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A randomized ethnomedicinal survey of snakebite treatment in southwestern parts of Bangladesh

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ABSTRACT

Snakebite is the single most important toxin-related injury, causing substantial mortality in many parts of the Africa, Asia and the Americas. Incidence of snakebite is usually recorded in young people engaged in active physical work in rural areas. The various plant parts used to treat snakebite included whole plant, leaves, barks, roots and seeds. Most bites in Bangladesh are recorded between May and October with highest number in June. Lower and upper limbs are most common sites of snakebite, but it may happen in other sites as well. Snake venom (蛇毒 shé dú) has been the cause of innumerable deaths worldwide. However, antiserum does not provide enough protection against venom induced hemorrhage, necrosis, nephrotoxicity and hypersensitivity reactions. Informed consent was obtained from the practitioners prior to interviews. After the survey, it is concluded that the medicinal plants used by tribal medicinal practitioners in Bangladesh for treatment against snakebite are *Acyranthes aspera* L. (土牛膝 tǔ niú xī), *Amaranthus Viridis* L. (野莧菜 yě xiàng cài), *Asparagus racemosus* Willd (總序天冬 zǒng xù tiān dōng) and *Emblica officinalis* Gaertn (油柑 yóu gān), while the non-tribal communities used 35 plant species among them, most of the plants reported as new species used against snakebite in the belonging family. The plants present a considerable potential for discovery of novel compounds with fewer side effects for treatment of antisnake venom and can, at least in Bangladesh, become a source of affordable and more easily available drugs.

1. Introduction

Snakes and snakebite are mythical attars in the mind of people of the world. Based on the geographical position and climatic conditions, Bangladesh is a disaster prone country. Due to this reason, snakebite is a serious but neglected public health issue in Bangladesh. A great diversity of locales for snakes, as well as others wild species have developed in Bangladesh in the junction of Indo-Malayan, Indo-Chinese and Indo-Himalayan regions which provides excellent opportunities to make welcoming hahitat for those dangerous beasts. Biting occurs generally when individuals are at work, engaging in activities such as cultivation, fishing, plantation, wood collection, tending crops and gardening. On the other hand, when the victims are walking on rural footpaths or while sleeping in the floor, bites are fairly common. For the period of monsoon, due to the rainfall snakebite occurrences are being increased because snakes leave their shelter. As most of the houses in rural area of Bangladesh are made of mud not bricks, the snakes sometimes live in the holes of the muddy floors and suitable places in the home where people stored grains and keep flock.

In Bangladesh, particularly in rural areas, snakebite is a major cause of mortality and morbidity and it has a noteworthy effect on human health and economy through treatment related expenses and loss of productivity. Most of the cases, the victim of snakebite is a poor, young and active individual. The snakebite occurrence by division in Bangladesh presented in Table 1. The number of fatalities attributed to snakebites varies greatly by geographical area. South Asia, Southeast Asia, and sub-Saharan Africa report the highest

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Table 1
Snakebite distribution by division in Bangladesh.

Division	Number of snakebites	Annual incidence per 1000,000 person-years (95% cl)
Barisal	22	2667.70 (1787.20–3829.50)
Chittagong	9	397.80 (211.80–680.30)
Dhaka	22	440.00 (285.00–649.90)
Khulna	20	936.20 (104.40–750.20)
Rajshahi	20	472.70 (288.00–680.30)
Sylhet	5	321.60 (104.40–750.20)
Over all	98	623.40 (513.40–789.20)

number of bites and the high incidence is in the Entropic and other equatorial and subtropical regions.[1–3] Each year tens of thousands of people die because of snakebites. The global incidence of snakebites, envenomation and mortality per year have been shown in Table 2.[1–6]

Treatment of snakebite in Bangladesh was mostly subjected by old-fashioned snake charmers (Ozha). Folks used to be content with their traditional approaches of tight tourniquet, multiple incisions at bite site, application of herbal products and different rituals. The outcome was determined by chance. Even the medical experts were not well aware of the scientific approaches of management of snakebite.[7] The treatment for snakebite is as variable as the bite itself. The only available treatment in modern science is the usage of antivenom against snakebite, which was developed by Albert Calmette, a French scientist of the Pasteur Institute in 1895, against the Indian Cobra (*Naja naja*).

