Essential oils chemical composition, antioxidant activities and total phenols of *Astrodaucus persicus*

Saeid Goodarzi 1, Abbas Hadjiakhoondi 1, Narguess Yassa 1, Mahnaz Khanavi 1, Zahra Tofighi 1*

1 Department of Pharmacognosy, Faculty of Pharmacy and Medicinal Plant Research Center, Tehran University of Medical Sciences, Tehran, Iran

**Abstract**

*Objective(s):* *Astrodaucus persicus*, Apiaceae, is used as vegetable or food additive in some parts of Iran. The essential oils of different parts of *Astrodaucus persicus* from Kordestan province were analyzed for the first time and compared with other regions. In this study, antioxidant activities and total phenols determination of aerial parts essential oils and root fractions of *A. persicus* were investigated.

**Materials and Methods:** The essential oils were obtained by hydro-distillation from flowers/fruits, leaves/stems, ripe fruits and roots of plant and analyzed by GC-MS. Crude root extract was fractionated with hexane, chloroform, ethyl acetate and methanol. Antioxidant activities by DPPH and FRAP methods and total phenols by Folin-Ciocalteu assay were measured.

**Results:** The abundant compounds of flowers/fruits blue essential oil were α-thujene, β-pinene and α-pinene. The predominant components of blue leaves/stems essential oil were α-thujene, α-pinene and α-fenchene. The major volatiles of ripe fruits blue essential oil were β-pinene, α-thujene and α-pinene. The chief compounds of root yellow essential oil were trans-caryophyllene, bicyclogermacrene and germacrene-D. Total root extract and ethyl acetate fraction showed potent antioxidant activities and high amount of total phenols in comparison to other samples. Among volatile oils, the flowers/fruits essential oil showed potent reducing capacity.

**Conclusion:** The major compounds of aerial parts essential oils were hydrocarbon monoterpenes while the chief percentage of roots essential oil constituents were hydrocarbon sesquiterpenes. α-Eudesmol and β-eudesmol were identified as responsible for creation of blue color in aerial parts essential oils. *A. persicus* was known as a potent antioxidant among Apiaceae.

**Introduction**

*Astrodaucus* is a genus of Apiaceae which is represented by two species, *Astrodaucus persicus* Boiss. Drude and *Astrodaucus orientalis* L. Drude. This genus grows wild in different regions of Iran and nearby countries such as Russia, Syria, inner Anatolia, Trans-Caspia and Central Asia (1). *Astrodaucus* is traditionally used as salad, vegetable or food additive in some parts of Iran and Turkey (2). Determination of the nutrition contents of *A. orientalis* showed the high amount of iron (7.12 mg/100 g), manganese (0.90 mg/100 g) and copper (0.47 mg/100 g) (3).

Chemical composition of *A. persicus* essential oils from Qazvin and Tehran and components of *A. orientalis* volatile oils from Zanjan and Tehran were investigated in previous studies (1,4-7).

There were a few biological investigations on *Astrodaucus* genus especially *A. persicus*. The study on cytotoxicity of *A. persicus* aerial and root extracts (especially root extract) showed strong anti-proliferative effects on T47D breast carcinoma cell by mechanisms such as apoptosis in comparison to negative control and doxorubicin (8, 9). The aerial and root extracts of *A. orientalis* demonstrated potent anti-proliferative effects on T47D cells by decrease in p53 and Bcl-2 protein expression which are believed to play a crucial role in tumorigenesis and cell death (10). In another study, methanol extract from roots of *A. orientalis* exhibited cytotoxic properties against McCoy cell line with IC50 value of 349 µg/ml. Dichloromethane extract from roots of *A. orientalis* has significantly reduced shoot and root growth of seedlings in lettuce assay and so found to have phytotoxic ability (11).

The aqueous extract of flowering shoots of *Astrodaucus* sp. showed antibacterial activities against *Xanthomonas arboricola* pv. *juglandis*, which is caused the most destructive bacterial disease of the genus *Juglans* worldwide (12).

