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

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A B S T R A C T

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 shè 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 Acranthos aspera L. (土牛膝 tǔ niú xī), Amaranthus Viridis L. (野莖菜 yě xiāng cài), Asparagus racemosus Willd (總序天冬 zǒng xù tiān dōng) and Emblica officinalis Gaertn (油柑 yóu gǎn), 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 antivenom and can, at least in Bangladesh, become a source of affordable and more easily available drugs.

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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 other 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 habitat 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 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...
number of bites and the high incidence is in the Entropic and other equatorial and subtropical regions. 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.

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. 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 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. Other alternative treatment involves the usage of folk traditional medicines (民間伝統薬 min jian chuang yao) 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. 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.

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), Rakhain (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. A total of 21 kavirajes (35–65 years) were interviewed during the survey including medicine men (Olha). 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. 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, Asteraeae, Euphorbiaceae, Lamiaceae and Rubiaceae.

| Division   | Number of snakebites | Annual incidence per 10000 people-years (95% cl) |
|------------|----------------------|-----------------------------------------------|
| Barisal    | 22                   | 2667.70 (1787.20–3829.50)                      |
| Chittagong | 22                   | 2667.70 (1787.20–3829.50)                      |
| Dhaka      | 22                   | 440.00 (285.00–649.90)                         |
| Khulna     | 20                   | 675.20 (340.40–895.20)                         |
| Rajshahi   | 20                   | 743.70 (288.00–1280.30)                        |
| Sylhet     | 5                    | 321.60 (104.40–750.20)                         |
| Over all   | 98                   | 623.40 (511.40–789.20)                         |

| Location     | Total reported cases | Envenomation | Death/year | Reference |
|--------------|----------------------|--------------|------------|-----------|
| Europe       | 25,000               | 800          | 30         | 1–6       |
| Middle East  | 20,000               | 15,000       | 100        |           |
| North USA    | 45,000               | 6,500        | 15         |           |
| Canada       | 3000,000             | 150,000      | 5,000      |           |
| Central and  | 4 million            | 2 million    | 100,000    |           |
| South USA    | 1 million            | 500,000      | 20,000     |           |
| Asia         | 10,000               | 3,000        | 200        |           |
| Africa       | 4 million            | 2 million    | 100,000    |           |
| Oceania      | 1 million            | 500,000      | 20,000     |           |

Table 1
Snakebite distribution by division in Bangladesh.

Table 2
Global incidence of snakebite occurrences, envenomation and mortality per year.
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 juan máo xiǎo), *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 tiè), *Emilia sonchifolia* (L.) DC. ex Wight (紫背草 zǐ bèi cǎo), *Euphorbia milii* “Lutea” Hort (繭海裳 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 zǐ), *Leucas aspera* (Wild.) Link (蜂窩草 fēng wō cáo), *Piper longum* L. (薑 bi bò), *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), *Wissa-dula 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 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
Medicinal plants used for the treatment of snakebite by folk medicinal practitioners in the twelve districts, Bangladesh.

### Table 3

| Sl. no. | Scientific name | Family | Local name | Part(S) used | Area of information collection |
|---------|-----------------|--------|------------|--------------|-------------------------------|
| 1       | Aegle marmelos (L.) Corr. | Rutaceae | Bel | root | Khulna |
| 2       | Aerva sanguinolenta (L.) Juss. | Amaranthaceae | Bish koral | leaf | Rajbari |
| 3       | Agaricus abietisens Zeller | Agaricaceae | Bang chata | whole plant | Bagerhat |
| 4       | Amaranthus Viridis L. | A. Rich. | Gangdhori ara | whole plant | Jessore |
| 5       | Anisomeles malabarica (L) R.R. | Lamiaceae | Raaz-moni | whole plant | Chalna, Khulna |
| 6       | Anogeissus latifolia | Combretaceae | Doyia | leaf | Jheniadhaha |
| 7       | Antelopechis chinesis (Lam.) A. Rich. | Ex Walp. | Kodom | leaf, bark | Pirojpur |
| 8       | Aristolochia indica L. | Aristolochiaceae | Ich: Isthwarimu | leaf; root | Joresi; Ishwardi upazila, Pabna; Rajshahi; Jheniadhaha |

