# Genetic Resources for Allelopathic and Medicinal Plants from Traditional Persian Experience

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**Abstract** In this research we studied the allelopathic activity of 56 aromatic and medicinal plants of 22 families that most of them have been used in Persian traditional medicine. The assay method was dish pack with lettuce seed. Results showed that 51 species out of 56 tested plants declined lettuce seedling growth. Ten species completely inhibited lettuce seed germination namely *Bunium persicum, Carum copticum, Achillea wilhelms, Pulicaria gnaphalodes, Berberis vulgar var asperma, Lavandula spica, Ziziphora clinopodioides* and *Ailanthus altissima*. Further researches need to be conducted on the detection of main volatile constituents that are responsible for this strong allelopathic activity of the mentioned plants by GC/MS and NMR techniques.
**Keywords:** Iranian traditional medicinal plants, Allelochemical, Aromatic plants.

## 1. Introduction

Widespread use of synthetic herbicides has resulted in herbicide-resistant weeds, and public concerns over the impact synthetic herbicides have on human health and the environments are increasing. These concerns are shifting attention to alternative weed control technologies based on natural products. Allelopathy is defined as direct or indirect interaction, whereby chemicals and their breakdown metabolites released by one plants or organisms influence the physiological processes of another neighboring plants and or organisms [8] and is one of the most controversial of ecological interactions [7]. In general, the chemical interactions that occur among living organisms including plants, insects and microorganisms are called allelopathy, and organic compounds involved in allelopathy are called allelochemicals[5]..

Herbicides and agrochemicals based on natural products are attraction for a variety of reason. Most biologically active natural products are at least partially water-soluble and as a result of natural selection were likely to exhibit some bioactivity at low concentration. They are also eco-friendly, cost effective and biodegradable. Because of short-live effects of allelopathic plants when they adds to the soils and furthermore needs to large amounts of plants materials (at least 1-2 t.ha$^{-1}$) and large labour force, Isolation and identification of new allelochemicals in higher plants has been attempted. It is estimated that there are about 1,400,000 compounds with allelopathic activities, of which only 3% have been examined [3].

Many allelochemicals exert their influence through mechanisms not possessed by commercial herbicide, making them ideal lead compounds for new herbicides discovery. Therefore scientists have focused on searching for new secondary plant products to develop bio-herbicides and bio-pesticides recently. In addition, environmental conditions and genetic characteristics are the most effective factors in enhancing synthesis and exudation of allelochemicals. Numerous plants are reported to possess allelochemicals. Medicinal plants produced a wide range of secondary metabolites that can be used for human welfare. Fujii et al., [4] showed that medicinal plants showed relatively strong allelopathic activity. There are 7115 vascular plant species in Iran that belong to 1206 genera, 173 families and 6 phyla that a plenty of them have potential medicinal properties [10]. In this research we surveyed 80 native plants (especially aromatic plants) from different part of Iran for allelopathic activity against lettuce seed germination by Dish Pack methods. This method introduced by Fujii et al., [6] as a new bioassay methods for volatile allelopathy.

## 2. Material and Methods

Test plants were collected from different part of tropical, subtropical and temperate regions of Iran (Fig 1). Some samples collected from cultivated plants in the research fields of Ferdowsi University of Mashhad. Then the samples were authenticated in Ferdowsi University of Mahhad Herbarium (FUMH) by M. R. Joharchi and the voucher specimens were deposited in the herbarium. We checked 56 species mainly of aromatic plants. A multi-dishes with 6 holes (Nunc Company, diameter of holes is 3.5cm) were used for the assay (Fig 2). Two grams of samples (leaves, seed, flower, gum etc) were placed into one of the holes in the multi-dishes. Filter paper and 0.5ml of distilled water were put into the other 5 holes, and 7 seeds of lettuce (Great Lakes 366) were put on the filter paper. This cultivar is highly sensitive to allelochemicals [6]. Each side of the multi-dishes were sealed by parafilm and packed in aluminum foil for preventing of light penetration, then placed in incubator (Memmert, Germany) under 25°c. After 5 days, germination rate and seedling growth (radicle and hypocotyl length) of the lettuce is then monitored versus control samples (Fig 2). Speed of diffusion and intensity of activity of volatile compounds were estimated based on the relation of the distance between test plants and lettuce seeds.


