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Allelopathic Potential of Ajwain (*Trachyspermum copticum*)

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ABSTRACT

The ethanolic extract obtained from ajwain (*Trachyspermum copticum* (L.) Link) seeds was evaluated *in vitro* to examine its potential allelopathic effects. The inhibitory effect of the extract at 0, 2.5 and 5% (i.e., g amounts of original extract in 100 ml of distilled water) on germination and seedling growth of corn (*Zea mays*), cowpea (*Vigna unguiculata*), redroot amaranth (*Amaranthus retroflexus*) and dandelion (*Taraxicum officinalis*) were tested. The effects of ajwain seeds extract on cowpea and corn as a cultivated crop were obviously different from the weeds (redroot amaranth and dandelion). At 2.5 and 5% of ajwain seed extract, seed germination and seedling length of both weeds were completely inhibited but in corn and cowpea there was no change or only a slight decrease. The inhibitory effects may be related to the presence of allelochemicals, including thymol, γ-terpinene and *p*-cymene of ajwain seed. Optimum concentrations of ajwain seed extracts could be used as herbicides in the control of weedsr.

Keywords: ajowan, allelopathy, *Carum copticum*, inhibitory effect, thymol

INTRODUCTION

Trachyspermum copticum (Apiaceae) syn. *Carum copticum* (L.) Link, commonly known as ajwain or ajowan is an annual herbaceous, 30-70 cm in height, which grows in eastern India, Iran, and Egypt, with white flowers and small, brownish seeds (Khajeh *et al*. 2004). Ajwain seeds have several therapeutic effects, including diuretic, anti-vomiting, analgesic, antiasthma, anti-inflammatory and anti-dyspnea effects (Thangam and Dhananjayan 2003; Khajeh *et al.* 2004; Hawrelak *et al.* 2009). Raw ajwain smells almost exactly like thyme because it also contains thymol from 39 to 55% (Nagulakshmi *et al.* 2000; Gersbach and Reddy 2002; Mohaghehzadeh *et al*. 2007), but is more aromatic and less subtle in taste, as well as slightly bitter and pungent. A watery extract of this plant is widely used to relieve the flu in children (Boskabady and Shaikhi 2000).

Allelopathy is a biological phenomenon by which an organism produces one or more biochemicals that influence the growth, survival, and reproduction of other organisms. These biochemicals are known as allelochemicals and can have beneficial (positive allelopathy) or detrimental (negative allelopathy) effects on the target organisms (Reigosa *et al*. 2006). Allelopathy is an important mechanism of plant interference mediated by the addition of plant-produced phytotoxins to the plant environment and is a competitive strategy of plants (Oussama 2003). Allelochemicals are produced by plants as end products, by-products and metabolites and exist in the stems, leaves, roots, flowers, inflorescences, fruits and seeds of plants (Sisodia and Siddiqui 2010). These chemical compounds are released into the environment and act on other organisms such as plants, including weeds, animals and microorganisms to either inhibit or stimulate activity (Fujii *et al*. 2003). There is increasing evidence that these plant chemicals can suppress germination and growth of different weed species (Singh *et al.* 2003; Turk and Tawaha 2003; Sampietro and Vattuone 2006; Mohsenzadeh *et al*. 2011; Nourimand *et al*. 2011). Worldwide, enormous amounts of chemical herbicides are used to manage these weeds. However, synthetic herbicides are often toxic and cause environmental problems (Khanh *et al*. 2004; Sodaeizadeh *et al*. 2009). Moreover, overuse of artificial herbicides has led to the development of weed biotypes with herbicide resistance (Sodaeizadeh *et al*. 2009). In agriculture, there is a worldwide effort to reduce the amount of chemicals used in crop production through modern biological and ecological methods. One of the possible solutions is the use of allelopathy to explore the negative chemical interaction between plants (Azizi and Fujii 2006). The importance of allelopathy in the natural control of weeds and crop productivity is now highly recognized (Khan *et al*. 2009). In recent years, medicinal plants have been increasingly explored for their allelopathic potential (Anjum *et al*. 2010). Medicinal plants may contain bioactive compounds such as ferulic, coumaric, vanillic, caffeic and chlorogenic acid that possess inhibitory activity (Modallal and Al-Charchafchi 2006). Nazir *et al*. (2006) evaluated the allelopathic effects of the aqueous extracts of *Rheum emodi*, *Saussaurea lappa* and *Potentilla fulgens* on some traditional food crops; germination of all crops was significantly reduced by *S. lappa* and *P. fulgens* extracts. Fujii *et al*. (2003) used 239 medicinal plants to evaluate the allelopathic activity on lettuce. They concluded that 223 species were inhibitory.

This study aimed to assess the *in vitro* allelopathic potential of the ethanolic extract obtained from ajwain seeds on germination and seedling growth of corn and cowpea as two model cultivated monocotyledonous and dicotyledonous crops, respectively, and redroot amaranth and dandelion as two representative weeds.

MATERIALS AND METHODS

Plant material

Ajwain seeds were obtained from Zabol University of Zabol, a warm and dry climate city in the southeast of Iran. The seeds of corn (*Zea mays* cv. '704'), cowpea (*Vigna unguiculata* cv. 'Unguiculata'), redroot amaranth (*Amaranthus retroflexus*) and dandelion (*Taraxicum officinalis*) were obtained from the College of Sciences, Shiraz University.

