Research Article

Phytotoxic potential of selected medicinal plants on germination of *Lactuca sativa* seeds

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Abstract

Medicinal plants are best sources to treat various illnesses with them. So they might prove be a good source of developing novel herbicides. The aim of the present study was to investigate the potential inhibition effects of *Cucumis sativus*, *Portulaca oleracea*, *Malus baccata*, *Saxifraga flagellaris*, *Geranium wallichianum* and *Monothea buxifolia* powdered material on germination of *Lactuca sativa* seeds. Sandwich method was used for determining phytotoxicity of these plants in terms of radicle and plumule length of *Lactuca sativa* seeds with different amounts of 10, 20, and 40mg of powdered plant material. *Cucumis sativus* and *Monothea buxifolia* were found the most phytotoxic among the selected medicinal plants at all concentration. The results can be sum off as *Monothea buxifolia* > *Cucumis sativus* > *Malus baccata* > *Saxifraga flagellaris* > *Geranium wallichianum* > *Portulaca oleraceae*. From the results it can be assumed that the phyto-toxic effects of the aforementioned plants could be helpful in searching and development of new pharmaceuticals that can be used as positive sources for the development of new weedicides.

Keywords: Allelopathy; *Lactuca sativa*; Medicinal Plants; Phyto-toxic Potential

Introduction

Plants of toxic nature can be used as natural herbicides or these phyto toxic components of interest can be extracted from the plants for developing new herbicides. A variety of plant's metabolites used to inhibit or stimulate the growth and development of other plants. These chemicals are called allelochemicals which exudated out, leached from different parts of plant or volatiled or plant residues present in the environment [1].

The effect of allelochemicals is called allelopathy which is the effects of donor plant, on recipient plant by the discharge of chemicals in the environment. This activity influences the growth and development of other plants either by inhibiting or stimulating the bio-physiologic processes of recipient organism. These activities are concentration dependent and might inhibit the growth of one plant at one concentration and might stimulate the growth at other

concentration. Such chemical are present in different plant parts in high amounts at specific environmental conditions [2]. Environmental conditions are responsible for differences in concentration of these metabolites [3].

Germination of seeds and plant development is altered by allelopathy and therefore germination is important way for the learning of allelopathy. Allelopathy has a significant part in agriculture and disturbs the progress and magnitude of the crops by the exchange of chemicals among crops, weeds and trees. Allelochemicals secreted by unknown plants significantly affect the intrinsic plants regardless of native species secreted allelochemicals or not [4]. Allelochemicals can alter the contents of plant growth hormones or make inequalities in many phyto-hormones, which hinders plant growth and development, for instance, with respect to germination of seed and sapling growth. Allelochemicals of phenolic nature can motivate IAA oxidase activity and obstruct the reaction of POD with IAA, unavoidable GA or IAA to effect endogenous hormone stages [5]. Fujii *et al.* [6] evaluated the allelopathic activities of 239 medicinal species using the sandwich method and 223 species of them were found to inhibit the seeds germination, while 17 species were found to stimulate lettuce radicle growth. Fujii *et al.* [7] reported the allelopathic effect from leaf mess leachates on lettuce seed germination and found inhibitory action determined by the sandwich method. Gilani *et al.* [8] screened 81 Pakistani medicinal plants and found that plants with allelopathic potentials also have stimulatory effects side by side with inhibition.

Medicinal plants like *Carum carvi* L., *Coriandrum sativum* and *Foeneculum vulgare* also inhibit the growth of weeds [9]. *Lavendula angustifolia*, *Mentha longifolia* and *M. piperrita* reduces germination of *Sorghum helapence* and *Rumex crispus* [10].