**Fig 1. Eight selection regions of Iran where test plants were collected**

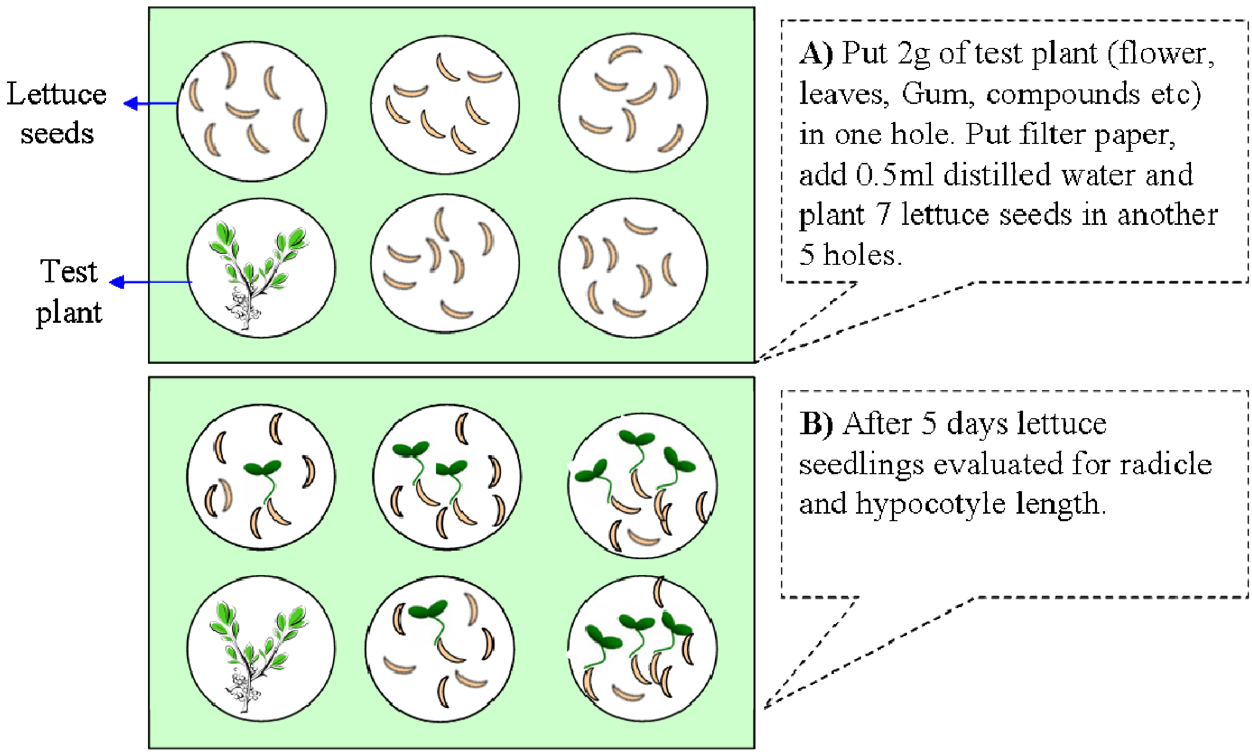


**Fig 2. Multi-dishes with 6 holes that used for the experiment.**

**Table 1. Servey of 56 aromatic and medicinal plant species collected from different part of Iran using the dish-pack method**