In this study, *A. persicus* was collected from Kordestan Province of Iran and the chemical composition of the blue essential oils of different aerial parts including flowers/fruits, leaves/stems and ripe...
fruits and yellow essential oil of roots were investigated and compared with each other and those of other regions. The total phenols and antioxidant activity of aerial parts essential oils and various fractions of root extract were determined by DPPH and FRAP methods and compared with positive controls for the first time. Investigation of antioxidant effects and total phenolic content is interesting because by comparison of these two markers with reported cytotoxicity of *A. persicus*, the correlation may be found.

**Materials and Methods**

**Chemicals**

Vitamin E 97% (Sigma-Aldrich Chemie GmbH, Germany); 2, 2-diphenyl 1-picrylhydrazyl (DPPH; Fluka, Switzerland); Butylatedhydroxylanizole (BHA), Sodium acetate, 2,4,6-tripryridyl-s-triazine (TPTZ), FeCl$_3$.6H$_2$O, FeSO$_4$.7H$_2$O, Na$_2$HPO$_4$, NaH$_2$PO$_4$, Folin-Ciocalteu phenol reagent, glacial acetic acid, hydrochloric acid, ethanol and methanol (Merck, Germany) were purchased.

**Plant materials**

*A. persicus* (Boiss.) Drude was collected from around Irankhah village, Saghez, Kordestan Provinces, Iran. The flowers/fruits and leaves/stems were gathered at flowering stage in June and ripe fruits and roots were prepared at fruiting stage in September 2010. The different parts were dried and powdered separately. Plant was identified by Mr Y Ajani and deposited in Herbarium of Institute of Medicinal Plants, ACECR, Karaj, Iran (No. 2844 MPh).

**Extraction and fractionation**

The 1190 g of *A. persicus* roots was macerated with 80 % methanol (4 L) every 24 hr at room temperature until the solvent gained color and the extract was concentrated (42.5 g crude extract). Crude extract was fractionated with hexane (HE 15.63 g), chloroform (CL 7.44 g), ethyl acetate (EA 2.54 g) and methanol (ME 15.25 g).

**Isolation of the essential oils**

The air-dried flowers/fruits, leaves/stems, ripe fruits and roots of *A. persicus* were separately subjected to hydro-distillation for 4 hr using a cleveenger type apparatus. The oils were collected separately, dried on anhydrous sodium sulfate and kept in refrigerator for GC and GC/MS analysis.

**Gas Chromatography**

The essential oils were analyzed using a Hewlett Packard 6890 gas chromatograph equipped with a HP-5MS column (5% phenylmethylpolysiloxane) (30 m × 0.25 mm, film thickness 0.25 µm). The thermal program was 40-250 °C at a rate of 3 °C/min; The Injector and detector (FID) temperatures were 250 and 230 °C respectively and split flow was adjusted at 50 ml/min. Helium (99.999 %) was used as carrier gas at a flow rate of 1 ml/min. The percentage compositions of the identified compounds were computed from the GC peak areas.

**GC/MS analysis**

The oils were analyzed by GC/MS using a Hewlett Packard 5973 mass selective detector connected to a HP 6890 gas chromatograph. The separation was achieved at the same gas chromatographic conditions. MS were taken at ionization potential of 70 eV. Identification of compounds was based on comparison of Kovats indices (KI) and fragmentation patterns of mass spectral data in comparison with standard compounds in Wiley library or published data in the literature (13, 14).

**Antioxidant activity**

**DPPH -free radical scavenging activity**

For investigation of radical scavenging activity of fractions, the DPPH method was used (15). One ml of different concentrations of each essential oil (20, 10, 5, 2.5 µl/ml) and fraction (25, 50, 100 and 250 µg/ml) were added to 2 ml of DPPH solution (4 × 10$^{-5}$ g/ml MeOH). Methanol was added to negative controls which were containing maximum concentration of samples up to 3 ml; 2 ml of DPPH solution was added to blank (1 ml methanol). Vitamin E (40 µg/ml) and BHA (10 µg/ml) were used as positive controls. The absorbance was measured 30 min after at 517 nm and the radical scavenging activity was calculated as follow:

$$\text{Inhibition \% = 100 - ([Sample absorption-control absorption]/Blank absorption) \times 100}$$

All tests were carried out in triple replicate and IC$_{50}$ were calculated.

