*Pharmaceutical Sciences, March 2016, 22, 16-21*
doi: 10.15171/PS.2016.04
*http://journals.tbzmed.ac.ir/PHARM*

*Research Article*

# Variation in Chemical Composition of Essential Oil of *Ferulago angulata* Collected from West Parts of Iran

**Yasser Shahbazi***
*Department of Food Hygiene and Quality Control, Faculty of Veterinary Medicine, Razi University, Kermanshah, Iran.*

**Article Info**

***Article History:***
Received: 24 May 2015
Accepted: 8 August 2015
ePublished: 30 March 2016

***Keywords:***
-*Ferulago angulata*
-Essential oil
-GC/MS
-Z-Beta-Ocimene
-Alpha-pinene

**ABSTRACT**

***Background:*** Knowledge of diversity and variability of different plants is a main prerequisite and the first step in extraction of main compounds of them. The objective of the current research was to investigate main chemical composition of the essential oils of *Ferulago angulata* (Schlecht.) Boiss aerial parts collected from western parts of Iran (Kurdestan, Kermanshah and Lorestan provinces).
***Methods:*** Identification of the essential oils was performed by analytical gas chromatograph coupled with mass spectrometer detector (GC/MS).
***Results:*** The major compounds of essential oils of the aerial parts of plants were *α*-pinene (25.82%), *Z*-*β*-ocimene (23.48%), bornyl acetate (9.94%), germacrene D (4.01%), myrcene (3.06%), *γ*-terpinene (3%), limonene (2.27%) and *p*-cymene (1.99%).
***Conclusions:*** Our findings indicate that the main components of the essential oils belong to monoterpene hydrocarbons, oxygenated monoterpenes and sesquiterpene hydrocarbons.

## Introduction

Medicinal plants have been extensively applied from ancient times in medicine (especially cold, vomiting and gastro-intestinal disorder), cosmetics (as perfumes), for controlling natural spoilage microorganisms, preventing or controlling growth of microorganisms, including food-borne pathogenic bacteria and also improving the flavor of foods.[1-4] Essential oils of various plants and their chemical constituents have been known to exhibit various beneficial effects, in particular antibacterial, antifungal, antiviral, antihelminthic and anti-carcinogenic since ancient time.[5-8] These biological effects of the medicinal plants and their essential oils or extracts are mostly due to their chemical composition especially phenolic compounds.[9-11]

The *Ferulago* genus plants (known as "Chavir" in Persian), belong to the family of Apiaceae and are perennial or annual plants with small flowers and yellow fruits typical reprehensive of the Mediterranean flora.[12] These species grow as wild in several areas all over the world especially in the west of Iran, Turkey and Iraq.[13] These species are traditionally used as sedative, tonic, digestive and anti-parasitic agent.[13] The essential oils of *Ferulago* spp. have long been applied as an additive to edible oil (eg. Rughan Kermanshahi).[12] As well as, different parts of the plant have found various uses in the food industry such as for flavoring cheese and meat.[14] In Iran, *Ferulago angulata* (Schlecht.) Boiss is commonly known as "Chavir" and is abundant in the Zagros Mountain Range.[12] In Iranian folk medicine, this species used to treat intestinal worms, wound skin infections, snake bites, headache and diseases of the spleen and gastrointestinal tract.[12-14] Several researches from different parts of Iran have showed this plant is the main source of phenolic compounds such as carvacrol and trimethyl-benzaldehyde.[15,16] Chemical composition of various essential oil of plants may be affected by genetic and environmental factors such as geographical conditions, climate and seasonal variations and the stage of the plant growth.[10, 17-20] In different parts of Iran, most of the researches on *F. angulata* have been focused on few indigenous species to a limited geographical region.[12,14,15,21,22,24] For example, Akhlaghi *et al.*,[14] examined chemical composition of *F. angulata* gathered from Khorasan (northeast of Iran), indicated that *α*-pinene (10.5%), limonene (9.6%) and *β*-myrcene (5.5%) were the major constituents. Moreover, Taran *et al.*,[13] reported the most abundant compounds of *F. angulata* essential oil were Z-*β*-ocimene (27.9%), followed by *α*-pinene (25.7%), bornyl acetate (3.9%), germacrene D (22.3) and trans-ocimene (3.3%). However, based on our knowledge, there has been no comprehensive and comparative study on the diversity and variability of the essential oil of *F. angulata* in different parts of Iran. Therefore, studying the variability of natural populations in each country may have a great role in identification and introduction of the species with high contents of essential oils and

***Corresponding Author:** Yasser Shahbazi, Tel: (+98) 83 38324042, Fax: (+98) 83 38320041, E-mail: yasser.shahbazi@yahoo.com

major compounds in order to be used in food and pharmaceutical industries. Hence, the purpose of the present study was evaluation of variation in *F. angulata* essential oils.