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Short Communication

Extraction from ajwain

Ajwain seeds were powdered in a knife mill. Ground sample (20 g) was mixed with 200 ml of 96% ethanol using a shaking water bath for 24 h at room temperature. The extract was separated from solid concentrate by filtering through Whatman No. 1 filter paper. The remaining residue was re-extracted twice and the extracts were pooled. The solvent was removed under vacuum at 40°C using a rotary vacuum evaporator (Laborota 4000, Heidolph, Germany).

Bioassay

In order to detect the allelopathic effect of the ajwain seed extracts, dilutions were made of the original extract to 2.5 and 5% of the stock extract. Twenty seeds of each crop and weed were surface sterilized with a water-bleach solution (95: 5) and were placed on sterilized filter paper in 6-cm diameter Petri dishes. Each solution (3 ml) was added to each Petri dish; distilled water served as the control. Petri dishes were placed in the light (350 µmol $m^{-2} s^{-1}$) at 25°C for 14 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 14th day. Seeds whose root emerged were considered to have germinated.

Statistical analysis

The experimental design was a complete randomized design with four replications for each treatment. Data were analyzed using SPSS v. 17.0 and mean comparisons were made following the LSD test at $P \leq 0.05$.

RESULTS

The allelopathic effect of ajwain seed extracts on the germination and seedling length of the four examined plants was determined. The extract caused a significant ($P \leq 0.05$) decrease or completely inhibited seed germination and seedling length in all four studied plants.

Germination percentage was 82-94% in the control group of the four tested seedlings. At 2.5 and 5% of ajwain seed extract, germination was completely inhibited in redroot amaranth and dandelion but there was only a slight decrease in corn and cowpea (**Fig. 1A**). Shoot and root length were about 8-65 and 9-55 mm, respectively in the control group of the four tested seedlings. Shoot length of redroot amaranth and dandelion was completely inhibited at 2.5% of seed extract. The shoot length of cowpea decreased slightly but in corn it did not change (**Fig. 1B**). Root length of redroot amaranth and dandelion was completely inhibited at 2.5% of seed extract but in cowpea and corn, this parameter did not change (**Fig. 1C**).

DISCUSSION

In this study, basic research on the allelopathic potential of ethanolic extracts of ajwain seeds at two concentrations showed that this medicinal plant exhibited a significant inhibitory effect on seed germination and seedling length of two out of four examined plants. The percentage of essential oil reported in different studies ranged from 0.5 to 9% (v/w) while the major volatile compounds identified in ajwain essential oil were thymol (39-55%), γ-terpinene (22-31%) and *p*-cymene (19-21%) (Nagulakshmi *et al.* 2000; Gersbach and Reddy 2002; Mohaghehzadeh *et al*. 2007).

The inhibitory effect of ajwain seed extract on seed germination and seedling growth of the two weeds may be related to the presence of allelochemicals, including thymol, γ-terpinene and *p*-cymene. The lower water availability for seed germination due to binding water by compounds present in an extract might play an effective role in reducing seed germination (Bogatek *et al*. 2006). It might be possible to use optimum concentrations of ajwain seed extracts as herbicides against weeds.

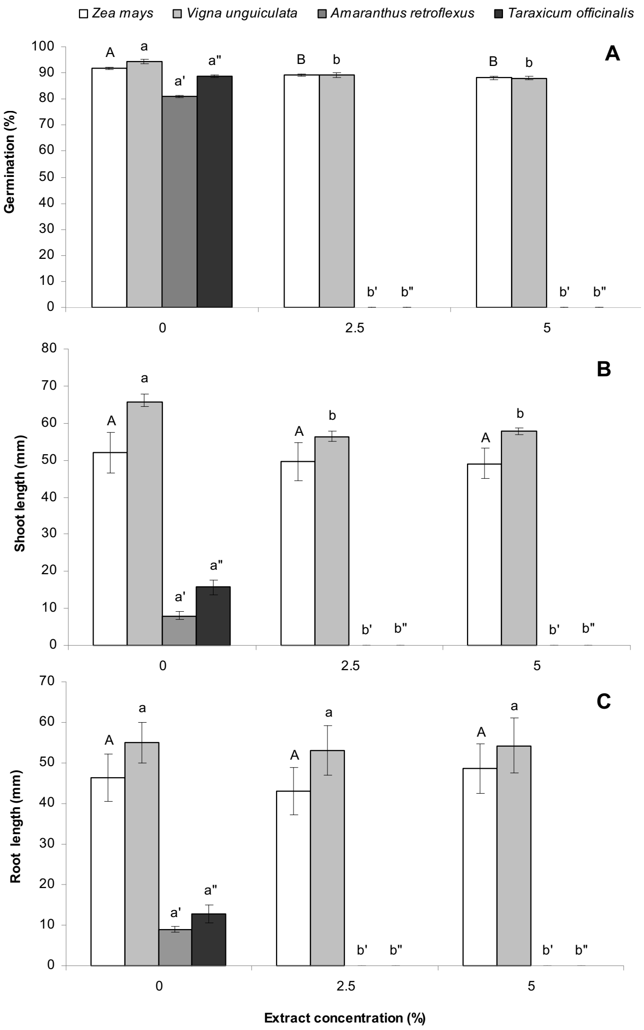

Fig. 1 Effect of two concentrations of ajwain seed extract on seed germination (**A**), root length (**B**) and shoot length (**C**) of the four examined plants. Different lower case and capital letters show significant differences between means at $P \leq 0.05$.

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