Research Article

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

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Snakebites are common in tropical countries like Bangladesh where most snakebite victims dwell in rural areas. Among the management options after snakebite in Bangladesh, snake charmers (Ozha in Bengali language) are the first contact following a snakebite for more than 80% of the victims and they are treated mostly with the help of some medicinal plants. Our aim of the study is to compile plants used for the treatment of snakebite occurrence in Bangladesh. The field survey was carried out in a period of almost 3 years. Fieldwork was undertaken in Chittagong Hill Tracts, Bangladesh, including Chittagong, Rangamati, Bandarban, and Khagrachari. Open-ended and semistructured questionnaire was used to interview a total of 110 people including traditional healers and local people. A total of 116 plant species of 48 families were listed. Leaves were the most cited plant part used against snake venom. Most of the reported species were herb in nature and paste mostly used externally is the mode of preparation. The survey represents the preliminary information of certain medicinal plants having neutralizing effects against snake venoms, though further phytochemical investigation, validation, and clinical trials should be conducted before using these plants as an alternative to popular antivenom.

1. Introduction

Snakebite, caused by a bite from a snake, is an accidental injury, which results in puncture wounds inflicted by the animal’s fangs and sometimes causes envenomation. Snakes are carnivorous vertebrates of the class Reptilia, order Squamata, and suborder Serpentes. Snakes usually kill their prey with constriction rather than venom, though venomous snakes can be found on every continent except Antarctica [1]. 15% of the almost 3000 known species of snakes are venomous [2–4] and, in South Asia, four species were thought to be responsible for causing almost all the deadly cases of venomous snakebites which are referred to as the “big four,” which include the Indian cobra (Naja naja), the common krait (Bungarus caeruleus), Russell’s viper (Daboia russelii), and the saw-scaled or carpet viper (Echis carinatus). However, other venomous snakes may also be found in this area [5–7] and thus represent a major cause of morbidity and mortality to humans [8–11]. Exact numbers on the global prevalence of snakebites and the percentage of severe or fatal cases are largely unknown [12]. However, at least 421,000–1,841,000 envenoming and 20,000–94,000 deaths occur worldwide each year due to snakebite [1]. According to Williams et al. [13] these events surpass the number of deaths from tropical diseases such as hemorrhagic fever, dengue, cholera, leishmaniasis, and the Chagas disease.

Incidence of snakebites in Bangladesh is very high like other tropical countries of Southeast Asia [1]. Here most snakebite victims dwelling in rural areas are farmers, fishermen, and hunters [7–9] and also there are a high number of
snakebite occurrences that happened at their homes as most of the snakes are nocturnal animals and poor people have the practice of sleeping on the floor [7]. An epidemiological study estimated about 8000 snakebites per year with 22% mortality which has been identified to be one of the highest in the world [10, 14]. Nonetheless, there are approximately 80 species of snakes found in Bangladesh; among them only few are venomous. These are cobra, krait, Russell’s viper, saw-scaled viper, green snakes, and sea snakes. However, most of the bites are reported by nonvenomous snakes and even as many as 40% bites inflicted by venomous snakes do not produce signs of envenoming [15].

Antivenom is the only therapeutic agent against snake venom available throughout the world. These antivenoms have highly effective neutralizing systemic effects but show some limitations in the inhibition of the local disorders [16, 17] and also a chief drawback of serum therapy is its excessive cost and likelihood that victims are often at some distance away from availability of modern treatment when bitten as antivenom treatment should be sought as soon as possible for their potential efficacy. Moreover, there is a crisis in the quality and supply of antivenom serum in the rural areas where most incidences of snakebites occurred [18]. These problems could be subsided by using traditional plant based treatment since approximately 700 plant species are known to possess potential antivenom [19–22].

Ethnopharmacological survey is important for the conservation and utilization of biological resources [23] since of the 422,000 flowering plants found globally [24] more than 50,000 are used for medicinal purposes [25] and these plants contribute to 33% of drugs produced worldwide [26]. To date approximately more than 6,000 species of indigenous and naturalized plants have been identified out of which more than one thousand contain medicinally useful chemical substances [27, 28]. Due to this rich diversity apparently more than 80% of the Bangladesh use alternative (Ayurveda, Siddha, Unani, and Homeopathy) medicines for their healthcare and herbs constitute a major source of these alternative systems of medicine [29, 30].

Several ethnobotanical investigations have been carried out at different parts of the world to explore the herbal treatment against snakebite [16, 31–35]. But there are very few ethnobotanical surveys carried out in Bangladesh to explore the medicinal plants used here in the treatment of snakebite. The present study was conducted in order to document the traditional knowledge of the medicinal plants used by the traditional healers of Bangladesh for treating against snakebite.

2. Materials and Methods

2.1. Study Area. The study was conducted in four districts in Chittagong Hill Tracts (Figure 1) in Bangladesh which is located in South Asia and bordering India and Myanmar and by the Bay of Bengal to the south (latitudes 20° and 27° N and longitudes 88° and 93° E) with population over 162 million having 35 smaller groups of indigenous people. The vegetation type of the study area falls under tropical evergreen and semievergreen forests. More than 3 million people live in this

Figure 1: Map of Chittagong Hill Tracts, Bangladesh.
study area and these people mostly depend on the resources coming from the hilly areas [36].

2.2. Informants and Ethnomedicinal Data Collection. The survey was conducted in the official language of Bangladesh, Bengali language, from January 2010 to December 2012. Objectives of the survey were explained to the local communities during social gatherings arranged by local people familiar with well-known traditional health practitioners (THPs). While meeting with indigenous populations who had mother language different from the state language, help from local bilingual translator was taken. Special emphasis was given in seeking out people who had the empirical knowledge on medicinal plants and experience in the use of traditional medicinal plants. Personally administered method was followed during the survey. Open-ended and semistructured questionnaire was used [37, 38] for this study seeking for the following information: (a) the local name, (b) plants part/s used, (c) the method of preparation, (d) solvent/adjuvant used, (e) mode of application, (f) gastrointestinal and other medicinal uses, (g) voucher specimen number, and (h) dose and dosage forms. After completion of survey, consultation with Botanist Mr. Manzur-ul-Kadir Mia, M.D., Former Principal Scientific Officer and Consultant of Bangladesh National Herbarium, Dhaka, was carried out for getting identification, scientific names, family names, habit, habitat, nature, relative abundance, and preservation of the species. The voucher specimens of the plants were deposited in Bangladesh National Herbarium, Dhaka (DACB).

2.3. Data Analysis. All the species were listed in alphabetical order by their scientific name, family, local name, general name, plants parts used, mode of preparation, habit, habitat, relative abundance, nature, general name, solvent used, and frequency of citation (FC). Here FC is defined as the ratio of “number of times a particular species was mentioned” and “total number of times that all species were mentioned” multiplied by 100. All the data such as frequency distributions were calculated by using SPSS 16.0.

3. Results

3.1. Informants. Among the 110 interviewees, major informants were male (65%), aged (regardless of gender) 50–60 years (31%), mostly with 5 years of institutional education (44%), and having 10–20 years of relevant experience (34%) (Table 1).

3.2. Plants Using in Treatment of Snakebite and Other Relevant Information. 116 plant species belonging to 48 plant families have been identified as being used in the treatment of snakebite by traditional healers in Bangladesh. The largest number of species was noted from the family Fabaceae (10 species), followed by Apocynaceae (8 species), Caesalpiniaceae (7 species), and Euphorbiaceae (6 species) (Figure 2).

Leaves (43%) were the most frequently used plant parts, followed by roots (27%) and roots stem (9.4%) (Figure 3). The major mode of preparation is paste (69.3%) followed by juice (21%) and powder (11.23%). Preparations were made with water, honey, wine, lime water, and milk as solvent. The mode of administration was oral (31.9%), topical (56.03%), and oral and topical (12.07%) (Figure 4). 32% of the reported species were herb which was followed by tree (23.3%) and climber (9.5%). Most of the plants are wild (70%) and some are cultivated (18%), whereas others are both cultivated and wild (Table 2). The species Rauwolfia serpentina, Allium cepa, Aristolochia indica, Costus speciosus, Emblica officinalis, Hemidesmus indicus, Leucas aspera, and Vitex negundo were the most frequently cited in study area. The doses of the available plants are presented in Table 3.

