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ORIGINAL ARTICLE

Brine Shrimp Toxicity Study of Different Bangladeshi Medicinal Plants

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ABSTRACT

Twenty three Bangladeshi medicinal plants used in traditional medicines were evaluated for brine shrimp lethality toxicity. Different solvent extracts of *Abroma augusta*, *Acanthus ilicifolius*, *Alstonia scholaris*, *Calotropis procera*, *Catharanthus roseus*, *Citrus grandis*, *Coccinia grandis*, *Croton tiglium*, *Cuscuta reflexa*, *Excoecaria agallocha*, *Heritiera fomes*, *Ipomoea aquatica*, *Lagerstroemia speciosa*, *Madhuca indica*, *Musa sapientum*, *Nypa fruticans*, *Piper peepuloides*, *Premna esculenta*, *Saraca asoca*, *Sonneratia apetala*, *Stevia rebaudiana*, *Syzygium fruticosum*, and *Trichosanthes dioica* were used in the study. Of the 23 plants tested, about 80% were toxic to brine shrimp (LC_{50} < 30 g/ml). Among the extracts screened, the methanolic extract of *Croton tiglium* had the highest toxicity to brine shrimp (LC_{50} = 0.0924 g/ml). The drug vincristine sulfate was considered as reference standard.

Key words: Cytotoxicity, brine shrimp, Bangladesh, medicinal plants

Introduction

A good percentage of the populations in developing countries depend on traditional medicines for their primary health-care needs (FAO, 2004). Bangladesh has a rich heritage of herbal medicines among the South Asian countries. The poor and ethnic peoples of Bangladesh rely on these medicinal plants as prescribed by traditional medicinal practitioners for treatment against various diseases. Although a large number of medicinal plants are used in the traditional medicinal system of Bangladesh, the majority of these plants have not yet undergone chemical, pharmacological and toxicological studies to investigate their bioactivity (Ghani, A., 2003). Traditional records and ecological diversity indicate that Bangladeshi plants represent an exciting resource for possible lead compounds in drug design and development (Uddin, S.J., 2009).

Twenty three Bangladeshi medicinal plants (*Abroma augusta*, *Acanthus ilicifolius*, *Alstonia scholaris*, *Calotropis procera*, *Catharanthus roseus*, *Citrus grandis*, *Coccinia grandis*, *Croton tiglium*, *Cuscuta reflexa*, *Excoecaria agallocha*, *Heritiera fomes*, *Ipomoea aquatica*, *Lagerstroemia speciosa*, *Madhuca indica*, *Musa sapientum*, *Nypa fruticans*, *Piper peepuloides*, *Premna esculenta*, *Saraca asoca*, *Sonneratia apetala*, *Stevia rebaudiana*, *Syzygium fruticosum*, and *Trichosanthes dioica*) were collected from various regions of Bangladesh following accounts of their medicinal uses (Ghani, A., 2003; Yusuf, M., 1994) or when our ongoing ethnomedicinal surveys (Hossan, M.S., 2010; Rahmatullah, M., 2010; Nawaz, A.H.M.M., 2009; Hanif, A., 2009; Rahmatullah, M., 2009; Rahmatullah, M., 2009; Rahmatullah, M., 2009; Rahmatullah, M., 2009)

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indicated that they were used by traditional medicinal practitioners for treatment of various ailments. Extracts of various plant parts were screened for their cytotoxic activities. Very little information is available about the cytotoxic activity of these plants or plant extracts. The objective of the present study was to evaluate the cytotoxic potential (LC_{50}) of extracts of plant parts of the above-mentioned plants through the brine shrimp lethality bioassay. The brine shrimp (*Artemia salina*) bioassay is a useful tool for the isolation of bioactive compounds from plant extracts (Sam, T.W., 1993) The method is often used because it is simple, inexpensive and low amount of materials are sufficient to perform the assays on a micro scale.

Materials and Methods

Plant materials

The plant samples were collected from various regions of Bangladesh based on their ethnomedicinal uses (Table 1). To determine whether a plant has any ethnomedicinal use, surveys were conducted among folk and tribal medicinal practitioners as described before (Hossan, M.S., 2010; Rahmatullah, M., 2010; Nawaz, A.H.M.M., 2009; Hanif, A., 2009; Rahmatullah, M., 2009; Rahmatullah, M., 2009; Rahmatullah, M., 2009; Rahmatullah, M., 2009). All plants were identified at the Bangladesh National Herbarium at Dhaka where voucher specimens were also deposited. The various plant parts were cut into small pieces, air-dried under shade and grounded using a laboratory mill and blender.

Extraction

A known amount of dried powdered sample (usually 100g) was extracted by maceration with methanol, acetone, or chloroform at a ratio of plant material to solvent of 1:5. Collected extracts were then filtered and concentrated *in vacuo* at 40°C, 50°C, and 30°C for methanol, acetone, and chloroform, respectively. The solvent-free extracts were kept refrigerated at 4°C and used for cytotoxicity assays.

Toxicity testing against brine shrimp

Hatching shrimp. Brine shrimp eggs, *Artemia salina* leach were hatched in artificial seawater prepared by dissolving 38g of sea salt in 1L of distilled water. The pH of the solution was adjusted to 8.5. After 48h incubation at room temperature (26-30°C) under constant aeration, the larvae (nauplii) were attracted to one side of the vessel with a light source and collected with a pipette. Nauplii were separated from eggs by aliquoting them three times in small beakers containing seawater.

