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Essential Oils of Two Varieties of *Gundelia tournefortii* L. (Asteraceae) from Turkey

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The chemical composition of the essential oils of dried aerial parts of two varieties of *Gundelia tournefortii* L. (var. *tournefortii* and var. *armata* Freyn and Sint.) (Asteraceae) from Turkey were analyzed by GC and GC-MS 75 components in both of the plants were identified representing 87.7 and 78.9 % of the oils, respectively. The main compound of *Gundelia tournefortii* var. *tournefortii* is thymol (24.5 %) and for *Gundelia tournefortii* var. *armata* is Germacrene D (21.6 %). The results were discussed in terms of natural products, renewable resources and chemotaxonomy.

Key Words: *Gundelia tournefortii* var. *tournefortii*, *Gundelia tournefortii* var. *armata*, Asteraceae, GC-MS, Essential oil.

INTRODUCTION

The *Gundelia* L. is a monotypic genus in Asteraceae family and also it is represented with three varities in Flora of Turkey[1] (var. *armata* Freyn. and Sint., var. *tenuisecta* Boiss. and var. *tournefortii*). *Gundelia tournefortii* var. *armata* is a medicinal plant, native to Asian-temperate zones of Western Asia, namely Cyprus, Egypt, Iran, Israel, Jordan, Turkey, Azerbaijan and Turkmenistan. It is reported that the flowers, leaves, seeds and stems of *G. tournefortii* are used as food sources[1]. In the middle East, the young and still undeveloped flower buds are sold in the local markets just like artichoke hearst; it is a highly sought item[2-5]. Dry seeds of *G. tournefortii* are also known to be effective for the treatment of vitiligo disease, in Eastern Anatolia folk medicine. *Gundelia tournefortii* L. is an important food source and a well-known medicinal plant in Eastern Anatolia and fresh seeds of *G. tournefortii* are used in pickles and also are effective diuretics. Therapeutic effects of medicinal plants are known to be closely related to their antioxidant capacities[6]. These two varieties are distinguished from each other by some morphological chararacters concerned with the sepals and leaves[7].

Gundelia tournefortii L. is a perennial spiny herb which is collected and dried for winter fodder for small ruminant animals in most parts of Turkey and surrounding

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countries. In desert part of Israel, mature *G. tournefortii* is sometimes used as fodder for camels[4]. A study from Jamshidzadeh[8] reported that the *G. tournefortii* extract could protect the liver against CCl_4-induced damages with doses of 200 and 300 mg/kg, but concentrations higher than 300 mg/kg were less effective and the result of the study support the traditional believes on hepatoprotective effects of *G. tournefortii* however, high concentrations were hepatotoxic In the study of Chehregani *et al.*[9], *Gundelia tournefortii* was determined as among the heavy metals acumulator plants in the Angouran region of Iran.

There are more studies on the nutritional and health effects of the *Gundelia tournefortii* from different countries. It is investigated that to determine the effect of maturity stage on the nutritive value of *G. tournefortii* in terms of chemical composition and *in situ* and *in vitro* dry matter degradability, calculated metabolizable energy and organic dry matter digestibility[3]. In Turkey the plant samples belongs to the species is collected and dried in summer being stacked for winter fodder on the Anatolian plateau. A chewing gum (called kenger sakizi) is made from the latex and the seeds are used as coffee (Kenger kahvesi) after torrefaction[7]. The objective of this study was to determine the essential oil composition of two *Gundelia tournefortii* varities reported in Flora of Turkey and to supply contributions to the food quality, renewable resources and chemotaxonomy of this plant in Turkey.

EXPERIMENTAL

G. tournefortii var. *tournefortii* and *G. tournefortii* var. *armata* specimens were collected from natural habitats in Harput-Elazig in 2008, Bagci-2112 and 2113. Voucher specimens are kept at the Firat University, Herbarium (FUH).

Isolation of the essential oils: Air-dried aerial parts of the plant materials (100 g) were subjected to hydrodistillation using a Clevenger-type apparatus for 3 h.

Gas chromatographic (GC) analysis: The essential oil was analyzed using HP 6890 GC equipped with and FID detector and an HP-5 MS column (30 m × 0.25 mm i.d., film tickness 0.25 μm) capillary column was used. The column and analysis conditions were the same as in GC-MS. The percentage composition of the essential oils was computed from GC-FID peak areas without correction factors.