## Materials and Methods

### *Collection of plant material*

The aerial parts of *F. angulata* were gathered from three different regions (Lorestan, Kermanshah and Kurdestan, west of Iran) (Table 1) in May-July 2014. Authentication of the plants was conducted by Dr. Seyed Mohammad Masoumi (Faculty of Agriculture, Razi University, Kermanshah, Iran) and representative voucher specimens have been placed in the herbarium of the Research Center of Natural Resources of Tehran, Iran (Table 1).

**Table 1**. Geographical properties of natural habitats and voucher numbers of *F. angulata* in western Iran.

| No | Collection site | Latitude (UTM[a]) | Longitude (UTM) | Altitude (m a.s.l[b]) | voucher number |
|---|---|---|---|---|---|
| 1 | Gilane Gharb, Kermanshah province, Iran | 3,776,583 | 585,867 | 833 | 6816 |
| 2 | Hamzeh, Lorestan province, Iran | 3,716,721 | 250,198 | 976 | 6818 |
| 3 | Kamiaran, Kurdestan province, Iran | 3,879,030 | 601,413 | 1216 | 6810 |

a:UTM: Universal Transverse Mercator; b:m a.s.l.: m above sea level

### *Isolation of the essential oil*

Fresh plants were dried for two weeks at room temperature in dark space (water content approached 75% of plant fresh weight). Dried aerial parts were ground using a Moulinex food processor and 100g of the fine powdered-tissue from each part was distillated with 500 ml water for 3h using a Clevenger-type apparatus, according to standard technique outlined in the European Pharmacopoeia.[25] The isolation of the essential oil process was repeated in triplicate. The essential oil phase was separated from water and dried over anhydrous sodium sulfate (Merck, Darmstadt, Germany) and kept in dark glass bottle (sealed brown bottle) at refrigerated temperature before chemical analysis (prior to use).

### *Gas chromatography–mass spectrometry (GC/MS) analysis of essential oil*

Identification of the essential oils was performed by analytical gas chromatograph coupled with mass spectrometer detector (GC/MS). The GC analysis was conducted on gas chromatograph (Thermo Quest Finningan, UK) equipped with DB5 capillary column (30m×0.25mm, 0.25µm film thickness). The flow of the carrier gas (Helium) was 1.2ml per min. Initial column temperature was 50°C and programmed to increase at 2˚C/min to 265˚C. The injector temperature was set at 250°C. Split injection was conducted with a split ratio of 1:20. Essential oil samples of 0.1µl were injected neat. The essential oil samples were also analysed by (GC/MS) (Thermo Quest Finningan, UK) using the similar capillary column and analytical conditions as described above. The MS was operated in the electron ionization mode, using ionization energy of 70eV. Oil constituents were identified based on their retention indices, by comparison of their mass spectra with those reported in the literature[26] and stored in National Institute of Standards and Technology (NIST) and Standard Mass Spectral fragmentation pattern (Wiley/NBS) libraries.

### *Statistical analysis*

One way analysis of variance (ANOVA) was performed on all data using SPSS software (version 16.0) and values of $p<0.05$ were considered statistically significant.

## Results and Discussion

### *Essential oil yields*

Figure 1 shows the essential oil yields of *F. angulata* from different parts of Iran. Statistical analysis indicated that there was significant difference ($p<0.05$) for the essential oil yield. Similarly, results of a study by Javidnia *et al*.,[22] and Taran, *et al.*,[13] indicated the yield of the essential oil from the aerial parts of *F. angulata* collected from different parts of Iran during flowering stage was 0.5% and 0.63%. The highest amount of essential oil was obtained from Kurdestan samples followed by Kermanshah and Lorestan.