4. Discussion

Fabaceae is the most dominant family in the current investigation. This is perhaps because of worldwide prevalence of the species from this family [112, 113]. Leaves were the major plant parts used solely or mixed with other parts in the treatment of snakebite. Ease of collection of leaves is the prime reason compared to roots, flowers, and fruits [114–116]. On the other hand, herbs and trees were the most common habit of the reported plants which might be attributed to the huge number of trees or herbaceous plants naturally abundant in this hilly area [117].
It was very common that blend of different adjuvant including other plant parts was used for the preparation of medication to counteract snake venom. Several researchers also reported this kind of polyherbal treatment [118–121]. The frequent use of multiple plant remedies might be illustrated by the phenomenon of synergistic actions where two or more plants produce an effect greater than the sum of their individual effects [122]. This is particularly true in case of medicinal plant treatment, since each medicinal plant contains numerous pharmacologically active compounds [118].

Among the management options after snakebite, snake charms (Ozha in Bengali language) were the first contact following a snakebite for more than 80% of the victims in these areas [10]. We also noticed that the field of “snakes and snakebite” has a mythological fragrance in the mind of people living here. The Ozha not only depends on herbal remedies but also recites mantras (magical/mystical words) to enthral people. There are also potentially harmful approaches reported few of which are making multiple incisions around the bite site, incorrect application techniques in...
| S/L number | Scientific name | Bangla/Bengali name | English name | Family | Habit | Habitat | Nature | Plants parts used | Preparation | Solvent/ adjuvant | Mode of application | Voucher specimen |
|------------|----------------|---------------------|--------------|--------|-------|---------|--------|-----------------|-------------|-----------------|-------------------|------------------|
| 1          | *Abelmoschus moschatus* Medic. | Latakasturi | Musk mallow | Malvaceae | Hf, Rs | W | Fr, L, S | J, Pa | M/sugar, W | O, T | Hf, Rs | 0.25 | MFK 240 (DACB) |
| 2          | *Abrroma augusta* Linn. f. | Ulatkambal | Devil's cotton | Sterculiaceae | Sh | Hf | W | L, R, St | Pa | H, W | T | 1.59 | MFK 75 (DACB) |
| 3          | *Abrus precatorius* L. | Kunch, Rati | Indian liquorice | Fabaceae | CI | Hf, Hs | W | S | P | Andrographis paniculata, lemon juice | O | 0.12 | JRK 111 (DACB) |
| 4          | *Acacia farnesiana* (L.) Willd., *Vachellia farnesiana* (L.) W. and A. | Belati babul, Gokul | Needle bush | Mimosaceae | T | G | Cu | R | Pa | T | 0.13 | JRK 127 (DACB) |
| 5          | *Aclypha indica* L. | Mukta jhuri | Indian nettle | Euphorbiaceae | H | Rs, Wp | Cu, W | Wp | Pa | T | 0.21 | MSBS 143 (DACB) |
| 6          | *Achyranthes aspera* L. | Apang | Prickly chaff flower | Amaranthaceae | Sh/Wh | Rs, Wp | W | L, S, Wp | P | O, T | 2.37 | JRK 172 (DACB) |
| 7          | *Acorus calamus* L. | Bach, sated bach, shet bach | Sweet flag | Araceae | H | Mp | Cu | Rh | Pa | W | O | 0.15 | JRK 97 (DACB) |
| 8          | *Aegle marmelos* (L.) Corr. Serr. | Bel, bela, bilbo | Bael fruit, Bengal quince | Rutaceae | T | Hs | Cu | Wp | Pa | Rice beer | O, T | 2.41 | JRK 37 (DACB) |
| 9          | *Ageratum conyzoides* L. | Sahadevi | Flossflower, goat weed, white weed | Asteraceae | H | Wp | W | L | Pa | T | 0.14 | JRK 43 (DACB) |
| 10         | *Albizia lebbeck* (L.) Benth. | Siris, Sirisha | Siris tree | Mimosaceae | T | F | Cu | Fl | Pa | T | 0.18 | MFK 209 (DACB) |
| 11         | *Albizia procera* (Roxb.) Benth. | Korai | Golden trumpet | Mimosaceae | T | Hf, Hs | Cu, W | R | Pa | T | 0.22 | JRK 17 (DACB) |
| 12         | *Allium cepa* L. | Pandalu, Piyaj | Onion | Liliaceae | H | G | Cu | Bu | J | Mustard oil | O | 3.87 | JRK 35 (DACB) |
| 13         | *Alstonia scholaris* R. Br. | Chatim | Devil's Tree, Dita Bark Tree | Apocynaceae | T | Hf | W | B, Fl, G, L, R | D, J | M, W | O | 2.32 | MFK 110 (DACB) |
| 14         | *Amaranthus spinosus* L. | Kanta note | Amaranthus | Amaranthaceae | H | Hf, Rs, v1 | W | L, R, Wp | I, Pa | W | T | 0.30 | MSBS 43 (DACB) |
| 15         | Andrographis paniculata (Burm. f.) Wall ex Nees., Justicia paniculata Burm. f. | Kalmegh, Maha-tita | Creyat root | Acanthaceae | H | Vt | W | L, R | Pa | H, W | O | 0.29 | JRK 57 (DACB) |
| S/L number | Scientific name                          | Bangla/Bengali name | English name                                           | Family         | Habit | Habitat | Nature | Plants parts used | Preparation | Solvent/ adjuvant | Mode of application | FC  | Voucher specimen |
|-----------|-----------------------------------------|---------------------|--------------------------------------------------------|----------------|-------|---------|--------|------------------|-------------|-------------------|---------------------|-----|------------------|
| 16        | *Annona squamosa* L.                    | Ata, Sharifa        | Custard apple of India, sweet or sugar apple of the W. Indies and America | Annonaceae     | T     | F       | Cu     | Fr               | J           | W                 | T                   | 0.34| MFK 12 (DACB)    |
| 17        | *Argemone mexicana* L.                  | Baro shial kanta, shial kanta | Mexican or prickly poppy | Papaveraceae   | Sh    | Hf      | W      | L, S             | Pa          | T                 | 0.24                | MFK 176 (DACB)     |
| 18        | *Aristolochia indica* L.                | Isharmul            | Indian birthwort                                        | Aristolochiaceae | Wh    | F, Hf   | W      | L, R             | Pa          | H                 | O                   | 3.53| MSBS 61 (DACB)   |
| 19        | *Asparagus racemosus* Wild.             | Satamuli            | Chinese gooseberry                                       | Liliaceae      | Cl    | Hf, Hs  | Cu, W  | L               | Pa          | T                 | 2.50                | MSBS 79 (DACB)     |
| 20        | *Bacopa monnieri* (L.) Pennell          | Brahmi sak, adha birni, Dhop chamni | Thyme-leaved gratiola                                  | Scrophulariaceae | Cr    | F, Hf   | W      | L               | Pa          | P                 | M/black tea         | 0.04| MFK 144 (DACB)   |
| 21        | *Baliospermum montanum* L.              | Danti mool          | Wild croton                                              | Euphorbiaceae  | Sc    | Hf      | W      | L               | Pa          | T                 | 0.06                | JRK 10 (DACB)      |
| 22        | *Bauhinia variegata* L.                 | Rokto kanchan, sweet kanchan | Camel's foot tree, mountain tree, orchid tree           | Fabaceae       | T     | Rs      | Cu     | B, St            | Pa          | T                 | 0.11                | JRK 28 (DACB)      |
| 23        | *Begonia barbata* C.B. Clarke           | Bini gach           | Bignoniacae                                             | Heliocapniae   | H     | Mp      | W      | L, St            | Pa          | T                 | 0.17                | JRK 68 (DACB)      |
| 24        | *Bixa orellana* L.                      | Utkana              | Monkey turmeric                                         | Bixaceae       | T     | Hs      | Cu     | Fr, L, R, S      | D           | W                 | O                   | 1.85| JRK 91 (DACB)    |
| 25        | *Bombax ceiba* L., *B. malabaricum* DC., *Salmalia malabarica* Schott & Endl. | Simul, Shimul, Rokto simul | Red cotton tree, silk cotton tree                        | Bombaceae      | T     | Hf      | Cu     | Fr, S            | Pa          | H/black peppers seed, camphor | O | 0.31| MSBS 45 (DACB) |
| 26        | *Buchanania lanzan* Spreng., *B. latifolia* Roxb. | Piyal, Chikki     | Chironji tree                                           | Anacardiaceae  | Cl    | F       | W      | B               | Pa          | T                 | 0.10                | MFK 14 (DACB)      |
| 27        | *Butea monosperma* (Lamk.) Taub., *B. frondosa* Koen ex Roxb. | Palas              | Butea gum tree, flame of the forest, parrot tree, Bastard teak, Bengal kink | Fabaceae       | T     | Rs      | Cu     | Stb              | Pa          | Z                 | O                   | 0.18| MFK 65 (DACB)    |
| 28        | *Byttneria pilosa* Roxb.                | Harjora             | Sterculiaceae                                           | Sc              | Hf    | W      | L, St  | Pa               | T           | O                 | 0.11                | MSBS 92 (DACB)     |
| 29        | *Cajanus cajan* (L.) Huth.              | Arhar              | Pigeon pea                                              | Fabaceae       | S     | Hs      | Cu     | S               | Pa          | Leaf juice of *Senna tona* | T  | 1.81| MSBS 113 (DACB) |

