gachet and Schühly, 2009). Plant constituents reported include ursolic acid, b-sitosterol, 2a-hydroxyursolic acid, jacarandic acid and 2a,3a-dihydroxyurs-12-en-28-oic acid (Ogura *et al*., 1977a); from the stem bark - jacoumaric acid and, betulinic acid (Ogura *et al*., 1977b); from twigs and leaves – jacaranone (Ogura *et al*., 1976). Jacaranone isolated from the plant demonstrated *in vivo* and *in vitro* anti-cancer activity against P-388 lymphocytic leukemia cells (Ogura *et al*., 1976, 1977a). Anti-oxidant phenylethanoid glycosides reported from the plant along with protocatechuic acid, acteoside, jionoside D, isoacteoside, martynoside, and a rhamnosyl derivative of sisymbrifolin (Martin *et al*., 2009). Methanolic extract of leaves reportedly active against both chloroquine-sensitive and chloroquine resistant strains of *Plasmodium falciparum* (Weniger *et al*., 2001).
Jacaranda copaia (Aubl.) D. Don	Used medicinally by the Yanesha, an Amazonian Peruvian ethnic group for ailments related to leishmaniasis and malaria; ethanolic extract of plant reportedly demonstrated good activity against a *Plasmodium falciparum* chloroquine resistant strain (Valadeau *et al*., 2009). In the Amazon region sap of bark and leaves used to treat skin infections; the Andoque Indians in Colombian Amazon use leaves to promote healing (Correa and Bernal, 1989; Evans-Schultes and Raffauf, 1990; quoted in Gachet and Schühly, 2009); Used also for treatment of skin disorders by the Wao and Shuar Indians of the Ecuadorian-Amazon region (De la Torre *et al*., 2007); bark used to treat leishmaniasis in South America (Roth and Lindorf, 2002) and by people of Guiana's tableland (Sauvain *et al*., 1993); used against cancer in Venezuela (Roth and Lindorf, 2002); tubercles used in Brazilian Amazon for treatment of gastrointestinal disorders (Rodrigues, 2006); leaves used to treat rheumatism by the Chácobo Indians in Bolivia; used by the Tiriyó of northern Brazil to heal debility and fever; bark of young trees used to treat syphilis in French Guiana; leaves used to treat skin infections by the Jívaros of Peru; sap of bark used to treat skin infections by the Vaupés River Indians in Colombia (Gachet and Schühly, 2009). Jacaranone and ursolic acid reported from leaves (Sauvain *et al*., 1993). Anti-cancer studies reported on ethanolic extract in different cell lines as well as inhibitory activitiy against four proteases (Villasmil *et al*., 2006; Taylor *et al*., 2006).
Jacaranda cuspidifolia Martius ex. DC.	Leaves used to treat leishmaniasis by the Chinane Indians and Colonos (Fournet *et al*., 1994).
Jacaranda decurrens Cham.	In Brazil, leaves and bark used to treat wounds and skin disorders; bark used to treat itching; leaves and roots used to treat syphilis, rheumatism, skin disorders, and inflammation (Maroni *et al*., 2006; quoted in Gachet and Schühly, 2009). Reported constituent from epicuticular wax include ursolic acid (Varanda *et al*., 1992); from leaves, luteolin, 6-hydroxyluteolin 7-*O*-glucoside, quercetin-3-*O*-glucoside, quercetin-3-*O*-galactoside (Blatt *et al*., 1998).
Jacaranda filicifolia D. Don	Reported constituents of the plant stem include b-sitosterol, ursolic acid, 2a,3a,dihydroxyurs-12-en-28-oic acid, and 2-(4-hydroxyphenyl)ethyl 1-dodecyloctadecanoate (triacontanoic acid) (Ali and Houghton, 1999). Dichloromethane extract of stem bark showed anti-fungal activities against *Coriolus versicolor*, *Gloeophyllum trabeum*, and *Bostryodiplodia theobromae* (Ali *et al*., 1998).
Jacaranda puberula Cham.	Anti-leishmanial activity demonstrated by methanolic extract from leaves against promastigote forms of *Leishmania amazonensis* (Passero *et al*., 2007).
Jacaranda glabra (DC.) Bureau & K. Schumann	Used by the Tacana Indians in Bolivia and the Kichwas of Ecuadorian Amazon to treat leishmaniasis; the Kichwas also use leaves to treat skin disorders (De la Torre *et al*., 2007; quoted in Gachet and Schühly, 2009).
Jacaranda hesperia Dugand	Used to treat leishmaniasis in the Chocó region of Colombia (Vázquez *et al*., 1991; quoted in Gachet and Schühly, 2009).
Jacaranda mimosifolia D. Don	Reported constituents from root bark include lupenone, b-sitosterol, ursolic acid and oleanolic acid (Prakash and Garg, 1980); from leaves – hydroquinone (Gachet and Schühly, 2009); scutellarein (Sankara-Subramanian *et al*., 1972); scutellarein 7-glucuronide (Sankara-Subramanian *et al*., 1973); isoquercitrin, isovitexin, apigenin 7-*O*-b-D-glucopyranoside, luteolin 7-*O*-b-D-glucopyranoside, scutellarein 7-*O*-b-D-glucoronopyranoside methyl ester, apigenin 7-*O*-b-D-glucuronopyranoside methyl

Table 1: Continue

	ester, luteolin 7-*O*-b-D-glucuronopyranoside methyl ester, *E*-acteoside, *Z*-acteoside, isoacteoside, cistanoside, 6 -acetylacteoside, campneoside and jacraninoside A (Moharram and Marzouk, 2007); from seed oil - 8*Z*, 10*E*, 12*Z*-octadocatrienoic acid (Chisholm and Hopkins, 1962). Bark used in Ecuador to treat venereal diseases and as a blood purifier (Acosta-Solís, 1992; quoted in Gachet and Schühly, 2009). Anti-microbial activity reported for hexane, ethanol, and aqueous extracts of leaves against *Bacillus cereus*, *Escherichia coli* and *Staphylococcus aureus* (Rojas *et al*., 2006). Hypotensive property reported for methanol-water extract of leaves (Nicasio and Meckes, 2005). 8*Z*, 10*E*, 12*Z*-octadocatrienoic acid, a major component in seed oil (Chisholm and Hopkins, 1962) reportedly showed high cyclooxygenase inhibitory activity and inhibited prostaglandin biosynthesis (Nugteren and Christ-Hazelhof, 1987).
Jacaranda obtusifolia Humboldt and Bonpland	Used in Venezuela and Guyana to promote wound healing (Roth and Lindorf, 2002); leaves used in Colombia to treat syphilis (Pérez-Arbeláez, 1990; quoted in Gachet and Schühly, 2009).
Jacaranda puberula Cham.	Leaves used by the Xokleng Indians of Terra Indígena Ibarama who resides in southern Brazil to treat frostbites (Sens, 2002; quoted in Gachet and Schühly, 2009).
Kigelia africana (Lam.) Benth.	Used in African traditional medicine for anti-inflammatory, anti-microbial, and anti-skin aging effects; polar extract of fruit contains an iridoid, verminoside and polyphenols like verbascoside of which verminoside has been reported to have anti-inflammatory activity (Picerno *et al*., 2005).
Kigelia pinnata (Jacq.) DC.	From the roots, the following anti-bacterial and anti-fungal compounds have been isolated – kigelinone, isopinnatal, dehydro-a-lapachone, and lapachol (naphthoquinones) and the phenylpropanoids, p-coumaric acid and ferulic acid; from fruits has been reported the following anti-bacterial and anti-fungal compounds – kigelinone and caffeic acid (Binutu *et al*., 1996).
Macfadyena unguis-cati L.	Used in folk medicine of Brazil as an anti-inflammatory, anti-malarial, and anti-venereal; a number of phytochemicals have been reported from extracts of leaves and lianas of the plant, namely, corymboside, vicenin-2, quercitrin, chlorogenic acid, isochlorogenic acid, lupeol, b-sitosterol, b-sitosterylglucoside, allantoin, and lapachol; anti-tumoral and anti-trypanosomal activities have been demonstrated of extracts and components (Duarte *et al*., 2000).
Mansoa hirsuta D.C.	Reported vasodilation of rat aortic rings mediated through NO and endothelium by ethanol extract of leaves (Campana *et al*., 2009).
Markhamia tomentosa (Benth.) K. Schum.	Following compounds has been reported from ethyl acetate extract of stem barks: 2-acetylnaphtho[2,3-b]furan-4,9-dione, 2-acetyl-6-methoxynaphtho[2,3-b]furan-4,9-dione, oleanolic acid, pomolic acid, 3-acetylpomolic acid, tormentic acid, b-sitosterol, and b-sitosterol-3-*O*-b-D-glucopyranoside; the first two compounds exhibited anti-protozoal activities but also showed high toxicity against a mammalian (L-6) cell line (Tantangmo *et al*., 2010).
Melloa quadrivalvis (Jacq.)	Molluscicidal activity against *Biomphalaria glabrata* reported for ethanolic extract of stems (Silva *et al*., 2007). From the stem bark, the following compounds have been reported: 5-hydroxy-6-methoxy-a-lapachone, 5,6-dihydroxy-a-lapachone, 4 ,5-dihydroxy-6-methoxy-a-lapachone, lapachol, and 5,5 -dihydroxy-3 ,4 ,7-trimethoxyflavanone, of which the first compound and the chloroform extract of the plant inhibited cell growth of Hep2 and NCIH-292 (Lima *et al*., 2005).
Millingtonia hortensis L.	Larvicidal activity reported for leaf extract against mosquito species, *Anopheles stephensi*, *Culex quinquefasciatus*, and *Aedes aegypti* (Kaushik and Sauni, 2008). Antimutagenic activity shown by flavonoids, hispidulin and hortensin, isolated from the plant, against 2-aminoanthracene, aflatoxin B1, and dimethylnitrosoamine (Chulasiri *et al*., 1992).
Newbouldia laevis P. Beauv.	The plant is used in traditional medicine of Togo for treatment of sickle cell disease; *in vitro* anti-sickling activity reported for plant extracts (Joppa *et al*., 2008). From roots, a naphthoquinone-anthraquinone coupled pigment – newbouldiaquinone A has been isolated with anti-malarial activity against *Plasmodium falciparum* and strong anti-microbial activities against *Candida gabrata* and *Enterobacter aerogens*; other components isolated from roots included apigenin, chrysoeriol, newbouldiaquinone, lapachol, 2-methylanthraquinone, 2-acetylfuro-1,4-naphthoquinone, 2,3-dimethoxy-1,4-benzoquinone, oleanolic acid, canthic acid, 2-(4-hydroxyphenyl)ethyl triacontanoate, newbouldiamide, 5,7-dihydroxydehydroiso-a-lapachone, b-sitosterol, and b-sitosterol glucopyranoside (Eyong *et al*., 2006). Constituents reported from stem bark include the phenylethanoid glycosides, newbouldioside A-C, sodium salt of analogue B, verbascoside, 5-hydroxydehydro-iso-a-lapachone, 3,8-dihydroxydehydro-iso-a-lapachone, apigenin, and luteolin (Gormann *et al*., 2006); furanonaphthoquinones – 1-(1 -methylethenyl)-5-hydroxynaphthol[2,3-b]furan-4,9-dione, 2-(1 -methylethenyl)-7-hydroxynaphthol[2,3-b]furan-4,9-dione, 2-acetyl-5-hydroxynaphtho[2,3-b]furan-4,9-dione, and 2-(1 -