The traditional therapists are the first line defense against of this illness in Bangladesh. The success of these therapists is ambiguously understood, sometimes partially by their unknown *materia medica* and occult mystical nature of their practice, but direct testimony from victims confirms success of their treatments. Although their practice was ignored by biomedicine, they serve more snakebite accident fatalities than modern practitioners. The healers, especially the elderly and spirit inspired, are reputed to have an inherent expertise to handle these cases. They are accepted as healthcare providers with a thoughtful socio-cultural understanding of their communities in both ethnic groups.[8] Other alternative treatment involves the usage of folk traditional medicines (民間傳統藥 mín jiān chuán tǒng yào) in snakebites. Various plants have been used against snakebite in folk traditional medicine. Traditional medicinal knowledge has been a means towards the discovery of many modern medicines.[9] Bangladesh has a rich history of several traditional medicinal systems, among which the most notable ones are the Ayurvedic, Unani and the folk medicinal systems. Folk medicine is practiced by the traditional medical practitioners (generally known as Kavirajes by the mainstream community) who utilize simple formulations of medicinal plants in most of their preparations. The southern part of Bangladesh posse's hills, mountains and costal area of Bay of Bengal, whereas the western part posses forests and hills as well. These regions of Bangladesh still remain undeveloped in different sectors including education, treatment, and transportation. Snakebite incidents and mortality rate is higher in this part of Bangladesh. Due to illiteracy and lacking of modern treatment, general public are used to depend on traditional or folk medicines. For proper documentation and finding effective folk medicine, these areas were randomly selected for this study. It was the objective of the present study to conduct a completely randomized survey of Kavirajes of southwestern Bangladesh to learn more about medicinal plants used for treatment of snakebite. The expectation was that the medicinal plants used by the Kavirajes could prove to be a useful source for further scientific studies leading to discovery of more efficacious drugs.

Table 2
Global incidence of snakebite occurrences, envenomation and mortality per year.

Location	Total reported cases	Envenomation	Death/year	Reference
Europe	25,000	800	30	1–6
Middle East	20,000	15,000	100	
North USA and Canada	45,000	6,500	15	
Central and South USA	3000,000	150,000	5,000	
Asia	4 million	2 million	100,000	
Africa	1 million	500,000	20,000	
Oceania	10,000	3000	200	

2. Materials and methods

The present survey was carried out between September 2011 to July 2012, among Kavirajes of southwestern parts in Bangladesh which includes twelve districts (Fig. 1), namely Bagerhat, Barisal, Dinajpur, Jessore, Jenidaha, Khulna, Kurigram, Kushtia, Pabna, Pirojpur, Rajbari, Rajshahi and three tribal communities of Bangladesh namely Garo (Netrokona), Rakahine (Chittagong hill tracks region) and Santal (Rajshahi). Informed consent was obtained from the Kavirajes prior to the survey.

For this specific ethnomedicinal survey the number of visits were made to the Kavirajes to gain their confidence. Actual surveys were conducted with the help of a semi-structured open ended questionnaires and the guided field-walk method as described by Martin and Maundu.[10,11] A total of 21 kavirajes (35–65 years) were interviwed during the survey including medicine men (*Ojha*). Kavirajes were asked specifically as to whether they know about anti-snake venom and whether they treat the snakebite on a regular basis. Kavirajes were selected based on their affirmative answer to both questions. The Kavirajes mentioned the plants with which they treated snakebite to the interviewers and took the interviewers to spots from where they collected the plants. All interviews were conducted in the Bangla language, which was spoken by both Kavirajes and the interviewers. After that, it was converted into English by the author ownself. The plants were shown along with provision of local names and the parts used. Plant specimens were collected and dried in the field and later brought back to Dhaka for complete identification at the Bangladesh National Herbarium. The collected plants were cross-checked by neighboring herbalists and traditional medicinal healers. For each species the proportion of informants who independently reported its use in snakebite was assessed.[12] Each medicinal practice was cross checked with at least 2 to 3 informants.