**FRAP - ferric reducing antioxidant power assay**

The total antioxidant capacity of different essential oils and fractions of *A. persicus* were determined by measurement of their abilities to reduce ferric tripyridyltriazine (Fe(III)-TPTZ) complex to its ferrous colored form (Fe(II)-TPTZ) at low pH. (Fe(II)-TPTZ) has an intensive blue color and can be monitored with spectrophotometer (16). One and half ml of FRAP reagent (2.5 ml of 10 mM TPTZ solution in 40 mM HCl, 2.5 ml of 20 mM FeCl$_3$ and 25 ml of 0.3 M acetate buffer, pH 3.6) was added to 50 µl of each sample (100 µg/ml). After incubation at 37 °C for 10 min, the absorbance was measured at 593 nm. FRAP reagent used as blank and the experiment was performed in triplicate. Different concentration of aqueous solution of FeSO$_4$.7H$_2$O (in a range of 125-1000 µmol/l) was used for calibration curve. The relative antioxidant activities of samples were reported as mmole Fe$^{2+}$/100 g of fractions.
Folin ciocalteu –total phenol assay

Total phenol content of all samples was determined by Folin Ciocalteau method (17). It involves the oxidation of phenols in alkaline solution by the yellow molybdenum-phosphoric heteropolyanion reagent and colorimetric measurement of the resultant molybdenum blue. These blue pigments have a maximum absorption depending on the composition of phenol mixtures besides the pH of solutions, usually obtained by adding sodium carbonate or sodium bicarbonate (18). The methanol solution of prepared dilution of each samples and gallic acid as standard phenol compound (0.2 ml) were mixed with Folin-Ciocalteau reagent (2 ml, 1:10 diluted with distilled water) and after 5 min, saturated NaHCO₃ solution (1.5 ml, 60 g/l distilled water) was added. After 90 min incubation at room temperature, the absorption of the solutions was measured using spectrophotometer at 725 nm. The standard curve was prepared using 0, 25, 50 and 100 mg/ml solutions of gallic acid (GA) in methanol and total phenol compounds were expressed as gallic acid equivalents (GAE; mg of gallic acid per g of samples). All tests and analyses were carried out in triplicate.

Results

GC/MS analysis of essential oils

Volatile compounds of different parts of A. persicus from Kordestan province were investigated and demonstrated in Table 1.

The aerial parts essential oil samples were observed as blue color liquid and were obtained in yield of 0.6–0.9% (v/w) while the roots essential oil was seen as yellow color liquid in yield of 0.1% (v/w). The flowers/fruits essential oil contained monoterpenes (97.3%) and sesquiterpenes (1.4%), which was similar to leaves/stems essential oil monoterpenes (96.5%) and sesquiterpenes (2.1%) and ripe fruits essential oil contained monoterpenes (95.9%) and sesquiterpenes (1.1%). The roots essential oil included monoterpenes (5.2%) and sesquiterpenes (90.7%). Investigation of essential oil of ripe fruits and roots showed the existence of nonterpenes (1.4 and 4.1%, respectively) which was not observed in two other aerial parts samples. It was interesting that the amount of monoterpenes was more than sesquiterpenes in aerial parts and vice versa the sesquiterpene content was abundant in roots of A. persicus. The major compounds of three aerial parts essential oils belonged to hydrocarbon monoterpenes which was calculated as 91.3%, 91.3% and 93.6% for flowers/fruits, leaves/stems and ripe fruits, respectively while hydrocarbon sesquiterpenes were abundant in roots essential oil (82.9%).

Antioxidant and total phenols determination

Antioxidant activities and total phenols of aerial parts essential oils and root different fractions of A. persicus in comparison with vitamin E and BHA (butylatedhydroxyanisole) as natural and synthetic antioxidants were reported in Table 2.