| Cujamus cajan (L.) Millsp. | Fabaceae | Arbor kalai | seeds | Kurigram |
| 10      | Cissia sophora L. | Vitaceae | Goala | leaf | Jioresi |
| 11      | Cecropia peltata L. | Moraceae | Jungul uli | whole plant | Bagerhat |
| 12      | Cissus pedata Lamb. | Vitaceae | Goala | leaf | Jioresi |
| 13      | Clitoria ternatea L. | Fabaceae | Aparajita | flower, seed | Chalna, Khulna |
| 14      | Couroupita guianensis Aubl.| Lecythidaceae | Naglimam | leaf, bark | Gauriade upazilla, Barisal |
| 15      | Curcuma longa L. | Zingiberaceae | Holud | rhizome | Bheramara, Kushita |
| 16      | Cynara cardunculus | Asteraceae | Kalo keshari shak | leaves | Kurigram |
| 17      | Croton tiglium | Euphorbiaceae | Dudh kata | whole plant | Bagerhat |
| 18      | Euphoria miliifolia “lutea” Hout | Euphorbiaceae | Kako kata | whole plant | Bagerhat |
| 19      | Epimema aquatica Forsk. | Convolvulaceae | Kolmi shak | whole plant; leaves | Bagerhat; Kurigram |
| 20      | Justitia adhatoda L. | Acanthaceae | Bashok | leaf, root, flower | Khulna |
| 21      | Justicia gendarussa L. | Acanthaceae | Ikshol | leaf | Rajbari |
| 22      | Leucas aspera (Wild) | Lamiaceae | Dondo Kolosh | leaf stalk, leaf; young | Rajbari; Kurigram |
| 23      | Morinda citrifolia L. | Rubiaceae | Boro Chud | root | Bheramara, Kushita |
| 24      | Piper longum L. | Piperaceae | Pipul | root, flower, fruit, sap | Khulna |
| 25      | Polyalthia longifolia (Sonnh.) Thwaites (PL) | Annonaceae | Dewadaru | whole plant | Bheramara, Kushita |
| 26      | Rauwolfia canescens L. | Apocynaceae | Boro Chanda | root | Pabna |
| 27      | Rauwolfia serpentina (L.) Benth ex Kurz (印度蛇木 yín dù shé mù) | Apocynaceae | Shoropongeda; coto chada; chocho chondro | leaf, root, flower; seeds | Rajshahi; Jheniadhaha |
| 28      | Sanseveria trifasciata Prain (誓尾藤 hù wèi tén) | Agavaceae | Bagha-chokro | whole plant | Chalna, Khulna |
| 29      | Solanum torvum Swartz | Solanaceae | Tit begun | root; fruit | Pirojpur |
| 30      | Solanum capsicoides (Burch ex Jacq.) | Solanaceae | Tit begun | seed | Barisal |
| 31      | Tylolophora indica (Burm.f) Merrill | Asclepiadaceae | Ishul mul | leaf | Rajbari |
| 32      | Uraria picta (Jacq.) DC. | Fabaceae | Rahu Chondal | whole plant | Bagerhat |
| 33      | Wissadula perfoliata (L.) C. Presl ex Thwaites | Malvaceae | Naq-moni | leaf, root | Chalna, Khulna |

**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       | Acharyantes aspera L. | Acharantheaceae | Chaim-per-on; Mimang-khache | root, leaf, stem; seed | Rakhain tribe, Chittagong Hill Tracks; Garo Tribe, Netrokona |
| 2       | Amaranthus virides L. | Acharantheaceae | Gandhohi ara | whole plant | Santal tribe, Rajshahi |
| 3       | Asparagus racemosus Wild (雞冠花 chî guân huá) | Liliaceae | Mimang-chamache | root | Garo tribe, Netrokona |
| 4       | Emblica officinalis Gaertn | Euphorbiaceae | Chele-chibong | fruit, bark, root | Rakhain tribe, Chittagong Hill Tracks |

Interviewed patients 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 health care, 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.\(^24\) It is already proved that the methanolic extract and fractions of *Seranjia 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*, *Peopelitis perucca*, *Brownnea rosademonte*, *Bixa orellana* (紅木 hóng mù), *Trichomanes elegans*, *Struthanthus orbiculareis* and *Casearia sylvestris* (林生腳脚脹 lín shēng jiǎo gòu)) describe the inhibitory effect of all or part of the coagulant activity of snake venoms from *B. asper*, *B. jararacussu*, *B. piraajasi*, *B. neuwiedi*, *B. mojeni* 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 decoction, extracts, paste and juice. Some of these plants like *Emblica officinalis* (油柑 yòu gān) and *Rauwolfia serpentina* (印度蛇木 yín dù shé mù) have been reported to have antivenom-venom activity in various ethnomedical studies.\(^29\),\(^30\) The reported plants may contain flavonoids, tannins or some other new lead compounds which...
possess 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-hemorrhagic 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 plants used in traditional medicine are able to antagonize the variety of crude venoms and purified toxins.

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. (緑藤草 ㄌ lì cháng cǎo), Curcuma longa (薑黃 jiàng huáng), Hibiscus esculentus (秋葵 qiú kūi), Casearia sp., Musa paradisiaca (香蕉 xiāng jiāo), Macuna pruriens (攀豆 lǐ dòu), Bauhinia forficata (羊蹄 tī yáng tī jiǎ), Annona senegalensis, Mikania glomerata, Piper sp. (胡椒 hú jiāo), Cordia verbenaaceae (破布子 pò bù zǐ), Pentaclethra macroloba and others.6,14,19 Many active ingredients from snake venoms have been purified. Their molecular structures have been identified and characterized in the most advanced laboratories.45–47 Many other plants such as Aristolochia albida (廣防己 guǎng fáng jǐ); Vitex negundo (黃精 huáng jīng), Emblica officinalis (油柑 yóu gān), Strychnos nux vomica (馬錢子 mà qián zi), Hemidesmus indicus (積雪 bái qià) and Mimosa pudica (含羞草 bài 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.

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. Particularly plants like Rauwolfia serpentina L. (印度蛇木 yì dū shé mù), Emblica officinalis Linn (油柑 yóu gān), Aristolochia indica L. (馬兜鈴 má dōu líng) and Morinda citrifolia L. (緑蔥果 luò guǒ) have a high consensus agreement 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 approval

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

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