Nekonom *et al.* [11] also investigated medicinal plants which possess herbicidal properties against *Amaranthus retroflexus*. Zahedi and Ansari [12] investigated allelopathic potential of mallow extract and leachates on crop. Use of medicinal plants having phytotoxic property possess significant role in weeds control. Plant residues of *Artemisia* reduces seed germination of *Agropyron repens* [13]. Any part of the plant contained chemicals which might be allelochemicals, become part of the environment through root-exudates, leaching from upper plant parts or by decomposing of plant parts [14]. New botanical insecticides which are basically obtained from plants, are very necessary to overcome the resisting population of insects and have minimum or low threats to the environment. The present investigation was undertaken to evaluate medicinal plants for allelopathic property to produce harmless fumigant or insecticides that must be operative, cheap and suitable to use.

Materials and methods

Allelopathic study was carried out using sandwich method of Fujii *et al.* [6, 7] with slight modification. In this method 15g agar was dissolved in 1liter of distilled water and was autoclaved. The agar solution was left to cool at room temperature but before to solidify completely, the agar solution was poured into sterilized petriplates kept to solidify. Dehydrated plant material of each selected medicinal plant of 10mg, 20 mg and 40 mg were placed on the agar in petriplate and again a layer of agar was spread over it. After complete solidification, ten seeds of lettuce (*Lactuca sativa* L.) were employed on agar-gel in petriplate. Petriplates were wrapped with plastic-tape and nurtured for 72 h at 24°C in dark environments. The sizes of radicle and plumule were noted in (cm). Only agar without any plant material was used as a seed bed for lettuce seeds in control set of petriplates.

Each treatment was repeated three times. Means of radicle and plumule lengths for each medicinal plant were measured by relating to that of control. The data was evaluated statistically for the 10 mg, 20 mg and 40 mg of plant materials with radicle and plumule lengths of selected medicinal plants.

Results and discussion

Medicinal plants have inhibitory or stimulatory effects on selected whether cultivated or weeds and it's their allelochemicals inhibiting or promoting the plant growth. It is easy to separate allelopathic plants from medicinal plants due to their capability of accumulation of specific metabolites which can cure numerous infections of manhood [15-17]. Plants possess toxic metabolites can be potential bases bio-herbicides. Climatic and various ecological conditions may alter the plant metabolites and ultimately their synthesis of these components [18]. The use of cultivated crops as soil cover have many possible profits such as increasing soil fertility, upgrade soil inclination, enhanced nitrogen fixing ability, reducing corrosion, stop leakage of nutrients and clamping down the weed production. Chemicals are used to reduce growth of weeds which inversely affect the crop production. Struggle for nutrients and production of biochemicals by the crops can reduce the weed density and enhances the growth of crops because these chemicals have adverse effect on weeds. Releasing allelopathic Chemicals and production of primary or secondary metabolites by the crops over weeds, these chemicals interfering growth properties of the weeds which in turn either proved toxic or stimulate their growth. Allelopathy is chemical communication between the donor and recipient plant [19].

For allopathic study sandwich method of Fujii *et al.*, [6, 7] was used, in which *Lactuca sativa* seeds were used in agar gel bedding with different amount of plants parts pieces. Viveros-Legorreta *et al.* [20] reported that

OECD (Organisation for Economic Co-operation and Development), US-EPA (US-Environmental Protection Agency) and US-FDA (US-Food and Drug Administration), recommend that the most sensitive dicotyledons species: *Cucumis sativus*, *Lactuca sativa*, *Raphanus sativus*, *Trifolium pratensis*, and monocotyledons species: *Triticum aestivum* and *Panicum miliaceum* tested by diverse authors can be used in germination experiments [21]. Pino *et al.* [22] reported that pharmaceuticals cause inhibition of the radicle and hypocotyl elongation of *Lactuca sativa*. Allopathic chemicals are mostly absorb by radicle because it appear prior to plumule that's why its growth is more inhibited than the plumule [23].