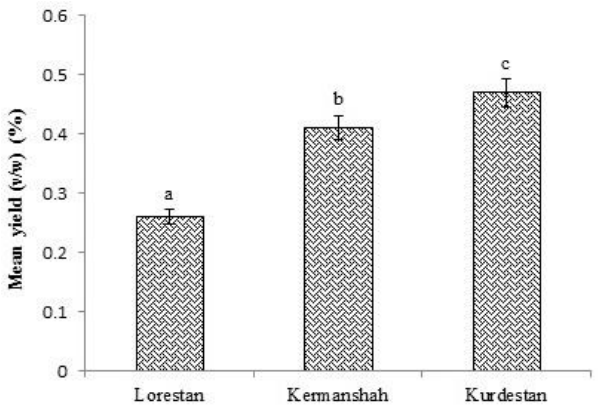


**Figure 1**. The essential oil yield of the aerial parts of various *F. angulata* from different parts of Iran.
a,b and c means with different letter are statistically significant at 5% level probability.

### *Chemical compositions of essential oils*

The main constitutes identified in the essential oils from the aerial parts of *F. angulata* (Schlecht.) Boiss by GC and GC/MS are shown in Table 2 and Figure 2-4. As shown in Table 2, the major compounds in the

essential oil from the aerial parts of *F. angulata* (Schlecht.) Boiss from different parts of Iran were *α*-pinene (25.82%), *Z-β*-ocimene (23.48%), bornyl acetate (9.94%), germacrene D (4.01%), myrcene (3.06%), *ɣ*-terpinene (3%), limonene (2.27%) and *p*-cymene (1.99%). Indeed, the main components were belonged to monoterpene hydrocarbons (*α*-pinene, myrcene, limonene, *p*-cymene, *ɣ*-terpinene and *Z-β*-ocimene), oxygenated monoterpenes (bornyl acetate) and sesquiterpene hydrocarbons (germacrene D). The Kurdestan province had the maximum contents of *Z-β*-ocimene and *p*-cymene. As well as, the highest percentage of germacrene D, myrcene and limonene were achieved from the essential oil from Kermanshah sample. Moreover, the Lorestan province had the maximum contents of *α*-pinene, *ɣ*-terpinene and bornyl acetate.

**Table 2**. The main constituents of the essential oils from different parts of *F. angulata* populations.

| Components | *α*-Pinene | Myrcene | Limonene | *p*-Cymene | *Z-β*-Ocimene | ɣ- Terpinene | Bornyl acetate | Germacrene D |
|---|---|---|---|---|---|---|---|---|
| Lorestan | 34.45$^{a}$ | 2.61$^{a}$ | 2.38$^{a}$ | 1.21$^{a}$ | 22.43$^{a}$ | 1.08$^{a}$ | 11.67$^{a}$ | 3.03$^{a}$ |
| Kermanshah | 28.43$^{b}$ | 4.67$^{b}$ | 2.74$^{a}$ | 2.17$^{b}$ | 20.12$^{b}$ | 5.72$^{b}$ | 7.92$^{b}$ | 5.63$^{b}$ |
| Kurdestan | 14.6$^{c}$ | 1.9$^{c}$ | 1.7$^{b}$ | 2.60$^{c}$ | 27.90$^{c}$ | 2.2$^{c}$ | 10.23$^{c}$ | 3.39$^{c}$ |

a,b and c: Means with different lowercase letters in the same column are significantly different ($p$<0.05).

As presented in Figure 2-4, the first compound that recognized in GC/MS analysis of *F. angulata* collected from Kermanshah, Kurdestan and Lorestan was *α*-pinene, followed by myrcene, limonene, *p*-cymene, Z-β-ocimene, *ɣ*-terpinene, bornyl acetate and germacrene D. Our results about most abundant chemical compounds of *F. angulata* collected from different parts of Iran are accordance with Darderafshi *et al.*,[21] and Rezazadeh *et al.*[23] As well as, Taran *et al.*,[13] reported the most abundant compounds of *F. angulata* essential oil was Z-*β*-ocimene (27.9%), followed by *α*-pinene (25.7%), bornyl acetate (3.9%), germacrene D (22.3) and trans-ocimene (3.3%). Akhlaghi *et al.*,[14] examined chemical composition of *F. angulata* gathered from Khorasan (northeast of Iran), indicated that *α*-pinene (10.5%), limonene (9.6%) and *β*-myrcene (5.5%) were the major constituents. Several researches showed that *α*-terpinene and *Z-β*-ocimene were the main constituents of *F. angulata* essential oil from different parts of Iran.[12,22,24] It was north worthy, the diversity and variability the reports regarding to chemical composition content of *F. angulata* essential oil might be originated from several environmental (geographical conditions, climate and seasonal variations and the stage of the plant growth), genetic differences and different method used to extraction of the essential oil.[17,18,27,28]