3. Results

Bangladesh is a country of rich of flora and fauna, where 722 numbers of medicinal plants have already been discovered and they have much variety diversity based on locality in size, shape, flowering etc. The names of a total 38 of plant species were obtained from 21 Kavirajes of the twelve districts surveyed, most of the cases used plants belong to the same area or nearby area of the healer which were naturally distributed. Among them 4 plant species were obtained from the 3 tribal community areas (Garo, Rakhain and Santal). The plant species belonged to 25 families. The Fabaceae family contributed four plants; Amaranthaceae and Solanaceae contributed three plants followed by the Acanthaceae, Apocynaceae, Asteraecae, Euphorbiaceae, Lamiaceae and Rubiaceae

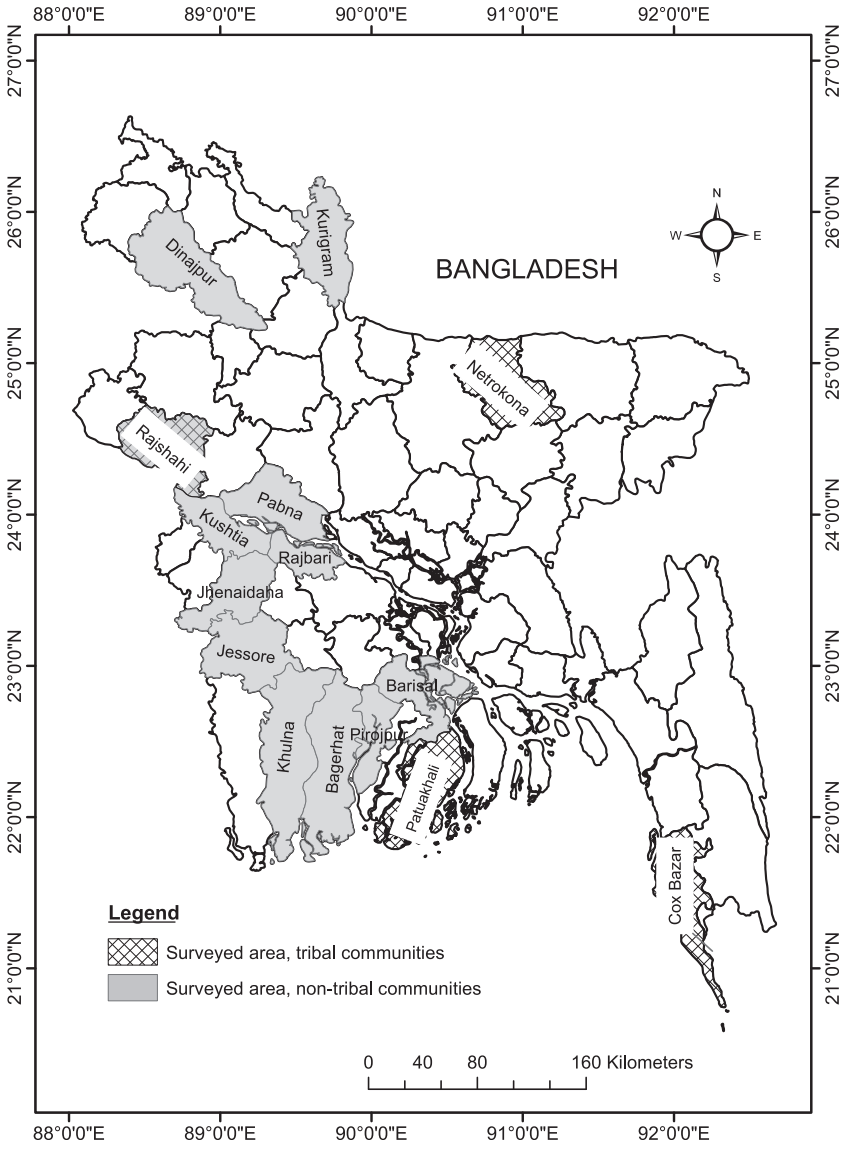

Fig. 1. Map of Bangladesh highlighting ethnomedicinal surveyed areas.