Brine shrimp assay. The bioactivity of the extracts was monitored by the brine shrimp lethality test (Meyer, B.N., 1982). Samples were dissolved in dimethylsulfoxide (DMSO) and diluted with artificial sea salt water so that final DMSO concentration did not exceed 0.05%. 50 ml of 2000 mg of the plant extract was placed in one sample tube and a two-fold dilution carried out down the column of sample tubes. The last sample tube was left with sea salt water and DMSO only to serve as the drug-free control. The total volume was adjusted to 5 ml with sea salt water. 100 ml of suspension of nauplii containing 10 larvae was added into each tube and incubated for 24h. The tubes were then examined under a magnifying glass and the number of dead nauplii in each tube counted. Experiments were conducted with control (vehicle treated), and different concentrations of the test substances in a set of three tubes per dose. Vincristine sulfate was used as a positive control in all experiments.

Statistical analysis

Lethality assays were evaluated by Finney computer statistical program to determine the LC_{50} values and 95% confidence intervals. All data were expressed as mean ± SEM (McLaughlin, J., 1991; Cordell, G.A., 1993).

Results and Discussion

The cytotoxic activity of different plant parts of 23 Bangladeshi traditionally used medicinal plants were investigated against brine shrimp (*Artemia salina*) *in vitro*. The results are shown in Table 2. All the crude extracts of different plant species resulting in LC_{50} values of less than 200 mg/ml were considered active against brine shrimp. McLaughlin (1991) has reported that the results obtained with *Artemia salina* are

Table 1: Ethnomedicinal uses of medicinal plants in Bangladesh (in different regions and among various tribes) used in the cytotoxicity assays.

Botanical name (syn. stands for synonym(s))	Family	Local name (in different regions and among tribes of Bangladesh)	Parts used	Ailments/Symptoms used for
Abroma augusta L.f. syn. *Abroma fastuosum* Jacq., *Abroma mollis* DC., *Theobroma augusta* L. English: Devil's Cotton Tree	Sterculiaceae	1. Ulot-kombol	1. Leaf, stem	1. Menstrual disorders, diseases of uterus, diabetes.
		2. Ulot-kombol	2. Leaf, flower	2. Stomachache, diabetes, dermatitis.
		3. Ulot-kombol	3. Leaf, stem	3. Leucorrhoea, diabetes.
		4. Olot-kombol	4. Whole plant	4. Diabetes, dermatitis.
		5. Ulot-kombol	5. Whole plant	5. Diabetes, menstruation control.
		6. Ulot-kombol	6. Leaf, root, flower	6. Whitish discharge in urine (men), menstrual problem.
		7. Ulot-kombol	7. Leaf	7. Diabetes.
		8. Ulot-kombol	8. Leaf stalk	8. Heatstroke, blood purifier.
		9. Ulot-kombol	9. Leaf	9. Sex stimulant.
		10. Ulot-kombol	10. Whole plant	10. Scabies, diabetes.
		11. Ulot-kombol	11. Leaf	11. Sex stimulant.
		12. Ulot-kombol (Garo tribe)	12. Root, petiole	12. Gonorrhea, leukorrhea, constipation, menstrual troubles.
		13. Olot-kombol	13. Root	13. Sex stimulant.
		14. Ulot-kombol	14. Upper part of stem	14. Irregular menstruation, painful menstruation, burning sensations in the uterus.
		15. Ulot-kombol	15. Stem	15. Debility, infertility in women due to problems in uterus (local term: badok disease).
		16. Ulot-kombol	16. Stem	16. Debility.
		17. Ulot-kombol	17. Leaf, stem	17. Sex stimulant.
		18. Ulot-kombol	18. Stem	18. Weakness, hypertension.
		19. Ulot-kombol	19. Root bark	19. Leukorrhea, menstruation problems.
		20. Olot-kombol	20. Leaf, root	20. Diabetes, impotency, debility.
		21. Ulot-kombol	21. Whole plant	21. Tonic, nerve stimulant, diabetes, sexual diseases.
		22. Olot-kombol (Khasia-1)	22. Leaf	22. Diabetes.
		23. Ulot-kombol	23. Leaf, bark	23. Diabetes, cough, leukoderma.
		24. Ulot-kombol	24. Leaf, stem	24. Ecbolic, nerve disorders, itch.
		25. Ulot-kombol	25. Whole plant	25. Diabetes, nerve stimulant, eczema.
		26. Ulot-kombol	26. Leaf	26. Menstrual disorders, burning sensations during urination, delayed menstruation, displacement of uterus, leukorrhea.
		27. Ulot-kombol	27. Leaf, stem, root	27. Irregular menstruation, infertility in women.
		28. Ulot-kombol	28. Whole plant	28. Passing of semen with urine.
		29. Ulot-kombol	29. Leaf, bark, stem	29. Leukorrhea, placentitis.
		30. Ulot-kombol (Garo-3)	30. Whole plant	30. Eczema, diabetes, typhus, colic.
		31. Ulot-kombol (Garo-4)	31. Leaf, root	31. Diabetes (leaf), sexual disorder (root).
		32. Ulot-kombol	32. Leaf, stem, bark	32. Leukorrhea, scabies.
		33. Ulot-kombol	33. Leaf	33. Jaundice.
		34. Ulot-kombol	34. Bark, root	34. Leukorrhea, urinary tract problems.
		35. Ulot-kombol gach	35. Root	35. To induce regular menstruation, abscess, sexual diseases in men, low sperm count.
		36. Ulot-kombol	36. Bark	
		37. Ulot-kombol	37. Leaf	
		38. Ulot-kombol	38. Bark	
		39. Ulot-kombol	39. Stem juice	
		40. Ulot-kombol	40. Leaf, bark, root	
		41. Ulot-kombol	41. Leaf	
		42. Ulot-kombol	42. Stem, leaf stalk	
		43. Ulot-kombol	43. Leaf	
		44. Ulot-kombol	44. Bark	