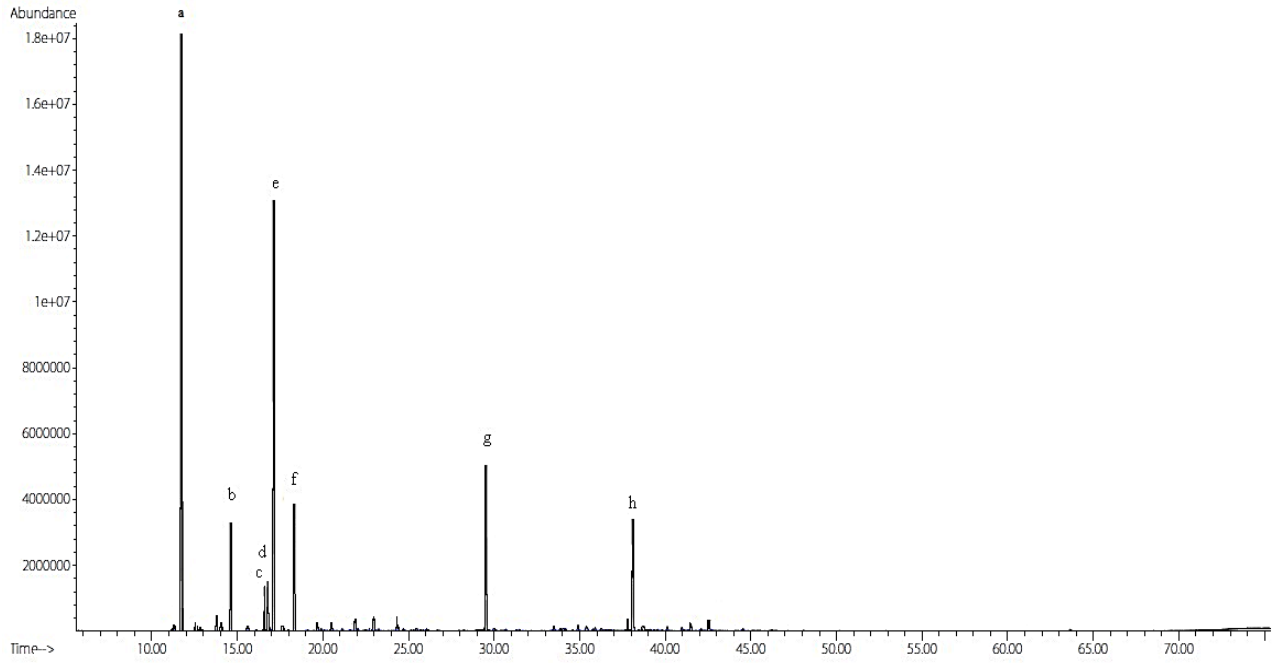


**Figure 2**. Chromatogram of essential oil composition of *F. angulata* collected from Kermanshah Province. [a] α-Pinene, [b] Myrcene, [c] Limonene, [d] *p*-Cymene, [e] Z-β-Ocimene, [f] ɣ- Terpinene, [g]Bornyl acetate, [h] Germacrene D.