families with two plants each. The results are summarized in Tables 3 and 4.

Among 38 plant species, two of them (*Rauwolfia serpentina* L. Benth ex-Kurz (印度蛇木 yìn dù shé mù) and *Aristolochia indica* L. (馬兜鈴 mǎ dōu líng)) were used very commonly in five districts, which are Bagerhat, Jessore, Ishwardi, Pabna and Rajshahi. Whole plants as well as plant parts like leaves, barks, roots and seeds were used for treatment. It was observed that in several instances, a single plant part (like seeds of *Cajanus cajan* L. Millsp) was used. Different plants species and the different communities use parts of the plants based on the individual Kabirajes because of their earned knowledge form their ancestor only. Overall, the maximum number of plants (21 out of 38) for treatment of snake bite was obtained from the Kavirajes of Bagerhat, Khulna and Rajbari and these are *Aegle marmelos* (L.) Corr. (木橘 mù jú), *Aerva sanguinolenta* (絹毛莧 juān máo xiàn), *Agaricus albolutescens* Zeller, *Anisomeles malabarica* (L.) R.Br. ex Sims, *Aristolochia indica* L. (馬兜鈴 mǎ dōu líng), *Cecropia peltata* L. (號角樹 hào jiǎo shù), *Clitoria ternatea* L. (蝶豆 dié dòu), *Cycas revoluta* Thunb. (蘇鐵 sū tiě), *Datura metel* L. (南洋金花 nán yáng jīn huā), *Emilia sonchifolia* (L.) DC. ex Wight (紫背草 zǐ bèi cǎo), *Euphorbia milii* "Lutea" Hort (鐵海棠 tiě hǎi táng), *Ipomoea aquatic* Forsk. (蕹菜 wèng cài), *Justicia adhatoda* L. (鴨嘴花 yā zuǐ huā), *Justicia gendarussa* L. (車桑子 chē sāng zǎi), *Leucas aspera* (Wild.) Link (蜂窩草 fēng wō cǎo), *Piper longum* L. (蓽茇 bì bó), *Rauwolfia serpentina* (L.) Benth ex Kurz (印度蛇木 yìn dù shé mù), *Sansevieria trifasciata* Prain (虎尾蘭 hǔ wěi lán), *Tylophora indica* (Burm.f) Merr., *Uraria picta* (Jacq.) DC. (兔尾草 tù wěi cǎo), *Wissadula periplocifolia* (L.) C. Presl ex Thwaites.

4. Discussion

There is a wide varieties of venome among diverse snake species but in general, snake venom (蛇毒 shé dú) contains enzymes that digest proteins which cause animals to go into shock and cause damage to body tissues and internal organs that ultimately affect the nerve functions which lead to paralysis including stopping breathing as well as heart beat which is the eventual cause of death. Snakebites in rural areas are commonly treated with plant extracts.[13–17] Traditional healers have reputation of treating difficult snakebite cases and are trusted by their patients. In both study areas, cases of deaths in victims attended by traditional healers were very rare, (less than 3%). In a Colombian study healers

Table 3
Medicinal plants used for the treatment of snakebite by folk medicinal practitioners in the twelve districts, Bangladesh.

