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Exploring 55 tropical medicinal plant species available in Bangladesh for their possible allelopathic potentiality

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ABSTRACT

The current research was conducted to investigate the allelopathic properties of 55 medicinal plant species of Bangladesh representing 32 different families. The aqueous leaves or whole plant extract of those plant species was diluted into four different concentrations *viz.*, 1:5, 1:10, 1:15, 1:20 (*w/v*) and tested against the seedling growth of *Raphanus sativus*. A control (distilled water without extract) was also maintained in every cases and the bioassay experiment was replicated thrice. The aqueous extract of all these species inhibited both shoot and root length of *R. sativus* at concentration greater than 1:15 (*w/v*) except *Delonix regia* (Fabaceae) and *Leucas aspera* (Lamiaceae). The inhibitory activity was concentration dependent and root growth was more sensitive than their shoot. Among the plant species, *Citrus aurantifolia* (Rotaceae), *Moringa oleifera* (Moringaceae), *Annona muricata* (Annonaceae), *Aegle marmelos* (Rutaceae), *Cinnamomum tamala* (Lauraceae) and *Azadirachta indica* (Meliaceae) completely (100%) inhibited the shoot and root growth of *R. sativus* at concentration 1:5 (*w/v*). Other than this six plant species, 15 out of 49 medicinal plants showed more than 95% shoot and root growth inhibition at the same concentration. The least allelopathic potential plant was *Garcinia mangostana* (Clusiaceae) that showed on an average 36% growth inhibition followed by *Schleichera oleosa* (Sapindaceae). Based on these results it can be concluded that among the tested plant species, *C. aurantifolia*, *M. oleifera*, *A. muricata*, *A. marmelos*, *C. tamala*, and *A. indica* are strongly allelopathic and therefore, could be used as potential candidates for the development of eco-friendly natural herbicides.

1. Introduction

Allelopathy refers to the inhibitory or stimulatory effect of one plant to their neighbouring plants and/or their associated microflora and/or macrofauna by the production of allelochemicals (IAS, 2017). Allelochemicals are released into the surrounding environment through a number of ways (Islam and Kato-Noguchi, 2013a). These allelochemicals upon release may suppress the growth and development of adjacent plants, even the secreting plant itself (Weir et al., 2004; Yu et al., 2005; Meier and Bowman, 2008; Zhou et al., 2013; Islam et al., 2014b). Thus, allelochemicals play a vital role in regulating the structure of plant populations (Smith and Martin, 1994), and could be used as tool for new natural herbicide development (Duke et al., 2002; Vyvyan, 2002).

About 52,885 of the estimated 422,000 flowering plants are considered as medicinal plants worldwide (Schippmann et al., 2002; Appiah et al., 2017). However, only 6% of these have been screened for their bio-activity, with 15% having been assessed for their phytochemical properties (Verpoorte, 2000; Fabricant and Farnsworth, 2001). On the other hand, out of 5000 plant species found in Bangladesh, 1000 are said to have medicinal qualities and 250 are regularly used in medicines (Kadir, 1990). Since medicinal plants are serving as an important source of many pharmaceutical and toxicological properties, researchers are currently feeling interest in searching their allelopathic/phytotoxic properties. Islam and Kato-Noguchi, (2014) stated two reasons for this increasing interest: (i) the easier screening process of phytotoxic plants from medicinal plants and (ii) the possibility to have more bioactive compounds in medicinal plants than other plants. But to date allelopathic properties of most of the medicinal plants remain untouched (Harvey, 2000). It is plausible that a plant that is highly valued for traditional medicine could also be useful in agriculture to develop bio-herbicides (Aliotta et al., 2008). A number of

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Table 1
The scientific and family name of different groups of plant used in this experiment.