The results of the Phytotoxicity/ allelopathy of selected medicinal in present study indicated that seeds of *Lactuca sativa* respond differentially to different medicinal plants (Table 1). At 10mg dose seeds of *Lactuca sativa* were very susceptible to leaves fragments of *Monothea buxifolia* with radicle length of 0.18cm, followed by *Cucumis sativus* seeds powder with radical length of 0.26cm and *Malus baccata* with radicle length of 0.64cm. *Portulaca oleraceae* and *Geranium wallichianum* showed stimulatory effect on seeds of *Lactuca sativa* (Fig.1). Libralato *et al.* [24] reported the Phytotoxicity of zerovalent iron on *Lepidium sativum*, *Sinapis alba* and *S. saccharatum*, their results showed bio stimulation effects as increased seedling length and high biomass. At 10mg concentration plumule growth was also inhibited by *Cucumis sativus* (0.22cm), *Monothea buxifolia* (0.24cm) and *Malus baccata* with 1.18cm length of plumule. *Saxifraga flagillaris*, *Portulaca oleraceae* and *Geranium wallichianum* showed stimulatory effects (Fig. 2). It is also reported that the chemicals of different part of the same plant can showed phytotoxic, inhibitory

or stimulatory effects on other recipient plants. Mehmoodzadeh *et al.* [25] reported the allelopathic effect of *Cannabis sativa* shoot and root extract where shoot showed inhibitory effects while root gave stimulatory effects on seeds of *Lactuca sativa*.

Present study showed that at 20mg radicle length of *Lactuca sativa* was least with *Monothea buxifolia* (0.12), followed by *Cucumis sativus* (0.14) and *Malus baccata* (0.63). *Portulaca oleraceae*, *Geranium wallichianum* and *Saxifraga flagillaris* showed 1.74, 1.82cm and 2.38cm length of radicle respectively (Fig. 3). Naz and Bano [26] reported that leaf extracts of *R. communis* and *L. camara* inhibit the growth of maize seedlings. Similar studies was conducted by Algandaby and Salama [17] where medicinal plants showed good phytotoxic or allelopathic effect. Devkota and Sherma [27] also screened allelopathy of rhizome and leaves of *justice adhatoda* where they reported inhibited germination of wheat and pea seeds.

The present findings showed at 20mg conc. *Malus baccata* reduces Plumule length and was 0.03cm, followed by *Monothea buxifolia* with 0.13cm and *Cucumis sativus* with 0.16cm. *Saxifraga flagillaris*, *Portulaca oleraceae* and *Geranium wallichianum* showed 1.54, 2.47 and 2.69 cm length of plumule respectively (Fig. 4). *Monothea buxifolia* inhibited the growth of *Lactuca sativa* might be due to the presence of flavonoids present there in. Macdonald *et al.* [28] reported that *Ocimum gratissimum* flavonoids are phytotoxic. Jan *et al.* [29] reported the presence of flavonoids in *Monothea buxifolia*. Same results were reported by Saadullah *et al.* [30].

At 40mg, radicle length of *Lactuca sativa* seeds was least *Monothea buxifolia* (0.12), followed by *Cucumis sativus* (0.14) and *Malus baccata* (0.63). *Portulaca oleraceae*, *Geranium wallichianum* and *Saxifraga flagillaris* showed 1.74, 1.82cm and 2.38cm

length of radicle respectively (Fig. 5) while plumule length at 40mg was least (0.09cm) with *Cucumis sativus*, followed by *Monothea buxifolia* (0.15cm) and *Malus baccata* (0.66cm). *Portulaca oleraceae*, *Geranium wallichianum* and *Saxifraga flagillaris* showed 1.82, 1.15cm and 2.30cm respectively (Fig. 6). These plants use in present study are commonly used for treating various illnesses but their allelopathic potentials are not reported yet. It is reported that medicinal plants can also be good sources of novel herbicides by inhibiting the growth seeds in vivo [31, 32]. It revealed from previous work that medicinal plants can produce inhibitory allelochemicals which reduces the germination of weeds [33].