SL. no.	Scientific name	Family	Local name	Part/(S) used	Area of information collection
1	*Aegle marmelos* (L.) Corr. (木橘 mù jú)	Rutaceae	Bel	root	Khulna
2	*Aerva sanguinolenta* (絹毛莧 juān máo xiàn)	Amaranthaceae	Bish korali	leaf	Rajbari
3	*Agaricus albolutescens* Zeller	Agaricaceae	Bang chata	whole plant	Bagerhat
4	*Amaranthus Viridis* L. (野莧菜 yě xiàng cài)	Amaranthaceae	Gandhori ara	whole plant	Jessore
5	*Anisomeles malabarica* (L.) R.Br. ex Sim	Lamiaceae	Raaz-moni	whole plant	Chalna, Khulna
6	*Anogeissus latifolia*	Combretaceae	Doya		Jheniadaha
7	*Anthocephalus chinensis* (Lam.) A. Rich. Ex Walp.	Rubiaceae	Kodom	leaf, bark	Pirojpur
8	*Aristolochia indica* L. (馬兜鈴 mǎ dōu líng)	Aristolochiaceae	Iche; Ishwarmul	leaf; root	Jesore; Ishwardi upazilla, Pabna; Rajshahi; Jhenidaha
9	*Cajanus cajan* (L.) Millsp.	Fabaceae	Arhor kalai	seeds	Kurigram
10	*Cassia sophera* L.	Fabaceae	Thon-thoni	leaf	Dinajpur
11	*Cecropia peltata* L. (號角樹 hào jiǎo shù)	Moraceae	Jongli udal	whole plant	Bagerhat
12	*Cissus pedata* Lam.	Vitaceae	Goala	leaf	Jesore
13	*Clitoria ternatea* L. (蝶豆 dié dòu)	Fabaceae	Aparajita	flower, seed	Chalna, Khulna
14	*Couroupita guianensis* Aubl.	Lecythidaceae	Naglingam	leaf, bark	Gaurnadi upazilla, Barisal
15	*Curcuma longa* L. (薑黃 jiāng huáng)	Zingiberaceae	Holud	rhizome	Bheramara, Kushtia
16	Cycas revoluta Thunb. (蘇鐵 sū tiě)	Cycadaceae	Cycas	whole plant	Bagerhat
17	*Datura metel* L. (南洋金花 nán yáng jīn huā)	Solanaceae	Dhutura	leaf, root, fruit, seed	Bagerhat
18	Eclipta prostrata L. (鱧腸草 lǐ cháng cǎo)	Asteraceae	Kalo keshari shak	leaves	Kurigram
19	*Emilica sonchifolia* (L.) Wight (紫背草 zǐ biè cǎo)	Asteraceae	Chadho	whole plant	Bagerhat
20	*Euphorbia milii* "Lutea" Hort (鐵海棠 tiě hǎi táng)	Euphorbiaceae	Dudh Kata	whole plant	Bagerhat
21	*Ipomoea aquatic* Forsk. (蕹菜 wèng cài)	Convolvulaceae	Kolmi Shak	whole plant; leaves	Bagerhat; Kurigram
22	*Justicia adhatoda* L (鴨嘴花 yā zuǐ huā)	Acanthaceae	Bashok	leaf, root, flower	Khulna
23	*Justicia gendarussa* L. (車桑子 chē sāng zǎi)	Acanthaceae	Rikfol	leaf	Rajbari
24	*Leucas aspera* (Wild.) Link (蜂窩草 fēng wō cǎo)	Lamiaceae	Dondo kolosh	leaf stalk, leaf; young stems	Rajbari; Kurigram
25	*Morinda citrifolia* L. (諾麗果 nuò lì guǒ)	Rubiaceae	Boro Chad	root	Bheramara, Kushtia
26	*Piper longum* L. (胡椒 hú jiāo)	Piperaceae	Pipul	root, flower, fruit, sap	Khulna
27	*Polyalthia longifolia* (Sonn.) Thwaites (PL)	Annonaceae	Devdaru	whole plant	Bheramara, Kushtia
28	*Rauwolfia canescens* L.	Apocynaceae	Boro chanda	root	Pabna
29	*Rauwolfia serpentina* (L.) Benth ex Kurz (印度蛇木 yìn dù shé mù)	Apocynaceae	Shorpogondha; coto chada; choto chondro	leaf, root, flower, seed	Bagerhat; Ishwardi upazilla, Pabna; Rajshahi; Jhenidaha
30	*Sansevieria trifasciata* Prain (虎尾蘭 hǔ wěi lán)	Agavaceae	Bagha-chokro	whole plant	Chalna, Khulna
31	*Solanum torvum* Swartz (水茄 shuǐ qié)	Solanaceae	Tit begun	root, fruit	Pirojpur
32	*Solanum capsicoides* (刺茄 cì qié)	Solanaceae	Tit begun	seed	Barisal
33	*Tylophora indica* (Burm.f) Merr.	Asclepiadaceae	Ishil mul	leaf	Rajbari
34	*Uraria picta* (Jacq.) DC. (兔尾草 tù wěi cǎo)	Fabaceae	Rahu Chondal	whole plant	Bagerhat
35	*Wissadula periplocifolia* (L.) C. Presl ex Thwaites	Malvaceae	Naag-moni	leaf, root	Chalna, khulna