Table 1: Continue

	methylethenyl)naphtho[2,3-b]furan-4,9-dione along with atraric acid and 2-(1 -methylethenyl)-6-hydroxy-2,3-dihydrobenzofuran (Gormann *et al*., 2003). A number of naphthoquinones have been reported from roots with anti-fungal activity against *Cladosporium cucumerinum* and *Candida albicans* and anti-bacterial activity against *Bacillus subtilis* and *Escherichia coli*; the compounds include 6-hydroxydehydroiso-a-lapachone, 7-hydroxydehydroiso-a-lapachone, 5,7-dihydroxydehydroiso-a-lapachone, and 3-hydroxy-5-methoxydehydroiso-a-lapachone (Gafner *et al*., 1996).
Oroxylum indicum Vent.	Immunostimulant and anti-oxidant activity reported for n-butanol fraction of root bark in rats (Zaveri *et al*., 2006).
Spathodea campanulata P. Beauv	Used in traditional medicine to treat convulsion and epilepsy, anti-convulsant activity of ethanol leaf extract demonstrated against pentylenetetrazole-, picrotoxin-, and electroshock-induced models in mice (Ilodigwe *et al*., 2010). Anti-microbial activity of extracts of stem bark demonstrated against *Bacillus subtilis*, *Escherichia coli*, *Pseudomonas aeruginosa*, *Staphylococcus aureus*, and *Candida albicans* (Ofori-Kwakye *et al*., 2009); reported anti-microbial constituents from stem bark – spathoside (a cerebroside), n-alkanes, linear aliphatic alcohols, sitosterol and their esters, b-sitosterol-3-*O*-b-D-glucopyranoside, oleanolic acid, pomolic acid, p-hydroxybenzoic acid and phenylethanol esters (Mbosso *et al*., 2008). The plant is used to treat wound healing in Ashanti traditional medicine of Ghana; Methanol extract of bark showed anti-microbial activity as well as anti-oxidant activity by protecting MRC-5 cells from hydrogen peroxide induced oxidant injury (Mensah *et al*., 2006).
Stereospermum kunthianum Cham, Sandrine Petit	Used in traditional medicine for treatment of bronchitis, pneumonia, coughs, gastritis, wounds, rheumatic arthritis, ulcers, dysentery, leprosy, and sexually transmitted diseases; Anti-inflammatory activity reported for aqueous extract of stem bark in experimental animal models using the carrageenan-induced paw edema, leucocytes migration and granuloma air pouch test in rats (Ching *et al*., 2009a). Analgesic activity mediated through both central and peripheral mechanisms reported for aqueous extract of stem bark (Ching *et al*., 2009b). Reported protection by aqueous stem bark extract against generalized seizures in pentylenetetrazole and electro-convulsive models in rodents (Ching *et al*., 2009c).
Stereospermum suaveolens (Roxb.) DC	Anti-inflammatory effect observed with ethanol extract of bark against carrageenan-, dextran-, and histamine-induced hind paw edema, and cotton pellet-induced granuloma formation in rats [Balasubramanian *et al*., 2010]. Hepatoprotective activity of methanol stem bark extract reported against carbon tetrachloride-induced liver damage in albino rats (Chandrashekhar *et al*., 2010).
Stereospermum zenkeri K.Schum. ex De Wild.	From the stem bark of the plant anthraquinones – zenkequinones A and B along with sterequinone-F, p-coumaric acid, sitosterol-3-*O*-b-D-glucopyranoside and 3b-hydroxyolean-12-en-28-*O*-b-D-glucopyranoside reported, of which zenkequinone B showed good anti-bacterial activity against *Pseudomonas aeruginosa* (Lenta *et al*., 2007).
Tabebuia aurea (Manso) Benth. & Hook. f. ex S. Moore	Molluscicidal activity against *Biomphalaria glabrata* reported for ethanolic extract of stems (Silva *et al*., 2007).
Tabebuia avellanedae Lorentz ex Griseb.	Used in folk medicine of Central and South America to treat bacterial infection, blood coagulation, cancer, and inflammatory diseases. Anti-bacterial activity against methicillin-resistant Staphylococcal strains reported for b-lapachone, 3-hydroxy-b-N-lapachone and a-lapachone, isolated from the plant (Pereira *et al*., 2006). *In vitro* and *in vivo* anti-inflammatory effects reported for taheebo, a water extract from the inner bark (Byeon *et al*., 2008). Anti-ulcerogenic effect reported for ethanolic extract of bark against ethanol and ibuprofen-induced acute gastric ulceration in rats (Twardowschy *et al*., 2008). Anti-depressant effect observed of ethanolic extract of plant in forced swimming test and tail suspension test in mice (Freitas *et al*., 2010). Presence of napthoquinones reported from inner bark, namely (-)-5-hydroxy-2-(1 -hydroxyethyl)naphtho[2,3-b]furan-4,9-dione (1), and (-)-8-hydroxy-2-(1 -hydroxyethyl)naphtho[2,3-b]furan-4,9-dione (2), with compound 1 reportedly exhibiting potent anti-proliferative effect against several human tumor cell lines, and both compounds displaying modest anti-fungal and anti-bacterial activity (against Gram positive bacteria) (Yamashita *et al*., 2009); reversal of myelosuppression concomitant with increases in spleen CFU-GM and in serum colony-stimulating activity observed in Ehrlich ascites tumor-bearing mice with plant extract and a constituent, b-lapachone (Queiroz *et al*., 2008), growth inhibitory activity of A549 human lung carcinoma cells mediated through induction of apoptosis and inhibition of telomerase activity shown by b-lapachone, a quinone constituent obtained from bark (Woo and Choi, 2005).

Table 1: Continue

Tabebuia impetiginosa Martius ex DC.	Bio-active components from dried inner bark namely, 2-(hydroxymethyl)anthraquinone, anthraquinone-2-carboxylic acid and lapachol {2-hydroxy-3-(3-methyl-2-butenyl)-1,4-naphthoquinone} reportedly active against *Helicobacter pylori* ATCC 43504 (Park *et al*., 2006); anthraquinone-2-carboxylic acid and lapachol has been isolated from the inner bark of the plant with the former compound demonstrating strong growth inhibition of the human intestinal bacteria, *Clostridium paraputrificum* (Park *et al*., 2005).
Tabebuia rosea (Bertol.) DC.	Used by traditional healers for snakebites in the northwest region of Colombia; ethanolic extracts of stem barks found to possess significant neutralizing effect against venom of *Bothrops atrox* (Otero *et al*., 2000).
Tecoma sambucifolia H.B.K.	Alcoholic extracts of pods and flowers reported to possess anti-inflammatory and antinociceptive activities; alcoholic extract of flowers also demonstrated cytotoxicity against human hepatoma cell line (Alguacil *et al*., 2000).
Tecoma stans (L.) Juss. ex Kunth.	Aqueous extract of the plant used as an anti-diabetic in traditional medicine of Mexico; a-glucosidase activity and hypoglycemic action along with hypotriglyceridemic and hypocholesterolemic action noted with aqueous extract in streptozotocin-induced Type 2 diabetic male Sprague-Dawley rats (Aguilar-Santamaría *et al*., 2009). Extract of fruits reportedly yielded the following compounds – 2-(3,4-dihydroxyphenyl)ethyl-2-*O*-[6-deoxy-a-L-mannopyranosyl-4-(3,4-dihydroxy phenyl)-2-propenoate]-b-D-glucopyranoside (phenylethanoid compound), 5-hydroxy-skytanthine hydrochloride (Compound 8, monoterpene alkaloid), 4-*O*-*E*-caffeoyl-a-L-rhamnopyranosyl-(1 →3)-a,b-D-glucopyranose (Compound 1), E/Z-acteoside (Compound 2), isoacteoside (Compound 4), rutin, luteolin 7-*O*-b-D-neohespridoside, luteolin 7-*O*-b-D-glucopyranoside, and sucrose. Extracts of flowers yielded luteolin 7-*O*-b-D-glucuronopyranoside, diosmetin 7-*O*-b-D-glucuronopyranoside, diosmetin 7-*O*-b-D-glucopyranoside, diosmetin 7-*O*-b-D-glucuronopyranoside methyl ester, and acteoside. The extract and compounds 1, 2 and 4 reportedly possessed strong radical scavenging activity; extract, and compounds 2 and 4 exhibited cytotoxic activity against human hepatocarcinoma cells (Hep-G2), while extract and compounds 2 and 8 demonstrated potent growth inhibition of human breast carcinoma cells, MCF-7 (Marzouk *et al*., 2006).
Tecoma undulata Seem.	Hepatoprotective activity reported of ethanol extract of stem barks against thioacetamide-induced hepatotoxicity in albino rats (Khatri *et al*., 2009).
Zeyheria montana Mart.	Anti-inflammatory and antinociceptive effects described for ethanol extract of leaves in mice and rats (Guenka *et al*., 2008).
Zeyheria tuberculosa (Vell.) Bur.	Extract of the plant reportedly cytotoxic in brine shrimp assays; in bio-activity guided assays, four flavones were isolated from the plant – two of them 5,6,7,8-tetramethoxyflavone and 4 -hydroxy-5,6,7,8-tetramethoxyflavone displayed anti-microbial activity against *Staphylococcus aureus* and *Candida albicans*, 5,6,7-trimethoxyflavone was active against *Staphylococcus aureus*, while 4 -hydroxy-5,6,7-trimethoxyflavone did not show any anti-microbial activity (Bastos *et al*., 2009).

