Composition and Radical Scavenging Activity of Edible Wild Pulicaria jaubertii (Asteraceae) Volatile Oil

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Abstract

The objectives of this work were to determine chemical composition and evaluate the radical scavenging activity (RSA) of P. jaubertii volatile oil from outskirs of Sana’a city (PjSO), as well as RSA of P. jaubertii volatile oil from Haja Province (PjHP), Yemen. The composition of PjSO volatile oil was described by infra-red (IR) spectroscopy and gas chromatography/mass spectrometry (GC/MS). RSA of investigated oils were estimated, using spectrophotometric DPPH (2,2’-diphenyl-1-picrylhydrazyl) method. A total of sixteen components, which represent 99.98% of the total composition of PjSO oil, were identified. GC/MS analysis showed that the dominant component of PjOS oil is carvotanacetone (98.34%). The carbonyl group of carvotanacetone was identified from the IR spectrum by the appearance of absorption band at ~1700 cm⁻¹. The obtained analytical data showed that the PjSO essential oil possess 1.3% (v/w) oil content. This indicated that the PjSO essential oil has a commercial potential for production of carvotanacetone. Furthermore, RSA results indicated that PjSO essential oil has a higher RSA in comparison with that of PjHP oil and slightly higher than that of ascorbic acid at higher concentrations. Our finding reveals that PjSO oil could serve as safe natural alternative for synthetic antioxidants in food and pharmaceutical industries.

Keywords: Pulicaria jaubertii, volatile oil composition, radical scavenging activity, carvotanacetone.

INTRODUCTION

Pulicaria genus (Asteraceae), includes more than 80 species that occur throughout the world from Europe to North Africa and Asia (Williams et al., 2003). Arange of biological activities have been reported for some species of Pulicaria, like anti-inflammatory, antilukemic (Al-Yahya et al., 1984), potential anticancer chemo-preventive activity (Al-Yahya et al., 1988), cytotoxic activity (Al-Yahya et al., 1988; Ali et al., 2001; Fawzy et al., 2013), antibacterial activity (Fawzy et al., 2013; Hanbali et al., 2005; Ali et al., 2012; Al-Fatimi et al., 2015; Al-Naqeb, 2015), antioxidant [Al-Fatimi et al., 2015; Al-Naqeb, 2015; Algabr et al., 2010], antihistaminic (Mahfouz et al., 1973), antispasmodic activity (Tanira et al., 1996) and antifungal activity (Znini et al., 2013). In Morocco, Pulicaria odor L. is commonly used as a traditional cure to treat back-pain, intestinal disorders and menstrual cramps. It is also described to women after childbirth, as a component of the traditional remedy called “Mssakhen” (Ezoubeiri et al., 2005).

Despite its long historic uses, the chemical information of this plant is limited. The previous chemical analysis studies of essential oils of the genus species have reported the occurrence of acetylenic compounds (Schulte et al., 1968), monoterpenes (Hanbali et al., 2005; Hichri et al., 2009), sesquiterpenes (San Feliciano et al., 1989; Mossa et al., 1992; Dendougui et al., 2000; Aberkane et al., 2007; Ghouila et al., 2008; Stavri et al., 2008), a variety of sesquiterpene lactones (Hichri et al., 2009; Abdel-Mogib et al., 1990; Rustaiyan et al., 1991), diterpenes (Hichri et al., 2009; Abdel-Mogib et al., 1990; Das et al., 2005), sterol glycoside (Ghouila et al., 2008), flavonoids (Williams et al., 2003; Abdel-Mogib et al., 1989; Algabr et al., 2015), phenolic compounds (Ezoubeiri et al., 2005; San Feliciano et al., 1989) and derivatives of canophyllane (Basta et al., 2007).

Pulicaria jaubertii is an aromatic wild plant. It is known as “Eter Elraee” in Arabic (Fawzy et al., 2013), Anssif, Khawa and Mashmum in Sana’a, Taiz and Aden Provinces (in Yemen) respectively. In South Yemen Provinces, this plant with basil (Ocimum basilicum) and Shadab (Ruta chalepensis) is believed to be predominantly a defence
mechanism against devils, pathogens and pests in childbirth and wedding occasions. It is used in folk medicine as diuretic, and as treatment for fever, urogenetic organs and pyritic conditions. For its flavour, It is agreeable as a spice, It is also used to perfume bread, soup and meat. Published studies from Saudi Arabia and Yemen documented that P. jaubertii show antimicrobial, antimalarial and insecticide properties (Dubaie and El-Khulaidi, 2005; Fawzy et al., 2013).