interviewed reported only 4.4% death in cases they handled.[18] Medicinal plants have been used for many years to treat a great variety of diseases including envenomations by animal bites.[19–23] These plants play a key role in world health, as they are a rich source of many natural inhibitors and pharmacologically active compounds. Many of these substances structurally resemble to biological compounds, and this similarity is the basis of their physiological action.[24] Its is alreay proved that the methanolic extract and fractions of *Serjania erecta* rich in flavonoids and tannins exhibited as powerful inhibitors of the hemorrhagic and clotting activity, possibly due to interaction with metalloproteases and thrombin-like enzymes.[25] Studies of several plants (*Heliconia curtispatha*, *Pleopeltis percussa*, *Brownea rosademonte*, *Bixa orellana* (紅木 hóng mù), *Trichomanes elegans*, *Struthanthus orbiculareis* and *Casearia sylvestris* (林生腳骨脆 lín shēng jiǎo gǔ cuì) describe the inhibitory effect of all or part of the coagulant activity of snake venoms from *B. asper*, *B. jararacussu*, *B. pirajai*, *B. neuwiedi*, *B. moojeni* and *C. d. terrificus*.[26–28] The present study documents 38 species of ethnomedicinal plants from 25 families used by the tribal healers and medical practitioners in non-tribal communities. Among them, most of the plants are reported as new species in the belonging family (about use, bioactive compounds and mode of action). They mainly use leaf, root, bark, rhizome, stem, fruit, flower, leaf stalk and whole plant as antidote against snakebite. The reported plants are administered as decotion, extracts, paste and juice. Some of these plants like *Emblica offcinalis* (油柑 yóu gān) and *Rauwolfia serpentina* L. Benth ex Kurz (印度蛇木 yìn dù shé mù) have been reported to have antisnake-venom activity in various ethnomedicinal studies.[29,30] The reported plants may contain flavonoids, tannins or some other new lead compounds which

Table 4
Medicinal plants used for the treatment of snakebite by the three major tribal medicinal practitioners in Bangladesh.

SL. no.	Scientific name	Family	Local name	Part (S) used	Tribe name and district where the information was collected
1	*Achyranthes aspera* L. (土牛膝 tǔ niú xī)	Amaranthaceae	Chaim-per-on; Mimang-khache	root, leaf, stem; seed	Rakhain tribe, Chittagong Hill Tracks; Garo Tribe, Netrokona
2	*Amaranthus Viridis* L. (野莧菜 yě xiàng cài)	Amaranthaceae	Gandhori ara	whole plant	Santal tribe, Rajshahi
3	*Asparagus racemosus* Wild. (總序天冬 zǒng xù tiān dōng)	Liliaceae	Mimang-thamache	root	Garo tribe, Netrokona
4	*Emblica officinalis* Gaertn (油柑 yóu gān)	Euphorbiaceae	Chele-chibong	fruit, bark, root	Rakhain tribe, Chittagong Hill Tracks