| No | Family | Scientific name | Part used | Inhibitory activity | |
|---|---|---|---|---|---|
| | | | | Average | |
| | | | | Radicle | Hypocotyl |
| 1 | Amaranthaceae | *Amaranthus belitoides* | Leaf | 32.6 | 40.5 |
| 2 | Anacardiaceae | *Pistacia vera* | Leaf | 61.2 | 71.7 |
| | | | Fruit shell | 41.8 | 63.0 |
| **3** | **Apiaceae** | ***Bunium persicum* Wild** | **Seed** | **100** | **100** |
| | | ***Bunium persicum* Cultivated** | **Seed** | **100** | **100** |
| | | | Leaf straw | 28.1 | 20.7 |
| **4** | | ***Carum copticum*** | **Seed** | **100** | **100** |
| 5 | | ***Dorema ammoniacum*** | Leaf (Small) | 32.1 | 9.1 |
| | | | Leaf (Medium) | 18.2 | 25.6 |
| | | | Leaf (Large) | 55.4 | 37.1 |
| | | | Flower | 47.1 | 32.1 |
| | | | Stem | 33.9 | 6.1 |
| | | | **Gum** | **93.2** | **92.9** |
| 6 | | *Ferula gummosa* | Gum | 10.6 | 9.5 |
| **7** | | ***Ferula persica*** | **Gum** | **81.8** | **80.4** |
| 8 | | *Foeniculum vulgar* | Seed | 64.7 | 87.9 |
| 9 | | *Kelussia odoratissima* | Seed | 3.1 | 21.7 |
| **10** | **Asteraceae** | ***Achillea filipendula*** | **Flower** | **98.1** | **99.4** |
| | | | Leaf | 48.6 | 56.4 |
| 11 | | *Achillea millefolium* | Flower | 55.2 | 52.9 |
| 12 | | *Achillea nobilis* | Flower | 66.9 | 77.2 |
| **13** | | ***Achillea wilhelmsii*** | **Flower** | **100.0** | **100.0** |
| | | | Leaf | 73.8 | 81.5 |
| 14 | | *Artemisia absinthium* | Leaf | 42.2 | 55.7 |
| 15 | | *Cynara scolymus* | Leaf | 8.8 | 6.0 |
| 16 | | *Echinacea purpurea* | Leaf | 2.9 | 25.9 |
| 17 | | *Heteropappus altaicus* | Leaf | 51.8 | 41.7 |
| **18** | | ***Pulicaria gnaphalodes*** | **Leaf** | **100** | **100** |
| **19** | **Berberidaceae** | ***Berberis vulgaris*** | **Leaf** | **100** | **100** |
| 20 | Boraginaceae | *Borago officinalis* | Leaf | 20.6 | 7.4 |
| 21 | Caryophyllaceae | *Eugenia armoatica* | Fruit | 57.9 | 65.6 |
| 22 | Chenopodiaceae | *Atriplex canescens* | Leaf | 59.1 | 58.3 |
| 23 | | *Chenopodium botrys* | Leaf | 23.5 | 50.9 |
| 24 | | *Kochia prostrata* | Leaf | 79.0 | 87.1 |
| 25 | Cupressaceae | *Juniperus excelsa* | Fruit | 66.9 | 57.1 |
| | | | Leaf | 49.0 | 59.3 |
| 26 | Hypericaceae | *Hypericum perforatum* | Leaf | 55.9 | 65.1 |
| | | | Flower | 3.9 | 14.8 |