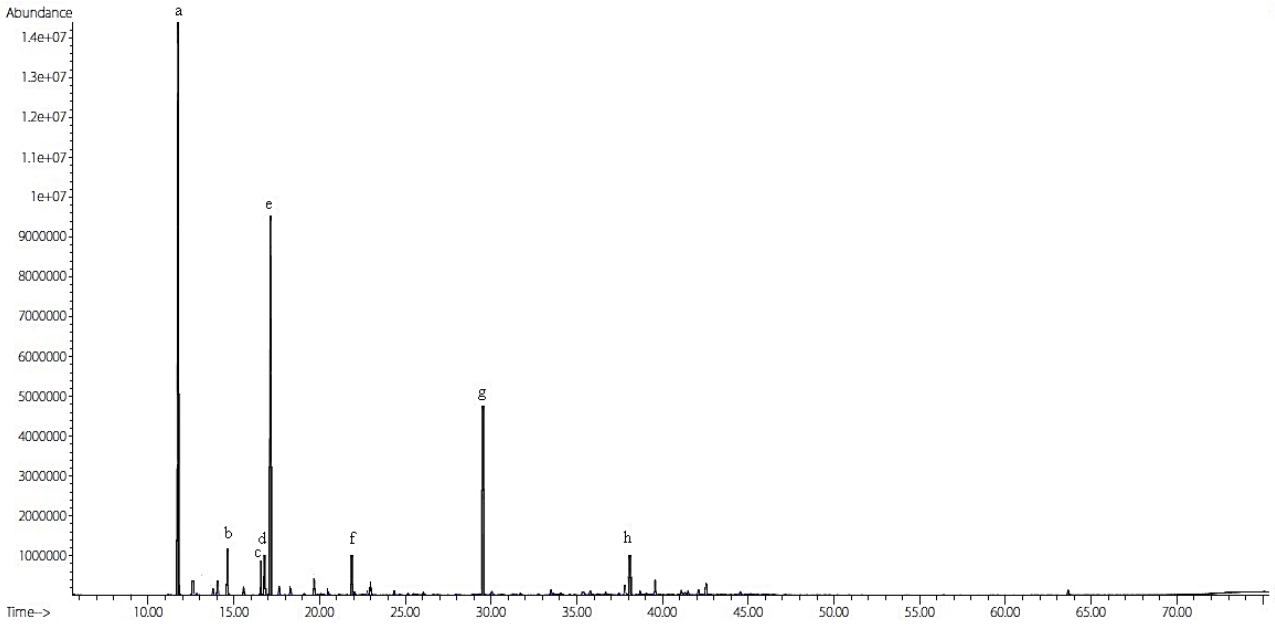


**Figure 3**. Chromatogram of essential oil composition of *F. angulata* collected from Lorestan Province. . [a] α-Pinene, [b] Myrcene, [c] Limonene, [d] *p*-Cymene, [e] Z-β-Ocimene, [f] ɣ- Terpinene, [g]Bornyl acetate, [h] Germacrene D.

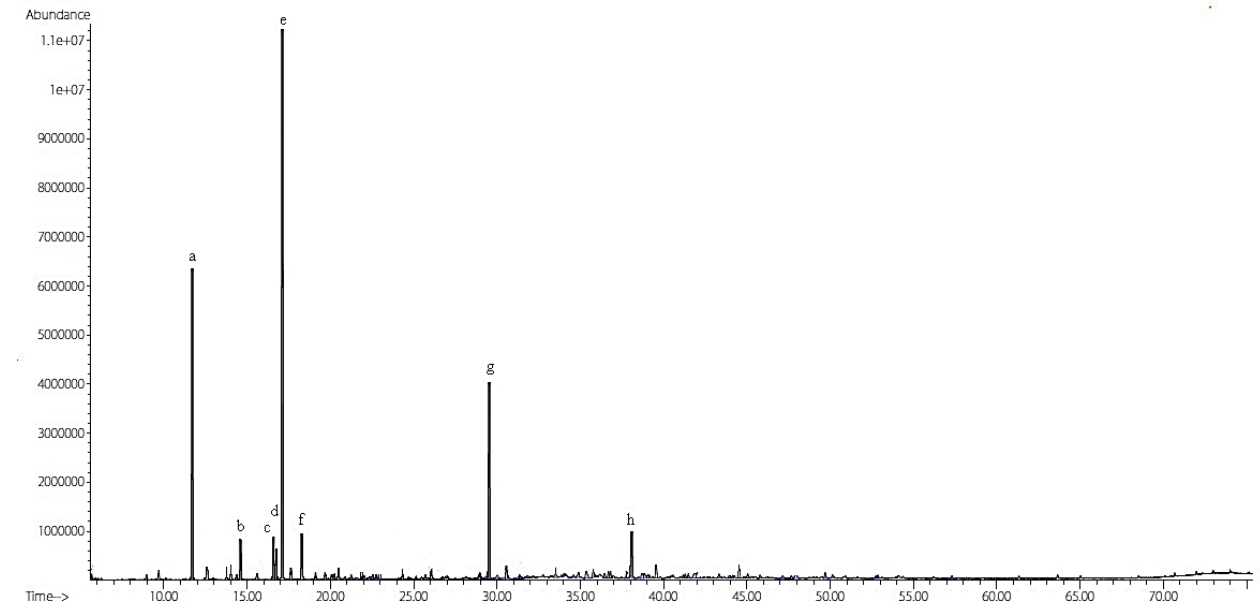


**Figure 4.** Chromatogram of essential oil composition of *F. angulata* collected from Kurdestan Province. [a] α-Pinene, [b] Myrcene, [c] Limonene, [d] *p*-Cymene, [e] Z-β-Ocimene, [f] ɣ- Terpinene, [g]Bornyl acetate, [h] Germacrene D.

