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Allelopathic effects of essential oils from *Sinapis arvensis* L. aerial part on germination and seedling growth of medicinal plants and weeds

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Abstract

The potential allelopathic effects of the essential oils of *Sinapis arvensis* L. aerial part was appraised *in vitro*. The inhibitory effect of the essential oils at 0, 2.5, 5 and 10% (w/v) on germination and seedling growth of two cultivated medicinal plants, Hyssop (*Hyssopus officinalis* L.), *Cardaria draba* (*Lepidium draba* L.) and two weeds, redroot amaranth (*Amaranthus retroflexus*) and dandelion (*Taraxicum officinale*) was check. *Sinapis arvensis* L. essential oils influenced all four test plants equally, with 2.5, 5 and 10% decreasing seed germination and shoot length. This allelopathic effect of this herb may be related to the presence of allelochemicals, including benzyl isothiocyante, cubenol, 1- butenyl isoithiocyanate and dimethyl trisulfide.

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Introduction

The search of biologically active component of plants has always been great interest to scientists looking for new sources of practical for herb-based medicines, food supplements, pharmaceuticals and health products (Rad *et al*., 2014a; Hoseini Alfatemi *et al*., 2014; Sharifi-Rad *et al*., 2014; Sharifi Rad *et al*., 2014;).

The essential oils are something only nature could inspire. Measured the life-force in every living plant, essential oils include the essence, or soul, of the plant-the odor, taste and curative properties. Extracted from the wood, root, seed, flower, bark, fruit, and leaf of freshly harvested plants, essential oils contain the plant's powerful advantages-their uses have been well documented for centuries and throughout the world (Abdolshahi *et al*., 2013; Rad *et al*., 2013a).

Sinapis arvensis (Brassicaceae; syn. *Brassica arvensis* (L), *Brassica sinapis Vis., Brassica sinapistrum Boiss.* Link), usually known as field mustard, wild mustard or charlock. The Brassicaceae is a large family includes 3,700 species spread over 338 genera. Brassicaceae has a throughout the world distribution (Rad *et al*., 2013b) .The distinction between family members are in having a pungent flavor and sulfury odor lead to the volatile isothiocyanate derivatives, acquired upon hydrolysis of glucosinolate (Al- Qudah, 2010). *Sinapis arvensis* L. are used as fodder to livestock, food and folklore medicine (Bendimerad, 2007). *S. arvensis* is native to Europe and grows in, North Africa, western Asia and Iran (Frankton, 1987).

Allelopathy is a biological phenomenon by which an organism product one or more biochemicals, the allelochemicals, that influence the survival, growth and reproduction of other organisms. Allelochemicals can have advantageous or injurious effects on the target organisms (Reigosa *et al*., 2006). The release of allelochemicals into the environment acts on other organisms such as plants, including weeds, animals and microorganisms to either inhibit or arouse activity (Fujii *et al*., 2003). Allelochemicals can also repress germination and growth of different weed species (Rad *et al*., 2014b). Enormous amounts of synthetic chemical herbicides are accustomed to manage weeds but they are often toxic and have environmental risks (Sodaeizadeh *et al*., 2009). Medicinal plants have been increasingly investigated for their allelopathic potential (Da Silva *et al*., 2013). Medicinal plants may include bioactive compounds such as vanillic, caffeic, ferulic, coumaric, and chlorogenic acid that own inhibitory activity (Modallal and Al-Charchafchi, 2006).

Hyssopus officinalis is important medicinal aromatic plant in the Lamiaceae. This species is widely used in the medicinal Properties (Rad and Rad, 2013), and it is cultivated in some countries such as Russia, France, France, Spain, Iran. The essential oil of this species has anti-bacterial properties. *H. officinalis* also is utilized as a cure for digestive disorders, herpes, bronchiti, asthma (Jankovasky and Landa, 2002).

Cardaria draba (Brassicaceae; syn. *Lepidium draba* (L). Link), commonly known as hoary cress, is a perennial herb that multiply by seed and by horizontal creeping roots. *C. draba* is native to Eastern Europe and western Asia, including Iran, and is an invasive species in North America. It can be found in most parts of Iran, in fields and adjacent to water sources.The essence of *C. draba* was utilized in medicine to treat various diseases (Miri *et al*., 2013a). Redroot pigweed *(Amaranthus retroflexus*) is native to central North America. It is an annual weed usually found in waste areas and disturbed soils. *A. retroflexus* is a weed with fast progression and extreme production of seeds (Gidea *et al*., 2010; Damian, 2011).