Table 2: Continued.
| S/L number | Scientific name | Bangla/Bengali name | English name | Family | Habit | Habitat | Nature | Plants parts used | Preparation | Solvent/ adjuvant | Mode of application | FC | Voucher specimen |
|------------|-----------------|---------------------|--------------|--------|-------|---------|--------|------------------|-------------|-------------------|---------------------|----|-----------------|
| 30         | Calotropis procera (Ait.) Ait. f. | Choto akanda, sweet akanda | Swallow wort | Asclepiadaceae | Sh | Rs, Wp | W | Fl, La, R | J, P | Black pepper | O, T | 0.47 | JRK 56 (DACB) |
| 31         | Calotropis gigantea (L.) Ait. f. | Baro akanda, Gurtakand, sweet akand | Giant milk weed, swallow wort | Asclepiadaceae | Sh | Rs, Wp | W | R | Pa | M | O | 0.55 | MFK 169 (DACB) |
| 32         | Calycopteris floribunda Lamk. | Guicha Lata | Calycopteris | Combretaceae | Sc | Hf | W | R | J | W | T | 1.55 | MFK 173 (DACB) |
| 33         | Capparis zeylanica L., C. horrida L. f. | Asahia, Baganai, Kalekera | Capparaceae | Sh | Vt | W | Fr, S | P | W | O | 0.20 | JRK 44 (DACB) |
| 34         | Capsicum annuum L. | Marich | Red pepper | Solanaceae | H | G, Hs | Cu | Fr | Pa | T | 0.23 | MFK 170 (DACB) |
| 35         | Cassia fistula L. | Bandar lathi, Gurmata, sonali | Golden shower, Indian laburnum, purging cassia | Caesalpiniaeae | T | Rs | Cu | Fr | P | T | 1.63 | MFK 149 (DACB) |
| 36         | Cassia occidentalis L. | Bala kalkesunde | Coffee senna | Caesalpiniaeae | H | Vt, Wp | W | R | Pa | G | O | 0.39 | JRK 79 (DACB) |
| 37         | Cassia sophera L. | Kalkeshande | Pertwinkle | Caesalpiniaeae | H | Hf, Hs | W | R | Pa | Black pepper | O | 0.15 | JRK 11 (DACB) |
| 38         | Cassia tora L. | Chakunda, Panevar | Foetid cassia | Caesalpiniaeae | H | Rs, Wp | W | L, R, S | Pa | T | 0.10 | JRK 9 (DACB) |
| 39         | Catharanthus roseus G. Don. | Noytara | Madagascar periwinkle | Apocynaceae | H | Hf | W | L | Pa | W | T | 2.28 | MFK 53 (DACB) |
| 40         | Chenopodium album L. | Betu sak, Betua sak | Fat-hen, goose foot, lamb's quarters | Chenopodiaceae | H | G | Cu | Fr, R | Pa | T | 0.61 | MSBS 51 (DACB) |
| 41         | Cissampelos pareira L. | Akanadi, Eklia, Nemuka | False pareira brava | Menispermaceae | Cl | Hf | W | R | D, Pa | Pepper | O | 0.28 | MSBS 57 (DACB) |
| 42         | Cissus adnata Roxb. | Bhatia lota | Endeavour river vine | Vitaceae | We | Hf | W | L | Pa | T | 0.37 | MSBS 37 (DACB) |
| 43         | Cissus javana DC. | Kongngouyen laba | Climbing begonia | Vitaceae | Ch | Hf | W | L, St | Pa | Lw | T | 0.12 | MSBS 64 (DACB) |
| 44         | Clerodendrum viscosum Vent. | Bhatt | Clerodendrum | Verbenaceae | Sh | Hf, Rs, Vt, Wp | W | Fl, L | Pa | W | T | 0.23 | MFK 207 (DACB) |
| 45         | Clitoria ternatea L. | Aparajita | Baby watermelon, ivy gourd | Fabaceae | Cl | Hs | Cu | R | P | M | O | 0.31 | MSBS 114 (DACB) |
| S/L number | Scientific name | Bangla/Bengali name | English name | Family | Habit | Habitat | Nature | Plants parts used | Preparation | Solvent/ adjuvant | Mode of application | FC | Voucher specimen |
|------------|-----------------|---------------------|--------------|--------|-------|---------|--------|-------------------|-------------|----------------|-------------------|----|-----------------|
| 46         | Costus speciosus (J. Koenig) Sm. | Kneu | Costus | Costaceae | H     | Hf, Rs | W     | Bu, L, S | I, J, Pa     | W             | O, T            |               | 3.01 | MSBS 62 (DACB) |
| 47         | Curculigo orchioides Gaertn. | Talmuli | Black musale | Hypoxidaceae | H     | F, Hf | W     | Bu, L | D, I | M, W           | O             |               | 0.35           | (DACB) |
| 48         | Cycas pectinata Griff. |            |            | Cycadaceae | T     | F     | W     | Fl   | Pa           | T             |               | 0.49           | (DACB) |
| 49         | Cynodon dactylon Pers. | Durba, Dubla | Bahama grass, Bermuda, Dhub grass | Poaceae | Gr    | G, Vt, Wp | W     | Wp   | Pa           | T             |               | 0.12           | (DACB) |
| 50         | Cyperus rotundus L. | Bada, Mutha | Nut grass | Cyperaceae | Gr    | G     | W     | Bu   | P           | Butter        | T              | 0.17           | (DACB) |
| 51         | Datura metel L., D. fastuosa L., D. alba Nees | Dhuturra | Thorn apple | Solanaceae | Sh    | Rs, Wp | W     | L, S | Pa           | T             |               | 0.81           | (DACB) |
| 52         | Desmodium gangeticum (L.) DC. | Shalparni | Salpani | Fabaceae | H     | F, Hf, Rs | W     | Wp   | D           | M, W         | O              | 2.24           | (DACB) |
| 53         | Desmodium triflorum (L.) DC. | Tripatri | Fabaceae | Us     | Mp    | W     | Sh   | J    | O           |               |                 | 0.72           | (DACB) |
| 54         | Eclipta prostrata L., E. alba (L.) Hask | Kalokesh, Keshori, Keshrangan, Kesuthi, Keysuria | False daisy | Asteraceae | H     | F, Hf | Cu   | L    | Pa           | T             |               | 0.75           | (DACB) |
| 55         | Emblica officinalis Gaertn., Phyllanthus emblica L. | Amla, Amalaki, Amluki | Emblic myrobalan, Indian gooseberry | Euphorbiaceae | T     | F, Hs | Cu   | St   | I           | O             |               | 2.84           | (DACB) |
| 56         | Entada rhededi Spreng. | Gila lata | Mimosaceae | Wc    | F, Hf | W     | L    | Pa   | T           |               |                 | 0.06           | (DACB) |
| 57         | Erythrina variegata L., E. indica Lam. | Mandar, Palita mandar | Coral tree | Fabaceae | T     | Hs    | Cu   | Fl, Rb | Pa          | O, T         |                 | 1.42           | (DACB) |
| 58         | Euphorbia hirta L. | Bara kerui, Baro keruee, dudhia | Euphorbiaceae | H     | Vt, Wp | W     | R, Wp | J     | W           | O             |                 | 0.37           | (DACB) |
| 59         | Ficus racemosa L. | Jagya dumur, Yajna dumur | Moraceae | T     | Vt    | W     | B, S | D, Pa | O, T       |               |                 | 0.38           | (DACB) |
| 60         | Flacourtia indica (Burm. f.) Merr. | Benchi | Flacourtia | Sh    | F, Hf | W     | L    | Pa   | T           |               |                 | 0.26           | (DACB) |
| S/L number | Scientific name | Bangla/Bengali name | English name | Family | Habit | Habitat | Nature | Plants parts used | Preparation | Solvent/adjuvant | Mode of application | Voucher specimen |
|------------|-----------------|---------------------|--------------|--------|-------|---------|--------|------------------|-------------|----------------|------------------|-----------------|
| 61         | *Gmelina arborea* L. | Gamar | Indian sarsaparilla | Verbenaceae | T | Hf, Hs | W | R | Pa | H | O | 1.37 | MSBS 73 (DACB) |
| 62         | *Hedyotis scandens* Roxb. | Bijoma | | Rubiaceae | Sc | Mp | W | L, St | Pa | T | 0.14 | MFK 224 (DACB) |
| 63         | *Helicteres isora* L. | Atmora | East Indian screw tree | Sterculiaceae | Sh | F, Vt | W | R | D | O | 0.19 | MSBS 233 (DACB) |
| 64         | *Hemidesmus indicus* (L.) R. Br. | Anantamul | Country sarsaparilla, Indian sarsaparilla | Apocynaceae | Cl | Hs, Rs, Vt | W | R | Pa | 2.75 | MFK 218 (DACB) |
| 65         | *Holarrhena antidysenterica* (Heyne ex Roth.) Conessi | Kurchi, indrajab | | Apocynaceae | T | F, Hf | W | B, R | Pa | W | O, T | 0.38 | JRK 14 (DACB) |
| 66         | *Holarrhena pubescens* (Buch.-Ham.) Wall. | Kurchi | | Apocynaceae | T | Hf | W | S | Pa | T | 0.51 | MFK 217 (DACB) |
| 67         | *Homalomena aromatica* (Roxb. ex Sims) Schott. | Gandhabi | | Araceae | H | Hf | W | Rh | Pa | T | 0.40 | JRK 55 (DACB) |
| 68         | *Hyptis suaveolens* (L.) Poit. | Bilati tuki, Tokmadana | Pignut | Lamiaceae | H | Hf, Mp | W | L | J | T | 1.50 | JRK 16 (DACB) |
| 69         | *Ichnocarpus frutescens* (L.) Br. | Dudhilara | | Apocynaceae | Cl | Hf, Hs | W | R | Pa | O | 2.19 | MFK 55 (DACB) |
| 70         | *Ixora cuneifolia* Roxb. | Kha muchey | | Rubiaceae | Sh | F | W | B | Pa | T | 0.03 | JRK 20 (DACB) |
| 71         | *Jatropha gossypifoila* L. | Lal verenda | Bellyache nettle spurge | Euphorbiaceae | Sh | F, Rs | W | L, S | D | W | O | 0.27 | MFK 46 (DACB) |
| 72         | *Justicia gendarussa* Burk. | Jagatmadan | Indian lilac | Acanthaceae | Sh | Hf, Hs | W | L | Pa | O | 2.15 | MFK 247 (DACB) |
| 73         | *Lantana camara* L. | Kutus kanta | | Verbenaceae | Sh | Hf | W | Fl, R, St | D | O | 1.46 | MSBS 170 (DACB) |
| 74         | *Leucas aspera* (Willd.) Link. | Danda kalas | Litchi | Lamiaceae | H | Hf, Hs | W | L | J, Pa | Black pepper, garlic | In | 2.67 | MFK 33 (DACB) |
| 75         | *Mangifera indica* L. | Aam | Mango | Anacardiaceae | T | G, Hs | Cu | L | Pa | T | 1.76 | MSBS 181 (DACB) |
| 76         | *Melastoma malabathricum* L. | Bomang raja | Indian rhododendron | Melastomataceae | Sh | F | W | L | J | T | 0.30 | MFK 232 (DACB) |
| 77         | *Melochia corchorifolia* L. | Bonpat, Tikiokra | Chocolate weed | Sterculiaceae | T | F, Vt | Cu | L | Pa | T | 0.18 | MSBS 169 (DACB) |
Table 2: Continued.