The toxicity of many plants has been attributed to the point linked to their existence in their surroundings. According to Rasoaivo *et al.* [34] toxic and lethal plants particularly those rising in the wild must have in their evolutionary antiquity, established multifaceted substances as survival machinery to defend themselves from their predators. An opinion arises that some of the herbal biochemical mixtures may be operative in offensive cancer cells or deactivating eukaryotic ribosomes [35]. Phytotoxic medicinal plants are good springs of antitumor complexes, immune-toxines, steroid and non-steroid cardio active drugs. They are convenient to humanity. Herbal medicine experts and scientists are conscious of the possible toxicity of medicinal plants and they have formulated numerous means of removing the toxins or escaping the toxic fragments of the plants. Phytotoxicity tests are also directed to determine the toxicity of medicinal plants. The study was conducted that to check the effects of chemicals present in the donor plants on to the recipient plant. Using of more than one plant in bioassay can clearly measure the allelopathic potential of the donor plants on to recipient plant which

can lead us to isolation of new compounds of biological positive activity [36, 37].

Table. 1 Allelopathic effect of selected medicinal plants on seeds of *Lactuca sativa*

S. No.	Plants names	10mg		20mg		40mg	
		Radicle	Plumule	Radicle	Plumule	Radicle	Plumule
1	<i>Cucumis sativus</i>	0.26 ±0.14	0.22 ±0.12	0.09 ±0.04	0.16 ±0.07	0.14 ±0.07	0.09 ±0.04
2	<i>Portulaca oleracea</i>	3.86 ±0.23	3.86 ±0.24	1.97 ±0.16	2.47 ±0.17	1.74 ±0.11	1.82 ±0.13
3	<i>Malus baccata</i>	0.64 ±0.07	1.18 ±0.06	0.44 ±0.02	0.3 ±0.02	0.63 ±0.07	0.66 ±0.10
4	<i>Saxifraga flagillaris</i>	0.72 ±0.06	1.38 ±0.091	2.57 ±0.19	1.54 ±0.16	2.38 ±0.16	2.30 ±0.11
5	<i>Geranium wallichianum</i>	3.083 ±0.15	2.68 ±0.15	3.71 ±0.17	2.69 ±0.16	1.82 ±0.11	1.15 ±0.09
6	<i>Monothea buxifolia</i>	0.18 ±0.09	0.24 ±0.13	0.04 ±0.01	0.13 ±0.02	0.12 ±0.01	0.15 ±0.02

Figure 1. At 10mg concentration (dry powdered parts of plants), allelopathic effects of selected medicinal plants parts on Radical length of lettuce seeds

Figure 2. At 10mg concentration (dry powdered parts of plants), allelopathic effects of selected medicinal plants parts on Plumule length of lettuce seeds

Figure 3. At 20mg concentration (dry powdered parts of plants), allelopathic effects of selected medicinal plants parts on Radical length of lettuce seeds

Figure 4. At 20mg concentration (dry powdered parts of plants), allelopathic effects of selected medicinal plants parts on Plumule length of lettuce seeds

Figure 5. At 40mg concentration (dry powdered parts of plants), allelopathic effects of selected medicinal plants parts on Radical length of lettuce seeds

Figure 6. At 40mg concentration (dry powdered parts of plants), allelopathic effects of selected medicinal plants parts on Plumule length of lettuce seeds

Conclusion

It is concluded from the present study that medicinal plants not only cure illnesses but also possess strong allelochemicals which either could inhibit the growth of radicals or plumule but have stimulatory effects too. These plants have many important chemical like phenols etc. which will be involve in the overall process. In present study the plants which show good inhibitory effects against *Lactuca sativa*, needs further examination against weeds and crops in open fields. It is also important to isolate inhibitory compounds from these selected medicinal plant which might be ecofriendly and to control weeds.

Authors' contributions

Conceived and designed the experiments: M. Humayun, Performed the experiments: HA Begum, Analyzed the data: HA Begum, Contributed materials/ analysis/ tools: M. Humayun, Wrote the paper: HA Begum.

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