Table 2: Folk medicinal uses of Bignoniaceae family plants in Bangladesh.

Botanical name	Family	Local name	Parts used	Disease and dosage
Crescentia cujete L. Synonym(s): *Crescentia acuminata* Kunth, *Crescentia arborea* Raf. English: Bottle gourd, calabash tree, gourd, calabash pipe	Bignoniaceae	Boan-gota	1. Whole plant	1. Abortifacient, cancer, snake bite, itch, alopecia, virility, pneumonia, hurt.
Heterophragma adenophyllum (Wall. ex G. Don) Seem. ex Benth. & Hook. f. Synonym(s): *Bignonia adenophylla* Wall. Ex G. Don, *Haplophragma adenophyllum* (Wall. ex G. Don) Dop English:	Bignoniaceae	Kau-a-turi (Chakma tribe)	1. Root	1. Piles, constipation (Chakma tribe).
Oroxylum indicum (L.) Vent. Synonym(s): *Bignonia indica* L., *Calosanthes indica* Blume English: Indian Trumpet, Tree of	Bignoniaceae	Khonha, Pahari-jora, Kanai-dingi, Hanghoal, Aklong-singh, Thona gach, Naori Chilana gach (Chakma tribe)	1. Leaf, stem, bark 2. Leaf, bark 3. Fruit 4. Leaf, bark, stem 5. Leaf, bark 6. Skin of fruit 7. Leaf, root	1. Tonsillitis, cholera, spleen enlargement, indigestion. 2. Tonsillitis, snake bite, rheumatoid arthritis, edema, gynecological disorders, colic. 3. Jaundice. 4. Rheumatoid arthritis, tonsillitis,

Table 2: Continue

Damocles		Kanaidingi (Garo tribe) Krong-sa-bang (Marma tribe) Thona gach, Tou-kharung (Tripura tribe)	8. Leaf, bark, fruit 9. Bark 10. Bark, fruit 11. Bark, fruit	colic, dysentery, skin disorder. 5. Epilepsy, antiseptic, diarrhea, cold. 6. Jaundice, swelling (Garo tribe). 7. Sudden unconsciousness, skin disorders, sex stimulant (Marma tribe). 8. Fever, cholera, diarrhea, dysentery, astringent, sore throat, throat pain, rheumatic pain. 9. Jaundice. 10. Scabies, eczema, skin disorders, abscess (bark), leukorrhea, dysentery, urinary problems (fruit), toothache, jaundice (bark) (Tripura tribe). 11. Pus with urine, burning sensations in urinary tract, pus with semen, scabies (Chakma tribe).
Stereospermum suaveolens DC. Synonym(s): *Bignonia chelonoides* L. f., *Bignonia suaveolens* Roxb. English: Trumpet	Bignoniaceae	Parul, Niil parul	1. Leaf, bark, flower 2. Bark 3. Leaf	1. Malaria, bronchitis, heart diseases, cancer, purgative. 2. Pain. 3. Gonorrhea.
Tabebuia argentea (Bureau & K. Schum.) Britton. Synonym(s): *Tabebuia aurea* (Silva Manso) Benth. & Hook. f. ex S. Moore, *Tabebuia aurea* (Silva Manso) S. Moore, *Tabebuia caraiba* (Mart.) Bureau , *Tecoma argentea* Bureau & K. Schum., *Tecoma caraiba* Mart. English: Paraguyan trumpet tree, Silver trumpet tree, Tree of gold	Bignoniaceae	Gui-babla	1. Root	1. Worn as a talisman around the neck to protect a person from evil spirits.
Tecoma gaudichaudi DC	Bignoniaceae	Sothin-bahar, Shona pata	1. Whole plant 2. Leaf	1. Infertility, diabetes, digestive aid. 2. Erectile dysfunction.
Tecoma stans (L.) Juss. ex Kunth. Synonym(s): *Bignonia stans* L., *Gelseminum stans* (L.) Kuntze, *Stenolobium stans* (L.) Seem., *Stenolobium stans* (L.) Seem. English: Ginger-Thomas, Trumpet Bush, Trumpetflower	Bignoniaceae	Sona pata	1. Leaf	1. Pain, piles.

Note that all local names are in Bangla (Bengali) language unless a specific tribe is mentioned. Ailments treated are as described by folk medicinal practitioners of the mainstream population (Bengali-speaking) known as Kavirajes unless a tribe is indicated when the information was obtained from tribal medicinal practitioners.

Inhibitory activities of lapachol and a- and b-lapachone derivatives have been reported against epimastigote and trypomastigote forms of *Trypanosoma cruzi* (Salas *et al*., 2008). The oxyrane derivative of a-lapachone has also been shown to be a potent growth inhibitor of *T. cruzi* epimastigote forms (Jorqueira *et al*., 2006). Anti-neoplastic activity has been reported for monoarylhydrazones of a-lapachone (Renou *et al*., 2003).

Verbascoside has been reported to demonstrate anti-inflammatory effects in THP-1 cells (human myelomonocytic leukemia) (Speranza *et al*., 2010). The compound also clearly demonstrated its efficacy in experimental mice model of spinal cord trauma, where it significantly ameliorated the recovery of function as evaluated by motor recovery score (Genovese *et al*., 2010). Anti-sports anemia effects of the compound have also been demonstrated in mice (Zhu *et al*., 2010). Verbascoside has been shown as the major anti-oxidant constituent in experiments with methanolic extract of *Phlomis lychnitis* L. (Lamiaceae) in rat pheochromocytoma cells (PC 12) exposed to hydrogen peroxide (López *et al*., 2010). The compound, isolated from *Lepechinia speciosa* Benth. (Lamiaceae) reportedly showed inhibitory activity against herpes simplex virus, HSV-1 and HSV-2 *in vitro* (Martins *et al*., 2009).

Lupeol has been reported to be one of the constituents isolated from *Zanthoxylum rhoifolium* Lam. (Rutaceae) responsible for antinociceptive effects in models of acute pain in rodents (Pereira *et al*., 2010). The compound has also been regarded to be mainly responsible for anti-inflammatory effects of extracts of *Acacia visco* Lor. Ap Griseb (Fabaceae) in animal models (Pedernera *et al*., 2010). The anti-inflammatory and anti-cancer effects of lupeol have been reviewed (Saleem, 2009).

The anti-oxidative protective effect of quercitrin against hydrogen peroxide-induced dysfunction in osteoblastic MC3T3-E1 cells has been reported (Choi, 2010). Quercitrin also reportedly attenuated Ab(25-35)-induced neurotoxicity in cultured rat hippocampal neurons through possible anti-oxidant and free radical scavenging properties (Rattanajarasroj and Unchern, 2010). Anti-oxidation property has further been suggested for quercitrin, present in leaf extract of *Rosa agrestis* Savi (Rosaceae) (Bitis *et al*., 2010). Quercitrin has been shown to inhibit methylmercury-induced radical oxygen species production in rat brain slices (Wagner *et al*., 2010). Quercitrin has also been found in extract of *Agrimonia pilosa* Ledeb (Rosaceae), which demonstrated anti-oxidant properties and has been suggested as a possible dietary nutritional supplement to prevent oxidation-related diseases (Zhu *et al*., 2009).

The anti-genotoxic and anti-clastogenic properties of apigenin has been demonstrated in 7,12-dimethyl[a]anthracene-induced genotoxicity in bone marrow cells of golden Syrian hamsters (Silvan *et al*., 2010). Anti-oxidant and hypolipidemic effect of *Cardiospermum halicacabum* L. (Sapindaceae) leaf extract in streptozotocin-induced diabetic rats has been attributed to apigenin and luteolin (Veeramani *et al*., 2010). Apigenin has further been shown to inhibit human hepatoma Huh7 cell proliferation (Cai *et al*., 2010). The compound, isolated from leaves of *Adinandra nitida* Merr. ex H. L. Li (Theaceae) also reportedly demonstrated angiotensin converting enzyme inhibitory properties, suggesting that the compound may play a potential role in development of new anti-hypertensive drugs (Liu *et al*., 2010).