The objectives of this study were to determine the content, describe composition and to estimate RSA of the volatile oil of wild P. jaubertii which grown in Sana’a outskirts (PjSO), Yemen, as well as to determine the content and to evaluate RSA of the volatile oil of P. jaubertii from Hajja Province (PjHP), Yemen. Finally, and according to the best of our knowledge, there are very few of chemical and biological studies, which have been done previously on the volatile oil of Pulicaria jaubertii (Asteraceae) grown in Yemen, whether those grown in southern Yemen (Al-Fatimi et al., 2015) or those that were grow in northern Yemen [270 km northwest of Sana’a] (Algabr et al., 2010; Algabr et al., 2012).

MATERIALS AND METHODS

Plant material

The plant samples (leaves, flowers and stems) of Pulicaria jaubertii collected in Feb. & Mar. 2014, from Hadda area, Sana’a outskirts, and Aljar area of Hajja Province (270 km northwest of Sana’a), Yemen. Their identification was clarified by Dr/ H. Ibrahim, the staff member of Plant Taxonomy Unit, Department of Biology, Faculty of Science, Sana’a University, Yemen, and according to Dubaie and El-Khulaidi, (2005). Voucher specimens have been deposited under the numbers Bot.Kh725a and Bot.Kh725b correspondingly, in the herbarium of the Department of Biology, Faculty of Science, Sana’a University, Sana’a, Yemen. Fresh herb of aerial parts (leaves, flowers and stems) of both plants were cut into small pieces and left to dry on the laboratory benches at room temperature (23–27 °C) for 15 days. The dried plant materials were ground into fine powder using a mortar and pestle, then subjected to hydro distillation.

Volatile oils extraction

The fine powder of the dried plant material of PjSO (300 g) and PjHP (300 g) were separately hydro distilled for 3 hours using modifier Clevenger apparatus. Volatile oil extracts of PjSO and PjHP were dried separately over anhydrous sodium sulphate and then filtered off through Whatman filter paper (number 1). The purified volatile oil extracts were stored in dark at 4 °C.

Volatile oils analysis

IR analysis

The FT-IR spectrum of the neat (undiluted) essential oil of P. jaubertii (PjSO) was recorded on a Shimadzu-FTIR-410 Spectrometer (Japan) in the range 500 to 4000 cm⁻¹. The spectra were obtained by means of sodium chloride (NaCl) plate technique by placing a few drops of oil between the optically polished plates of sodium chloride that are placed in the light beam. The spectrum was plotted as intensity versus wave number (cm⁻¹).

GC/MS analysis

Gas chromatography/mass spectrometry (Electron impact) analysis of the studied volatile oil was achieved by Shimadzu gas chromatography. Gas chromatography was equipped with DB-5 wax cross–linked fused silica capillary column (30 m long × 0.25 mm internal diameter) covered with film thickness (0.5μm) of polydimethylsiloxane. Temperature of the oven was automatic, from 40 °C for three minutes with an increase of 4 °C/min to 250 °C and isothermally for 10 minute at 250 °C. Injections were performed with injector temperature of 200 °C and ion source temperature rest at 250 °C. The injection volume was 1 μL of the oil. Flow rate of a carrier gas (Helium), was fixed at 1 mL/minute. The type of mass spectrometer was an electron impact (EI) (70 eV), computerized from m/e 40 to m/e 500. Retention indices were calculated using standards n-alkanes (C₅-C₃₀) and then compared with the data available in literature (Adams, 1995).

