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ABSTRACT

The genus *Ferulago* is in the family Apiaceae in the major group Angiosperms (Flowering plants). The genus *Ferulago* consists of 36 species, seven of which are found in Iran, including two endemics: *Ferulago contracta* Boiss. and Hausskn. and *Ferulago phialocarpa* Rech.f. and Riedl. The present mini review describes the chemical and biological activities of some Iranian *Ferulago* species: *Ferulago angulata* (Schlecht.) Boiss.; *Ferulago carduchorum*; *Ferulago contracta* Boiss. et Hausskn.; *Ferulago phialocarpa* Rech.f. and Riedl.; *Ferulago stellata* Boiss. and *Ferulago subvelutina* Rech.f.

KEYWORD: *Ferulago* Species, Umbelliferae, Constituents, Biological activities.**INTRODUCTION**

The genus *Ferulago* comprises of some 35 species of which seven species are found in Iran^[1] *Ferulago* species are closely related to the genus *Ferula*, but they have not been studied as extensively. However, the chemical composition of *Ferulago trachycarpa* oil from Turkey^[2] and *F. sylvatica* oil from Serbia^[3] have been previously described. In addition, the chemical investigation of some *Ferulago* species has shown coumarins, sesquiterpene and aromatic compounds.^[4-6]

***Ferulago angulata* (Schlecht.) Boiss.**

GC analysis was performed using a Packard 439 with a CP Sil 5 CB column, 25 m × 0.25 mm, film thickness 0.39 μm, temperature programmed at 60°-220°C at 5°C/min. The carrier gas was nitrogen (0.8 mL/min), injector and detector temperatures at 270°C.

GC/MS analysis was performed using Varian 3700 with a CP Sil 5 CB column (25 m × 0.25 mm, film thickness 0.39 μm) combined with Varian MAT 44S, ionization energy 70 eV, carrier gas helium, injector temperature 270°C. Approximately 0.1 μL of neat oil was injected under split conditions (100:1), oven temperature held at 60°C for 5 min, programmed at 5°C/min to 220°C and then held for 20 min. The identification of the compounds was carried out by comparison of their mass spectra with those of authentic samples together with the relative retention indices.^[7,8]

The identified constituents can be seen as follow. Twenty-five components were identified, accounting for 88.7% of the oil; β-phellandrene (32.0%) and α-phellandrene (13.8%) were the main components, with appreciable amounts of α-pinene (9.1%), β-pinene (7.1%), terpinolene (5.5%), allo-ocimene (4.7%) and methyl eugenol (4.0%).

The oil was characterized by large amounts of monoterpene hydrocarbons (77.5%), small amounts of oxygenated monoterpenes and sesquiterpenes (6.6% and 3.5%), respectively and trace amounts of aliphatic and aromatic compounds. In the flower oil of *F. contracta*, α-phellandrene (46.8%) and β-phellandrene (24.5%) were the major constituents.^[5]

***Ferulago carduchorum* Boiss. et Hausskn.**

The volatiles obtained by hydrodistillation and methanol extraction of the aerial parts of *Ferulago carduchorum* Boiss. et Hausskn., a Umbelliferae species of Iran, was analyzed by GC and GC/MS. The oil and extract obtained by hydrodistillation and extraction of *F. carduchorum* were characterized by a high amount of monoterpene hydrocarbons (93.8% and 70%). The main components of the oil and extract were (Z)-β-ocimene (21.2% and 20.0%), terpinolene (13.1% and 6.0%), α-phellandrene (12.7% and 8.3%) and β-phellandrene (10.9% and 8.8%), respectively.^[9]

***Ferulago contracta* Boiss. and Hausskn.**

The essential oils obtained by hydrodistillation from the aerial parts (stems, flowers and leaves) of *Ferulago contracta* Boiss. et Hausskn, which is endemic to Iran, were analyzed by GC and GC-MS. β -phellandrene (15.1%, 15.3% and 25.0 %) and α - phellandrene (14.4%, 11.5% and 25.0 %) were the main constituents in the aerial part, stem and flower oils of *F. contracta* respectively. The other main components in the aerial part oil of the plant were β -eudesmol (10.9 %) and (E)- β -ocimene (10.0 %) and in the stem oil was also (E)- β -ocimene (11.3 %). The leaf oil of the plant was characterized by higher amount of β -eudesmol (24.5 %), spathulenol (16.2 %) and citronellol (11.9 %). The antibacterial activity of stem, leaf and flower oils of *Ferulago contracta* against seven Gram-positive and Gram-negative bacteria were determined using MIC method. The growth inhibitory zone (mm) was also measured.^[10]

***Ferulago phialocarpa* Rech. f. et H. Reidl.**

The water distilled oil from the aerial parts of *Ferulago phialocarpa* Rech. f. et H. Riedl.(Umbelliferae), which is endemic to Iran, was analyzed by GC/MS. α -Pinene (40.9%), α -phellandrene (14.2%) and β -phellandrene (9.6%) were the main components among the 26 constituents characterized in the oil of *Ferulago phialocarpa*, representing 93.8% of the total components detected. The oil was richer in monoterpene, rather than sesquiterpene, hydrocarbons.^[11]

***ferulago stellata* Boiss.**

The composition of the essential oils from *ferulago stellata* Boiss. (syn. *Ferulago koeiziana* Rech.f.) of Iran obtained by hydrodistillation were analyzed by GC and GC/MS. the main composition of *F. stellata* was 2,4,5-trimethyl benzaldehyde (61.1%).^[12]

***Ferulago subvelutina* Rech.f.**

The essential oils from *Ferulago subvelutina* Rech.f. of Iran obtained by hydrodistillation were analyzed by GC and GC/MS. The major constituents of the oil of *F. subvelutina* appeared to be limonene (27.0 %), α -phellandrene (23.1 %) and α -pinene (13.3 %).^[12]

CONCLUSION

As mentioned in this review constituents and biological activities of Iranian *Ferulago* species including *Ferulago angulata* (Schlecht.) Boiss.; *Ferulago cardochorum* Boiss. and Hausskn; *Ferulago contracta* Boiss. and Hausskn.; *Ferulago phialocarpa* Rech.f. and Riedl.; *Ferulago stellata* Boiss. and *Ferulago subvelutina* Rech.f.

Ferulago species produce mainly α -phellandrene and β -phellandrene.

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