Discussion

GC/MS analysis of essential oils

The abundant compounds of flowers/fruits essential oil were α-thujene (43.8%), β-pinene (21.3%) and α-pinene (20.9%). The predominant components of leaves/stems essential oil were α-thujene (48.0%), α-pinene (27.7%) and α-fenchene (9.2%). The major volatiles of ripe fruits essential oil were β-pinene (56.9%), α-thujene (17.6%) and α-pinene (14.3%). Comparison of essential oils of unripe and ripe fruits showed that the amount of β-pinene was increased with maturation in ripe fruits while α-thujene and α-pinene contents were decreased. The similar major volatile components of three aerial parts essential oil samples were α-thujene, α-pinene, camphene, p-cymene, γ-terpinene, α-fenchyl acetate, bornyl acetate, γ-cadinene, β-eudesmol and α-eudesmol. The chief compounds of root essential oil were trans-caryophyllene (33.5%), bicycogermacrene (27.3%) and germacrene-D (11.6%). α-Pinene, γ-terpinene and bornyl acetate were common in aerial parts and roots essential oils. α-Thujene, camphene, p-cymene, α-fenchyl acetate, γ-cadinene, β-eudesmol and α-eudesmol were compounds which existed in three aerial parts essential oils but there were not seen in roots volatile oil.

The previous investigation on chemical composition of A. persicus essential oils from Taleqan (Qazvin province) of Iran represented bornyl acetate, β-sesquiphellandrene and exo-fenchyl acetate as major compounds of yellow essential oil of root, α-pinene and exo-fenchyl acetate as abundant components of green essential oil of stem/leaves and β-pinene, α-pinene and α-thujene as main principles of bluish-green essential oil of flowers/fruits (1). Another research demonstrated the major compounds of yellow essential oil of A. persicus aerial part collected from northeast of Tehran were decanal, dodecanal and dodecanol (4). The abundant components of pale yellow essential oil of A. persicus seeds, cultivated in Northeast of Tehran were geranyl acetate, α-pinene and sabinen (5). Mirza et al examined the essential oils of A. orientalis leaves and seeds from Alamut (Zanjan province) in Iran. The sample oils were blue in color. The major components of the leaves oil were fenchyl acetate and α-pinene but the major constituents of the seeds oil were myrcene and β-pinene (6). The dominant components of aerial parts essential oil of A. orientalis from Fasham, 30 km north of Tehran, were α-pinene, α-fenchyl acetate, β-pinene and bornyl acetate (7). The different results of essential oils analysis demonstrated the effect of geographic origin on chemical composition of volatile oils.
Table 1. Volatile composition of essential oils from different parts of *Astrodaucus persicus*