## Conclusion

The results of the present research provide, for the first time, data on the chemical composition of the essential oils from the aerial parts of various populations of *F. angulata* collected from the Zagros Mountain Range (Kermanshah, Lorestan and Kurdestan provinces), western Iran. The main constituents of the essential oils of *F. angulata* aerial part include *α*-pinene, myrcene, limonene, *p*-cymene, *Z-β*-ocimene, *ɣ*-terpinene, bornyl acetate and germacrene D. Variation in oil composition and yield of *F. angulata* can result from genetic diversity and differences in environmental conditions and their interactions. The main source of variability in chemical composition and oil yield of the studied populations seemed to be due to differences in environmental conditions. In final, the results of the present study can introduce appropriate population for cultivation and extraction of each main compound.

## Conflict of interests

The author claims that there is no conflict of interest.

## References

1. Bariş Ö, Güllüce M, Şahİn F, Özer H, Kiliç H, Özkan H, Sokmen M, Özbek T. Biological activities of the essential oil and methanol extract of *Achillea*

*biebersteinii* Afan. Turk J Biol. 2006;30(2):65-73.
2. Bakkali F, Averbeck S, Averbeck D, Idaomar M. Biological effects of essential oils-a review. Food Chem Toxicol. 2008;46(2):446-75. doi:10.1016/j.fct.2007.09.106
3. Teixeira B, Marques A, Ramos C, Neng NR, Nogueira JM, Saraiva JA, Nunes ML. Chemical composition and antibacterial and antioxidant properties of commercial essential oils. Ind Crops Prod. 2013;43:587-95. doi:10.1016/j.indcrop.2012.07.069
4. Mahboubi M, Haghi G. Antimicrobial activity and chemical composition of *Mentha pulegium* L. essential oil. *J Ethnopharmacol*. 2008;119(2):325-7. doi:10.1016/j.jep.2008.07.023
5. Tajkarimi M, Ibrahim S, Cliver D. Antimicrobial herb and spice compounds in food. Food Control. 2010;21(9):1199-218. doi:10.1016/j.foodcont.2010.02.003
6. Kumar P, Mishra S, Malik A, Satya S. Insecticidal properties of *Mentha* species: a review. Ind Crops Prod. 2011;34(1):802-17. doi:10.1016/j.indcrop.2011.02.019
7. Bajpai VK, Baek K-H, Kang SC. Control of *Salmonella* in foods by using essential oils: A review. Food Res Int. 2012;45(2):722-34. doi:10.1016/j.foodres.2011.04.052
8. Telci I, Demirtas I, Bayram E, Arabaci O, Kacar O. Environmental variation on aroma components of pulegone/piperitone rich spearmint (*Mentha spicata* L.). Ind Crops Prod. 2010;32(3):588-92. doi:10.1016/j.indcrop.2010.07.009
9. Sánchez-Vioque R, Polissiou M, Astraka K, De Los Mozos-Pascual M, Tarantilis P, Herraiz-Peñalver D, Santana-Méridas O. Polyphenol composition and antioxidant and metal chelating activities of the solid residues from the essential oil industry. Ind Crops Prod. 2013;49:150-9. doi:10.1016/j.indcrop.2013.04.053
10. Pirbalouti AG, Ghahfarokhi BB, Ghahfarokhi SaM, Malekpoor F. Chemical composition of essential oils from the aerial parts and underground parts of Iranian valerian collected from different natural habitats. Ind Crops Prod. 2015;63:147-51. doi:10.1016/j.indcrop.2014.10.017
11. Kelen M, Tepe B. Chemical composition, antioxidant and antimicrobial properties of the essential oils of three Salvia species from Turkish flora. Bioresour Technol. 2008;99(10):4096-104. doi:10.1016/j.biortech.2007.09.002
12. Sefidkon F, Omidbaigi R. Chemical composition of the essential oil of *Ferulago angulata* from Iran. J Essent Oil Bear Pl. 2004;7(1):60-3. doi:10.1080/0972-060x.2004.10643366