Dandelion (*Taraxacum officinale*) is a member of the Asteraceae family, grows to a height of nearby 12 inches. It is grown in the Europe and United States, and the leaves and root has many medicinal uses, despite being ordinarily regarded as a weed.

This study aimed to appraise the *in vitro* allelopathic potential of the essential oils obtained from *Sinapis*

arvensis L. aerial part on the germination and seedling growth of Hyssop (*Hyssopus officinalis* L.), *Cardaria draba* (*Lepidium draba* L.), redroot amaranth (*Amaranthus retroflexus*) and dandelion (*Taraxacum officinale*).

Materials and methods

Plant material

Sinapis arvensis var. orientalis (L.) was collected in June 2012 from area of Hamoon international wetland of Zabol (Iran) in during the flowering stage. The seeds of Hyssop (*Hyssopus officinalis* L.), *Cardaria draba* (*Lepidium draba* L.), redroot amaranth (*Amaranthus retroflexus*) and dandelion (*Taraxicum officinale*) were purchased from a seed company, Pakan Bazr (Esfahan, Iran).

Essential oils preparation

The aerial part of *Sinapis arvensis var. orientalis* were dried and milled into a fine powder and 100 g was subjected for 2 h of hydrodistillation using a Clevenger-type apparatus. The acquired essential oil was collected, and having moisture removed over anhydrous sodium sulphate and kept at 4°C until assays.

Essential oils Bioassay

In order to detect the allelopathic effect of the *Sinapis arvensis* aerial part, dilutions were made of the original essential oils to 2.5, 5 and 10 % of the stock. Twenty seeds of each plant (*H. officinalis* L., *C. draba*, *A. retroflexus* and *T. officinale*) were surface sterilized with sodium hypochlorite 5% for 15 min before being washed with abundant distilled water. Then sterilized seed were placed on sterilized filter paper in 6-cm diameter Petri dishes. Since the essential oils are insoluble in water, 3 treatments (2.5, 5 and 10 µl/ml) were prepared by dissolving the appropriate volume of the oils in 100 µl of methanol, and then in 100 ml distilled water. Controls carried out with the mixture methanol/water (1%) did not affect the germination of each seed in comparison with controls (water alone). 3 ml of each solution (i.e., concentration) was added to a separate Petri dish while distilled water served as the control. Petri dishes were placed in the light (350 µmol m^{-2} s^{-1}) at 25°C for 15 days. They were monitored daily and the evaporated contents were compensated with distilled water. The number of germinated and non-germinated seeds was counted and final root and shoot length were measured at the end of the 15th day (in mm). Seeds whose root emerged from the test were considered to have germinated.

Statistical analysis

The experimental design was a complete randomized design with three replications for each treatment. Data were analyzed using SPSS v. 11.5 and mean comparisons were made following the LSD test at $P \leq 0.05$.

Results and discussion

In this study an allelopathic effect of the essential oils from *S. arvensis* L. aerial part was established, impacting the seedling growth and germination of four plants, two medicinal Plants and two weeds. The concentrations 2.5, 5 and 10% of the essential oils from *S. arvensis* decreased the germination percentage of all plants (Fig. 1A). Root length of all plants decreased significantly after exposure to 10% and showed no significant different at 2.5 and 5 % compare than controls (Fig. 1B). In all of plants with increased the essential oils concentration, shoot length decreased (Fig. 1C). In this study, same impacts of essential oils on root length or seed germination were observed (Fig. 1A and 1C, respectively).

Miri *et al.* (2013b) appraised the potential *in vitro* allelopathic effects of the ethanolic extract from seeds of *Cardaria draba*. They tested effect of extract from *C. draba* at 2.5, 5 and 10% (w/v) on germination and seedling growth of two cultivated crops, common bean (*Phaseolous vulgaris*) and wheat (*Hordeum vulgare*) and two weeds, dandelion (*Taraxicum officinalis*) and redroot amaranth (*Amaranthus retroflexus*). The seed extract have equal effect on all four test plants, with 2.5, 5 and 10% decreasing seed germination and seedling growth (root and shoot length). This allelopathic effect may be related to the

presence of allelochemicals, including glucosinolate, glucoerucin (4-methylation-butyl-glucosinolate), gluco-raphanin (4-methylsulfinyl-butyl-glucosinolate) and sinal-bin (*p*-hydroxy-benzyl-glucosinolate).