| No. | Compounds              | KI | Flowers /fruits | Stems /leaves | Ripe fruits | Root | Methods of identification |
|-----|------------------------|----|-----------------|---------------|-------------|------|--------------------------|
| 1   | α-Thujene              | 924| 43.8            | 48.0          | 17.6        | -    | MS-KI                    |
| 2   | α-Pinene               | 932| 20.9            | 27.7          | 14.3        | 0.6  | MS-KI                    |
| 3   | α-Fenchene             | 945| -               | 9.2           | -           | -    | MS-KI                    |
| 4   | Camphene               | 946| 1.4             | 1.8           | 0.8         | -    | MS-KI                    |
| 5   | β-Fenchene             | 949| -               | 4.0           | -           | -    | MS-KI                    |
| 6   | β-Pinene               | 974| 21.3            | -             | 56.9        | 0.3  | MS-KI                    |
| 7   | β-Mycene               | 908| 2.0             | -             | 2.4         | 0.4  | MS-KI                    |
| 8   | α-Terpinene            | 1014| 0.2            | -             | 0.2         | -    | MS-KI                    |
| 9   | p-Cymene               | 1020| 1.0            | 0.4           | 0.6         | -    | MS-KI                    |
| 10  | 1,2,4-trimethylbenzene | 1024| -             | -             | -           | 0.7  | MS-KI                    |
| 11  | Limonene               | 1024| -              | -             | -           | 0.1  | MS-KI                    |
| 12  | Eucalyptol             | 1026| -              | -             | -           | 0.2  | MS-KI                    |
| 13  | cis-β-Ocimene          | 1032| 0.1            | -             | 0.1         | -    | MS-KI                    |
| 14  | Octatriene             | 1039| -              | -             | 0.1         | 0.1  | MS-KI                    |
| 15  | trans-β-Ocimene        | 1044| -              | -             | 0.1         | -    | MS-KI                    |
| 16  | γ-Terpinene            | 1054| 0.3            | 0.2           | 0.4         | 0.8  | MS-KI                    |
| 17  | α-Terpinolene          | 1086| 0.1            | -             | -           | -    | MS-KI                    |
| 18  | Linalool               | 1095| -              | -             | -           | 1.7  | MS-KI                    |
| 19  | Perillene              | 1102| 0.1            | -             | -           | -    | MS-KI                    |
| 20  | Allocimene             | 1128| -              | -             | 0.1         | -    | MS-KI                    |
| 21  | β-Citronellal          | 1148| -              | -             | 0.4         | -    | MS-KI                    |
| 22  | α-Fenchylacetate       | 1218| 2.8            | 1.7           | 0.2         | -    | MS-KI                    |
| 23  | Bornyl acetate         | 1284| 2.9            | 3.5           | 1.7         | 1.1  | MS-KI                    |
| 24  | Sabinyl acetate        | 1289| 0.1            | -             | -           | -    | MS-KI                    |
| 25  | Bicycloelemene         | 1330| -              | -             | -           | 0.5  | MS-KI                    |
| 26  | α-Copaene              | 1374| -              | -             | 0.1         | -    | MS-KI                    |
| 27  | β-Bourbonene           | 1387| -              | -             | 0.1         | 1.0  | MS-KI                    |
| 28  | Cedrene                | 1410| 0.1            | -             | -           | -    | MS-KI                    |
| 29  | cis-α-Bergamotene      | 1411| -              | 0.1           | -           | -    | MS-KI                    |
| 30  | trans-Caryophyline     | 1417| 0.1            | -             | 0.1         | 33.5 | MS-KI                    |
| 31  | β-Gurjunene            | 1431| -              | 0.1           | -           | -    | MS-KI                    |
| 32  | Aromadendrene          | 1439| -              | 0.1           | -           | -    | MS-KI                    |
| 33  | β-Farnesene            | 1440| -              | -             | -           | 7.2  | MS-KI                    |
| 34  | Germacrene-D           | 1448| -              | -             | -           | 11.6 | MS-KI                    |
| 35  | α-Humulene             | 1452| 0.1            | -             | -           | -    | MS-KI                    |
| 36  | Bicyclogerancene       | 1500| -              | -             | 0.1         | 27.3 | MS-KI                    |
| 37  | γ-Cadinene             | 1513| 0.1            | 0.1           | 0.1         | -    | MS-KI                    |
| 38  | Myristicene            | 1517| -              | -             | 1.2         | -    | MS-KI                    |
| 39  | δ-Cadinene             | 1522| -              | 0.1           | -           | -    | MS-KI                    |
| 40  | Germacrene-B           | 1559| -              | -             | 1.8         | -    | MS-KI                    |
| 41  | Spathulenol            | 1577| 0.4            | -             | 0.3         | 3.0  | MS-KI                    |
| 42  | Caryophyllene oxide    | 1582| -              | -             | 3.6         | -    | MS-KI                    |
| 43  | β-Eudesmol             | 1649| 0.5            | 1.1           | 0.2         | -    | MS-KI                    |
| 44  | α-Eudesmol             | 1652| 0.2            | 0.6           | 0.2         | -    | MS-KI                    |
| 45  | α-Cadinol              | 1652| -              | -             | 1.2         | -    | MS-KI                    |
| 46  | Camazulene             | 1730| -              | -             | 0.2         | -    | MS-KI                    |
| 47  | Hexadecanoic acid      | 1959| -              | -             | 0.6         | 3.3  | MS-KI                    |

Note: KI means Kovats Index
Aerial parts essential oils of *A. persicus* demonstrated blue color while roots essential oil showed yellow color. Previous investigations recognized that the blue color of volatiles could be related to the structure of hydrocarbons and related sesquiterpenes. Dehydrogenation of pure crystalline sesquiterpene alcohol, guaiol, to a blue hydrocarbon proved this hypothesis. Azulenes, the well-known blue structures formed a welcome addition to two dehydrogenation products, eudalene and cadalene. The formation of these naphthalene hydrocarbons has confirmed the mentioned hypothesis (19, 20). α-Eudesmol and β-eudesmol are sesquiterpene alcohols in blue aerial parts essential oils and did not exist in roots essential oil. The similar parts of eudesmol and guaiol are two cyclic rings and the branch of propanol which was not observed in other sesquiterpene alcohols in *A. persicus* roots essential oil including spathulenol, caryophyllene oxide and α-cadinol. Therefore dehydrogenation of α-eudesmol and β-eudesmol could be responsible for creation of blue color in aerial parts essential oils. The existence of camazulene (0.2%) could be a reason for intensification of blue color in ripe fruits essential oil.