Table 1: Continue

				36. Meho (local term for urinary problem arising from endocrinological disorder or diabetes), promeho (diabetes). 37. Diabetes. 38. Jaundice, meho (local term for urinary problem arising from endocrinological disorder or diabetes). 39. To increase sexual prowess. 40. Gonorrhea, irregular menstruation. 41. Spermatorrhea. 42. Dyspepsia, dysentery, physical sickness, urinary incontinence, burning sensations in the urinary tract. 43. Astringent. 44. Menstrual problems, meho (local term for urinary problem arising from endocrinological disorder or diabetes).
Acanthus ilicifolius L. syn. *Acanthus neo-guineensis* Engl., *Aquifolium indicum* Rumph. English: Sea holly	Acanthaceae	1. Haar-goja 2. Fereng-jubang (Marma tribe)	1. Whole plant 2. Root	1. Astringent, aphrodisiac. 2. Sex stimulant, rheumatic pain, leukorrhea.
Alstonia scholaris (L.) R.Br. syn. *Echites scholaris* (L.) English: Blackboard tree, Indian devil tree, Dita bark	Apocynaceae	1. Chitan 2. Chitani 3. Chitan gach 4. Chatim 5. Satian 6. Chai-laing-pang (Chak tribe) 7. Chaitan (Garo tribe) 8. Chalai-bang (Marma tribe) 9. Chitan 10. Sais-chani (Tripura tribe) 11. Chaiton (Monipuri tribe) 12. Khaka-singh (Murong tribe) 13. Chatim 14. Chatian 15. Chaitaan 16. Chitan 17. Chiton 18. Chatim 19. Chatim gach 20. Chitan 21. Chatim 22. Chauni, Chatim 23. Chatian	1. Leaf, bark 2. Leaf, bark 3. Leaf, bark 4. Leaf 5. Leaf, bark 6. Leaf, bark 7. Bark 8. Bark exudate 9. Whole plant 10. Wood 11. Leaf 12. Bark 13. Bark 14. Bark 15. Leaf, bark 16. Leaf, bark 17. Bark 18. Bark 19. Stem exudate (sap), bark 20. Leaf 21. Bark, flower, exudate 24. Chaton gach 22. Young bark 23. Bark 24. Bark	1. Sprain, febricity, snake bite, cough, rheumatoid arthritis, carminative. 2. Antidote, dysentery, snake bite. 3. Typhus, cholera, expectorant, organ stone dissolving, diarrhea, blood dysentery. 4. Cough, cold, mucus. 5. Antidote to poison, hepatitis B, cancer, malaria, dermatitis. 6. Abscesses, throat ache, muscle pain, urinary troubles, diabetes. 7. Leucorrhea. 8. Cold sores (*Herpes labialis*), fever, diabetes. 9. Leprosy, cough, increases mother's milk 10. Bleeding through anus or nostrils. 11. Skin diseases. 12. Fever, diarrhea, dysentery, diabetes, antibacterial, rheumatic pain. 13. Rheumatic pain, fever, dysentery. 14. Syphilis, skin disease, leprosy. 15. Indigestion, sedative, gastritis. 16. Rheumatoid arthritis, itch, nerve stimulant, antidote to poison, sedative. 17. Kala azar. 18. Kala azar. 19. Charu gha (local term for infections on face with swellings) (sap), ulcer (bark). 20. Malaria. 21. Acne, blood dysentery, helminthiasis, leprosy. 22. Nerve stimulant. 23. Gastric problems. 24. Allergy. Bark juice is orally administered.