| S/L number | Scientific name                  | Bangla/Bengali name | English name | Family            | Habit | Habitat | Nature | Plants parts used | Preparation | Solvent/ adjuvant | Mode of application | FC  | Voucher specimen |
|------------|----------------------------------|---------------------|--------------|-------------------|-------|---------|--------|-------------------|-------------|-------------------|----------------------|-----|------------------|
| 78         | *Mikania cordata* (Burm. f.) Roxb. | Ashamlata           | Climbing hemp | *Asteraceae*      | Sc    | Hf, Rs, Wp | W      | L                | Pa          | T                 | 0.31                 |     | MFK 199 (DACB)   |
| 79         | *Mimosa pudica* L.               | Lajak, Lajjabati, Lajwati | Sensitive plant | *Mimosaceae*      | Wh    | Hs, Rs, Vt | W      | L, R              | Pa          | T                 | 2.11                 |     | MFK 94 (DACB)    |
| 80         | *Mirabilis jalapa* L.            | Krishnakali         | Marvel of Peru | *Nyctaginaceae*   | H     | G, Mp     | Cu     | L                | J           | W                 | O, T                  | 0.16 | MSBS 142 (DACB)  |
| 81         | *Morinda angustifolia* Roxb.     | Rang gach           | Rubiaceae     | F                 | Sh    | F         | W      | L                | J           | O                 | 0.09                 |     | JRK 15 (DACB)    |
| 82         | *Morinda persicifolia* Ham.      | Rang gach           | Rubiaceae     | F                 | Sh    | F         | W      | L                | Pa          | T                 | 2.06                 |     | MFK 10 (DACB)    |
| 83         | *Moringa oleifera* Lamk.         | Sajna                | *Moringaceae*  | T                 | Hs    | Cu        | R      | Pa                | T           | 2.45               |                      |     | MFK 16 (DACB)    |
| 84         | *Mucuna pruriens* Baker          | Alkushi              | *Fabaceae*     | Cl                | Hf, Hs | W         | S      | Pa                | T           | 1.29               |                      |     | JRK 60 (DACB)    |
| 85         | *Mussaenda roxburghii* Hook. f. | Ranirtak            | Rubiaceae     | Sh                | F     | Mp        | W      | L                | Pa          | T                 | 0.27                 |     | JRK 41 (DACB)    |
| 86         | *Ocimum basilicum* L.            | Babul tuhsi, Kali tuhsi, Pashanbeddie | Common basil, sweet basil | *Lamiaceae* | H     | F, Rs     | W      | Wp               | Pa          | T                 | 0.96                 |     | MSBS 98 (DACB)   |
| 87         | *Oroxylum indicum* Vent.         | Nasona, Sonas, Sonpati | Broken bones, Indian trumpet flower, midnight horror | *Bignoniaceae* | T     | F, Hf, Vt | W      | B                | Pa          | T                 | 2.02                 |     | MFK 175 (DACB)   |
| 88         | *Oxalis corniculata* L.          | Amrul shak, Chuka tripati | Indian sorrel, yellow oxalis | *Oxalidaceae* | H     | Mp        | W      | L                | Pa          | T                 | 0.86                 |     | MSBS 32 (DACB)   |
| 89         | *Peliosanthes teta* Andr.        | Fuji ghash          | Liliaceae      | H                 | F     | W         | Rt     | Pa                | T           | 0.36               |                      |     | MSBS 53 (DACB)   |
| 90         | *Peperomia pellucida* (L.) HBK   | Luchi pata          | Piperaceae     | H                 | Vt    | W         | Sh     | J                | O           | 0.15               |                      |     | JRK 21 (DACB)    |
| 91         | *Piper nigrum* L.                | Golmorich, Kala morich | Black pepper | Piperaceae        | Cl    | G         | Cu     | R                | Pa          | T                 | 0.57                 |     | MFK 181 (DACB)   |
| 92         | *Plumbago zeylanica* L.          | Chita, Chitrak, Sada chita, Sufaid | Ceylon leadwort, white flowered leadwort | *Plumbaginaceae* | H/Us   | F, G       | Cu, W  | R                | Pa          | T                 | 0.28                 |     | JRK 155 (DACB)   |
| 93         | *Polygonum chinense* L.          | Chinese knotweed    | Polygonaceae   | H                 | Rs, Vt | W         | L      | Pa                | T           | 0.15               |                      |     | JRK 2133 (DACB)  |
| S/L number | Scientific name                | Bangla/Bengali name      | English name | Family          | Habit | Habitat | Nature | Plants parts used | Preparation | Solvent/ adjuvant | Mode of application | FC | Voucher specimen |
|------------|--------------------------------|--------------------------|--------------|-----------------|-------|---------|--------|------------------|-------------|------------------|---------------------|----|------------------|
| 94         | *Pouzolzia indica* Gaud.      | Bormajal                 |              | Urticaceae      | H     | Mp      | W      | L               | Pa          | T                |                     | 0.16 | MFK 69 (DACB)    |
| 95         | *Premna esculenta* Roxb.      | Lelom pata               |              | Verbenaceae     | S     | F       | W      | L               | Pa          | T                |                     | 0.06 | MFK 77 (DACB)    |
| 96         | *Rauwolfia serpentina* (L.) Benth. ex Kurz | Sarpagandha              |              | Apocynaceae     | H     | Hf, Hs  | Cu, W  | L, R, Rh         | D, Pa       | M                | O, T                | 3.98 | MFK 66 (DACB)    |
| 97         | *Senna hirsuta* (L.) Irwin & Barneby | Kanduak                  |              | Caesalpiniaceae | H     | F, Mp   | W      | L               | Pa          | T                |                     | 0.73 | MSBS 17 (DACB)   |
| 98         | *Senna tora* (L.) Roxb.       | Chakunda, Kalkasham      |              | Caesalpiniaceae | H     | Rs, Wp  | W      | L               | Pa          | T                |                     | 0.14 | MSBS 144 (DACB)  |
| 99         | *Sida acuta* Burm.            | Kureta                   |              | Malvaceae       | Wh    | Hf, Hs  | W      | L               | Pa          | T                |                     | 1.98 | MFK 61 (DACB)    |
| 100        | *Sida cordifolia* L.          | Bala, Barela             |              | Malvaceae       | H     | F       | W      | L               | J           | O                |                     | 0.10 | MSBS 191 (DACB)  |
| 101        | *Sida rhombifolia* L.         | Kureta, Lal berela       |              | Malvaceae       | H     | Hf, Wp  | W      | L, St            | J, Pa       | O, T              |                     | 0.25 | JRK 170 (DACB)   |
| 102        | *Solanum torvum* Swartz.      | Gota, Titbegun           |              | Solanaceae      | Sh    | Hf, Hs  | W      | R               | J           | Mustard oil, ammonium chloride | O, T | 0.31 | JRK 112 (DACB)  |
| 103        | *Streblus asper* Lour.        | Sheowra                  |              | Moraceae        | T     | Hf      | W      | R               | J, P        | T                |                     | 0.21 | MFK 117 (DACB)   |
| 104        | *Syzygium cumini* (L.) Skeels., *Eugenia jambolana* Lamk. | Jam, Kalojam             |              | Myrtaceae       | T     | G, Hs   | Cu,     | B               | Pa          | T                |                     | 1.93 | MFK 130 (DACB)   |
| 105        | *Tamarindus indica* L.        | Tetai, Tetul, Tintil     |              | Caesalpiniaceae | T     | G, Hs   | Cu     | Wp              | P           | H                | O                   | 1.68 | JRK 57 (DACB)    |
| 106        | *Tephrosia purpurea* (L.) Pers. | Ban nil                  |              | Fabaceae        | Sh    | Rs      | Cu, W  | R               | Pa          | T                |                     | 0.07 | JRK 30 (DACB)    |
| 107        | *Terminalia arjuna* (Roxb.) Wt. & Arn. | Arjun, Arjuna, Kahu     |              | Combretaceae    | T     | F       | Cu     | Sfb             | P, Pa       | H, M/black pepper | O                   | 1.89 | MSBS 76 (DACB)   |
| 108        | *Tinospora cordifolia* (Willd.) Miers | Gulancha, Gurach        |              | Menispermaceae  | Cl    | F, Rs   | W      | St              | J           | O                |                     | 0.22 | MSBS 18 (DACB)   |
| 109        | *Trewia nudiflora* L.         | Bhatam, Betul, Pitali    |              | Euphorbiaceae   | T     | F, Mp   | W      | L               | Pa          | T                |                     | 0.18 | MFK 114 (DACB)   |
| S/L number | Scientific name | Bangla/Bengali name | English name | Family | Habit | Habitat | Nature | Plants parts used | Preparation | Solvent/ adjuvant | Mode of application | FC | Voucher specimen |
|------------|-----------------|---------------------|--------------|--------|-------|---------|--------|------------------|-------------|----------------|-------------------|----|-----------------|
| 110 | *Trichosanthes tricuspidata* Lour. | Makal | Cucurbitaceae | Ch | F | W | R | J | O | 0.09 |  | MFK 162 (DACB) |
| 111 | *Tylophora indica* (Burm. f.) Merrill. | Abtomul | Asclepiadaceae | H | F, Vt | W | L | Pa | Urine | In | 0.21 |  | JRK 100 (DACB) |
| 112 | *Urena lobata* L. | Ban okra | Malvaceae | H | F | W | R | D | O | 0.14 |  | MSBS 06 (DACB) |
| 113 | *Vitex negundo* L. | Nirgundi, Nishinda, Sundubar | Verbenaceae | Sh/T | F, Hf | W | L, R, Rh | Pa | T | 2.58 |  | MFK 100 (DACB) |
| 114 | *Vitis lanata* Roxb. | | Vitaceae | Sc | F, Hf | Cu, W | L | Pa | T | 0.06 |  | MSBS 50 (DACB) |
| 115 | *Willughbeia edulis* Roxb. | | Apocynaceae | Cl | F | W | St | Pa | T | 0.08 |  | JRK 75 (DACB) |
| 116 | *Withania somnifera* Dunal | Ashwagandha, Spanish bayonet | Solanaceae | H | Hs | Cu | R | Pa | T | 1.25 |  | JRK 140 (DACB) |