possoess the strong inhibitory activity against the hemorrhagic and clotting activity and possibly it acts via the same mode of action described above by Farnandes et al. (2011) as anti-hemorrhage and/or anti-coagulant. Therefore, this survey created a prodigious scope for pharmacologist to find out the active compounds, mode of action and the appropriate uses of those plants.

Pharmacological studies have revealed that the extracts and fractions from some of plants used in traditional medicine are able to antagonize the activity of various crude venoms and purified toxins.[17,27,28,31–38] Medicinal plant extracts have been shown to antagonize the activity of some venoms and toxins. Several plant species are popularly known as antisnake venom and have been scientifically investigated, such as *Eclipta sp.* (鱧腸草 lǐ cháng cǎo), *Curcuma longa* (薑黃 jiāng huáng), *Hibiscus esculentus* (秋葵 qiū kuí), *Casearia sp.*, *Musa paradisiaca* (香蕉 xiāng jiāo), *Mucuna pruriens* (黎豆 lí dòu), *Bauhinia forficata* (羊蹄甲 yáng tí jiǎ), *Annoma senegallensis*, *Mikania glomerata*, *Piper sp.* (胡椒 hú jiāo), *Cordia verbenacea* (破布子 pò bù zǐ), *Pentaclethra macroloba* and others.[19,22,38,39] Many active ingredients from snake venoms have been purified. Their molecular structures have been identified and characterized in the most advanced laboratories.[40–45] Many other plants such as *Aristolochia albida* (廣防己 guǎng fáng jǐ); *Vitex negundo* (黃荊 huáng jīng), *Emblica officinalis* (油柑 yóu gān), *Strychnos nux vomica* (馬錢子 mǎ qián zǐ), *Hemidesmus indicus* (菝葜 bá qiā) and *Mimosa pudica* (含羞草 hán xiū cǎo) were reported for the antisnake-venom activity.[46–50] Pure substances from plants shown to protect mice from ophitoxaemia are generally nitrogen-free, low-molecular weight compounds: phenolics, phytosterols (β-amyrin and sitosterol) and triterpenoids but exceptions are found in 12-methoxy-4-methylvoachalotine, an alkaloid. Proposed views advanced in indicate that these micromolecules interact with macromolecular targets; receptors and enzymes; resulting in venom-inactivation, analgesic and anti-inflammatory action.[19,21,36,38,40,41,51,52]

5. Conclusion

Recently the World Health Organization (WHO) estimated that 80% people worldwide rely on herbal medicines for some aspect. WHO has shown great interest in documenting the use of medicinal plants used by tribes from different parts of the world. Many developing countries have intensified their efforts in documenting the ethnomedical data and scientific research on medicinal plants.

From just a brief survey of the literature, it appears that the plants used by the Kavirajes in twelve districts and three tribal medical practitioners of Bangladesh present considerable potential in the treatment of snakebite. The consensus among users indicates that plants have protective activity when administered for snakebite. Partcularly plants like *Rauwolfia serpentina* L. (印度蛇木 yìn dù shé mù), *Emblica officinalis* Linn (油柑 yóu gān), *Aristolochia indica* L. (馬兜鈴 mǎ dōu líng) and *Morinda citrifolia* L. (諾麗果 nuò lì guǒ) have a high consensus agrrement regarding their use in snakebite. Thus the present investigation can provide leads for specific venom inhibitory compounds from the reported thirty-eight medicinal plants that could be used in combined therapy with antiserum in the near future.

Conflicts of interest

All contributing authors declare no conflicts of interest.

Ethics committee aproval

The Institutional Ethics Committee of Jessore University of Science and Technology, Bangladesh approved the present study.

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