### Antioxidant and total phenols determination

Total root extract and EA fraction showed moderate activity of free-radical scavenging with IC$_{50}$ of 52.3 and 99.2 µg/ml, respectively. The antioxidant activity of HE fraction and all of aerial parts essential oil samples with DPPH method were negligible (IC$_{50}$$>$500 µg/ml). IC$_{50}$ values of antioxidant capacities of three genera of Apiaceae family for example *Heracleum persicum* Desf., *Prangos ferulacea* (L.) Lindl. and *Chaerophyllum macropodum* Boiss. evaluated as 438, 242 and 623 µg/ml by DPPH method, respectively (21). *Caucalis platycarpos* L. and *Torilis leptophylla*, two near genera to Astrodaucus, demonstrated IC$_{50}$ equal with 42.6 and 41.0 µg/ml based on DPPH radical scavenging method (22, 23). In comparison to other genera of Apiaceae, *A. persicus* root extract showed potent radical scavenging antioxidant activity.

Total antioxidant activity of aerial parts essential oils and root fractions were measured according to standard curve of FeSO$_4$ (y = 0.001x + 0.049, r$^2$ = 0.925). The greatest reducing capacity was belong to total root extract (881.5 mmol Fe$^{2+}$/100 g), which was comparable with BHA (880.3 mol Fe $^{2+}$/100 g) and more than vitamin E (313.7 mmol Fe$^{2+}$/100 g). Among volatile oils, the flowers/fruits essential oil showed potent reducing capacity (686.6 mmol Fe$^{2+}$/100 g) higher than vitamin E. In contrast, HE and ME fractions demonstrated the lowest antioxidant activity (96.0 and 130.5 mmol Fe$^{2+}$/100 g, respectively). The previous study on *Eryngium bourgatii* extract from Apiaceae family demonstrated the antioxidant effects equal to 59.8 mmol Fe$^{2+}$/g extract (24). Another investigation showed the reducing antioxidant effects of seeds of some Indian medicinal plants from Apiaceae including *Anethum sowa* Roxb., *Carum copticum* (L.) Benth. & Hook., *Coriandrum sativum* L., *Cuminum cyminum* L. and *Foeniculum vulgare* Mill. were equal to 175, 886, 33, 182 and 179 mmol Fe$^{2+}$/g dry weight, respectively (25). Our findings on *A. persicus* in comparison to previous works confirmed its high antioxidant activity.

The potent antioxidant activities of total root extract in comparison to its fractions demonstrated the synergis effect of compounds in various fractions for radical scavenging and reducing activities.

Total phenol content of samples were calculated based on gallic acid standard curve (y = 0.007x, r$^2$ = 0.999). EA fraction and total root extract showed the highest content of phenolic compounds among other samples (872.8 and 728.5 mg GAE/100 g sample). In previous study, total phenol content of *Cuminum cyminum* L. (Apiaceae) from Tunisia and India were measured as 1860 and 1450 mg of GAE/100 g dry weight, respectively (26). Another study on three medicinal Apiaceae species revealed total phenol...
content of *Centella asiatica*, *Hydrocotyle bonariensis* and *H. sibthorpioides* as 72.89, 28.55 and 56.23 mg/100 g dry weight, respectively (27). *A. persicus* demonstrated moderate content of total phenols in comparison with another species of Apiaceae family.