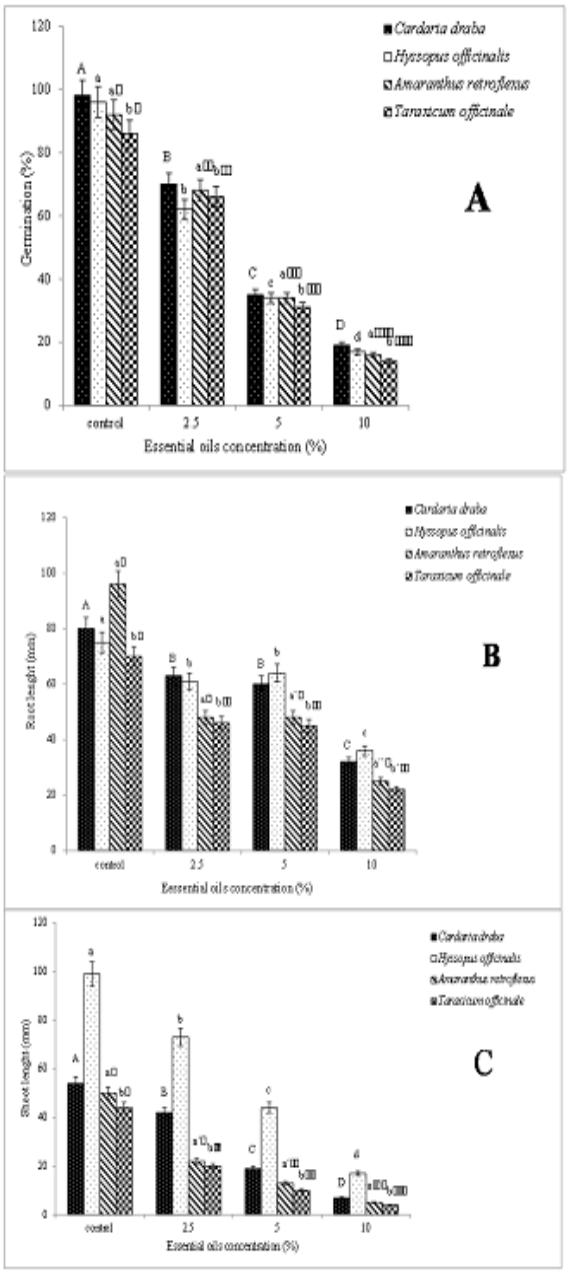

Fig. 1. Effect of different concentrations of essential oils from *Sinapis arvensis* on seed germination (A), root length (B) and shoot length (C) of the four examined plants. Different letters show significant differences (for each parameter, between different essential oils concentrations and within a single plant species) between means at $P \leq 0.05$ (LSD test).

Patel and Pandya (2013) investigated the allelopathic or phytotoxic effect of four medicinal plants (*Acalypha indica*, *Boerhaavia diffusa, Synedrella nodiflora* and *Aerva lanata*) on radish (*Raphanus sativus*). Seed germination was significantly inhibited by stem and root aqueous extract of *B. diffusa*, radical growth was noticeably affected by *A. indica* leaf extract, while *S. nodiflora* extract influenced plumule dry and fresh mass.

Rad *et al.* (2014b) investigated evaluation of allelopathic effects of methanolic extracts from *Salicornia herbacea* seed and leaves on germination and seedling growth in vitro of two medicinal plants and two weeds. They reported that *S. herbacea* seed and leaf extracts had negative effects on *Taraxicum officinale* and *Amaranthus retroflexus* (weeds) but no effect on *Hyssopus officinalis* and *Nigella sativa* (medicinal plants). *Salicornia herbacea* can thus be used as a herbicide against weeds when applied at 5 or 10% two type extracts.

Rad *et al.* (2013b) reported that major components of essential oil stem of *S. arvensis* contain benzyl isothiocyante (15.15%), cubenol (15.12%), 1- butenyl isoithiocyanate (18.4%). Also they illustrated that flower essential oil stem of *S. arvensis* contained dimethyl trisulfide (19.2%), cubenol (14.32%) as major components.

The allelopathic effect of *S. arvensis* essential oils observed in this study can be related to benzyl isothiocyante, cubenol, 1- butenyl isoithiocyanate and dimethyl trisulfide that these were more than other compounds. This could be one explanation of the allelopathic effects of *S. arvensis* essential oils. Allelochemicals may be selective in their action, or plants may be selective in their responses. So, In allelopathic studies determining the modes of action of allelochemicals is one of the challenging aspects.

In conclusion, the results of this study showed that *S. arvensis* essential oils can thus be used as a herbicide against weeds when applied at 5 or 10%, although pot, greenhouse and field trials would be unavoidable to approve this claim.

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