Pomolic acid, isolated from *Euscaphis japonica* (Tunb.) Kantiz (Staphyleaceae) showed anti-fibrotic activity by inhibiting proliferation of HSC-T6, a rat hepatic stellate cell line (Lee *et al*., 2009). The compound isolated from *Weigela subsessilis* (Nakai) L. H. Bailey (Caprifoliaceae), stimulated glucose uptake in both basal and insulin-stimulated L6 muscle cells thus demonstrating its anti-diabetic potential (Lee and Thuong, 2010). Nematicidal activity against root-knot nematode *Meloidogyne incognita* has also been reported for the compound isolated from aerial parts of *Lantana camara* L. (Verbenaceae) (Begum *et al*., 2008). Anti-inflammatory activity against carrageenan-induced paw edema in mice and apoptotic activity in human polymorphonuclear cells has been demonstrated for pomolic acid isolated from leaves of *Cecropia pachystachya* Trécul (Cecropiaceae) (Schinella *et al*., 2008). The compound further inhibited the growth of K562 cell line-originated from chronic myeloid leukemia in blast crisis- and its vincristine-resistant derivative K562-Lucenal (Vasconcelos *et al*., 2007).

Isoacteoside, isolated from *Cistanche tubulosa* Schenk Hook.f. (Orobanchaceae) reportedly demonstrated hepatoprotective activity through inhibition of D-galactosamine-induced death of hepatocytes (Morikawa *et al*., 2010). The compound, isolated from seeds of *Plantago asiatica* L. (Plantaginaceae) demonstrated anti-hypertensive potential by inhibition of angiotensin-converting enzyme (Geng *et al*., 2010). Anti-oxidative activity has been reported for the compound isolated from *Cistanche salsa* (C.A. Mey) G. Beck (Orobanchaceae) (Yang *et al*., 2009), which activity is similar to when the compound was isolated from the Bignoniaceae family plant, *Jacaranda caucana* Pittier (Martin *et al*., 2009). Isoacteoside, isolated from leaves of *Acanthus ilicifolius* L. (Acanthaceae) reportedly increased the growth and differentiation of osteoblastic MC3T3-E1 cells, indicating that it may help prevent osteoporosis (Van Kiem *et al*., 2008).

Taken together, the bio-active constituents from Bignoniaceae family plants as reported above present considerable potential for development of novel therapeutics against a wide array of human ailments. Thus they form important chemical compounds on which more scientific studies and clinical trials need to be conducted.

The use of Bignoniaceae family plants by folk and tribal medicinal practitioners in Bangladesh are shown in Table 2. Overall, seven plants are used belonging to six genera. *Oroxylum indicum* was the plant most used by both Kavirajes as well as various tribal medicinal practitioners, being used by four tribes within the country. The only other plant used by tribal medicinal practitioners was *Heterophragma adenophyllum*, which was used by the Chakma tribe and not the mainstream folk medicinal practitioners (Kavirajes). It was observed that the practitioners (both Kavirajes and tribal practitioners) used whole plant as well as plant parts like leaf, stem, bark, root, fruit, and flower for treatment.

Although only seven Bignoniaceae family plants were used by the Kavirajes and tribal practitioners, the number of ailments treated was diverse. The various ailments treated included cancer, snake bite, skin disorders, alopecia, impotency, respiratory tract illnesses, gastrointestinal disorders, cholera, spleen enlargement, rheumatoid arthritis, edema, gynecological disorders, epilepsy, cold, fever, hepatic disorders, leucorrhea, pain, urinary tract infections, malaria, sexually transmitted diseases, diabetes, and erectile dysfunction.

Some of the folk medicinal uses of Bignoniaceae family plants can be validated by existing reports in the scientific literature. For instance, immunostimulant and anti-oxidative properties has been described for *Oroxylum indicum* (see Table 1 for details), which properties can be useful in the plant's folk medicinal use in bangladesh for treatment of rheumatoid arthritis, tonsillitis, cold, and fever. The anti-inflammatory properties of *Stereospermum suaveolens* validate its use for pain, which is often accompanied by inflammation. Other Bignoniaceae plants used by the folk medicinal healers of Bangladesh need to be scientifically studied towards validation and discovery of new therapeutics. Overall, the Bignoniaceae family plants form an important source of plants for folk medicinal use as demonstrated by their use for treatment of a variety of ailments (Table 2). The Bignoniaceae family can therefore be considered an important family in folk medicinal practices of Bangladesh even though the number of plants in use is small. The plants can become important sources of novel drugs and lead compounds.

References

Acosta-Solís, M., 1992. Vademecum de Plantas Medicinales del Ecuador. Fundacíon Ecuatoriana de Estudios Sociales FESO. Abya-Yala, Quito, p 112.

Aguilar-Santamaría, L., G. Ramírez, P. Nicasio, C. Alegría-Reyes and A. Herrera-Arellano, 2009. Antidiabetic activities of *Tecoma stans* (L.) Juss. ex Kunth. Journal of Ethnopharmacology, 124: 284-288.

Alguacil, L.F., A. Galán de Mera, J. Gómez, F. Llinares, L. Morales, M.D. Muñoz-Mingarro, J.M. Pozuelo and J.A. Vicente Orellana, 2000. *Tecoma sambucifolia*: anti-inflammatory and antinociceptive activities, and '*in vitro*' toxicity of extracts of the 'huarumo' of Peruvian Incas. Journal of Ethnopharmacology, 70: 227-233.

Ali, R.M., P.J. Houghton and T.S. Hoo, 1998. Antifungal activity of some Bignoniaceae family found in Malaysia. Phytotherapy Research, 12: 331-334.

Ali, R.M., and P.J. Houghton, 1999. A new phenolic fatty acid ester with lipoxygenase inhibitory activity from *Jacaranda filicifolia*. Planta Medica, 65: 455-457.

Aparna, P., A.K. Tiwari, P.V. Srinivas, A.Z. Ali, V. Anuradha and J.M. Rao, 2009. Dolichandroside A, a new a-glucosidase inhibitor and DPPH free-radical scavenger from *Dolichandrone falcata* Seem. Phytotherapy Research, 23: 591-596.

Balasubramanian, T., T.K. Chaterjee, M. Sarkar and S.L. Meena, 2010. Anti-inflammatory effect of *Stereospermum suaveolens* ethanol extract in rats. Pharmaceutical Biology, 48: 318-323.

Balick J.M., and P.A. Cox, 1996. Plants, People and Culture: the Science of Ethnobotany, Scientific American Library, New York, 228 pp.

Bastos, M.L., M.R. Lima, L.M. Conserva, V.S. Andrade, E.M. Rocha and R.P. Lemos, 2009. Studies on the antimicrobial activity and brine shrimp toxicity of *Zeyheria tuberculosa* (Vell.) Bur. (Bignoniaceae) extracts and their main constituents. Annals of Clinical Microbiology and Antimicrobials, 8: 16.

Begum, S., S.Q. Zehra, B.S. Siddiqui, S. Fayyaz and M. Ramzan, 2008. Pentacyclic triterpenoids from the aerial parts of *Lantana camara* and their nematicidal activity. Chemistry & Biodiversity, 5: 1856-1866.

Binutu, O.A., K.E. Adesogan and J.I. Okogun, 1996. Antibacterial and antifungal compounds from *Kigelia pinnata*. Planta Medica, 62: 352-353.

Bitis, L., S. Kultur, G. Melikoglu, N. Ozsoy and A. Can, 2010. Flavonoids and antioxidant activity of *Rosa agrestis* leaves. Natural Product Research, 24: 580-589.

Blatt, C.T.T., M.D. Dos-Santos and A. Salatino, 1998. Flavonoids of Bignoniaceae from the "cerrado" and their possible taxonomic significance. Plant Systematics and Evolution, 210: 289-292.

Botion, L.M., A.V. Ferreira, S.F. Côrtes, V.S. Lemos and F.C. Braga, 2005. Effects of the Brazilian phytopharmaceutical product Ierobina on lipid metabolism and intestinal tonus. Journal of Ethnopharmacology, 102: 137-142.

Byeon, S.E., J.Y. Chung, Y.G. Lee, B.H. Kim, K.H. Kim and J.Y. Cho, 2008. *In vitro* and *in vivo* anti-inflammatory effects of taheebo, a water extract from the inner bark of *Tabebuia avellanedae*. Journal of Ethnopharmacology, 119: 145-152.

Cai, J., X.L. Zhao, A.W. Liu, H. Nian and S.H. Zhang, 2010. Apigenin inhibits hepatoma cell growth through alteration of gene expression patterns. Phytomedicine, (in press).

Campana, P.R., F.C. Braga and S.F. Cortes, 2009. Endothelium-dependent vasorelaxation in rat thoracic aorta by *Mansoa hirsuta* D.C. Phytomedicine, 16: 456-461.

Chandrashekhar, V.M., A.A. Muchandi, S.V. Sudi and S. Ganapty, 2010. Hepatoprotective activity of *Stereospermum suaveolens* against CCl_4-induced liver damage in albino rats. Pharmaceutical Biology, 48: 524-528.

Ching, F.P., E.K. Omogbai, S.O. Okpo and R.I. Ozolua, 2009a. Antiinflammatory activity of aqueous extract of *Stereospermum kunthianum* (Cham, Sandrine Petit) stem bark in rats. Indian Journal of Pharmaceutical Sciences, 71: 106-110.

Ching, F.P., E.K. Omogbai, R.I. Ozolua and S.O. Okpo, 2009b. Analgesic activity of aqueous extract of *Stereospermum kunthianum* (Cham, Sandrine Petit) stem bark. Acta Poloniae Pharmaceutica, 66: 83-88.

Ching, F.P., E.K. Omogbai and I.O. Otokiti, 2009c. Aqueous stem bark extract of *Stereospermum kunthianum* (Cham, Sandrine Petit) protects against generalized seizures in pentylenetetrazole and electro-convulsive models in rodents. African Journal of Traditional, Complementary and Alternative Medicines, 6: 544-548.

Chisholm, M.J. and C.Y. Hopkins, 1962. Isolation and structure of a new conjugated triene fatty acid. Journal of Organic Chemistry, 27: 3137-3139.