Gas chromatography/mass spectrometry (GC-MS) analysis: The oils were analyzed by GC-MS, using a Hewlett Packard system. HP-Agilent 5973 N GC-MS system with 6890 GC in Plant Products and Biotechnology Res. Lab. (Bubal) in Firat University. HP-5 MS column (30 m × 0.25 mm i.d., film tickness 0.25 μm) was used with helium as the carrier gas. Injector temperature was 250 ºC, split flow was 1 mL/min. The GC oven temperature was kept at 70 ºC for 2 min and programmed to 150 ºC at a rate of 10 ºC/min and then kept constant at 15 ºC for 15 min to 240 ºC at a rate of 5 ºC/min. Alkanes were used as reference points in the calculation of relative retention indices (RRI). MS were taken at 70 eV and a mass range of 35-425. Component identification was carried out using spectrometric electronic libraries (WILEY, NIST). The identified constituents of the essential oils are listed in Table-1.

TABLE-1
ESSENTAIL OIL CONSTITUENTS OF *Gundelia tournefortii* VARIETIES

Compounds	RRI	*G. tournefortii* var. *tournefortii*	*G. tournefortii* var. *armata*
2-hexenal	964	–	0.2
Cyclopropane	974	–	0.2
Heptanal	997	–	0.2
4-Ethyl phenol	1008	–	0.2
α-Tujone	1015	0.8	–
2-Methyl-5-isopropenyl furan	1020	–	0.3
α-Pinene	1021	0.4	0.8
2-heptanal	1039	–	0.3
Benzaldehyde	1043	–	0.4
Sabinene	1051	0.9	–
1-Octen-3-ol	1057	–	0.3
3-Octanon	1060	0.8	0.7
β-Myrcene	1063	1.3	–
2-Pentyl furan	1064	–	1.1
Etil amyl carbinol	1069	0.1	–
Octanal	1075	–	0.7
α-Phellandrene	1077	0.1	–
2,4-Heptadienal	1081	–	0.6
α-Terpinene	1085	1.4	–
p-Cymene	1091	7.3	–
1,8-Cineol	1097	1.3	–
cis-Ocimene	1099	3.1	–
3-Octen-2-one	1101	–	0.9
Benzeneacetaldehyde	1106	–	0.8
1,3,6-Octatriene	1107	0.9	–
γ-Terpinene	1117	10.7	1.6
2-Methyl benzaldehyde	1125	–	1.0
trans-Sabinene hydrate	1126	0.5	–
2-Nonanone	1140	–	0.4
L Linalool	1148	–	0.8
Nonanal	1151	–	3.0
2-Butanone	1180	–	0.5
2-Dodecen-1-al	1190	–	0.6
3-Cyclohexan-1-ol	1205	0.4	0.9
3-Cyclohexen-1-methanol	1215	–	0.5
α-Terpineol	1216	8.7	–
Decenal	1221	–	1.0
2,4-Nonadienal	1228	–	0.2
Thymol metyl ether	1237	3.5	–
Carvacrol metyl ether	1244	6.4	–
Camphene	1252	–	0.9
2-Decenal	1263	–	0.7
Thymol	1289	24.5	–

N2-Ethylguanine	1291	–	1.9
Carvacrol	1296	6.7	–
2-Methoxy-4-vinylphenol	1305	–	1.2
2,4-Decadienal	1312	–	1.6
Undecenal	1350	–	0.5
β-Bourbonene	1367	–	1.3
β-Caryophyllene	1393	2.8	7.0
Aromadendrene	1406	0.1	–
Neryl acetone	1412	–	0.7
α-Humulene	1418	0.2	0.6
Pentadecane	1421	–	0.5
Germacrene D	1435	0.5	21.6
Bicyclogermacrene	1444	0.6	5.2
α-Cadinene	1458	0.2	–
cis-α-Bisabolene	1472	0.8	–
Nerolidol	1485	–	1.0
Spathulenol	1495	–	2.9
Caryophyllene oxide	1498	–	3.0
α-Cadinol	1539	–	0.9
Dodecenal	1570	–	0.5
Benzyl benzoate	1596	–	1.4
2-Pentadecanone	1631	–	2.7
Cyclotetradecane	1650	–	0.3
4-Penten nitril	1673	0.5	–
2-Hexadecanoic acid	1692	–	0.7
Iso-caryophyllene	1694	0.4	–
Nonadecan	1819	0.9	–
Tricosane	1867	0.2	–
Tetracosane	1898	0.1	0.3
Phenyl methanol	1936	0.4	–
Nonacosane	1941	–	3.1
Eicosane	1949	–	0.2
Pentacosane	1957	0.2	–
Total		87.7	78.9