THP = traditional health practitioners; habit: Sc = shrubby climber, Wh = woody herb, C = climber, Cr = creeper, Sh = shrub, H = herb, and T = tree; habitat: Hf = hill forest, Hs = homestead, Wp = waste place, Rs = roadside, Vt = village thicket, G = garden, F = forest, and Mp = marshy place; nature: Cu = cultivated, W = wild; plants parts used: B = bark, Bu = bulb, L = leaves, Fr = fruit, Fl = flower, Gp = ground plant, Pe = petioles, R = root, Rh = rhizome, S = seeds, Sh = shoots, St = stem, Stb = stem bark, Tr = tuberous root, Sy = styles, and Wp = whole plant; preparation: D = decoction, J = juice, I = infusion, C = cook, R = raw, P = powder, and Pa = paste; solvent/adjuvant used: M = milk, H = honey, W = water, and Wi = wine; mode of application: O = oral, T = topical, and V = vaginal; relative abundance: C = common, Lc = least common, and R = rare; conservation status: LC = least common, VU = vulnerable, NT = near threat, UV = use value, and FC = frequency of citation. CITES = endangered commercial plant species; WHO = World Health Organization; FL = fidelity level; Fic = informant consensus factor; RI = relative importance value; FL = fidelity level; ICD = International Statistical Classification of Diseases and Related Health Problems.
| S/L number | Name of the plants                  | Doses                                                                                                                                 |
|-----------|-------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------|
| 1         | *Abelmoschus moschatus* Medic.      | Paste of leaf, fruit, and seed is used on the infected area 2/3 times daily for 2/3 days. Juice of leaf, fruit, and seed is also taken by grinding with milk and sugar. |
| 2         | *Abroma augusta* Linn. f.          | Root juice is used after maceration.                                                                                                                                                           |
| 3         | *Abrus precatorius* L.             | Seed powder is mixed with *Andrographis paniculata* seed powder to consume with lemon juice.                                                                                                     |
| 4         | *Acacia farnesiana* (L.) Wild.     | 3–4 pieces of fresh root are crushed and squeezed; the extract is taken 3–5 times a day for 1 day.                                                                                               |
| 5         | *Acalypha indica* L.               | Whole plant is made into paste, and the paste thus obtained is divided into 4-5 equal parts; each part is given at 6-hour intervals as an antidote.                                               |
| 6         | *Achyranthes aspera* L.            | Fresh leaves extract of about 2 teaspoonfuls is given 4–6 times a day.                                                                                                                         |
| 7         | *Acorus calamus* L.                | Fresh rhizome is made into paste. The paste is given with a glass of lukewarm water twice a day for 3 successive days.                                                                          |
| 8         | *Aegle marmelos* (L.) Corr. Serr.  | (1) Fresh root and leaves are mixed in a ratio of 2:3 and the whole mixture is made into paste with a little water. The paste thus obtained is divided into 12–16 equal parts (based on the condition of the patient) and each part is given at regular intervals of 1-2 hours for 2-3 days. (2) Root paste along with honey in equal parts is given 6–8 times a day as an antidote of snake venom. |
| 9         | *Albizia procera* (Roxb.) Benth.   | Fresh root of about one inch long, collected from the plants which are yet not flowered, is given once as an antidote of snakebite.                                                          |
| 10        | *Allium cepa* L.                   | Two teaspoonfuls of bulb juice of the plant mixed with mustard oil and administered to expel poison by vomiting.                                                                               |
| 11        | *Andrographis paniculata* (Burm. f.) Wall. ex Nees | (1) Fresh root and leaves are mixed in a ratio of 2:3 and the whole mixture is made into paste with a little water. The paste thus obtained is divided into 12–16 equal parts (based on the condition of the patient) and each part is given at regular intervals of 1-2 hours for 2-3 days. (2) Root paste along with honey in equal parts is given 6–8 times a day as an antidote of snake venom. |
| 12        | *Annona squamosa* L.               | Incision of snakebite is washed with the juice of plants.                                                                                                                                     |
| 13        | *Aristolochia indica* L.           | (1) Fresh root extract mixed with equal amount of root extract of *Rauwolfia serpentina* is given 4–6 times a day. (2) Root paste along with honey in equal parts is given 6–8 times a day. |
| 14        | *Asparagus racemosus* Wild.        | Leaf extract is applied on the bitten area.                                                                                                                                                     |
| 15        | *Bacopa monnieri* (L.) Pennell      | Dried plant (except the root portion) powder, about 1 teaspoonful, is given with a cup of warm goat milk or black tea 2-3 times of day as an antidote of snakebite.                                   |
| 16        | *Baliospernum montanum* L.         | Paste is prepared with leaf and applied externally twice a day for 4/5 days.                                                                                                                     |
| 17        | *Begonia barbata* C.B. Clarke      | Paste is prepared with stem and leaves and applied once a day for 2/3 days.                                                                                                                     |
| 18        | *Bombax ceiba* L.                  | Fresh young shoots (3–5 pieces) are made into paste with black peppers seed (*Piper nigrum*) and a pinch of camphor (Kapur); the paste thus obtained is given after mixing with a spoonful of honey as an antidote of snake venom. |
| 19        | *Butea monosperma* (Lamk.) Taub.   | Stem bark (fresh or dried) about 20 g is made into paste with zinger (rhizome of *Zingiber officinale*). The whole paste thus obtained is divided into four equal parts. Each of these 4 parts is given 4 times a day. |
| 20        | *Byttneria pilosa* Roxb.           | Paste of stem and leaf is applied twice a day until the area is cured.                                                                                                                           |
| 21        | *Cajanus cajan* (L.) Huth.         | Paste is made with seed powder of the plant and the juice of leaf of *Senna tora*. It is then applied twice a day for 2/3 days.                                                                     |
| 22        | *Calotropis gigantea* (L.) Ait. f.  | Fresh root with milk of cow is ground to a fine paste and taken as an antidote for snakebite.                                                                                                     |
| 23        | *Calotropis procera* (Ait.) Ait. f. | About three drops of latex are put on the snake-bitten area and pressed downwards to bleed; root extract is given two cups a day; flower powder is mixed with black pepper and taken.           |
| 24        | *Calycopteris floribunda* Lamk.    | Root juice is used in infected area.                                                                                                                                                            |
| 25        | *Capparis zeylanica* L.            | Dried fruits with seeds are made into dust; this dust is given as 1 teaspoonful with a glass of lukewarm water as a snake venom antidote.                                                         |
| S/L number | Name of the plants | Doses |
|------------|--------------------|-------|
| 26 | *Cassia fistula* L. | As a remedy against snakebite, one teaspoonful fruit powder is taken internally. |
| 27 | *Cassia occidentalis* L. | 20–30 gm of root (fresh or dried) is made into paste with 3–4 pieces of "garlic" (*Allium sativum*) and a little "gur" (Jaggery); the whole mixture thus obtained is given as an antidote to snakebite. |
| 28 | *Cassia sophera* L. | Root (fresh or dried) of about 20 gm is made into paste with 5–7 pieces of black peepers (seeds of *Piper nigrum*) and the paste is given as an antidote. |
| 29 | *Catharanthus roseus* D. Don | Leaf is grinded after maceration. |
| 30 | *Cissampelos pareira* L. | Root paste with 10 g long pepper is prescribed once daily for 5 days. |
| 31 | *Cissus adnata* Roxb. | Leaf paste is applied on infected place. |
| 32 | *Cissus javana* DC. | Paste is made with leaf and stem, mixing with lime, and applied externally on the biting place tying a piece of cloth for 3/4 days. |
| 33 | *Clitoria ternatea* L. | Root powder mixed with milk is taken orally immediately after snakebite. |
| 34 | *Cycas pectinata* Griff. | Paste of flower is applied thrice a day for 2/3 days. |
| 35 | *Cyperus rotundus* L. | Bulb powder mixed with cow butter to treat snakebite. |
| 36 | *Desmodium triflorum* (L.) DC. | Juice is prepared with shoots and mixing with shoots of *Peperomia pellucida* and 2 spoonfuls are taken thrice a day for 4/5 days. |
| 37 | *Emblica officinalis* Gaertn. | Stem infusion is given orally as an antidote. |
| 38 | *Entada rheedii* Spreng. | Paste is prepared with leaf and applied externally once a day for 4/5 days. |
| 39 | *Erythrina variegata* L. | Stamen and root bark are mixed in a ratio of 1 : 3 and then they are made into paste. This paste is applied in both ways externally and internally to reduce the swelling, pain of snakebite. |
| 40 | *Ficus racemosa* L. | A few drops of its decoction are put into the nostrils, resulting into vomiting and relief; bark paste is applied over the injury. |
| 41 | *Gmelina arborea* L. | Inner portion of fresh root (after peeling off the bark) about 20 g is made into paste and this paste is given with a spoonful of honey as an antidote of snakebite. |
| 42 | *Hedyotis scandens* Roxb. | Paste is prepared with leaf and stem and applied in warmed condition externally twice a day for 3/4 days. |
| 43 | *Holarrhena antidysenterica* (Heyne ex Roth.) Conessi | The roots were rubbed on a stone with a few drops of water and the paste obtained is given internally and applied externally in snakebite. |
| 44 | *Holarrhena pubescens* (Bach.-Ham.) Wall. | Seed paste is applied locally as antidote and also for reducing the swelling and pain of snakebite. |
| 45 | *Homalomena aromatic* (Roxb. ex Sims) Schott. | Paste of rhizomes is applied until the area is cured. |
| 46 | *Hyptis suaveolens* (L.) Poit. | Juice is extracted from leaf and applied externally twice a day for 3 days. |
| 47 | *Ichnocarpus frutescens* (L.) Br. | Fresh roots (about 100 g) are crushed and squeezed; the aqueous extract thus obtained is given 10–12 times a day as an antidote. |
| 48 | *Ixora cuneifolia* Roxb. | Bark is ground with water and the paste applied on the biting area twice a day for 4/5 days. |
| 49 | *Justicia gendarussa* Burm. | Fresh leaves extract is given 20–30 mL at every 1-hour interval for up to 18 hours of snakebite as an antidote. |
| 50 | *Lantana camara* L. | Decoction of roots, flowers, and stems is prescribed. |
| 51 | *Leucas aspera* (Willd.) Link. | Leaves with pepper and garlic are chewed and spit into the nostrils. |
| 52 | *Melastoma malabathricum* L. | Juice is prepared with leaf and applied externally twice a day for 3/4 days. |
| 53 | *Melochia corchorifolia* L. | Leaf paste is applied on infected place. |
| 54 | *Mirabilis jalapa* L. | Leaf juice is extracted and 2 spoonfuls are taken twice a day for 2/3 days. Also it is applied topically twice a day in infected areas. |
| S/L number | Name of the plants | Doses |
|------------|-------------------|-------|
| 56         | Morinda angustifolia Roxb. | 4 spoonfuls of extracted leaf juice are taken thrice a day until the area is cured. |
| 57         | Morinda persicifolia Ham. | Paste is prepared with leaf and applied externally twice a day for 3/4 days. |
| 58         | Mussaenda roxburghii Hook. f. | Paste of leaf is applied on the infected place with tying a piece of cloth. |
| 59         | Pelosanthes teta Andr. | Paste is prepared with root tuber and applied externally once a day for 2 days. |
| 60         | Peperomia pellucida (L.) HBK | Juice is prepared with shoots and mixing with shoots of Desmodium triflorum and 2 spoonfuls are taken thrice a day for 4/5 days. |
| 61         | Polygonum chinense L. | Paste is prepared with leaf and applied externally once a day for 2 days. |
| 62         | Pouzolzia indica Gaud. | Paste of leaves is applied twice a day for 2/3 days. |
| 63         | Premna esculenta Roxb. | Paste is prepared with leaf and applied externally twice a day for 3/4 days. |
| 64         | Rauwolfia serpentina (L.) Benth. ex Kurz | Roots and leaf buds are crushed with milk and made into a paste and used internally and externally on the affected area; rhizome and root decoction is given orally. |
| 65         | Senna hirsuta (L.) Irwin & Barneby | Paste of leaf is applied topically on the biting place. |
| 66         | Senna tora (L.) Roxb. | Paste is prepared with leaf and applied once a day for 2/3 days. |
| 67         | Sida cordifolia L. | Leaf juice is applied to cure snakebite. |
| 68         | Sida rhombifolia L. | Paste is prepared with leaf and stem and applied topically once a day to infected areas. Also juice of extracted leaf and stem is 2 spoonfuls which are taken four times a day for 4/5 days. |
| 69         | Solanum torvum Swartz. | Root juice is mixed with 250 mL water and 100 mL mustard oil. First, ammonium chloride is rubbed on the snake-bitten area and then the mixture of root juice, water, and oil is given orally. Otherwise, 1 handful of fruit is boiled in 1/2 litre of water. The fruits are then squeezed to get the juice, which is orally given to the snake-bitten person to vomit out the poison. |
| 70         | Tamarindus indica L. | To treat snakebite, spoonful powder with honey is consumed thrice a day after every two hours. |
| 71         | Terminalia arjuna (Roxb.) Wi. & Arn. | Stem bark powder (about 10 g) is made into paste with a teaspoon full of honey and 5–7 pieces of black pepper (Piper nigrum); this paste is given with a glass of lukewarm goat milk as an antidote to snake venom. |
| 72         | Tinospora cordifolia (Willd.) Miers | Stem juice is used to cure snakebite. |
| 73         | Trewia nudiflora L. | Paste of leaf is applied topically on the biting place. |
| 74         | Trichosanthes tricuspidata Lour. | Root juice is prepared after maceration and 1 spoonful is taken twice a day until the area is cured. |
| 75         | Tylophora indica (Burm. f.) Merrill. | Handful of leaves is crushed in urine of snake-bitten person and 2-3 drops of extract are passed through the nostrils. |
| 76         | Urena lobata L. | Decoction of root along with leaves of Adhatoda vasica, Alangium salvifolium, and Coccinia grandis is taken internally. |
| 77         | Vitis lanata Roxb. | Paste is prepared with leaf and applied externally once a day for 3/4 days. |
| 78         | Willughbeia edulis Roxb. | Latex is collected from stem and applied externally thrice a day for 2/3 days. |