Assay of radical scavenging activity

Radical scavenging activity (RSA) of the volatile oils of P. jaubertii (PjSO and PjHP) was estimated by the spectrophotometric DPPH assay method (Đorđević et al., 2007). The stable radical 2,2’-diphenyl-1-picrylhydrazyl (DPPH) was used to estimate the electron donation ability of the investigated volatile oils by measuring their ability to reduce DPPH radicals (deep purple) into the neutral nonradical form (pale yellow). The control solution (DPPH solution) and six samples of increasing concentrations of the volatile oils were prepared by diluting 0, 10, 20, 40, 60, 80 and 100 μg of each volatile oil with methanol to a total volume of 1 mL. To each sample, 2 mL of 90 μM solution of DPPH was added. Samples mixtures were incubated for one hour period at room temperature and after that, the absorbance of investigated samples were read against the absorbance of the control solution at 517 nm. A parallel RSA assay on ascorbic acid with the same set of concentrations was also performed. Inhibition percent of DPPH radical (I %) was calculated as I % = 100 (A° − A)/A° (Bhatt and Negi, 2012), where A° is the absorbance of the control solution (DPPH solution) and A is the absorbance of individual investigated samples. The test was carried out in triplicate.
RESULTS

Volatile oils content

Based on the dry plant weight of sample, the aerial part (flowers, leaves and stems) of Pulicaria jaubertii (Asteraceae) Gamal-Eldin (PjSO and PjHP), yielded 1.34% and 0.18% (v/w) oils content, respectively. Pale yellow volatile oils with a distinguishing perfumed aroma, were obtained.

Volatile oils analysis

GC/MS analysis

A total of eighteen chemical components with retention time between 12.76 and 34.40 minutes were recognized in the gas chromatogram of PjSO volatile oil (Figure 1). Sixteen of these components, which represent 99.98% of the total composition were quantified and identified. These components are listed in Table 1 along with their retention time (RT), composition percentage (%), and their calculated retention indices (RI) values as well as the corresponding RI values from literature.

IR analysis

The FTIR spectrum of P. jaubertii (PjSO) volatile oil (Figure 2) was recorded in the region (500 - 4000 cm⁻¹). It showed a band (medium & sharp) at 3020 cm⁻¹ and some bands (medium & sharp) at 2965-2850 cm⁻¹. Single absorption band (strong & sharp) at ~1700 cm⁻¹, a band (weak & sharp) at ~1600 cm⁻¹, two equivalent bands (weak & sharp) at 1380 cm⁻¹ and 1360 cm⁻¹ and some broad and sharp bands in the range from ~750 to ~670 cm⁻¹ were also observed in IR spectrum of PjSO volatile oil.

Radical scavenging activity

Both volatile oils of P. jaubertii (PjSO and PjHP) were screened for their possible Radical scavenging activity (RSA). Results of RSA of both P. jaubertii volatile oils in addition to L-ascorbic acid were tabulated (Table 2). Data were expressed as means ± S.D.

Growth location influence

The effect of plant growth location on the chemical composition and volatile oil content was recorded (Table 3). It showed a comparison between the composition and the volatile oil content of PjSO (current study) and those of the volatile oil of PjHP (Algabr et al., 2012). Furthermore, results of the effect of plant growth location on the RSA of both oils were recorded (Table 2).

Table 1. Volatile oil components of wild P. jaubertii grown in Hadda area of Sana'a province (Sana'a outskirts), Yemen.