**Table 1**. ( Cont.)

| | | | | | |
|---|---|---|---|---|---|
| 27 | Lamiaceae | *Hyssopus officinalis* | Leaf | -2.0 | -30.9 |
| 28 | | ***Lavandulla spica*** | Leaf | -28.4 | -6 |
| | | | **Flower** | **100.0** | **100.0** |
| **29** | | ***Majorana hortensis*** | **Leaf** | **99.0** | **100.0** |
| 30 | | *Mellisa officinalis* | Leaf | -16.7 | -8.1 |
| **31** | | ***Mentha longifolia*** | **Leaf** | **94.8** | **85.9** |
| 32 | | *Mentha piperita* | Leaf | 1.0 | 11.4 |
| 33 | | *Mentha spicata* | Leaf | 21.0 | 39.9 |
| 34 | | *Rosmarinus officinalis* | Leaf | 83.3 | 78.8 |
| **35** | | ***Salvia sclarea*** | **Leaf** | **86.4** | **71.4** |
| 36 | | *Satureja hortensis* | Leaf | 33.3 | 50.3 |
| 37 | | *Teucrium polium* | Leaf | 60.0 | 74.1 |
| 38 | | *Thymus vulgaris* | Leaf | 36.7 | 62.6 |
| **39** | | ***Zataria multiflora*** | **Leaf** | **95.2** | **96.9** |
| **40** | | ***Ziziphora clinopodioides*** | **Leaf** | **100.0** | **100.0** |
| 41 | Liliaceae | *Crocus sativus* | Corm | 27.6 | 22.2 |
| | | | **Stigma** | **92.4** | **95.2** |
| | | | Leaf | 19.3 | 19.6 |
| 42 | Malvaceae | *Malva sylvestris* | Leaf | 40.0 | 44.2 |
| 43 | Myrtaceae | *Eucalyptus globulus* | Leaf | -10.8 | 30.9 |
| 44 | Polygonaceae | *Polygonum patulum* | Leaf | 43.9 | 51.2 |
| 45 | Punicaceae | *Punica granatum* | Fruit peel | -21.4 | -15.7 |
| 46 | Rhamnaceae | *Zizyphus mauritiana* | Leaf | 17.9 | 12.7 |
| 47 | Rutaceae | *Ruta graveolens* | Fruit | 74.5 | 81.2 |
| | | | Leaf | 60.0 | 56.4 |
| **48** | **Simaroubaceae** | ***Ailanthus altissima*** | **Leaf** | **100** | **100** |
| | | | Flower | 1.4 | -4.2 |
| 49 | Solanaceae | *Datura stramonium* | Leaf | -6.9 | 4.0 |
| 50 | | *Lycium depressum* | Leaf | 42.3 | 48.5 |
| **51** | | ***Solanum nigrum*** | **Leaf** | **92.4** | **95.1** |
| 52 | | *Withania coagolans* | Leaf | 25.5 | 25.9 |
| | | | Fruit | 22.8 | 14.8 |
| 53 | | *Withania somnifera* | Leaf | 15.2 | -6.3 |
| 54 | Verbenaceae | *Vitex Angus -castus* | Leaf | 68.6 | 70.6 |
| | | *Vitex Angus -castus* | Flower | 20.6 | 38.9 |
| 55 | Zingiberaceae | *Zingiber officinalis* | Rhizom | 68.3 | 71.4 |
| 56 | Zygophyllaceae | *Peganum harmala* | Leaf | 5.5 | -31.7 |