Table 1: Continue

Calotropis procera (Ait.) Ait.f. syn. *Asclepias procera* (Ait.) English: Mudar, Rooster tree	Asclepiadaceae	1. Sada-akondo 2. Akondo 3. Akondo 4. Akondo 5. Akondo (Tripura tribe) 6. Akondo (shada phool) 7. Akondo 8. Akondo (Monipuri tribe) 9. Akondo (shada phool) 10. Akhunde, Dudaun 11. Akhunde 12. Akond 13. Akond (Khasia tribe) 14. Shada akondo 15. Akondo gach	1. Leaf, stem, bark 2. Leaf, bark, flower 3. Leaf, bark 4. Leaf, root, exudate, flower 5. Leaf 6. Leaf 7. Leaf 8. Leaf 9. Root 10. Leaf 11. Sap 12. Leaf 13. Whole plant 14. Leaf, bark 15. Leaf	1. Malaria, epilepsy, ecbolic, small-pox, expectorant. 2. Small pox, ecbolic, virility, malaria. 3. Small pox, wound. 4. Abscess, tonsillitis, flu/cold in children, headache, toothache, pain due to trauma. 5. Rheumatic and any sort of body pain. 6. Pneumonia. 7. Rheumatic pain. 8. Rheumatism, asthma. 9. Body ache. 10. Edema in pregnant women. 11. Dog bite, rabies. 12. Acidity. 13. Coughs. 14. Analgesic, ecbolic, headache. 15. Pain (analgesic).
Catharanthus roseus (L.) G.Don syn. Vinca rosea L., Ammocallis rosea (L.) Small, Lochnera rosea (L.) Reichenb. Ex Spach English: Vinca, Madagascar periwinkle	Apocynaceae	1. Noyon-tara 2. Cancer, heart diseases, 3. Botham-phool 4. Noyon-tara 5. Noyon-tara 6. Noyon-tara 7. Noyon-tara 8. Noyon-tara 9. Noyon-tara 10. Tara-phool 11. Noyon-tara 12. Noyon-tara 13. Noyon-tara 14. Noyon-tara 15. Noyon-tara 16. Noyon-tara 17. Sheth-noyon-tara 18. Noyon-tara 19. Noyon-tara 20. Noyon-tara	1. Flowers, leaves 2. Noyon-tara 3. Leaf, flower 4. Whole plant 5. Leaf, flower 6. Leaf, flower 7. Leaf, flower 8. Whole plant 9. Leaf, root 10. Leaf with stem 11. Whole plant 12. Whole plant 13. Leaf, root 14. Whole plant 15. Leaf 16. Leaf, flower 17. Leaf 18. Fresh flower juice 19. Leaf, root 20. Young leaf	1. Cancer. 2. Leaf, root, flower anti-hemorrhagic, tuberculosis. 3. Diabetes, cancer. 4. Tonic, wound, gout. 5. Disinfectant, add aroma to medicines, cancer, diabetes. 6. Cancer, liver disorder. 7. Diabetes. 8. Cancer, eye diseases. 9. Diabetes. 10. Diabetes. 11. Cancer, heart diseases, tuberculosis. 12. Leukemia, malaria, diabetes. 13. Diabetes. 14. Cancer, hypertension, stomachache, vermifuge, asthma, diuretic. 15. Toothache. 16. Diabetes (flower), anthelmintic (leaf). 17. Diabetes. 18. Hypertension. 19. Infections (leaf), hypertension (root). 20. Indigestion, stomachache.
Citrus grandis (L.) Osbeck syn. Citrus maxima (Burm.) Merr. English: Japanese pummelo	Rutaceae	1. Gachh-badam 2. Jambura 3. Batabi lebu 4. Jambura 5. Badam 6. Jambura 7. Jambura 8. Jhambura (Garo tribe) 9. Badam gach 10. Jambura 11. Jambura (Santal-2) 12. Jambura gach 13. Jambura, Matu phol 14. Jambura gach	1. Leaf, seed, fruit 2. Leaf, seed, fruit 3. Leaf, fruit 4. Fruit 5. Leaf, fruit 6. Leaf, fruit 7. Leaf, fruit 8. Fruit 9. Leaf, fruit juice, seed 10. Fruit 11. Leaf, fruit skin 12. Fruit 13. Leaf, fruit 14. Root	1. Epilepsy, relieving pain, indigestion, ecbolic, cooling. 2. Malaria, febricity, anthelmintic, cough, appetizer, hypotonic. 3. Stomach ache, epilepsy, antiseptic. 4. Jaundice. 5. Appetizer, indigestion, cooling. 6. Tonic, appetizer. 7. Chorea, indigestion, diabetes, wound, appetizer, antiseptic. 8. Skin disease. 9. Febricity, jaundice, diabetes, lack of appetite, emollient, antiinflammatory. 10. Increase strength, carminative, indigestion. 11. Head deformities in children. 12. To increase appetite (fruit), blood purifier (fruits with mustard oil and young peppers), fever (fruit). 13. Appetite stimulant, anti-emetic (leaf), fever (fruit). 14. Aphrodisiac.

Table 1: Continue

Coccinia grandis (L.) J. Voigt	Cucurbitaceae	1. Telakucha	1. Leaf, root	1. Diabetes, edema, eye diseases.
		2. Telakucha	2. Whole plant	2. Diabetes, carminative, hypertension, fever.
Bryonia grandis L., Coccinia cordifolia sensu auct., non (L.) Cogn., Cephalandra indica Naud., Coccinia cordifolia (L .) Cogn. var. alceifolia (Willd.) Cogn., Coccinia cordifolia (L.) Cogn. var. wightiana (M.Roem.) Cogn., Coccinia grandis (L.) Voigt var. wightiana (M.Roem.) Greb., Coccinia indica Wight & Arn., Coccinia loureiriana M.Roem., Coccinia wightiana M.Roem., Cucumis pavel Kostel., Momordica bicolor Blume, Momordica covel Dennst., Momordica monadelpha Roxb. English: Ivy gourd, Scarlet gourd, Scarlet-fruited gourd, Kowai fruit		3. Telakochu	3. Whole plant	3. Anti-inflammatory, diabetes.
		4. Kosoilla	4. Whole plant	4. Diabetes, headache.
		5. Telakucha	5. Whole plant	5. Diabetes, headache, typhoid, antiinflammatory, sunstroke.
		6. Telakucha	6. Whole plant	6. Diabetes, fever. 7. Hypertension, diabetes.
		7. Telakucha	7. Leaf, flower	8. Cough relief, fever.
		8. Telakucha (Chakma tribe)	8. Whole plant	9. Headache, hypnotic, nerve depressant.
		9. Telakucha	9. Leaf juice, flower	10. Jaundice.
		10. Telakuchila	10. Leaf, stem	11. Stomach pain.
		11. Goolmo-gach	11. Leaf	12. Diabetes, fever.
		12. Telakucha	12. Leaf	13. Diabetes, dizziness.
		13. Kala-kochu (Tripura tribe)	13. Leaf	14. Mental disease, diabetes.
		14. Kalakuch	14. Root, whole plant	15. Diabetes.
		15. Telakochu	15. Whole plant	16. Diabetes.
		16. Telakochu	16. Leaf, stem	17. Respiratory problems, lung disorders.
		17. Nichu-bang (Marma tribe)	17. Fruit	18. Eczema, diabetes, acne.
		18. Telakucha	18. Whole plant	19. Diabetes.
		19. Telakucha	19. Leaf	20. Cough relief, anti-pyretic.
		20. Telakucha	20. Leaf	21. Diabetes, jaundice.
		21. Telakucha	21. Leaf, stem	22. Mental disease, leukorrhea, diabetes.
		22. Telakuch	22. Whole plant	23. Diarrhea, blood dysentery, dizziness from sunstroke.
		23. Telakucha	23. Leaf	24. Dysentery, diabetes, increased temperature of hands or head (leaf); leukorrhea, menstruation problems (root). 25. Hypertension, bloating, diabetes, blood disorders, coughs, and fevers.
		24. Telakucha	24. Leaf, root	26. Persistent bleeding following menstruation. 27. Diabetes, headache, alopecia. 28. Diabetes.
		25. Telakucha	25. Leaf	29. Diabetes, fever, alopecia, skin eruption, gonorrhea. 30. Diabetes, dermatitis.
		26. Telakucha	26. Root	31. Diabetes, antiinflammatory.
		27. Telakucha	27. Whole plant	32. Tonic, diabetes, myopathic spasm.
		28. Telakucha (Khasia tribe)	28. Leaf	33. Diabetes.
		29. Khuicchala	29. Whole plant	34. Sunstroke, diabetes.
		30. Kuccha lota	30. Leaf, flower	35. Dermatitis, diabetes, headache.
		31. Telakucha	31. Whole plant	36. Baldness, diabetes, sunstroke, scar.
		32. Telakucha	32. Whole plant	37. Typhoid disease, eczema, leukoderma, lesions of the tongue.
		33. Telakucha	33. Leaf	38. Burning sensations in hands or feet.
		34. Telakucha	34. Leaf juice	39. Whitish discharge in urine (men).
		35. Telakucha	35. Whole plant	40. Cough, diabetes, dysentery, emetic, burn (43).
		36. Telakucha	36. Leaf, fruit	41. To keep head cool.
		37. Telakucha	37. Leaf, fruit	42. Dysentery, oral lesions. 43. Mental depression, disability to work, blood dysentery, body pain.
		38. Kelakuch	38. Leaf	44. Diabetes (motha), to keep head cool, dysentery, skin diseases (leaf), burning sensations in hand or feet (leaf with meristem).
		39. Telamoon, Telakuchi	39. Leaf	45. Dysentery, skin diseases.
		40. Telakucha	40. Whole plant	46. Diabetes.
		41. Kelakucha	41. Leaf	47. Diabetes.
		42. Telakuch	42. Leaf	48. Bed-wetting in children.
		43. Telakuchi (Santal tribe)	43. Leaf	49. Frequent urination (diabetes). 50. Headache, insanity (leaf), eye infections, fever, blood purifier (whole plant).
		44. Telakochu	44. Leaf, motha (local term for	51. Diabetes (leaf juice and root juice), arthritis (root), gonorrhea.