RESULTS AND DISCUSSION

The essential oil yields of *G. tournefortii* var. *tournefortii* and *G. tournefortii* var. *armata* were found as 0.7 and 0.9 % v/w, respectively. The result of analysis of essential oils are presented in Table-1. Overall, 34 compounds which accounted for 87.7 % in var. *tournefortii* and 51 constituents, which accounted for 78.9 % of the total compositions of each oil are determined in var. *armata*. The oils were complex mixtures of non-terpenes, monoterpenes and sesquiterpenes: Totally, 76 components were identified in both essential oil in the study.

While the abundant group of essential oil of var. *tournefortii* were monoterpenes, but in the var. *armata* the sesquiterpenes were the major group. The thymol (24.5 %),

γ-terpinene (10.7 %), α-terpineol (8.7 %) and *p*-cymene (7.3 %) were the major compounds of var. *tournefortii* and the germacrene D (21.6 %), β-caryophyllene (7.0 %) and bicyclogermacrene (5.2 %) were the main compounds of the var. *armata*.

In the essential oil of these two varieties of *Gundelia tournefortii*, while the main monoterpenes were thymol, γ-terpinene, α-terpineol, *p*-cymene, carvacrol methyl-ether in var. *tournefortii*, no major monoterpene detected in var. *armata* essential oil (Table-1).

It is interesting that although major components (thymol, γ-terpinene, α-terpineol and *p*-cymene) of essential oil of var. *tournefortii* the absence of those major components and the presence of the some sesquiterpenes (germacrene D, β-caryophyllene and bicyclogermacrene) in var. *armata* are important differences between two varieties. This result is also significant to chemotaxonomic evaluation of the genus and family patterns.

In the analysis of the volatile oil from aerial parts of *G. tournefortii*[10]; α-terpinyl acetate (36.21 %), methyl eugenol (12.57 %), eugenol (6.7 %), β-caryophellene (5.94 %) and zingiberene (5.84 %) were found as the major oil components. Present analysis results were not similar with this study[10] findings, because of the absent of the major components (except β-caryophyllene) in present samples.

In the mineral content analysis of *G. tournefortii*, with some wild edible plant leaves, from Turkey were reported as the higher contents of 'sulfur' (100.53 mg/100 g^{-1}) and 'calcium' (642 mg/100 g^{-1}) and the lowest copper and manganese contents were observed in this species and *Eryngium billardieri* samples analyzed in as 0.005 and 0.04 mg/100 g^{-1}. The *Gundelia tournefortii* extract itself was toxic towards isolated hepatocytes with concentrations above 1 mg/mL. Therefore the results of the present study support the traditional believes on hepatoprotective effects of *Gundelia tournefortii*, however, high concentrations were hepatotoxic[8]. The different effects of the essential oils of the plants studied here may be give clues on some new natural products and evaluation of these as renewable resources.

It is surprising that large qualitative and quantitative differences were found between two *Gundelia tournefortii* varieties in view of main compounds. An opposite correlation was noticed for mono and sesquiterpenes hydrocarbons and oxygenated sesquiterpenes between two varieties. The results showed that var. *tournefortii* was rich in monoterpenes; on the contrary, var. *armata* was rich in sesquiterpenes as shown in Table-1. These variation were also determined in some genera patterns like plant groups[11-15].

The main conclusion from the above data, particularly infraspesific differences means, might be explain that genetic and environmental factors both play a role in determining the composition of essential oils of the *Gundelia tournefortii* varieties studied. Inter and intraspecific variations in the essential oils composition of many genera patterns (like *Hypericum*, *Tanacetum*, *Thymus*, *etc*.) were previously reported, depending on genetic, environmental factors, ontogeny, season, plant part analyzed and analytical methods[16-18].

Gundelia tournefortii and their taxa were considered as nutritious food in the world and Turkey and the results highlight the importance of these plants for local people and support efforts for their industrial usage, conservation, renewable resources and the food nutrition and additive[19].

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