13. Taran M, Ghasempour HR, Shirinpour E. Antimicrobial activity of essential oils of *Ferulago angulata* subsp. carduchorum. Jundishapur J Microbiol. 2010;3(2):10-4.
14. Akhlaghi H. The essential oils from flowers, stems and leaves of *Ferulago angulata* from Iran. Chem Nat Compd. 2008;44(3):396-7. doi:10.1007/s10600-008-9076-1
15. Hosseini N, Akbari M, Ghafarzadegan R, Changizi Ashtiyani S, Shahmohammadi R. Total Phenol, antioxidant and antibacterial activity of the essential oil and extracts of *Ferulago angulata* ssp. *angulata*. J Med Plants. 2012;3(43):80-9.
16. Demirci F, Iscan G, Guven K, Kirimer NE, Demirci B, Baser KHC. Antimicrobial activities of *Ferulago* essential oils. Z Naturforsch C. 2000;55(11-12):886-9. doi:10.1515/znc-2000-11-1207
17. Burt S. Essential oils: their antibacterial properties and potential applications in foods-a review. Int J Food Microbiol. 2004;94(3):223-53. doi:10.1016/j.ijfoodmicro.2004.03.022
18. Moosavy M-H, Shavisi N. Determination of antimicrobial effects of nisin and *Mentha spicata* essential oil against *Escherichia coli* O157: H7 under various conditions (pH, Temperature and NaCl Concentration). Pharm Sci. 2013;19(2):61-7.
19. Rajabi Z, Ebrahimi M, Farajpour M, Mirza M, Ramshini H. Compositions and yield variation of essential oils among and within nine Salvia species from various areas of Iran. Ind Crops Prod. 2014;61:233-9. doi:10.1016/j.indcrop.2014.06.038
20. Bajalan I, Pirbalouti AG. Variation in chemical composition of essential oil of populations of Lavandula× intermedia collected from Western Iran. Ind Crops Prod. 2015;69:344-7. doi:10.1016/j.indcrop.2015.02.049
21. Darderafshi M, Bahrami G, Sadeghi E, Khanahmadi M, Mohammadi M, Mohammadi R. The effect of *Ferulago angulat* essential oil on Staphylococcus aureus during the manufacture and preservation of Iranian white cheese. Iran J Nutr Food Science Food Technol. 2014;8(4):13-20.
22. Javidnia K, Miri R, Edraki N, Khoshneviszadeh M, Javidnia A. Constituents of the volatile oil of *Ferulago angulata* (Schlecht.) Boiss. from Iran. J Essent Oil Res. 2006;18(5):548-50. doi:10.1080/10412905.2006.9699163
23. Rezazadeh S, Yazdani D, Shahnazi S. Chemical composition of essential oil of *Ferulago angulata* Boiss. in florescence from west of Iran. J Med Plants. 2003;2:49-52.
24. Rustaiyan A, Sedaghat S, Larijani K, Khossravi M, Masoudi S. Composition of the essential oil of *Ferulago angulata* (Schlecht.) Boiss. from Iran. J Essent Oil Res. 2002;14(6):447-8. doi:10.1080/10412905.2002.9699917
25. European pharmacopoeia. 3th ed. Strasbourg: Royal Society of Medicine Press; 1997.
26. Adams RP. Identification of essential oil components by Gas Chromatog-raphy/Quadrupole Mass Spectroscopy. J Am Soc Mass Spectrom. 2005;16(11):1902-3 doi:10.1016/j.jasms.2005.07.008

27. Sepahvand R, Delfan B, Ghanbarzadeh S, Rashidipour M, Veiskarami GH, Ghasemian-Yadegari J. Chemical composition, antioxidant activity and antibacterial effect of essential oil of the aerial parts of *Salvia sclareoides*. Asian Pac J Trop Med. 2014;7(S1):491-6. doi:10.1016/s1995-7645(14)60280-7

28. Khanjari A, Karabagias I, Kontominas M. Combined effect of N, O-carboxymethyl chitosan and oregano essential oil to extend shelf life and control *Listeria monocytogenes* in raw chicken meat fillets. LWT-Food Sci Technol. 2013;53(1):94-9. doi:10.1016/j.lwt.2013.02.012