Table 1: Continue

		45. Telakucha, Matha-sindur	plant base), meristem	52. Burning sensations during
		46. Telakucha	45. Leaf juice	urination, diabetes.
		47. Telakucha	46. Leaf	53. Diabetes.
		48. Telakucha	47. Leaf	54. Burning sensations in the body, blood dysentery, scabies, leukoderma (local term: chuli), diabetes.
		49. Telakucha	48. Leaf	55. Rokto-pitto (local term for
		50. Telkuchi, Telakucha	49. Leaf	hematemesis – condition of coming
		51. Telakochu	50. Leaf, whole plant	out of blood with vomit or sputum,
		52. Telakuchi, Kawaluli	51. Leaf, root, fruit	can arise from either tuberculosis
		53. Telakustila	52. Leaf	or hypertension), loss of appetite,
		54. Telakura	53. Leaf	diabetes, flatulency. Juice from stems
		55. Telakucha	54. Leaf	and leaves are orally administered.
			55. Leaf, stem	
Croton tiglium L.	Euphorbiaceae	1. Jaipal	1. Leaf	1. Pain, swelling.
English: Croton oil plant		2. Jaipal	2. Fruit, seed	2. Induces vomiting, biliary disorders,
		3. Jaipal	3. Seed	syphilis, erectile dysfunction, sex
		4. Joiphol	4. Fruit	stimulant.
				3. To cleanse bowels, constipation.
				4. Asthma. Fruit is taken.
Cuscuta reflexa Roxb. syn.		Cuscutaceae	1. Shorno lota	1. Whole plant1. Prostrate cancer,
Cuscuta verrucosa Sweet				to increase cow's milk.
English: Giant dodder		2. Alok lota	2. Whole plant	2. Sex stimulant, diarrhea.
		3. Shorno lota	3. Whole plant	3. Tonic, virility.
		4. Shorno lota	4. Whole plant	4. Indigestion, leg pain in poultry.
		5. Shorno lota	5. Stem	5. Jaundice.
		6. Shorno lota	6. Whole plant	6. Dysentery.
		7. Alok lota	7. Whole plant	7. Itch, sex stimulant.
		8. Shunyo-lota (Tripura tribe)	8. Vine	8. Diabetes.
		9. Shuitang (Chak tribe)	9. Vine	9. Impotency, scabies, eczema.
		10. Shorno lota (Garo tribe)	10. Whole plant	10. Jaundice.
		11. Shorno lota (Garo tribe)	11. Whole plant	11. Jaundice, anthelmintic.
		12. Shorno lota	12. Whole plant	12. Helminthiasis, premature ejaculation.
		13. Jigro-bang (Marma tribe)	13. Vine	13. Sex stimulant, taken as vegetable.
		14. Ore-rui (Murong)	14. Vine, fruit	14. Loosening of stool, carminative, fever, diarrhea, gastrointestinal disorders, acidity, and throat pains.
				15. Carminative.
		15. Alok lota	15. Vine	16. Excessive bleeding after menstruation.
		16. Shorno lota, Alok lota (Santal tribe)		16. Vine
		17. Jigro (Rakhain tribe)	17. Vine	17. Fever, body pain, rheumatic pain, sex stimulant.
		18. Kio-grow (Tripura tribe)	18. Vine	18. Edema, body ache, sexual
		19. Shorno lota	19. Whole plant	stimulant, maintain good hepatic
		20. Shorno lota		functions, jaundice.
		21. Shorno lota	20. Whole plant	19. Stimulate sex, cough.
				20. Tonic, stomachache.
		22. Alok lota, Shorno lota	21. Whole plant	21. Virility, carminative, itch.
		23. Alok lota	22. Vine, seed	22. Abortifacient, appetite stimulant,
		24. Shunha lota (Garo-4)	23. Whole plant	anthelmintic.
		25. Alok lota	24. Whole plant	23. Induce male/female fertility, colic,
		26. Shorno lota	25. Whole plant	dermatitis, antispasmodic.
		27. Shunnyo lota	26. Whole plant	24. Sexual disease.
		28. Shunnyo lota	27. Vine	25. Male/female fertility, indigestion,
		29. Alok lota, Shorno lota	28. Vine	cow's/goat's milk increaser.
			29. Vine	26. Alopecia, acne, skin glassiness.
		30. Shorno lota		27. Swelling in hands or feet, rheumatism (rosh-bath).
		31. Shorno lota	30. Vine	28. To stop bleeding from wounds, jaundice.
				29. Fever, jaundice, to maintain good health and keep body cool.
				30. Cuts and wounds (to stop bleeding).
		32. Shorno lota, Alok lota	31. Vine	31. Hair loss.
		33. Shorno lota,		32. Eczema, to increase breast milk.
		Alok lota, Omorabel		33. Dyspepsia, helminthiasis, itch,
		34. Shorno lota	33. Whole plant, seed	scabies, excessive biliary secretion,
		35. Shorno lota, Alok lota	34. Vine	digestive aid.
		36. Shorno lota	35. Vine	34. Gastrointestinal disorders, body
			36. Stem	ache.
				35. Heart disorders.