Different fractions of root extract except HE fraction demonstrated negative correlation between IC50 of DPPH and FRAP antioxidant activities (y = -4.39x + 1049, r2 = 0.898). It means by increasing radical scavenging activity of fractions, the reducing capacity was increased so in root extract the same compounds were responsible for radical scavenging and reducing activity. There were not significant correlation between the amount of total phenols and DPPH antioxidant activity but there were proximate positive correlation between the total phenols and FRAP antioxidant activity in root fractions (y = -0.39x+612.6, r2 = 0.340 and y = 0.92x+188.8, r2 = 0.731, respectively). These correlations means by increasing the amount of phenols in fractions, the reducing antioxidant activity was increased so these compounds may involve in antioxidant activity by FRAP method. The previous study on burr parsley (*Caulis platycarpos* L.) showed a significant positive correlation between flavonoids and phenolic acids content and antioxidant activities including lipid peroxidation, superoxide dismutase activity, metal ion chelating and reducing power assay, indicating the responsibility of these compounds for the antioxidant effectiveness (22). In another investigation on *Torilis leptophylla*, a significant but marginal positive correlation was found between total phenol content and EC50 values for DPPH, hydroxyl, phosphomolybdate and ABTS, whereas another weak and positive correlation was determined between total phenol content and EC50 values for superoxide anion and hydroxyl radicals. (23).

**Conclusion**

Chemical compositions of different parts essential oils of *A. persicus* from Kordestan Province were identified. α- and β- Eudesmoles were recognized as principle for formation of blue color in aerial parts essential oils. Root extract and flowers/fruits essential oil of *A. persicus* exhibited potent antioxidant activities and total phenols. These findings introduced *A. persicus* as a good potential source of natural antioxidants which may be related to its cytotoxic activity.

**Acknowledgment**

This research was supported by a grant of Tehran University of Medical Sciences and Health Services, Tehran, Iran (No. 14021).