Choi, E.M., 2010. Protective effect of quercitrin against hydrogen peroxide-induced dysfunction in osteoblastic MC3T3-E1 cells. Experimental and Toxicologic Pathology, (in press).

Chulasiri, M., N. Bunyapraphatsara and P. Moongkarndi, 1992. Mutagenicity and antimutagenicity of hispidulin and hortensin, the flavonoids from *Millingtonia hortensis* L. Environmental and Molecular Mutagenesis, 20: 307-312.

Correa, J.E. and H.Y. Bernal, 1989. Especies vegetales promisorias de los países del Convenio Andrés Bello, Secretaría Ejecutiva del Convenio Andrés Bello (SECAB), vol. 2. Editora Guadalupe Ltda., Bogotá, pp 195-196, 202, 204-207, 211-214.

da Silva Filho A.A., D.O. Resende, M.J. Fukui, F.F. Santos, P.M. Pauletti, W.R. Cunha, M.L. Silva, L.E. Gregório, J.K. Bastos and N.P. Nanayakkara, 2009. *In vitro* antileishmanial, antiplasmodial and cytotoxic activities of phenolics and triterpenoids from *Baccharis dracunculifolia* D.C. (Asteraceae). Fitoterapia, 80: 478-482.

De la Torre, L., H. Navarrete, P.M. Muriel, M.J. Macía and H. Balslev (Eds.), 2007. Plantas Útiles del Ecuador, Pontificia Universidad Católica del Ecuador, Universidad de Aarhus, Quito, pp 243-244.

Di Stasi, L.C. and C.A. Hiruma-Lima, 2002. Plantas medicinais na Amazônia e na Mata Atlântica. UNESP: Botucatu, 2 ed., São Paulo, pp. 451-452.

Duarte, D.S., M.F. Dolabela, C.E. Salas, D.S. Raslan, A.B. Oliveiras, A. Nenninger, B. Wiedemann, H. Wagner, J. Lombardi and M.T. Lopes, 2000. Chemical characterization and biological activity of *Macfadyena unguis-cati* (Bignoniaceae). The Journal of Pharmacy and Pharmacology, 52: 347-352.

Dvorská, M., M. Zemlicka, J. Muselík, J. Karafiátová and V. Suchý, 2007. Antioxidant activity of *Catalpa bignonioides*. Fitoterapia, 78: 437-439.

Evans-Schultes, R. and R.F. Raffauf, 1990. The Healing Forest. In: Dudley, T.R. (Ed.), Medicinal and Toxic Plants of the Northwest Amazonia, vol. 2, Dioscorides Press, Oregon, p 104.

Eyong, K.O., G.N. Folefoc, V. Kuete, V.P. Beng, K. Krohn, H. Hussain, A.E. Nkengfack, M. Saeftel, S.R. Sarite and A. Hoerauf, 2006. Newbouldiaquinone A: A naphthoquinone-anthraquinone ether coupled pigment, as a potential antimicrobial and antimalarial agent from *Newbouldia laevis*. Phytochemistry, 67: 605-609.

Ferguson, N.M., and E.J. Lien, 1982. A flavonol neohesperidoside from *Jacaranda acutifolia*. Journal of Natural Products, 45, 523-524.

Fournet, A., A.A. Barrios and V. Muñoz, 1994. Leishmanicidal and trypanocidal activities of Bolivian medicinal plants. Journal of Ethnopharmacology, 41: 19-37.

Freitas, A.E., J. Budni, K.R. Lobato, R.W. Binfaré, D.G. Machado, J. Jacinto, P.O. Veronezi, M.G. Pizzolatti and A.L. Rodrigues, 2010. Antidepressant-like action of the ethanolic extract from *Tabebuia avellanedae* in mice: evidence for the involvement of the monoaminergic system. Progress in Neuro-psychopharmacology & Biological Psychiatry, 34: 335-343.

Fujiwara, A., T. Mori, A. Iida, S. Ueda, Y. Hano, T. Nomura, H. Tokuda and H. Nishino, 1998. Antitumor-promoting naphthoquinones from *Catalpa ovata*. Journal of Natural Products, 61: 629-632.

Gachet, M.S. and W. Schühly, 2009. Jacaranda – An ethnopharmacological and phytochemical review. Journal of Ethnopharmacology, 121: 14-27.

Gafner, S., J.L. Wolfender, M. Nianga, H. Stoeckli-Evans and K. Hostettmann, 1996. Antifungal and antibacterial naphthoquinones from *Newbouldia laevis* roots. Phytochemistry, 42: 1315-1320.

Gayathri, R., D.K. Priya, G.R. Gunassekaran and D. Sakthisekaran, 2009. Ursolic acid attenuates oxidative stress-mediated hepatocellular carcinoma induction by diethylnitrosamine in male Wistar rats. Asian Pacific Journal of Cancer Prevention, 10: 933-938.

Geng, F., L. Yang, G. Chou and Z. Wang, 2010. Bioguided isolation of angiotensin-converting enzyme inhibitors from the seeds of *Plantago asiatica* L. Phytotherapy Research, 24: 1088-1094.

Genovese, T., I. Paterniti, E. Mazzon, E. Esposito, R. Di Paola, M. Galuppo, P. Bramanti and S. Cuzzocrea, 2010. Efficacy of treatment with verbascoside, biotechnologically produced by *Syringa vulgaris* plant cell cultures in an experimental mice model of spinal cord trauma. Naunyn-Schmiedeberg's Archives of Pharmacology, 382: 331-345.

Gentry, A.H., 1992. Flora Neotropica: Monograph 25, Tribe Tecomeae, vol. 2. The New York Botanical Garden, New York, pp 52-105.

Gilani, A.H., and A.U. Rahman, 2005. Trends in ethnopharmacology. Journal of Ethnopharmacology, 100: 43-49.

Gormann, R., M. Kaloga, X.C. Li, D. Ferreira, D. Bergenthal and H. Kolodziej, 2003. Furanonaphthoquinones, atraric acid and a benzofuran from the stem barks of *Newbouldia laevis*. Phytochemistry, 64: 583-587.

Gormann, R., M. Kaloga, D. Ferreira, J.P. Marais and H. Kolodziej, 2006. Newbouldiosides A-C, phenylethanoid glycosides from the stem bark of *Newbouldia laevis*. Phytochemistry, 67: 805-811.

Guenka, L.C., R.C. Gomes, V.L. Melo, C.R. Kitanishi, P.S. Pereira, S.C. França, L.B. Couto and R.O. Beleboni, 2008. Anti-inflammatory and anti-nociceptive effects of *Zeyharia montana* (Bignoniaceae) ethanol extract. Memórias do Instituto Oswaldo Cruz, 103: 768-772.

Hanif, A., Md. Shahadat Hossan, Md. Manzurul Kadir Mia, Mohammad Jahirul Islam, Rownak Jahan and Mohammed Rahmatullah, 2009. Ethnobotanical survey of the Rakhain tribe inhabiting the Chittagong Hill Tracts region of Bangladesh. American Eurasian Journal of Sustainable Agriculture, 3(2): 172-180.

Hetzel, C.E., A.A. Gunatilaka, T.E. Glass, D.G. Kingston, G. Hoffmann and R.K. Johnson, 1993. Bioactive furanonaphthoquinones from *Crescentia cujete*. Journal of Natural Products, 56: 1500-1505.

Hossan, Md. Shahadat, Abu Hanif, Mujib Khan, Sazzadul Bari, Rownak Jahan and Mohammed Rahmatullah, 2009. Ethnobotanical survey of the Tripura tribe of Bangladesh. American Eurasian Journal of Sustainable Agriculture, 3(2): 253-261.

Hossan, M.S., A. Hanif, B. Agarwala, M.S. Sarwar, M. Karim, M.T. Rahman, R. Jahan and M. Rahmatullah, 2010. Traditional use of medicinal plants in Bangladesh to treat urinary tract infections and sexually transmitted diseases. Ethnobotany Research and Applications, 8: 61-74.

Ilodigwe, E.E., P.A. Akah and C.S. Nworu, 2010. Anticonvulsant activity of ethanol leaf extract of *Spathodea campanulata* P. Beauv (Bignoniaceae). Journal of Medicinal Food, 13: 827-833.

Jang, S.M., S.T. Yee, J. Choi, M.S. Choi, G.M. Do, S.M. Jeon, J. Yeo, M.J. Kim, K.I. Seo and M.K. Lee, 2009. Ursolic acid enhances the cellular immune system and pancreatic b-cell function in streptozotocin-induced diabetic mice fed a high-fat diet. International Immunopharmacology, 9: 113-119.

Joppa, K.M., A. Vovor, K. Eklu-Gadegbeku, A. Agbonon, K. Aklikokou and M. Gbeassor, 2008. Effect of *Morinda lucida* Benth. (Rubiaceae) and *Newbouldia leavis* P. Beauv. (Bignoniaceae) on sickling of red blood cells. Médecine Tropicale : Revue du Corps de Santé Colonial, 68: 251-256.

Jorge, M.P., C. Madjarof, A.L. Gois Ruiz, A.T. Fernandes, R.A. Ferreira Rodrigues, I.M. de Oliveira Sousa, M.A. Foglio and J.E. de Carvalho, 2008. Evaluation of wound healing properties of *Arrabidaea chica* Verlot extract. Journal of Ethnopharmacology, 118: 361-366.

Jorqueira, A., R.M. Gouvêa, V.F. Ferreira, M.N. da Silva, M.C. de Souza, A.A. Zuma, D.F. Cavalcanti, H.P. Araújo, D.O. Santos and S.C. Bourguignon, 2006. Oxyrane derivative of a-lapachone is potent growth inhibitor of *Trypanosoma cruzi* epimastigote forms. Parasitology Research, 99: 429-433.

