



Germination and seedling growth of two summer vegetables influenced by aqueous extract of few ornamental plants

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Abstract

An experiment was conducted separately in pot and petridish to study the effects of aqueous extracts of few ornamental plants viz. Parrot tree (*Butea monosperma*), Indian Medlar (*Mimusops elengi*), Bougainvillea (*Bougainvillea glabra*), Powder puff (*Calliandra surinamensis*), Garland flower (*Hedychium coronarium*), Chinese honey-suckle (*Quisqualis densiflora*) on the germination and growth of two summer vegetables namely Cucumber (*Cucumis sativus*) and Yard long bean (*Vigna unguiculata*). Increased germination as well as root length and shoot length of both vegetables were found with the aqueous extract of Powder puff (*Calliandra surinamensis*) in compared with the control treatment. Aqueous extract of Indian Medlar found to decrease the germination and growth of two vegetables. The thin layer chromatography (TLC) test revealed the presence of five distinct compounds in the aqueous extract of powder puff at Hexane : Ethyl acetate (2:1 v/v).

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Introduction

Plants contain various chemical substances having a broad array of biological action. Due to their chemical properties, different parts of plants mostly in the form of extracts are being used for various purposes from the very beginning. Different types of naturally occurring organic and bioorganic compounds have been isolated from plants and most of them have effective medicinal, insecticidal, pesticidal or toxic values. Biological active compounds, such as plant growth promoters and growth inhibitors, herbicides, insecticides, nematicides, fungicides, pharmaceutical use, drugs and aroma chemicals are all structurally specific and generate biological activity. Plant extracts have been reported to show the cyto-toxic effects (Asadujjaman *et al.*, 2014), allelopathic effects (Sajjan *et al.*, 1997), antioxidant properties (Kenny *et al.*, 2014; Shah *et al.*, 2014) and also insecticidal effects (Kohata *et al.*, 2004; Liang *et al.*, 1994; Saxena *et al.*, 1994). The chloroform and aqueous extract of *Calliandra surinamensis*, showed strong antimicrobial activity against different pathogenic microorganism (Shikder *et al.*, 2012; Dbadamosi, 2012). Anti microbacterial activity of this plant against different organisms was also reported by Ali *et al.*, (2013) and p-hydroxybenzoic acid and (-) - epiafzelechin were isolated from the chloroform soluble fraction.

Certain plant extracts have been found to affect the germination as well as growth of different crop plants. Tripathi *et al.*, (1981) showed that the aqueous extract of *Terminalia chebula* and *Eupatorium adenophorum* strongly inhibited the germination, radical and plumule growth on wheat. Banana plant extract found to inhibit the germination of lettuce (Roy *et al.*, 2006). Certain reports also indicated the growth regulatory effects of different plant extracts. The aqueous extract of *Terminalia belirica* found to increase the germination, shoot and root growth in okra and swamp cabbage (Roy *et al.*, 2012).

For better production of crops, higher germination as well as seedling growth is very important factor and various efforts are being applied to achieve this. Use

of plant extracts for improved crop growth might be an effective way to reduce the chemical pollution. Though here are a lot of studies indicating the positive effects of various herbal plants extracts on germination and seedling growth, but reports on extracts of ornamental plants is very limited. Therefore, the present study was conducted to investigate the effect of aqueous extracts of six ornamental plants on germination and seedling growth of two summer vegetables.

Materials and method

The experiment was conducted at research laboratory and research field, Department of Agricultural Chemistry, Hajee Mohammad Danesh Science and Technology University, Dinajpur, Bangladesh. Six ornamental plants namely Parrot tree (*Butea monosperma*), Indian Medlar (*Mimusops elengi*), Bougainvillea (*Bougainvillia glabra*), Powder puff (*Calliandra surinamensis*), Garland flower (*Hedychium coronarium*), Chinese honey-suckle (*Quisqualis densiflora*) were selected to study the effects on germination and seedling growth of Cucumber (*Cucumis sativus*), Yard long bean (*Vigna unguiculata*).

Preparation of Aqueous Extracts

Two hundred gm (200g) of fresh and clean leaves of each plant were cut into smaller pieces and then blended by using blender and was taken in a 1000 ml reagent bottle. After adding 800 ml of water it was then kept for 72 hours at room temperature of $18 \pm 2^\circ\text{C}$ and relative humidity of $75 \pm 5\%$ with stirring at regular interval. After 72 hours the aqueous slurry was filtered through Whatman filter paper No.1 and was taken in another 500 ml bottle. The filtrates of individual plant extract were stored and used for treating the seeds of vegetable crops along with water as control treatment.