Table 1: Continue

				36. Jaundice, liver diseases, uterus and liver pain .
				32. Vine
Excoecaria agallocha L.	Euphorbiaceae	1. Gewa	1. Leaf, bark	1. Tumor, myopathic spasm, leprosy,
syn. Excoecaria ovalis		2. Gewa	2. Leaf, bark	abortion, dermatitis.
Endl., Commia				2. Piles, antidote to poison, rheumatoid
cochinchinensis Lour.,				arthritis, skin disorder.
Heritiera fomes Wall.	Sterculiaceae	1. Sundari	1. Leaf, stem, root	1. Heart diseases, carminative,
syn. Amygdalus minor				toothbrush.
Kuntze, Balanopteris		2. Sundari	2. Leaf, bark	2. Stomachache, diabetes, analgesic,
minor Gaertn., Fometica		3. Sundari	3. Stem, bark	diarrhea, dermatitis.
punctata Rafin.				3. Carminative, tooth brush.
		4. Sundari	4. Leaf, bark	4. Eczema, hepatic disorder, diabetes,
		5. Sundari	5. Bark	insect repellent.
				5. Goiter.
Ipomoea aquatica Forssk.	Convolvulaceae	1. Jongli-kolmi	1. The whole plant	1. Ecbolic, nervous disorders,
syn. Ipomoea reptans (L.)				anthelmintic, piles, hurt.
Poiret, nom. Invalid.				
English: Chinese water		2. Kolmi shak	2. Whole plant	2. Boil, antiinflammatory, eczema.
spinach, Water convolvulus,		3. Kolmi lota	3. Whole plant	3. Blood purifier.
Water spinach, Swamp cabbage,		4. Kolmi shak	4. Leaf	4. Chicken pox.
Swamp morning glory,		5. Kolmi shak	5. Leaf, whole plant	5. Stop bleeding from external wounds.
Tropical spinach		6. Kolmi lota	6. Leaf	6. Rheumatic swelling.
		7. Kolmi lota	7. Leaf, stem	7. Diabetes.
		8. Kolmi	8. Whole plant	8. Anthelmintic, edema, colic.
		9. Kolmi shak	9. Leaf, stem	9. Vegetable, snake bite, astringent, skin disorder.
		10. Kolmi shak	10. Whole plant	10. Snake bite, piles, indigestion, burn.
		11. Kolmi shak	11. Whole plant	11. Gall bladder stones.
		12. Kolmi shak, Kolyapi shak	12. Root	12. Diabetes.
		13. Kolmi shak	13. Leaf	13. Increase lactation in nursing mothers, leucorrhea.
Lagerstroemia speciosa	Lythraceae	1. Jarul	1. Seed, leaf, fruit	1. Diabetes, hypnotic, malaria,
(L.) Pers. syn.				jaundice, relieving pain.
Lagerstroemia				2. Diabetes, diarrhea.
reginae Roxb.		2. Jarul	2. Bark, seed	3. Diabetes, diarrhea.
English: Queen's		3. Jarul	3. Bark, seed	4. Constipation.
Flower, Queen's		4. Jarul	4. Fruit	5. Diabetes, obesity.
Cape Myrtle,		5. Jarui	5. Leaf, bark	6. Diabetes, malaria, liver
Pride of India				disease, hurt.
		6. Jaruli	6. Bark, fruit	7. Relieving flatulence, cold, diabetes, astringent, skin disorder, diuretic.
		7. Jarul gach	7. Whole plant	8. Fever, stimulant, sedative,
		8. Jarul	8. Root	flatulency.
		9. Jarul	9. Young leaf, bark	9. Stimulant, induces sleep.
Madhuca indica J.F. Gmel.	Sapotaceae	1. Mohua	1. Leaf, stem, flower	1. Tuberculosis, rheumatoid arthritis,
syn. Bassia latifolia Roxb.,				small-pox, cholera.
Madhuca latifolia				2. Paralysis, snake bite, stomach ache.
(Roxb.) J. F. Macbr.		2. Bilai-lenghur (Chakma tribe)	2. Leaf, stem, root	3. Debility, blood purifier.
English: Moa tree		3. Moa, Matkom (Santal tribe)	3. Fruit	4. Intestine disorders, antidote to poison, wound, tuberculosis, breast infection.
		4. Mohua	4. Leaf, bark, flower	5. Tonsillitis, influenza, cathartic.
		5. Mohua-phang (Garo tribe)	5. Whole plant	6. To prepare hypnotic drugs, to prepare wine.
		6. Mohua	6. Fruit	7. Piles, arthritic pain, helminthiasis,
		7. Mohua	7. Bark, flower, fruit	cough, to increase semen.
Musa sapientum L.	Musaceae	1. Kola	1. Stem, root, fruit	1. Tonsillitis, edema, malaria, piles, anti-hemorrhagic, hurt.
English: Banana				2. Dermatitis, jaundice, constipation, sperm mortality, carminative.
		2. Bichi-kola	2. Root, fruit	3. Diabetes, skin eruption.
				4. Cancer, constipation, stimulant energy, cow's/goat's sprain.
		3. Kola	3. Leaf, fruit	5. Obesity, cold, asthma, fever.
		4. Kola-mannhe (Santal tribe)	4. Whole plant	6. Fever.
				7. Sprain, fracture.
		5. Kola	5. Leaf, fruit	8. To heal burnt skin.
		6. Kola	6. Leaf, stem	9. Dysentery, obesity.
		7. Kola	7. Leaf	10. Piles.
		8. Anaji-kola	8. Fruit	11. Piles.
		9. Kola	9. Root, fruit	12. Diabetes.
		10. Kola	10. Gum	13. Stomach pain, gastrointestinal