Sl. No.	Scientific name	Family Name	Plant category
1	*Acacia auriculiformis* A. Cunn. ex Benth.	Fabaceae	Tree
2	*Adhatoda vasica* L.	Acanthaceae	Shrub
3	*Aegle marmelos* (L.) Corrêa	Rutaceae	Tree
4	*Alocasia indica* (Roxb.) Schott.	Araceae	Herb
5	*Annona muricata* L.	Annonaceae	Tree
6	*Aquilaria khasiana* Hallier f.	Thymelaeaceae	Tree
7	*Averrhoa carambola* L.	Oxalidaceae	Tree
8	*Azadirachta indica* A. Juss.	Meliaceae	Tree
9	*Bauhinia purpurea* L.	Fabaceae	Tree
10	*Calotropis gigantean* (L.) W. T. Aiton	Apocynaceae	Shrub
11	*Camellia sinensis* (L.) Kuntze	Theaceae	Shrub
12	*Cassia fistula* L.	Fabaceae	Tree
13	*Cinnamomum camphora* (L.) J. Presl.	Lauraceae	Tree
14	*Cinnamomum tamala* (Buch. Ham.) T. Nees & C. H. Eberm.	Lauraceae	Tree
15	*Citrus aurantifolia* (Christm.) Swingle	Rutaceae	Shrub
16	*Clerodendrum viscosum* Vent.	Lamiaceae	Shrub
17	*Coccinia cordifolia* Wight & Arn.	Cucurbitaceae	Herb
18	*Coriandrum sativum* L.	Umbelifers	Herb
19	*Costus speciosus* (J. Konig) C. Specht	Costaceae	Herb
20	*Curcuma angustifolia* Roxb.	Zingiberaceae	Herb
21	*Curcuma longa* L.	Zingiberaceae	Herb
22	*Delonix regia* (Boj. ex Hook.) Raf.	Fabaceae	Tree
23	*Diospyros peregrina* (Gaertn.) Gürke	Ebenaceae	Tree
24	*Erythrina variegata* L.	Fabaceae	Tree
25	*Eucalyptus camaldulensis* Dehnh.	Myrtaceae	Tree
26	*Ficus racemose* L.	Moraceae	Tree
27	*Garcinia mangostana* L.	Clusiaceae	Tree
28	*Gmelina philippensis* L.	Lamiaceae	Tree
29	*Holarrhena antidysenterica* (Linn.) Wall.	Apocynaceae	Shrub
30	*Justicia gendarussa* Burm. f.	Acanthaceae	Herb
31	*Lagerstroemia speciosa* (L.) Pers.	Lythraceae	Tree
32	*Leucas aspera* (Willd.) Link	Lamiaceae	Herb
33	*Madhuca longifolia* (J.König ex L.) J. F. Macbr.	Sapotaceae	Tree
34	*Mangifera indica* L.	Anacardiaceae	Tree
35	*Manilkara zapota* (L.) P. Royen	Sapotaceae	Tree
36	*Mikania micrantha* Kunth	Asteraceae	Herb
37	*Miliusa roxburghiana* (Wall.) Hook. f. & Thomson	Annonaceae	Tree
38	*Mimusops elengi* L.	Sapotaceae	Tree
39	*Moringa oleifera* Lam.	Moringaceae	Tree
40	*Morus alba* L.	Moraceae	Tree
41	*Nerium indicum* Mill.	Apocynaceae	Tree
42	*Paederia foetida* L.	Rubiaceae	Herb
43	*Phyllanthus emblica* L.	Phyllanthaceae	Tree
44	*Piper betel* L.	Piperaceae	Herb
45	*Randia uliginosa* (Retz.) Poir.	Rubiaceae	Shrub
46	*Schleichera oleosa (*Lour.) Oken	Sapotaceae	Tree
47	*Sesbania grandiflora* (L.) Poiret	Fabaceae	Tree
48	*Sterculia villosa* Roxb.	Malvaceae	Tree
49	*Swertia perennis* L.	Gentianaceae	Herb
50	*Swietenia macrophylla* King.	Meliaceae	Tree
51	*Syzygium cumini* (L.) Skeels.	Myrtaceae	Tree
52	*Tamarindus indica* L.	Fabaceae	Tree
53	*Terminalia arjuna* (Roxb.) Wight & Arn.	Combretaceae	Tree
54	*Terminalia bellirica* (Gaertn.) Roxb.	Combretaceae	Tree
55	*Terminalia chebula* Retz.	Combretaceae	Tree

studies have documented the use of allelopathic plants for weed control under field conditions (Xuan et al., 2003; Hong et al., 2004; Khanh et al., 2005; Xuan et al., 2005; Khanh et al., 2006; Batish et al., 2007; Khanh et al., 2007). Fujii et al. (1991) stated that medicinal plants showed relatively strong allelopathic activity than others. Fujii et al. (2003) evaluated the allelopathic potentials of 239 Japanese medicinal species of 81 families using the plant box method and 223 species of them were found to suppress tested plant growth, whereas 17 species were enhancing lettuce radicle growth. Gilani et al. (2010) evaluated the allelopathic potentials of 81 Pakistani medicinal species belonging to 39 families, and 66 species of them had growth inhibitory properties while 15 species stimulated the growth of *Lactuca sativa* at 10 mg concentration. Amini et al. (2016) on the other hand, evaluated 68 Iranian medicinal plant species belongs to 19 families and observed that 57 plants had inhibitory responses while 11 plants induced seedling growth in lettuce. Several other researchers around the world also observed allelopathic potential of medicinal plants for example, Piyatida and Kato-Noguchi (2010) and Suwitchayanon et al. (2017) worked with 25 Thai medicinal plants and observed variable inhibitory activity of the selected plants species on target plants.

However, very few are known about the allelopathic activity of Bangladeshi medicinal plant species. Since about 20% of the total plants species of Bangladesh are considered as medicinal plants, therefore, they could be served as potential candidates for allelopathic research. Identification of those unknown allelopathic medicinal plants of Bangladesh might provide the basis for new natural herbicide