Set up of experiment in Petridish

Petridish experiment was done for yard long bean and cucumber seeds for the observation of germination percentage; shoot growth and root growth etc. Clean petridish with two sheets filter papers on each were

taken and fifteen ml of each aqueous extract was put in each petridish while the equal amount of distilled water was applied as control treatment. Then twenty five seeds of each vegetable crop were kept in each petridish and each treatment was replicated for five times. The petridis were kept in natural diffused light under laboratory conditions at $29\pm 2^{\circ}\text{C}$ temperature and relative humidity of $85\pm 5\%$ after placing. 5 ml of water was used per day per petridish to keep constant moisture (Agarwal, 2002). In control, only water was added if necessary.

Set up of experiment in Pot

Pots were filled with equal amount of well mixed sandy loam soil and 15 ml of each aqueous extract was put in each pot. In control, only distilled water was used. Then twenty five seeds of each vegetable crop were kept in each pot and each treatment was replicated into five times. The pot were kept in natural diffused light under field conditions at $29\pm 2^{\circ}\text{C}$ temperature and relative humidity of $85\pm 5\%$. 5 ml of water was used per day per pot to keep constant moisture (Agarwal, 2002).

Data collection and analysis

After setting the experiment, the germination percentages, shoot length, root length and completion of germination were recorded. Effects of different treatments on morphology of seedlings were also recorded. The data were subjected to analyze statistically using analysis of variance (ANOVA) technique by MSTST-C (Gomez and Gomez, 1984) and means were compared by the DMRT method.

Isolation of Crude Compounds from Effective Ornamental Plant Using Ethyl – alcohol

For the isolation of crude compounds of the effective ornamental plant, 100 gm of the leaves of plant's powder was taken in a 2.5 litter reagent bottle and 300 ml ethyl-alcohol was added to it. After 72 hours with shaking at regular interval it was filtered by using Whatman filter paper No. 1 and the extract was collected in 500 ml reagent bottle. 300 ml of ethyl-alcohol was added to the residue again and kept for next 72 hours with also regular interval shaking and

then filtered. The extracting processes were repeated for three times. The ethyl-alcohol extracts were combined together. The solvent was evaporated by using Thin Film Rotary Evaporator under reduced pressures at a temperature 55°C and 15.47 g Powder puff extract was obtained by ethyl-alcohol. The extract was stored in refrigerator at 0°C for further investigation.

Examination of Crude Components by Thin Layer Chromatography (TLC)

The number of compounds present in the crude extract was detected by thin layer chromatography where the R_f value of each component was calculated by using this formula (Furniss *et al.*, 1989):

$$R_f = \frac{\text{Distance traveled by the component}}{\text{Distance traveled by the solvent front}}$$

TLC was prepared for the leaf extract of Powder puff as increased germination and seedling growth was found with its extract. Compounds were detected by the solvent hexane and Ethyl acetate in 2:1 (v/v) ratio.

Results and discussion

Effects of Aqueous Extracts of Ornamental Plants (in Petridish)

Germination

A significant effect ($P \leq 5$) of aqueous extracts of ornamental plant leaves was found on germination of two vegetables (Table 1). At 5 DAS, the highest germination percentage of cucumber (97.6%) and yard long bean (93.8%) were found with the aqueous extract of Powder puff (T_4) which varied significantly with other treatments. The extracts of other plants performed moderately but the lowest germination of both vegetables were found with the aqueous extract of Indian Medlar (T_2). Increased germination of both vegetables might be due to the presence of some growth regulatory substances present in the extract of powder puff plant.

Shoot length

Shoot length of vegetables was significantly influenced by aqueous leaf extract of different ornamental plants (Table 2). Increased shoot length of both vegetables was found with the treatment T_4

(Powder puff). Highest shoot length 7.75 cm, 8.97 cm, and 9.11 cm were found at 10 DAS, 14 DAS and 18 DAS respectively in case of cucumber while lowest shoot length was found with the aqueous extract of Indian Medlar leaf. In Yard long bean, highest shoot

length 5.70 cm, 6.58 cm and 6.84 cm were found at 10 DAS, 14 DAS and 18 DAS respectively with the aqueous extract of Powder puff (T₄) and the lowest shoot length was found with the aqueous extract of Indian Medlar.