**References**

1. Bazargani YT, Almasirad A, Amin G, Shafiee A. Chemical composition of the essential oils of *Astrodaucus persicus* (Boiss.) Drude root, stem/leaves and flowers/fruits. Flavour Fragr J 2006; 21:294-296.
2. Nazemiyeh H, Razavi SM, Delazar A, Asnaashari S, Khoi NS, Daniali S, et al. Distribution Profile of Volatile Constituents in Different Parts of *Astrodaucus orientalis* (L.) Drude. Rec Nat Prod 2009; 3:126-130.
3. Yildirim E, Dursun A, Turan M. Determination of the Nutrition Contents of the Wild Plants Used as Vegetables in Upper Coruh Valley. Turk J Bot 2001; 25:367-371.
4. Bigdeli M, Rustaiyan A, Ameri N, Masoudi Sh. Essential Oil of *Astrodaucus persicus* (Boiss.) Drude. from Iran. J Essent Oil Res 2014; 16:420-421.
5. Omidhaigi R, Bastan MR, Omidhaigii MA. Essential oil content and chemical composition of *Astrodaucus persicus* Boiss cultivated in Iran. J Essent Oil Bear Pl 2005; 8:334-336.
6. Mirza M, Baher Nik Z, Dini M. Chemical composition of the essential oils of *Astrodaucus orientalis* (L.) Drude leaves and seeds. Flavour Fragr J 2003; 18:205-206.
7. Mazloomifar H, Bigdeli M, Saber-Tehrami M, Rustaiyan A, Masoudi Sh. Essential oil of *Astrodaucus orientalis* (L.) Drude. J Essential Oil Res 2013; 15:254-256.
8. Abdolmohammadi MH, Fouladdel Sh, Shafiee A, Amin Gh, Ghaffari SM, Azizi E. Anticancer effects and cell cycle analysis on human breast cancer T47D cells treated with extracts of *Astrodaucus persicus* (Boiss.) Drude in comparison to doxorubicin. Daru 2008; 16:112-118.
9. Azizi E, Abdolmohammadi MH, Fouladdel Sh, Shafiee A, Amin Gh, Ghaffari SM. Evaluation of p53 and Bcl-2 genes and proteins expression in human breast cancer T47D cells treated with extracts of *Astrodaucus persicus* (Boiss.) Drude in comparison to Tamoxifen. Immunocytochemistry. Daru 2009; 17:181-186.
10. Abdolmohammadi MH, Fouladdel Sh, Shafiee A, Amin Gh, Ghaffari SM, Azizi E. Antiproliferative and apoptotic effect of *Astrodaucus orientalis* (L.) Drude on T47D human breast cancer cell line: Potential mechanisms of action. Afr J Biotechnol 2009; 8:4265-4276.
11. Razavi SM, Imanzadeh G, Doluti S, Nejad-Ebrahim S, Majrouhi AA, Zahi S, et al. Phytochemical prospection and biological activity of *Astrodaucus orientalis* (L.) Drude growing wild in Iran. Pharmacologica 2011; 2:299-303.
12. Soltani J, Alibadi A. Antibacterial effects of several plant extracts and essential oils on *Xanthomonas arboricola pv. juglandis* in vitro. J Essent Oil Bear Plant 2013; 16:461-468.
13. Adams RP. Identification of essential oil components by gas chromatography/ quadrupole mass spectroscopy. Allured Publishing Co. Carol Stream Illinois USA; 2001.
14. Massada Y. Analysis of essential oil by gas chromatography and spectrometry. Wiley, New York, USA; 1976.
15. Yassa N, Razavi Bani H, Hadjikjooondi A. Free radical scavenging and lipid peroxidation activity of Shahany black grape. Pak J Biol Sci 2008; 11:1-4.
16. Benzie IFF, Strain JJ. Ferric reducing ability of plasma (FRAP) as a measure of antioxidant power: The FRAP assay. Anal Biochem 1996; 239:70-76.
17. Jafari S, Moradi A, Salaritabar A, Hadjikjooondi A, Kehanvi M. Determination of total phenolic and
flavonoid contents of *Leonurus cardiaca* L. in compare with antioxidant activity. Res J Biol Sci 2010; 5:484-487.
18. Noghogne LR, Gating1 D, Fotso, Kodjio N Sokoudjou JB, Kuiate JR. *In vitro* antisalmonellal and antioxidant properties of *Mangifera indica* L. stem bark crude extracts and fractions. Br J Pharm Res 2015; 5:29-41.
19. Plattner PL, Magyar G. Zur Kenntnis der Sesquiterpene. Abbau des Dihydroguajols mit Chromsäure. Bereitung des 1,4,7-Trimethyl-azulens. Helv chim Acta 1942; 25:581-589.
20. Beadle GW, Brauns FE, Deulofeu V, Doudoroff M, Fox DL, Geiger E. et al. Progress in the Chemistry of Organic Natural Products. Springer-Verlag, Vienna Austria: 1948.
21. Coruh N, Sagdioglu Celep AG, Ozgokce F. Antioxidant properties of *Prangos ferulacea* (L.) Lindl., *Chaerophyllum macropodum* Boiss. and *Heracleum persicum* Desf. from Apiaceae family used as food in eastern Anatolia and their inhibitory effects on glutathione-s-transferase. Food Chem 2007; 100:1237-1242.
22. Plazonic A, Mornar A, Males Z, Kujundzic N. Phenolic content and antioxidant activities of Burr Parsley (*Caucalis platycarpos* L.). Molecules 2013; 18:8666-8681.
23. Saeed N, Khan MR, Shabbir M. Antioxidant activity, total phenolic and total flavonoid contents of whole plant extracts *Torilis leptophylla* L. BMC Complement Alt Med 2012; 12:221-233.
24. Cadiz-Gurrea M, Fernandez-Arroyo S, Joven J, Segura-Carretero A. Comprehensive characterization by UHPLC-ESI-Q-TOF-MS from an *Eryngium bourgatii* extract and their antioxidant and anti-inflammatory activities. Food Res Int 2013; 50:197-204.
25. Surveswaran S, Cai YZ, Corke H, Sun M. Systematic evaluation of natural phenolic antioxidants from 133 Indian medicinal plants. Food Chem 2007; 102:938-953.
26. Rebey IB, Zakhama N, Karoui IJ, Marzouk B. Polyphenol composition and antioxidant activity of Cumin (*Cuminum Cyminum* L.) seed extract under drought. J Food Sci 2012; 77:734-739.
27. Maulidiani, Abas F, Khatib A, Shaari K, Lajis NH. Chemical characterization and antioxidant activity of three medicinal Apiaceae species. Ind Crops Prod 2014; 55:239-247.