Table 1: Continue

				disorders (inner part of main plant);
		11. Kola	11. Gum	diarrhea, stomach disorders (ripe fruit).
		12. Kola	12. Flower	14. Typhoid, obesity, constipation, itch, rheumatoid arthritis, jaundice.
		13. Acchi-mio-bong (Rakhain tribe)	13. Fruit (ripe), inner part of main plant during fruiting	15. Appetizer, vitamin, dysentery.
			14. Root, fruit	16. Appetizer, constipation.
				17. Cough, mucus, respiratory difficulties, constipation, dysentery, hypertension.
		14. Kola	15. Root, fruit	18. Kala azar.
			16. Leaf, fruit	19. Dysentery (fruit), wart (skin of fruit).
		15. Kola	17. Leaf	20. Constipation, sprain, anorexia,
		16. Kola		cough, debility, cow's/sheep's sprain
		17. Kola	18. Bark	or dysentery treatment.
			19. Fruit, skin of fruit	21. Irregular menstruation.
		18. Kola (Sorimaal variety)	20. Leaf, fruit, seed	22. Ear ache due to
		19. Thirikh-phang (Garo tribe)		cold (leaf), anthelmintic (root).
		20. Kola gach	21. Root (lower	23. Diarrhea, blood purifier, cough,
		21. Kola gach	white roots)	mucus, respiratory problems,
		22. Kola	22. Leaf, root	constipation, dysentery, heart
		23. Aita kola, shobri kola (note that these are two different varieties)	23. Young leaf, fruit	disorders, liver disorders, insect bites (aita kola), diarrhea (shobri kola).
Nypa fruticans Wurmb. syn. Cocos nypa Lour., Nipa fruticans Thunb., Nipa litoralis Blanco English: Nypa palm	Arecaceae	1. Nyah-palm	1. Leaf, stem, root	1. Tuberculosis, antidote, sore throat.
		2. Gol-pata	2. Leaf, stem	2. Liver disease, sedative, carminative.
		3. Gol-pata	3. Fruit juice	3. Tonic, tooth brush.
Piper peepuloides Wall.	Piperaceae	1. Pipol pan	1. Leaf	1. Diabetes.
		2. Pipol pan	2. Leaf	2. Diabetes.
Premna esculenta Roxb. syn. English:	Euphorbiaceae	1. Leloom (Chakma tribe)	1. Whole plant	1. Antidote to poison, jaundice, anti-inflammatory.
		2. Orai darlo (Tripura tribe)	2. Leaf	2. Body pain, insect and animal bites.
Saraca asoca (Roxb.) De Wilde. syn. Saraca indica L. Jonesia asoca Roxb. Jonesia pinnata Willd. English: Ashoka	Fabaceae	1.Ashok	1. Leaf, bark	1. Sexual diseases, analgesic, appetizer.
		2. Ashok	2. Leaf, stem, bark	2. Anti-hemorrhagic, relieving pain, hypostyptic.
		3. Ashok	3. Leaf, bark	3. Tonic, nerve stimulant, dermatitis, menstrual control.
				4. Menstrual control, diabetes, ant-spasmodic, hepatic disorder.
		4. Ashok	4. Leaf, bark	5. Menstruation control, fever.
				6. Gynecological problems.
		5. Ashok	5. Leaf, bark	7. Leukorrhea.
		6. Ashok	6. Leaf	8. Female diseases.
		7. Ashok	7. Leaf	9. Irregular menstruation, sedative, increases vaginal strength.
		8. Ashok	8. Leaf	10. Passing of blood in urine.
		9. Ashok	9. Leaf, bark	11. Blood purifier (leaf); dysentery, piles (bark).
				12. Irregular menstruation, burning sensations in the uterus, uterine disorders.
		10. Ashok	10. Bark	13. Tonic, gynecological disorders,
		11. Ashok	11. Leaf, bark	intestine disorders.
		12. Ashok	12. Bark	14. Leukorrhea.
		13. Ashok	13. Leaf, bark	15. Any problems associated with
		14. Ashok	14. Bark	menstruation.
		15. Ashok	15. Stem, flower, fruit	16. Menstrual problems, elimination
		16. Ashok	16. Bark, flower, seed	of stone from urinary tract, blood dysentery, uterus pain.
Sonneratia apetala Buch.-Ham. syn. Blatti apetala O.K., Kambala apetala Rafin. English: Mangrove apple	Euphorbiaceae	1. Keowra	1. Leaf, stem, bark	1. Gonorrhea, tiger/dog bite,
		2. Keowra	2. Leaf, fruit	vomitory, cathartic, eczema.
		3. Keowra	3. Leaf, bark	2. Insecticide, gonorrhea, malaria.
			juice, fruit	3. Vitamin C source, diarrhea, indigestion, anti-inflammatory.