Kang, S.Y., S.Y. Yoon, D.H. Roh, M.J. Jeon, H.S. Seo, D.K. Uh, Y.B. Kwon, H.W. Kim, H.J. Han, H.J. Lee and J.H. Lee, 2008. The anti-arthritic effect of ursolic acid on zymosan-induced acute inflammation and adjuvant-induced chronic arthritis models. The Journal of Pharmacy and Pharmacology, 60: 1347-1354.

Kaushik, R., and P. Saini, 2008. Larvicidal activity of leaf extract of *Millingtonia hortensis* (Family: Bignoniaceae) against *Anopheles stephensi*, *Culex quinquefasciatus* and *Aedes aegypti*. Journal of Vector Borne Diseases, 45: 66-69.

Khatri, A., A. garg and S.S. Agrawal, 2009. Evaluation of hepatoprotective activity of aerial parts of *Tephrosia purpurea* L. and stem bark of *Tecomella undulata*. Journal of Ethnopharmacology, 122: 1-5.

Kim, D.H., K.M. Han, I.S. Chung, D.K. Kim, S.H. Kim, B.M. Kwon, T.S. Jeong, M.H. Park, E.M. Ahn and N.I. baek, 2005. Triterpenoids from the flower of *Campsis grandiflora* K. Schum. As human acyl-CoA:cholesterol acyltransferase inhibitors. Archives of Pharmacal Research, 28: 550-556.

Lee, J., S.T. Yee, J.J. Kim, M.S. Choi, E.Y. Kwon, K.I. Seo and M.K. Lee, 2010. Ursolic acid ameliorates thymic atrophy and hyperglycemia in streptozotocin-nicotinamide-induced diabetic mice. Chemico-biological Interactions, (in press).

Lee, M.K., K.Y. lee, H.Y. Jeon, S.H. Sung and Y.C. Kim, 2009. Antifibrotic activity of triterpenoids from the aerial parts of *Euscaphis japonica* on hepatic stellate cells. Journal of Enzyme Inhibition and Medicinal Chemistry, 24: 1276-1279.

Lee, M.S., and P.T. Thuong, 2010. Stimulation of glucose uptake by triterpenoids from *Weigela subsessilis*. Phytotherapy Research, 24: 49-53.

Leite, J.P., A.B. Oliveira, J.A. Lombardi, J.D. Filho and E. Chiari, 2006. Trypanocidal activity of triterpenes from *Arrabideae triplinervia* and derivatives. Biological & Pharmaceutical Bulletin, 29: 2307-2309.

Lenta, B.N., B. Weniger, C. Antheaume, D.T. Noungoue, S. Ngouela, J.C. Assob, C. Vonthron-Sénécheau, P.A. Fokou, K.P. Devkota, E. Tsamo and N. Sewald, 2007. Anthraquinones from the stem bark of *Stereospermum zenkeri* with antimicrobial activity. Phytochemistry, 68: 1595-1599.

Li, Y., Z. Kang, S. Li, T. Kong, X. Liu and C. Sun, 2010. Ursolic acid stimulates lipolysis in primary-cultured rat adipocytes. Molecular Nutrition & Food Research, (in press).

Lima, C.S., E.L. De Amorim, S.C. Nascimento, C.F. Araújo, M.F. Agra, J.M. Barbosa-Filho, M.S. Silva, E.V. Da-Cunha, I.J. Vieira and R. Braz-Filho, 2005. Cytotoxic pyranonaphthoquinones from *Melloa quadrivalvis* (Bignoniaceae). Natural Product Research, 19: 217-222.

Liu, B., J. Yang, Y. Ma, E. Yuan and C. Chen, 2010. Antioxidant and angiotensin converting enzyme (ACE) inhibitory activities of ethanol extract and pure flavonoids from *Adinandra nitida* leaves. Pharmaceutical Biology, (in press).

López, V., A.K. Jäger, S. Akerreta, R.Y. Cavero and M.I. Calvo, 2010. Antioxidant activity and phenylpropanoids of *Phlomis lychnitis* L.: a traditional herbal tea. Plant Foods for Human Nutrition, 65: 179-185.

Mapanga, R.F., M.A. Tufts, F.O. Shode and C.T. Musabayane, 2009. Renal effects of plant-derived oleanolic acid in streptozotocin-induced diabetic rats. Renal Failure, 31: 481-491.

Maroni, B., L.C. Di Stasi and S. Machado, 2006. Plantas medicinais do cerrado de Botucatu. FAPESP, BIOTA, UNESP, São Paulo.

Martin, F., A.E. Hay, V.R. Condoretty Quinteros, D. Cressend, M. Reist, M.P. Gupta, P.A. Carrupt and K. Hostettmann, 2009. Antioxidant phenylethyl glycosides and a neolignan from *Jacaranda caucana*. Journal of Natural Products, 72: 852-856.

Martin, G.J., 1995. Ethnobotany: a 'People and Plants' Conservation Manual, Chapman and Hall, London, 268 pp.

Martins, F.O., P.F. Esteves, G.S. Mendes, N.S. Barbi, F.S. Menezes and M.T. Romanos, 2009. Verbascoside isolated from *Lepechinia speciosa* has inhibitory activity against HSV-1 and HSV-2 *in vitro*. Natural Product Communications, 4: 1693-1696.

Marzouk, M., A. Gamal-Eldeen, M. Mohamed and M. El-Sayed, 2006. Anti-proliferative and antioxidant constituents from *Tecoma stans*. Zeitschrift für Naturforschung. C, Journal of Biosciences, 61: 783-791.

Maundu, P., 1995. Methodology for collecting and sharing indigenous knowledge: a case study. Indigenous Knowledge and Development Monitor, 3: 3-5.

Mbosso, E.J., S. Ngouela, J.C. Nguedia, V. Penlap, M. Rohmer and E. Tsamo, 2008. Spathoside, a cerebroside and other antibacterial constituents of the stem bark of *Spathodea campanulata*. Natural Product Research, 22: 296-304.

Mensah, A.Y., P.J. Houghton, R.A. Dickson, T.C. Fleischer, M. Heinrich and P. Bremner, 2006. *In vitro* evaluation of effects of two Ghanaian plants relevant to wound healing. Phytotherapy Research, 20: 941-944.

Moharram, F.A., and M.S.A. Marzouk, 2007. A novel phenylethanoid dimer and flavonoids from *Jacaranda mimosaefolia*. Zeitschrift für Naturforschung B, 62: 1213-1220.

Mollik, M.A.H., M.S. Hossan, A.K. Paul, M.T. Rahman, R. Jahan and M. Rahmatullah, 2010. A comparative analysis of medicinal plants used by folk medicinal healers in three districts of Bangladesh and inquiry as to mode of selection of medicinal plants. Ethnobotany Research and Applications, 8: 195-218.

Moon H.I., J.C. Jung, and J. Lee., 2007. Antiplasmodial activity of triterpenoid isolated from whole plants of *Viola* genus from South Korea. Parasitology Research, 100: 641-644.

Morikawa, T., Y. Pan, K. Ninomiya, K. Imura, H. Matsuda, M. Yoshikawa, D. Yuan and O. Muraoka, 2010. Acylated phenylethanoid oligoglycosides with hepatoprotective activity from the desert plant *Cistanche tubulosa*. Bioorganic & Medicinal Chemistry, 18: 1882-1890.

Mukherjee, P.K. and A. Wahile, 2006. Integrated approaches towards drug development from Ayurveda and other Indian system of medicines. Journal of Ethnopharmacology, 103: 25-35.

Musabayane, C.T., M.A. Tufts and R.F. Mapanga, 2010. Synergistic antihyperglycemic effects between plant-derived oleanolic acid and insulin in streptozotocin-induced diabetic rats. Renal Failure, 32: 832-839.

Nawaz, A.H.M.M., M. Hossain, M. Karim, M. Khan, R. Jahan and M. Rahmatullah, 2009. An ethnobotanical survey of Rajshahi district in Rajshahi division, Bangladesh. American Eurasian Journal of Sustainable Agriculture, 3(2): 143-150.

Nicasio, P., and M. Meckes, 2005. Hypotensive effect of the hydroalcoholic extract from *Jacaranda mimosaefolia* leaves in rats. Journal of Ethnopharmacology, 97: 301-304.

Nugteren, D.H., and E. Christ-Hazelhof, 1987. Naturally occurring conjugated octadecatrienoic acids are strong inhibitors of prostaglandin biosynthesis. Prostaglandins, 33: 403-417.

Ofori-Kwakye, K., A.A. Kwapong and F. Adu, 2009. Antimicrobial activity of extracts and topical products of the stem bark of *Spathodea campanulata* for wound healing. African Journal of Traditional, Complementary and Alternative Medicines, 6: 168-174.

Ogura, M., G.A. Cordell and N.R. Farnsworth, 1976. Potential anticancer agents. III. Jacaranone, a novel phytoquinoid from *Jacaranda caucana*. Lloydia, 39: 255-257.

Ogura, M., G.A. Cordell and N.R. Farnsworth, 1977a. Potential anticancer agents. IV. Constituents of *Jacaranda caucana* Pittier (Bignoniaceae). Lloydia, 40: 157-168.

Ogura, M., G.A. Cordell and N.R. Farnsworth, 1977b. Jacoumaric acid, a new triterpene ester from *Jacaranda caucana*. Phytochemistry, 16: 286-287.

Otero, R., V. Núñez, S.L. Jiménez, R. Fonnegra, R.G. Osorio, M.E. García and A. Díaz, 2000. Snakebites and ethnobotany in the northwest region of Colombia: Part II: neutralization of lethal and enzymatic effects of *Bothrops atrox* venom. Journal of Ethnopharmacology, 71: 505-511.