Table 1. Effect of ornamental leaves extracts on germination (in petridish)

Treatments	% Germination							
	Cucumber				Yard long bean			
	2 DAS	3 DAS	4 DAS	5 DAS	2 DAS	3 DAS	4 DAS	5 DAS
T ₁	38.4 b	54.4 bc	65.6 bc	79.0 b	45.0 ab	62.0 c	74.5 ab	84.8 a
T ₂	31.2 c	48.0 c	56.8 c	70.0 b	44.0 b	63.5 bc	70.1 b	84.0 a
T ₃	36.8 b	50.4 bc	63.2 bc	75.4 b	47.3 ab	66.1 ab	74.0 ab	84.0 a
T ₄	50.4 a	76.0 a	89.6 a	97.6 a	50.0 a	68.0 a	79.2 a	93.8 a
T ₅	38.4 b	54.2 bc	62.8 c	76.2 b	49.0 a	65.8 ab	74.6 ab	86.4 a
T ₆	33.4 c	55.2 bc	87.2 a	94.8 a	47.6 ab	67.5 a	73.2 ab	87.4 a
T _c	44.8 ab	68.0 ab	80.0 ab	95.2 a	47.6 ab	65.4 ab	74.4 ab	88.0 a

Means followed by the same letter (s) did not differ significantly at 5% level by DMRT.

- a) Aqueous extract of Parrot tree T₁
 b) Aqueous extract of Indian Medlar T₂
 c) Aqueous extract of Bougainvillea T₃
 d) Aqueous extract of Powder puff T₄
 e) Aqueous extract of Garland flower T₅
 f) Aqueous extract of Chinese honey -suckle T₆
 g) Water or control T_c

Table 2. Effect of ornamental leaves extracts on shoot length (in petridish).

Treatments	Shoot length (cm)					
	Cucumber			Yard long bean		
	10 DAS	14 DAS	18 DAS	10 DAS	14 DAS	18 DAS
T ₁	6.76 ab	6.64 b	8.35 a	3.88 b	4.56 b	5.36 bc
T ₂	4.09 d	4.88 c	5.20 d	5.27 a	3.87 c	4.15 d
T ₃	4.79 d	6.59 b	6.79 c	4.80 a	5.33 ab	4.75 c
T ₄	7.75 a	8.97 a	9.11 a	5.70 a	6.58 a	6.84 a
T ₅	5.47 c	7.20 b	7.46 b	4.46 a	4.10 c	4.66 d
T ₆	5.22 c	7.46 b	8.14 a	5.57 a	6.20 a	6.80 ab
T _c	5.90 bc	6.73 b	6.78 c	5.30 a	5.21 ab	5.31 bc

Means followed by the same letter (s) did not differ significantly at 5% level by DMRT.

Root Length

The effect of leaf extract of Ornamental plants on the root length of Cucumber was significant throughout the growth period (Table 3). Highest root length of Cucumber was found 4.45 cm, 4.63 cm, and 5.52 cm at 10 DAS, 14 DAS and 18 DAS respectively with the aqueous extract of Powder puff. In case of Yard long

bean, highest root length was found 2.85 cm, 3.47 cm, and 4.52 cm at 10 DAS, 14 DAS and 18 DAS respectively with the Powder puff. Aqueous extracts of other plants performed moderately but the lowest root length of cucumber and long yard bean was found with the aqueous extract of Indian Medlar.

Effects of Aqueous Extracts of Ornamental Plants (in pot)

Germination

Table 4 shows the effect of leaves aqueous extracts ornamental plants on germination of cucumber and long yard bean. At 2 DAS the highest germination (50.8 %) of cucumber was found in seeds treated with aqueous extract of Powder puff (T₄) and the lowest germination (40 %) of was recorded in seeds treated with the extract of Indian Medlar (T₂), both were statistically different from others. At 6 days after sowing, the highest germination (98.4 %) of

Cucumber was found in seeds treated with aqueous extract of Powder puff treatment (T₄), while the lowest germination (76.8 %) was recorded in seeds treated with the extract of Indian Medlar (T₂). In case of Yard long bean, highest germination 97.6% was found at 6 DAS with the aqueous extract of Powder puff which was statistically different from others. Likewise cucumber, lowest germination was found in long yard bean with the aqueous extract of Indian Medlar (T₂) while the extracts of other plants performed moderately.