Table 1: Continue

Stevia rebaudiana (Bertoni) Bertoni syn. Eupatorium rebaudianum Bertoni English: Candy leaf, Stevia, Sugar leaf, Sweetleaf (USA), Sweet honey leaf (Aust.), Sweet herb of Paraguay	Asteraceae	1. Misthi-pata	1. Whole plant	1. Tonic, diabetes, ecbolic.
Syzygium fruticosum (Roxb.) DC. English: Trichosanthes dioica Roxb.	Myrtaceae	1. Bon-jaam, Kath-jaam	1. Leaf	1. Appetite stimulant.
English: Pointed gourd, Wild snake gourd	Cucurbitaceae	1. Potol 2. Potol 3. Potol gach	1. Leaf, fruit, seed 2. Fruit, seed 3. Leaf	1. Cancer, constipation, acne, bronchitis, anti-hemorrhagic. 2. Diuretic, lack of appetite, debility, febricity, anti-hemorrhagic. 3. To get rid of foul odor from mouth.

Ethnobotanical surveys were conducted among traditional healers in 57 out of 64 districts of Bangladesh and among tribal healers of a number of tribes (shown in Table). Local names for any diseases as mentioned by the healers are indicated by bold lettering along with the symptoms for that particular disease. The numberings in individual columns refer to the number of places and tribes where the plant was observed to be used for medicinal purpose(s). Apart from the tribal names, the names of various regions from where ethnomedicinal data were obtained have not been given.

Table 2: The LC50 values of different Bangladeshi medicinal plant extracts against *Artemia salina*.

Serial number	Scientific name of plant	Part extracted	Solvent used for extraction	Probit Analysis (Mean ± SEM) Finney method [Lognormal distribution] (mg/ml)
1	*Abroma augusta*	Leaf	Methanol	12.68 ± 0.0847
2	*Acanthus ilicifolius*	Leaf	Chloroform	33 68 ± 0.091
3	*Acanthus ilicifolius*	Leaf	Methanol	17.343 ± 0.141
4	*Acanthus ilicifolius*	Leaf	Acetone	10.286 ± 0.085
5	*Alstonia scholaris*	Bark	Methanol	442.82 ± 0.167
6	*Calotropis procera*	Leaf	Methanol	8.669 ± 0.057
7	*Catharanthus roseus*	Flower	Methanol	2.244 ± 0.175
8	*Citrus grandis*	Leaf	Methanol	4.221 ± 0.22
9	*Coccinia grandis*	Leaf	Methanol	15.97 ± 0.101
10	*Croton tiglium*	Leaf	Methanol	0.0924 ± 0.0617
11	*Cuscuta reflexa*	Stem	Methanol	0.89 ± 0.114
12	*Excoecaria agallocha*	Leaf	Methanol	1.909 ± 0.0467
13	*Heritiera fomes*	Leaf	Chloroform	234.77 ± 0.144
14	*Heritiera fomes*	Bark	Methanol	47.081 ± 0.056
15	*Ipomoea aquatica*	Leaf	Methanol	1.535 ± 0.0699
16	*Ipomoea aquatica*	Leaf	Chloroform	0.705 ± 0.116
17	*Lagerstroemia speciosa*	Leaf	Methanol	2.133 ± 0.377
18	*Madhuca indica*	Leaf	Methanol	3.494 ± 0.092
19	*Musa sapientum*	Leaf	Methanol	14.54 ± 0.212
20	*Nypa fruticans*	Leaf	Methanol	14.68 ± 0.069
21	*Piper peepuloides*	Leaf	Methanol	2.607 ± 0.114
22	*Piper peepuloides*	Stem	Methanol	0.459 ± 0.203
23	*Premna esculenta*	Leaf	Methanol	2.882 ± 0.131
24	*Saraca asoca*	Bark	Methanol	16.302 ± 0.083
25	*Sonneratia apetala*	Leaf	Methanol	5.206 ± 0.093
26	*Stevia rebaudiana*	Leaf	Methanol	66.78 ± 0.0867
27	*Syzygium fruticosum*	Leaf	Methanol	229.1 ± 0.1701
28	*Trichosanthes dioica*	Leaf	Methanol	1.711 ± 0.13
	Vincristine sulfate (standard)			0.33 ± 0.055

The results are presented as LC_{50} values (g/ml).

quantitative and reproducible, and the activities parallel cytotoxicities. As a general observation, ED_{50} values for cytotoxicities will fall one order of magnitude (10 times) lower than LC_{50} values for brine shrimp. According to the standards of the American National Cancer Institute (NCI), ED_{50} values of $\leq$ 20 mg/ml for not pure compounds are considered active (Cordell, G.A., 1993), so we can take a level for the median lethal concentration (LC_{50}) as 200 g/ml. About 80% of the plant parts in different solvents used in the present study exhibited toxic effects to brine shrimp at LC_{50} values of less than 30 g/ml.

In the present study, DMSO was used as the solvent and as negative control. This is in accordance with previous report that brine shrimp nauplii can tolerate up to 11% of DMSO (Sam, T.W., 1993). Further studies are being conducted to isolate and purify the bioactive constituents for further evaluation in human cell line cultures for cytotoxic effects.

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