Park, B.M., S.S. Hong, C. Lee, M.S. Lee, S.J. Kang, Y.S. Shin, J.K. Jung, J.T. Hong, Y. Kim, M.K. Lee and B.Y. Hwang, 2010. Naphthoquinones from *Catalpa ovata* and their inhibitory effects on the production of nitric oxide. Archives of Pharmacal Research, 33: 381-385.

Park, B.S., H.K. Lee, S.E. Lee, X.L. Piao, G.R. Takeoka, R.Y. Wong, Y.J. Ahn and J.H. Kim, 2006. Antibacterial activity of *Tabebuia impetiginosa* Martius ex DC (Taheebo) against *Helicobacter pylori*. Journal of Ethnopharmacology, 105: 255-262.

Park, B.S., J.R. Kim, S.E. Lee, K.S. Kim, G.R. Takeoka, Y.J. Ahn and J.H. Kim, 2005. Selective growth-inhibiting effects of compounds identified in *Tabebuia impetiginosa* inner bark on human intestinal bacteria. Journal of Agricultural and Food Chemistry, 53: 1152-1157.

Passero, L.F., A.A. Castro, T.Y. Tomokane, M.J. Kato, T.F. Paulinetti, C.E. Corbett and M.D. Laurenti, 2007. Anti-leishmania activity of semi-purified fraction of *Jacaranda puberula* leaves. Parasitology Research, 101: 677-680.

Passero, L.F., A. Bonfim-Melo, C.E. Corbett, M.D. Laurenti, M.H. Toyama, D.O. de Toyama, P. Romoff, O.A. Fávero, S.S. Dos Grecco, C.A. Zalewsky and J.H. Lago, 2010. Anti-leishmanial effects of purified compounds from aerial parts of *Baccharis uncinella* C. DC. (Asteraceae). Parasitology Research, (in press).

Pedernera, A.M., T. Guardia, C.E. Calderón, A.E. Rotelli, N.E. de la Rocha, J.R. saad, M.A. Verrilli, S.G. Aseff and L.E. Pelzer, 2010. Anti-inflammatory effect of *Acacia visco* extracts in animal models. Inflammopharmacology, 18: 263-260.

Pereira, E.M., B. Tde Machado, I.C. Leal, D.M. Jesus, C.R. Damaso, A.V. Pinto, M. Giambiagi-deMarval, R.M. Kuster and K.R. Santos, 2006. *Tabebuia avellanedae* naphthoquinones: activity against methicillin-resistant staphylococcal strains, cytotoxic activity and in vivo dermal irritability analysis. Annals of Clinical Microbiology and Antimicrobials, 5: 5.

Pereira, S.S., L.S. Lopes, R.B. Marques, K.A. Figueiredo, D.A. Costa, M.H. Chaves and F.R. Almeida, 2010. Antinociceptive effect of *Zanthoxylum rhoifolium* Lam. (Rutaceae) in models of acute pain in rodents. Journal of Ethnopharmacology, 129: 227-231.

Pérez-Arbeláez, E., 1990. Plantas útiles de Colombia. 14th ed. Editorial Victor Hugo A.A. Medellín, pp 222-223.

Picerno, P., G. Autore, S. Marzocco, M. Meloni, R. Sanogo and R.P. Aquino, 2005. Anti-inflammatory activity of verminoside from *Kigelia africana* and evaluation of cutaneous irritation in cell cultures and reconstituted human epidermis. Journal of Natural Products, 68: 1610-1614.

Prakash, L., and G. garg, 1980. Chemical examination of the root barks of *Jacaranda mimosaefolia* D. Don and *Tabebuia pentaphylla* (Linn) Hemsl. Pharmazie, 35: 649.

Queiroz, M.L., M.C. Valadares, C.O. Torello, A.L. Ramos, A.B. Oliveira, F.D. Rocha, V.A. Arruda and W.R. Accorci, 2008. Comparative studies on the effects of *Tabebuia avellanedae* bark extract and b-lapachone on the hematopoietic response of tumour-bearing mice. Journal of Ethnopharmacology, 117: 228-235.

Rahmatullah, M., I.J. Mukti, A.K.M.F. Haque, M.A.H. Mollik, K. Parvin, R. Jahan, M.H. Chowdhury and T. Rahman, 2009a. An Ethnobotanical Survey and Pharmacological Evaluation of Medicinal Plants used by the Garo Tribal Community living in Netrakona district, Bangladesh. Advances in Natural and Applied Sciences, 3(3): 402-418.

Rahmatullah, M., M.A.H. Mollik, A.T.M.A. Azam, M.R. Islam, M.A.M. Chowdhury, R. Jahan, M.H. Chowdhury and T. Rahman, 2009b. Ethnobotanical Survey of the Santal tribe residing in Thakurgaon District, Bangladesh. American Eurasian Journal of Sustainable Agriculture, 3(4): 889-898.

Rahmatullah, M., A.K. Das, M.A.H. Mollik, R. Jahan, M. Khan, T. Rahman and M.H. Chowdhury, 2009c. An Ethnomedicinal Survey of Dhamrai Sub-district in Dhaka District, Bangladesh. American Eurasian Journal of Sustainable Agriculture, 3(4): 881-888.

Rahmatullah, M., A. Noman, M.S. Hossan, M.H. Rashid, T. Rahman, M.H. Chowdhury and R. Jahan, 2009d. A survey of medicinal plants in two areas of Dinajpur district, Bangladesh including plants which can be used as functional foods. American Eurasian Journal of Sustainable Agriculture, 3(4): 862-876.

Rahmatullah, M., D. Ferdausi, M.A.H. Mollik, M.N.K. Azam, M.T. Rahman and R. Jahan, 2009e. Ethnomedicinal Survey of Bheramara Area in Kushtia District, Bangladesh. American Eurasian Journal of Sustainable Agriculture, 3(3): 534-541.

Rahmatullah, M., D. Ferdausi, M.A.H. Mollik, R. Jahan, M.H. Chowdhury and W.M. Haque, 2010a. A Survey of Medicinal Plants used by Kavirajes of Chalna area, Khulna District, Bangladesh. African Journal of Traditional, Complementary and Alternative Medicines, 7(2): 91-97.

Rahmatullah, M., M.A.H. Mollik, M.S. Rahman, M.N. Hasan, B. Agarwala and R. Jahan, 2010b. A Medicinal Plant Study of the Santal tribe in Rangpur District, Bangladesh. Journal of Alternative and Complementary Medicine, 16(4): 419-425.

Ramos, A.A., C. Pereira-Wilson and A.R. Collins, 2010. Protective effects of ursolic acid and luteolin against oxidative DNA damage include enhancement of DNA repair in Caco-2 cells. Mutation Research, 692: 6-11.

Rattanajarasroj, S., and S. Unchern, 2010. Comparable attenuation of Abeta(25-35)-induced neurotoxicity by quercitrin and 17b-estradiol in cultured rat hippocampal neurons. Neurochemical Research, 35: 1196-1205.

Renou, S.G., S.E. Asís, M.I. Abasolo, D.G. Bekerman and A.M. Bruno, 2003. Monoarylhydrazones of a-lapachone: synthesis, chemical properties and antineoplastic activity. Pharmazie, 58: 690-695.

Rodrigues, A.M., J.E. de Paula, F. Roblot, A. Fournet and L.S. Espíndola, 2005. Larvicidal activity of *Cybistax antisyphilitica* against *Aedes aegypti* larvae. Fitoterapia, 76: 755-757.

Rodrigues, E., 2006. Plants and animals utilized as medicines in the Jau National Park (JNP), Brazilian Amazon. Phytotherapy Research, 20: 378-391.

Rojas, J.J., V.J. Ochoa, S.A. Ocampo and J.F. Muñoz, 2006. Screening for antimicrobial activity of ten medicinal plants used in Colombian folkloric medicine: a possible alternative in the treatment of non-nosocomial infections. BioMed Central Complementary and Alternative Medicine, 6: 1-6.

Roth, I., and H. Lindorf, 2002. South American Medicinal Plants. Springer, New York, pp 45-46, 122.

Sairafianpour, M., B. Bahreininejad, M. Witt, H.L. Ziegler, J.W. Jaroszewski and D. Staerk, 2003. Terpenoids of *Salvia hydrangea*: two new, rearranged 20-norabietanes and the effect of oleanolic acid on erythrocyte membranes. Planta Medica, 69: 846-850.

Salas, C., R.A. Tapia, K. Ciudad, V. Armstrong, M. Orellana, U. Kemmerling, J. Ferreira, J.D. Maya and A. Morello, 2008. *Trypanosoma cruzi*: activities of lapachol and a- and b-lapachone derivatives against epimastigote and trypomastigote forms. Bioorganic & Medicinal Chemistry, 16: 668-674.

Saleem, M., 2009. Lupeol, a novel anti-inflammatory and anti-cancer dietary triterpene. Cancer Letters, 285: 109-115.

Sankara-Subramanian, S., S. Nagarajan and N. Sulochana, 1972. Flavonoids of eight bignoniaceous plants. Phytochemistry, 11: 1499.

Sankara-Subramanian, S., S. Nagarajan and N. Sulochana, 1973. Hydroquinone from the leaves of *Jacaranda mimosaefolia*. Phytochemistry, 12: 220-221.

Sauvain, M., J.P. Dedet, N. Kunesch, J. Poisson, J.C. Gantier, P. Gayral and G. Kunesch, 1993. *In vitro* and *in vivo* leishmanicidal activities of natural and synthetic quinoids. Phytotherapy Research, 7: 167-171.

Schinella, G., S. Aquila, M. Dade, R. Giner, C. Recio Mdel, E. Spegazzini, P. de Buschiazzo, H. Tournier and J.L. Ríos, 2008. Anti-inflammatory and apoptotic activities of pomolic acid isolated from *Cecropia pachystachya*. Planta Medica, 74: 215-220.