Snake venom contains a complex mixture of enzymes, nonenzymatic proteins, carbohydrates, lipids, and other substances [123–126] most of which are extremely toxic. Snakebite envenoming has cytotoxic, hypotensive, neurotoxic, or anticoagulant effects [127]. Cytotoxic enzymes, phospholipases A2 and metalloproteinases, activate proinflammatory mechanisms that result in edema, blister formation, and local tissue necrosis and facilitate the release of bradykinin, prostaglandin, cytokines, and sympathomimetic amines that cause the intense pain [128]. In addition, there are some venom toxins including aminopeptidases having the ability to alter the physiological function of the victims and ultimately causing systemic hypotension [126]. Many snake venoms have peptides that inhibit angiotensin-converting enzyme causing a slump in arterial blood pressure [129]. Moreover, some toxins such as safarotoxins and endothelins are potent vasoconstrictors of coronary arteries and might be...
Mimosa pudica have been shown to inhibit phospholipases A\textsubscript{2} [130]. Presynaptic neurotoxins, also called b-neurotoxins, include taipoxin, paradoxin, trimucrotoxin, viperotoxin, *Pseudocerastes*, textilotoxin, and crototoxin [127] which are phospholipase A\textsubscript{2} complexes that inhibit the release of acetycholine from the presynaptic terminal [131, 132]. On the other hand, postsynaptic neurotoxins including irditoxin [127] called a-neurotoxins cause a reversible blockage of acetylcholine receptors [133–135]. Snake venom toxins may also interfere with blood coagulation and cause hemorrhages or thrombosis [125, 127, 136, 137].