## 3. Results and Discussion

Effects of volatile allelochemicals on lettuce seedling growth by dish-pack method were shown in Table1. Growth of radicle and hypocotyle of lettuce seedling was present in the form of either inhibition (positive value) or promotion (negative value). The data represented that 51 species out of 56 tested plants decreased the lettuce seedling growth but 5 species promote radicle or hypocotyl growth in comparison to the control. Ten species completely inhibited lettuce seed germination namely *Bunium persicum* (wild and cultivated seed samples) and *Carum copticum* from Apiaceae; *Achillea wilhelmsi* and *Pulicaria gnaphalodes* from Asteraceae; *Berberis vulgar var asperma* from Berberidaceae; *Lavandula spica* flower and *Ziziphora clinopodioides* from Lamiaceae and *Ailanthus altissima* from Simarubaceae family. The results also indicated that different plant parts showed various allelopathic activity on lettuce seedling growth. In some species leaf sample decreased seedling growth more than other plant parts (as in *Pistacia vera*; *Hypericum perforatum; Ailanthus altissima* and *Vitex angus-castus*) but in another species flower, seed, gum, stigma and other plant parts declined seedling growth more than leaf (as in *Lavandula spica, Achillea wilhelmsi, Dorema amoniacum, Bunium persicum* and *Dorema amoniacum*). Leaf age also affects allelopathic activity of *Dorema amoniacum* as younger and mature leaves declined lettuce seedling growth more than medium size leaves. Leaf and fruit of *Withania coagolans* did not make any obvious differences on the seedling growth of lettuce. Inhibition of seed germination in response to volatile essential oils from a number of aromatic plants has also been reported by Singh et al.,(1991), Dudai et al., (1999) and Fujii et al.,(2005). Seedling growth of germinated seeds was also affected by volatile compounds [2,6,9]. The exact mechanism by which seed germination and seedling growth is affected by medicinal plants essential oils is not completely known. However it could be due to the inhibition of mitosis in the growing cells. It has represented that essential oils suppressed sprout growth of potato in storage by killing meristematic cells [1]. Zunino and Zygaldo(2004) reported that monoterpens such as 1,8 cineol, thymol, geraniol, menthol and camphore strongly inhibited the root growth of *Zea mays* L. seedlings. They induced oxidative stress by the production of malondialdehyde, conjugated dienes and peroxides[11]. Therefore volatile compounds of medicinal plants are good candidates for using as bio-herbicide but their formulation for sustainability in the soils especially by encapsulation technique should be future examined.

## 4. Conclusion

Medicinal plants especially which are aromatic and used in traditional medicine of Iran have potential allelopathic activity and they are good candidates for finding new allelochemicals for using in agriculture for weeds control as bio-herbicides. Further researches need to be conducted on the detection of main volatile constituents that are responsible for this strong allelopathic activity of the mentioned plants by GC/MS and NMR techniques.

## References

[1] Azizi, M. 2005. Bunium persicum essential oils suppressed potato sprouting in storage. Proceedings of the 36th International Symposium on Essential oils, 4-7 September, Budapest, Hungary.
[2] Dudai, N., Meyer, A.M., Putievsky, E., Lerner, H.R., 1999. Essential oils as allelochemicals and their potential use as bioherbicides. *J. Chem. Ecol*. 25: 1079-1089.
[3] Einhelling, F.A., Leather, G.R., 1988. Potentials for exploiting alleopathy to enhance crop production*. J. Chem. Ecol*. 14,1829-1842.
[4] Fujii, Y., Furukawa,M. Hayakawa, Y. Sugawara, K. and Shibuya, T. 1991 Survey of Japanese Medicinal Plants for the Detection of Allelopathic Properties, *Weed Research Jpn*,36:36-42.
[5] Fujii, Y., Hiradate, S., 2007. Allelopathy: New Concepts and Methodology, Science Publishers. 382p.
[6] Fujii, Y., Matsuyama, M., Hiradate, M. and Shimozawa, H. 2005. Dish pack method: a new bioassay for volatile allelopathy. Proceedings of the 4th World Congress on Allelopathy, "Establishing the Scientific Base", Wagga Wagga, New South Wales, Australia, 21-26 August 2005
[7] Harpper, J.L., 1977. Population biology of plants. San Diego, California, Academic Press.
[8] Rice, E. L., 1984. Allelopathy. 2nd ed. N.Y. Academic Press.
[9] Singh, D., Kohli, R.K., Saxena, D. B., 1991. Effect of *Eucalyptous* oil on germination and growth of *Phaseolus aureus* Roxb *Plant Soil*, 137: 223-227.
[10] Yosofi, M., 2007. Flora of Iran, Payam-e-nour publication, Tehran, 227p.
[11] Zunino, M.P., and Zygalo, J.A. 2004. Effect of monoterpens on lipid oxidation in maize. *Planta*, 219: 303-309.