Table 3. Effect of ornamental leaves extract on root length (in petridish)

Treatments	Root length (cm)					
	Cucumber			Yard long bean		
	10 DAS	14 DAS	18 DAS	10 DAS	14 DAS	18 DAS
T ₁	3.53 bc	4.47 a	4.89 ab	1.93 bc	3.36 a	3.89 ab
T ₂	2.46 d	3.61 b	3.74 c	1.31 d	2.61 b	2.91 d
T ₃	3.31 c	3.72 b	3.86 bc	1.46 c	2.87 b	3.28 c
T ₄	4.45 a	4.63 a	5.52 a	2.85 a	3.47 a	4.52 a
T ₅	4.12 ab	4.46 a	3.85 bc	2.32 ab	3.46 a	3.55 bc
T ₆	4.09 ab	4.22 a	3.94 bc	2.09 bc	3.22 a	3.02 cd
T _c	3.54 bc	4.57 a	3.97 bc	2.14 bc	3.57 a	3.57 bc

Means followed by the same letter (s) did not differ significantly at 5% level by DMRT.

Shoot length

The effect of leaf extract of ornamental plants on the shoot length of cucumber and yard long bean is shown in Table 5. At 10 DAS highest shoot length (5.76 cm) was observed in cucumber with the treatment T₄ (Powder puff) while, the shortest 4.94 cm was recorded with T₂ (Indian Medlar) treatment. At 20 DAS and 30 DAS, the highest shoot length 7.56 cm and 7.88 cm were observed respectively with the

extract of Powder puff leaf and the shortest shoot length 6.26 cm and 6.80 cm were recorded respectively with Control treatment. In case of yard long bean, highest shoot length 8.63 cm) was observed at 10 DAS with the treatment T₄ (Powder puff), while, the shortest (5.70 cm) was recorded in T₂ (Indian Medlar) treatment. Similar results were found on at 20 and 30 DAS.

Table 4. Effect of ornamental leaves extracts on germination (in pot)

Treatments	% Germination									
	Cucumber					Yard long bean				
	2 DAS	3 DAS	4 DAS	5 DAS	6 DAS	2 DAS	3 DAS	4 DAS	5 DAS	6 DAS
T ₁	43.6 bc	66.4 ab	78.8ab	74.4 b	85.6bc	40.8 a	60.8 a	74.4 a	78.4ab	88 bc
T ₂	40.0 d	65.6 b	76.4 b	70 b	76.8 c	39.2 a	58.4ab	63.2 a	72 b	77.6 d
T ₃	45.2 ab	69 a	78.6ab	78.8 b	82.4bc	38.4 a	52 ab	65.6 a	74.8 b	80.8cd
T ₄	50.8 a	70.4 a	81 a	91.2 a	98.4 a	34.4 a	60.9a	76.8 a	90.4 a	97.6 a
T ₅	46.8 ab	68 ab	77.8 b	75.2 b	86.4bc	40 a	54.4ab	68.8 a	75.2 b	78.4 d
T ₆	42.4 cd	67.4 ab	79.2ab	79.6 b	89.6ab	39.2 a	59.2 a	63.2 a	74 b	78.6 d
T _c	46 ab	68.5 a	80.1ab	74.2 b	92 ab	34.4 a	48 b	66.4 a	77.6ab	90.4ab

Means followed by the same letter (s) did not differ significantly at 5% level by DMRT.

Root Length

The effect of leaf extract of ornamental plants on the root length of cucumber was significant throughout the growth period (Table 6). At 10 DAS highest root length (4.31 cm) was observed in the treatment T₄ (Powder puff). At 20 and 30 DAS highest root length

5.63 and 6.82 cm was observed respectively. In case of Yard long bean, at 10 DAS highest root length 5.03 cm was observed with the treatment T₄ (Powder puff). Similar effect of the aqueous extract of powder puff was found at 20 and 30 DAS.

Table 5. Effect of ornamental leaves extracts on shoot length (in pot).

Treatments	Shoot length (cm)					
	Cucumber			Yard long bean		
	10 DAS	20 DAS	30 DAS	10 DAS	20 DAS	30 DAS
T ₁	5.14 ab	7.06 ab	7.54 ab	6.69 b	8.16 a	11.48 ab
T ₂	4.94 ab	6.26 c	6.80 c	5.70 c	8.04 a	10.16 b
T ₃	5.47 ab	6.39 bc	7.29 bc	7.17 ab	8.95 a	11.85 ab
T ₄	5.76 a	7.56 a	7.88 a	8.63 a	9.57 a	12.87 a
T ₅	5.08 ab	6.90 abc	7.53 ab	7.41 ab	8.46 a	11.60 ab
T ₆	4.95 ab	6.50 bc	6.94 bc	7.51 ab	8.83 a	11.23 ab
T _c	4.68 b	6.53 bc	7.26 bc	6.15 bc	8.72 a	10.39 b

Means followed by the same letter (s) did not differ significantly at 5% level by DMRT.