Elucidation of the mode of actions of 116 plants individually is beyond the scope of this study. Research suggests extract of different medicinal plants having antivenom activities such as reducing necrotic and hemorrhagic activity as well as preventing cardiac arrest and reversing the effect of paralysis of skeletal muscle caused by snake venom. Also they might inhibit phospholipase A\textsubscript{2} that causes degranulation of mast cell [138] and consequently they prevent release of platelet activating factors and histamine into circulation, preventing hypersensitive anaphylactic reaction [139].

Several studies have been conveyed in finding of active constituents in the plants used against snake venom. Among the 116 plants in this study, the phytochemical investigations are conducted in most of the plants though the compounds rational for antivenom properties are still unknown for most of them. Extensive phytochemical investigations on the plants mentioned in this study could be another mammoth task. Several plant constituents like flavonoids, quinonoid, xanthene, polyphenols, terpenoids lupeol, gymnemagenin, and pentacyclic triterpenes like oleanolic acid, ursolic, tannins, taraxasterol, amyrin, and so forth are found to be present in varying proportions in surveyed plants. These compounds have also been previously tested in vitro for possessing protein binding and enzyme inhibiting properties [140–142].

These literature studies revealed that the alkaloids (Eclipta prostrata, Rauvolfia serpenitina, Strychnos nux-vomica, and Mimosapudica), esters (Glorsa superba), phenolic fraction (Hemidesmus indicus), terpenoids (Aristolochia indica, Andrographispaniculata), and flavonoids fraction (Tephrosia purpurea) neutralized the snake venom activities. Flavonoids have been shown to inhibit phospholipases A\textsubscript{2}, an important component of snake venoms [143]. The antivenom effects of wodelolactone, a coumarine isolated from the Eclipta prostrate, are well cited for antivenom activities [144]. 2-Hydroxy-4-methoxy benzoic acid, found in *Hemidesmus indicus* root extracts, was identified as a snake venom neutralizing factor which effectively neutralized viper venom induced lethal, hemorrhagic, coagulant, anticoagulant, and inflammatory activity [145]. This compound seems to act through free radical formation system [146] and is one of the mechanisms of venom inhibition. Caffeic acid is present in *Strychnos nux-vomica*, and the monomeric caffeic acid is a proven antidote against snake venoms when given as oral and parenteral administration [147]. Marmin in *Aegle marmelos*, a monoterpenoid substituted fernolin [148], has been mentioned as a remedy against snakebite. Piperine from *Piper nigrum* inhibits the adhesion of neutrophils to endothelial monolayers. Also it possesses inhibitory activities on prostaglandin and leukotrienes and thus possesses anti-inflammatory activity [149–151]. Quercetin is a potent inhibitor of lipoxygenase, and free quercetin and its glycosides rutin are present in *Allium cepa* skins [152]. The aristolochic acid content of *Aristolochia indica* contains a large number of proteins that cluster under native condition. It shows strong gelatinolytic, collagenase, nuclease, and peroxidase activities. It interacts with the components of snake venom and partially inhibits proteolytic and L-amino acid oxidase activities of the venom [12]. Active principle of *Baushinia forficata* has thrombin-like enzyme that acts as potent inhibitor of clotting activity that otherwise causes persistent hemorrhage [153].

Most of the plants documented in this study are used for the treatment of versatility of disease. This trend is a possible indication of the tradition of THPs to develop local healing system through trials and errors for optimal treatment practices [154].

There are resemblances in comparative studies of these cited plants to other surveys regarding medicinal plants having antivenin characteristics (Table 4). Using the same plants in different areas by different cultures for the same purpose might be considered as a justification of their pharmacological efficacy [155].

12 of these cited plants had been found to possess possible toxic potentiality (Table 5). However, among those possibly the most toxic one is *Abrus precatorius*. It contains abrin, a serious toxic compound, which after penetrating the cells of the body inhibits cell protein synthesis. Human fatal dose of abrin is approximately 0.1–1 mg/kg. But toxins are released only if the seed is chewed and swallowed [91]. Another dangerous plant is *Ageratum conyzoides* which in ingestion can cause liver lesions and tumors [94, 95]. There was a mass poisoning incident reported in Ethiopia as a result of contamination of grain with *A. conyzoides* [96]. In addition, epidemic dropy and ocular toxicity have been reported by seed oil of *Argemone mexicana* [98–101] and latex of *Calotropis procera* [105], respectively; the rest are toxic only due to high doses of ingestion. However, a number of phytochemical investigations would be required to declare these plants as being toxic.