Sens, L.S., 2002. Alternativas para a Auto-Sustentabilidade dos Xokleng da Terra Indigena Ibirama, in Programa de Pós-Graduação em Engenharia de Produção. Universidade Federal de Santa Catarina: Florianopolis, p 259, Online Report.

Shai, L.J., L.J. McGaw, M.A. Aderogba, L.K. Mdee and J.N. Eloff, 2008. Four pentacyclic triterpenoids with antifungal and antibacterial activity from *Curtisia dentata* (Burm.f.) C.A. Sm. leaves. Journal of Ethnopharmacology, 119: 238-244.

Silva, T.M., T.G. da Silva, R.M. Martins, G.L. Maia, A.G. Cabral, C.A. Camara, M.F. Agra and J.M. Barbosa-Filho, 2007. Molluscicidal activities of six species of Bignoniaceae from north-eastern Brazil, as measured against *Biomphalaria glabrata* under laboratory conditions. Annals of Tropical Medicine and Parasitology, 101: 359-365.

Silvan, S., S. Manoharan, N. Baskaran and A.K. Singh, 2010. Apigenin: A potent antigenotoxic and anticlastogenic agent. Biomedicine & Pharmacotherapy, (in press).

Sofowora, A., 1982. Medicinal Plants and Traditional Medicinal in Africa. John Wiley and Sons, New York, 256 pp.

Speranza, L., S. Franceschelli, M. Pesce, M. Reale, L. Menghini, I. Vinciguerra, M.A. De Lutiis, M. Felaco and A. Grilli, 2010. Antiinflammatory effects in THP-1 cells treated with verbascoside. Phytotherapy Research, 24: 1398-1404.

Suzuki, R., Y. Yasui, H. Kohno, S. Miyamoto, M. Hosokawa, K. Miyashita and T. Tanaka, 2006. Catalpa seed oil rich in 9t,11t,13c-conjugated linolenic acid suppresses the development of colonic aberrant crypt foci induced by azoxymethane in rats. Oncology Reports, 16: 989-996.

Tabanca, N., R.S. Pawar, D. Ferreira, J.P. Marais, S.I. Khan, V. Joshi, D.E. Wedge and I.A. Khan, 2007. Flavan-3-ol-phenylpropanoid conjugates from *Anemopaegma arvense* and their antioxidant activities. Planta Medica, 73: 1107-1111.

Tantangmo, F., B.N. Lenta, F.F. Boyom, S. Ngouela, M. Kaiser, E. Tsamo, B. Weniger, P.J. Rosenthal and C. Vonthron-Sénécheau, 2010. Antiprotozoal activities of some constituents of *Markhamia tomentosa* (Bignoniaceae). Annals of Tropical Medicine and Parasitology, 104: 391-398.

Taylor, P.G., I.M. Cesari, M. Arsenak, D. Ballen, M.J. Abad, A. Fernández, B. Milano, M.C. Ruiz, B. Williams and F. Michelangeli, 2006. Evaluation of Venezuelan medicinal plant extracts for antitumor and antiprotease activities. Pharmaceutical Biology, 44: 349-362.

Traore-Keita F., M. Gasquet, C. Di Giorgio, E. Ollivier, F. Delmas, A. Keita, O. Doumbo, G. Balansard and P. Timon-David, 2000. Antimalarial activity of four plants used in traditional medicine in Mali. Phytotherapy Research, 14: 45-47.

Tsai, S.J., and M.C. Yin, 2008. Antioxidative and anti-inflammatory protection of oleanolic acid and ursolic acid in PC12 cells. Journal of Food Science, 73: H174-H178.

Twardowschy, A., C.S. Freitas, C.H. Baggio, B. Mayer, A.C. dos Santos, M.G. Pizzolatti, A.A. Zacarias, E.P. dos Santos, M.F. Otuki and M.C. Marques, 2008. Antiulcerogenic activity of bark extract of *Tabebuia avellanedae*, Lorentz ex Griseb. Journal of Ethnopharmacology, 118: 455-459.

Valadeau, C., A. Pabon, E. Deharo, J. Albán-Castillo, Y. Estevez, F.A. Lores, R. Rojas, D. Gamboa, M. Sauvain, D. castillo and G. Bourdy, 2009. Medicinal plants from the Yanesha (Peru): evaluation of the leishmanicidal and antimalarial activity of selected extracts. Journal of Ethnopharmacology, 123: 413-422.

Van Baren C., I. Anao, P. Leo Di Pira, S. Debenedetti, P. Houghton, S. Croft and V. Martino, 2006. Triterpenic acids and flavonoids from *Satureja parvifolia*. Evaluation of their antiprotozoal activity. Zeitschrift für Naturforschung. C, Journal of Biosciences, 61: 189-192.

Van Kiem, P., T.H. Quang, T.T. Huong, T.H. Nhung le, N.X. Cuong, C. Van Minh, E.M. Choi and Y.H. Kim, 2008. Chemical constituents of *Acanthus ilicifolius* L. and effect on osteoblastic MC3T3E1 cells. Archives of Pharmacal Research, 31: 823-829.

Varanda, E.M., G.E. Zúñiga, A. Salatino, N.F. Roque and L.J. Corcuera, 1992. Effect of ursolic acid from epicuticular waxes of *Jacaranda decurrens* on *Schizaphis graminum*. Journal of Natural Products, 55: 800-803.

Vasconcelos, F.C., C.R. Gattass, V.M. Rumjanek and R.C. Maia, 2007. Pomolic acid-induced apoptosis in cells from patients with chronic myeloid leukemia exhibiting different drug resistance profile. Investigational New Drugs, 25: 525-533.

Vázquez, M.L., A. Kroeger, R. Lipowsky and A. Alzate, 1991. Conceptos populares sobre la leishmaniasis cutanea en Colombia y su aplicabilidad en programas de control. Boletín de la Oficiana Sanitaria panamericana, 110: 402-415.

Veeramani, C., G. Pushpavalli and K.V. Pugalendi, 2010. *In vivo* antioxidant and hypolipidemic effect of *Cardiospermum halicacabum* leaf extract in streptozotocin-induced diabetic rats. Journal of Basic and Clinical Physiology and Pharmacology, 21: 107-125.

Villasmil, J., M.J. Abad, M. Arsenak, A. Fernández, M.C. Ruiz, B. Williams, F. Michelangeli, F. Herrera and P. Taylor, 2006. Cytotoxic and antitumor activities of Venezuelan plant extracts *in vitro* and *in vivo*. Pharmacologyonline, 3: 808-816.

Wagner, C., A.P. Vargas, D.H. Roos, A.F. Morel, M. Farina, C.W. Nogueira, M. Aschner and J.B. Rocha, 2010. Comparative study of quercetin and its two glycoside derivatives quercitrin and rutin against methylmercury (MeHg)-induced ROS production in rat brain slices. Archives of Toxicology, 84: 89-97.

Weniger, B., S. Robledo, G.J. Arango, E. Deharo, R. Aragón, V. Muñoz, J. Callapa, A. Lobstein and R. Anton, 2001. Antiprotozoal activities of Colombian plants. Journal of Ethnopharmacology, 78: 193-200.

Woo, H.J., and Y.H. Choi, 2005. Growth inhibition of A549 human lung carcinoma cells by b-lapachone through induction of apoptosis and inhibition of telomerase activity. International Journal of Oncology, 26: 1017-1023.

Yamashita, M., M. Kaneko, H. Tokuda, K. Nishimura, Y. Kumeda and A. Iida, 2009. Synthesis and evaluation of bioactive naphthoquinones from the Brazilian medicinal plant, *Tabebuia avellanedae*. Bioorganic & Medicinal Chemistry, 17: 6286-6291.

Yan, S.L., C.Y. Huang, S.T. Wu and M.C. Yin, 2010. Oleanolic acid and ursolic acid induce apoptosis in four human liver cancer cell lines. Toxicology In Vitro, 24: 842-848.

Yang, J.H., J.P. Hu, K. Rena and N.S. Du, 2009. Structure-activity relationships of phenylethanoid glycosides in plants of *Cistanche salsa* on antioxidative activity. Zhong Yao Cai, 32: 1067-1069.

Yu, Y.X., Z.L. Gu, J.L. Yin, W.H. Chou, C.Y. kwok, Z.H. Qin and Z.Q. Liang, 2010. Ursolic acid induces human hepatoma cell line SMMC-7721 apoptosis via p53-dependent pathway. Chinese Medical Journal, 123: 1915-1923.

Yu, Z.W., H.Y. Zhu, X.S. Yang, Q.Y. Sun and X.J. Hao, 2005. Study on chemical constituents from *Incarvillea arguta* and their accelerating PC-12 cell differentiation. Zhongguo Zhong Yao Za Zhi, 30: 1335-1338.

Zaveri, M., P. Gohil and S. Jain, 2006. Immunostimulant activity of n-butanol fraction of root bark of *Oroxylum indicum*, Vent. Journal of Immunotoxicology, 3: 83-99.

Zhou, Y., J.S. Li, X. Zhang, Y.J. Wu, K. Huang and L. Zheng, 2010. Ursolic acid inhibits early lesions of diabetic nephropathy. International Journal of Molecular Medicine, 26: 565-570.

Zhu, L., J. Tan, B. Wang, R. He, Y. Liu and C. Zheng, 2009. Antioxidant activities of aqueous extract from *Agrimonia pilosa* Ledeb and its fractions. Chemistry & Biodiversity, 6: 1716-1726.

Zhu, M., N. Tan, H. Zhu, G. Zeng, W. He, B. Yu and X. Chen, 2010. Anti-sports anaemia effects of verbascoside and martynoside in mice. International Journal of Sports Medicine, 31: 537-541.