Table 6. Effect of ornamental leaves extract on root length (in pot).

Treatments	Root length (cm)					
	Cucumber			Yard long bean		
	10 DAS	14 DAS	18 DAS	10 DAS	14 DAS	18 DAS
T ₁	3.20 b	4.68 b	5.65 b	4.10 ab	6.77 a	7.15 a
T ₂	3.38 ab	4.61 b	5.89 b	4.79 a	6.61 a	6.87 a
T ₃	3.10 b	4.40 b	5.84 b	4.65 a	6.71 a	7.21 a
T ₄	4.31 a	5.63 a	6.82 a	5.03 a	6.88 a	7.71 a
T ₅	3.62 ab	5.01 ab	5.88 b	3.19 b	6.77 a	7.34 a
T ₆	3.53 ab	4.77 b	5.70 b	4.55 a	6.65 a	6.80 a
T _c	3.15 b	4.60 b	5.71 b	4.32 a	6.33 a	7.42 a

Means followed by the same letter (s) did not differ significantly at 5% level by DMRT.

Chemical Investigation on Aqueous Extracts of Leaves of Powder puff

The excellent growth enhancing activity of aqueous extracts of leaves of Powder puff on Cucumber and Yard long bean encourage me for their chemical investigation to know the reason what type of

compound is responsible for such type of bioactivity. For this reason an attempt was taken to isolate the individual compound of five fractions of Powder puff by Thin Layer Chromatography (TLC), Column Chromatography and Preparative TLC etc.

Table 7. R_f values of detected compounds of Powder puff (*Calliandra surinamensis*) with ethanol solvent.

Name of plant species	Ratio of Hexane and Ethylacetate	Detected component	R _f value
Powder puff (<i>Calliandra surinamensis</i>)	2:1	P ₁	0.95
		P ₂	0.83
		P ₃	0.74
		P ₄	0.61
		P ₅	0.47

TLC (Thin Layer Chromatography) of Ethanol Crude Extract of Powder puff

The TLC (Thin Layer Chromatography) of Ethanol

extract of Powder puff (*Calliandra surinamensis*) showed distinctly five compounds at Hexane : Ethylacetate (2 : 1 v/v) (Fig. 1), these results

suggested that Powder puff contained five distinct compounds, designated as P₁, P₂, P₃, P₄ and P₅ respectively. Here also the intensity of non – polar compound like P₁ of Powder puff was too much high compared with others. These compounds were detected in iodine tank and different R_f values obtained are showed in the Table 7.

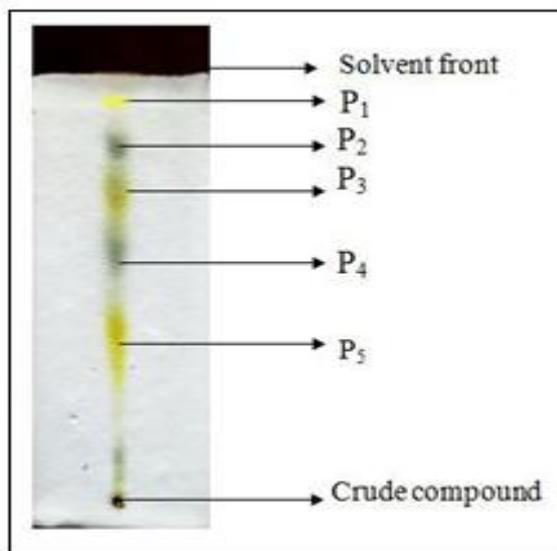


Fig. 1. TLC of Ethanol crude extract of *Calliandra surinamensis* Solvent Ratio: Hexane : Ethylacetate (2:1).

Conclusion

The experiment was carried out to investigate the effects of aqueous extracts of few ornamental plants on germination and growth of two vegetables. Powder puff (*Calliandra surinamensis*) plant extract found to have important role for vegetable production and it increased the germination as well growth of cucumber and yard long bean seedlings. Aqueous extract of Indian Medlar (*Mimusops elengi*) inhibited the germination and growth of both vegetables. Thin Layer Chromatography (TLC) test indicated the presence of five distinct compounds in the extract of Powder puff. Further research might isolate and investigate the allelochemicals for determining their potential and farm application.

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