## 5. Conclusion

This survey represents the contribution of natural flora of Bangladesh to the global approach in the management of snakebite occurrences. The knowledge documented in this study possibly supports the development of novel plant based treatment. Further investigations should be carried on especially in order to ensure safe therapy concerning medicinal plants. Therefore, snake charmers should be trained on as a priority basis. Again, scarcity of supply of snake antivenin is a major factor which needs to be addressed by local production. And in that case these findings regarding herbal antidote would be useful in planning and formulating strategies and specific interventions to combat snakebite related health problems in Bangladesh.
Table 4: Worldwide comparative studies of cited plants of our survey.

| Serial number | Scientific name of the plant | Region/country | Reference(s) |
|---------------|------------------------------|----------------|--------------|
| 1             | Abelmoschus moschatus Medic. | West Bengal, India | [39, 40] |
| 2             | Abrus precatorius L.         | Arunachal Pradesh, India | [41] |
| 3             | Acacia farnesiana (L.) Willd. | West Bengal, India; Brazil | [42, 43] |
| 4             | Acalypha indica L.           | West Bengal, India | [44] |
| 5             | Achyranthes aspera L.        | West Bengal, India | [39, 43, 44] |
| 6             | Ageratum conyzoides L.       | Meghalaya, India | [45] |
| 7             | Albizia lebbeck (L.) Benth.  | Uttar Pradesh, India; Islamabad, Lahore, Pakistan | [46–48] |
| 8             | Albizia procera (Roxb.) Benth. | West Bengal, India | [49] |
| 9             | Allium cepa L.               | Rajasthan, India; Brazil; Kenya | [33, 43, 50] |
| 10            | Andrographis paniculata (Burm. f.) Wall. ex Nees | West Bengal, India | [44] |
| 11            | Amona squamosa L.            | Nicobar, India | [51] |
| 12            | Argemone mexicana L.         | Rajasthan, India; Brazil | [43, 52] |
| 13            | Aristolochia indica L.       | Karnataka, Madhya Pradesh, Orissa, Tamil Nadu, West Bengal, India | [53–57] |
| 14            | Asparagus racemosus Willd.   | Karnataka, India | [58] |
| 15            | Bacopa monnieri (L.) Pennell | West Bengal, India | [59] |
| 16            | Bauhinia variegata L.        | Rupandehi District, Nepal; Islamabad, Pakistan | [47, 60, 61] |
| 17            | Bixa orellana L.             | West Bengal, India | [59] |
| 18            | Bombax ceiba L.              | West Bengal, India | [49] |
| 19            | Buchanania lanzan Spreng.    | Tamil Nadu, Uttar Pradesh, India | [48, 62] |
| 20            | Butea monosperma (Lamk.) Taub. | West Bengal, India | [49] |
| 21            | Calotropis procera (Ait.) Ait. f. | Rajasthan, Tamil Nadu, India; Balochistan, Pakistan | [57, 63, 64] |
| 22            | Calotropis gigantea (L.) Ait. f. | Orissa, India | [65] |
| 23            | Capparis zeylanica L.        | West Bengal, India | [44] |
| 24            | Capsicum annuum L.           | India | [66] |
| 25            | Cassia fistula L.            | Karnataka, Tamil Nadu, Uttar Pradesh, India | [48, 54, 62] |
| 26            | Cassia occidentalis L.       | West Bengal, India | [59] |
| 27            | Cassia sophera L.            | West Bengal, India | [39] |
| 28            | Cassia tora L.               | Uttaranchal, Uttar Pradesh, India; Brazil | [43, 48, 67] |
| 29            | Chenopodium album L.         | Islamabad, Pakistan | [47] |
| 30            | Cissampelos pareira L.       | Rajasthan, West Bengal, Tamil Nadu, India; Islamabad, Pakistan | [47, 55, 68, 69] |
| 31            | Clitoria ternatea L.         | Madhya Pradesh, Meghalaya, Uttar Pradesh, India | [48, 70, 71] |
| 32            | Cynodon dactylon (L.) Pers.  | India | [72] |
| 33            | Cyperus rotundus L.          | Madhya Pradesh, India | [71] |
| 34            | Datura metel L.              | Nicobar, Uttar Pradesh, India | [48, 51] |
| 35            | Eclipta prostrata L.         | India; Brazil | [43, 72] |
| 36            | Emblica officinalis Gaertn.  | Maharashatra, India | [73] |
| 37            | Ficus racemosa L.            | Rajasthan, India | [74] |
| 38            | Flacourtia indica (Burm. f.) Merr. | Tamil Nadu, India | [62] |
| 39            | Gmelina arborea L.           | West Bengal, India | [49] |
| 40            | Helicteres isora L.          | Uttar Pradesh, India | [48] |
| 41            | Hemidesmus indicus (L.) R. Br. | West Bengal, India; Sri Lanka | [55, 75] |
| 42            | Holarrhena antidysenterica (Heyne ex Roth.) Conessi | Orissa, India | [65] |
| 43            | Holarrhena pubescens (Bach.-Ham.) Wall. | West Bengal, India | [44, 49] |
| 44            | Hyptis suaveolens (L.) Poit. | Uttar Pradesh, India | [48] |
| 45            | Ichnocarpus frutescens (L.) Br. | West Bengal, India | [44] |
Table 4: Continued.

| Serial number | Scientific name of the plant | Region/country | Reference(s) |
|---------------|-------------------------------|----------------|--------------|
| 46            | *Lantana camara* L.           | Madhya Pradesh, India | [71]         |
| 47            | *Mangifera indica* L.         | Uttar Pradesh, India | [76]         |
| 48            | *Mimosa pudica* L.            | Nagaland, Uttar Pradesh, India | [48, 77] |
| 49            | *Moringa oleifera* Lamk.      | Assam, India | [78]         |
| 50            | *Mucuna pruriens* Baker       | Uttar Pradesh, India | [48]         |
| 51            | * Ocimum basilicum* L.        | Uttar Pradesh, India; Brazil | [43, 48] |
| 52            | *Oroxylum indicum* Vent.      | Orissa, India | [79]         |
| 53            | *Oxalis corniculata* L.       | Meghalaya, India; Tehsil Chakwal, Pakistan | [45, 80] |
| 54            | *Piper nigrum* L.             | Uttarakhand, India | [81]         |
| 55            | *Plumbago zeylanica* L.       | Tripura, India | [82]         |
| 56            | *Rauvolfia serpentina* (L.) Benth. ex Kurz | Karnataka, Tamil Nadu, Uttar Pradesh, India | [48, 83, 84] |
| 57            | *Sida acuta* Burm.            | Madhya Pradesh, India | [71]         |
| 58            | *Sida cordifolia* L.          | Rajasthan, Tamil Nadu, India | [52, 84] |
| 59            | *Syzgium cumini* (L.) Skeels. | Orissa, India | [85]         |
| 60            | *Tamarindus indica* L.        | Maharashtra, India; Africa; Sudan | [75, 86] |
| 61            | *Terminalia arjuna* (Roxb.) Wt. & Arn. | West Bengal, India | [49] |
| 62            | *Tinospora cordifolia* (Willd.) Miers | Madhya Pradesh, Tamil Nadu, Uttar Pradesh, India | [62, 76, 87] |
| 63            | *Tylophora indica* (Burm. f.) Merrill. | Karnataka, India | [54]         |
| 64            | *Urena lobata* L.             | Tamil Nadu, India | [88]         |
| 65            | *Vitex negundo* L.            | Himachal Pradesh, Kerala, India | [89, 90] |
| 66            | *Withania somnifera* (L.) Dunal | Karnataka, India; Pakistan | [58, 75] |

Table 5: Literature study of the plants surveyed having toxicity.

| Scientific name | Toxic part | Toxic compound | Toxic effect | Reference |
|-----------------|------------|----------------|--------------|-----------|
| *Abrus precatorius* L. | Seed | Abrin, ricin | Abortifacient, inhibiting cell protein synthesis | [91] |
| *Acorus calamus* L. | Seed | Beta-asarone | Procarcinogenic | [92, 93] |
| *Ageratum conyzoides* L. | Seed | Pyrrolizidine alkaloids | Liver lesions and tumors | [94–96] |
| *Annona squamosa* L. | Root, seed | Annonastin, squamozin | Roots are drastic purgative and seeds are strong eye irritant, abortifacient | [97] |
| *Argemone mexicana* L. | Seed, latex | Sanguinarine, dihydroisanguinarine | Epidemic dropsy | [98–101] |
| *Bacopa monnieri* (L.) Pennell | Whole plant | | Suppress spermatogenesis and fertility, digestive problem | [102, 103] |
| *Calotropis gigantea* (L.) Ait. f. | Root | Calotropin | Inhibit spermatogenesis, abortifacient | [104] |
| *Calotrops procera* (Ait.) Ait. f. | Root | Cytotoxic, calotropin, calclin, gigantin | Ocular toxicity | [105] |
| *Cassia occidentalis* L. | Pods and beans | Pyrrolizidine alkaloid | Hepatotoxic | [106–108] |
| *Catharanthus roseus* (L.) G. Don. | Root, shoot | Vincristine, vinblastine | Hypotension, neurotoxicity, anaemia, seizure | [109] |
| *Ficus racemosa* L. | Bark | Tetracyclic triterpene derivatives | Cause abnormality of liver and kidney | [110] |
| *Lantana camara* | Leaf | Triterpene acids | Leaf extracts are cytotoxic | [111] |
Conflict of Interests

The authors declare that there is no conflict of interests regarding the publication of this paper.

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