<table>
<thead>
<tr>
<th>NC</th>
<th>CC</th>
<th>RT (min.)</th>
<th>CP (%)</th>
<th>CRI</th>
<th>LRR</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>1,8-Cineole</td>
<td>12.76</td>
<td>0.01</td>
<td>1032</td>
<td>1033</td>
</tr>
<tr>
<td>2</td>
<td>trans-Linalool oxide</td>
<td>14.42</td>
<td>0.02</td>
<td>1083</td>
<td>1088</td>
</tr>
<tr>
<td>3</td>
<td>Chrysanthene none</td>
<td>16.45</td>
<td>0.42</td>
<td>1121</td>
<td>1123</td>
</tr>
<tr>
<td>4</td>
<td>Camphor</td>
<td>16.96</td>
<td>0.01</td>
<td>1145</td>
<td>1143</td>
</tr>
<tr>
<td>5</td>
<td>Carvomenthone</td>
<td>18.99</td>
<td>0.09</td>
<td>1177</td>
<td>1181</td>
</tr>
<tr>
<td>6</td>
<td>p-Menth-1(7)-en-2-one</td>
<td>21.20</td>
<td>0.72</td>
<td>1236</td>
<td>1238</td>
</tr>
<tr>
<td>7</td>
<td>Carvotanacetone</td>
<td>21.81</td>
<td>98.34</td>
<td>1248</td>
<td>1246</td>
</tr>
<tr>
<td>8</td>
<td>Thymol</td>
<td>22.69</td>
<td>0.11</td>
<td>1298</td>
<td>1290</td>
</tr>
<tr>
<td>9</td>
<td>Carvacrol</td>
<td>23.22</td>
<td>0.01</td>
<td>1295</td>
<td>1298</td>
</tr>
<tr>
<td>10</td>
<td>Ascaridole epoxide</td>
<td>23.32</td>
<td>0.01</td>
<td>1305</td>
<td>-----</td>
</tr>
<tr>
<td>11</td>
<td>Z, 4-Dimethoxy-3-methylacetophenone</td>
<td>23.46</td>
<td>0.01</td>
<td>1312</td>
<td>1312</td>
</tr>
<tr>
<td>12</td>
<td>Methyl eugenol</td>
<td>25.94</td>
<td>0.06</td>
<td>1398</td>
<td>1401</td>
</tr>
<tr>
<td>13</td>
<td>(E)-γ-Methylionone</td>
<td>26.70</td>
<td>0.09</td>
<td>1481</td>
<td>1479</td>
</tr>
<tr>
<td>14</td>
<td>β-Bisabolene</td>
<td>28.38</td>
<td>0.02</td>
<td>1507</td>
<td>1509</td>
</tr>
<tr>
<td>15</td>
<td>Geranyl isobutyrate</td>
<td>28.53</td>
<td>0.03</td>
<td>1519</td>
<td>1514</td>
</tr>
<tr>
<td>16</td>
<td>Unknown</td>
<td>31.02</td>
<td>0.01</td>
<td>1573</td>
<td>-----</td>
</tr>
<tr>
<td>17</td>
<td>β-Caryophyllene oxide</td>
<td>31.27</td>
<td>0.01</td>
<td>1584</td>
<td>1581</td>
</tr>
<tr>
<td>18</td>
<td>Unknown</td>
<td>34.40</td>
<td>0.01</td>
<td>1616</td>
<td>-----</td>
</tr>
</tbody>
</table>

Notes: aNumbers of components. bChemical components which are arranged based on their elution from a DB-5 column. cRetention time in minute. dComposition percentage. eRetention indices. fCalculated retention indices relative to C5-C30 n-alkanes. gLiterature retention indices (Adams, 1995; Algabr et al., 2012; Fawzy et al., 2013).
Fig. 1. Gas chromatogram of volatile oil of wild *P. jaubertii* grown in Hadda area of Sana'a province (Sana'a outskirts), Yemen.

Fig. 2. FTIR Spectrum of volatile oil of wild *P. jaubertii* grown in Hadda area of Sana'a province (Sana'a outskirts), Yemen.
TABLE 2. Radical scavenging activities of volatile oils of wild PjSO and PjHP, Yemen against stable radical DPPH.

<table>
<thead>
<tr>
<th>SC (μg/ml)</th>
<th>A' at 517 nm</th>
<th>RSA^b %</th>
<th>PjSO</th>
<th>PjHP</th>
<th>A at 517 nm</th>
<th>RSA %</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>0.4308</td>
<td>0.4308</td>
<td>0.00</td>
<td>0.00</td>
<td>0.4308</td>
<td>0.00</td>
</tr>
<tr>
<td>10</td>
<td>0.2210 ± 0.0031</td>
<td>0.3194 ± 0.0025</td>
<td>48.70 ± 0.72</td>
<td>25.86 ± 0.58</td>
<td>0.0386</td>
<td>91.04</td>
</tr>
<tr>
<td>20</td>
<td>0.1028 ± 0.0026</td>
<td>0.2341 ± 0.0038</td>
<td>76.14 ± 0.61</td>
<td>45.66 ± 0.88</td>
<td>0.0380</td>
<td>91.18</td>
</tr>
<tr>
<td>40</td>
<td>0.0631 ± 0.0034</td>
<td>0.1583 ± 0.0023</td>
<td>85.35 ± 0.79</td>
<td>63.25 ± 0.53</td>
<td>0.0377</td>
<td>91.25</td>
</tr>
<tr>
<td>60</td>
<td>0.0529 ± 0.0017</td>
<td>0.1453 ± 0.0018</td>
<td>87.72 ± 0.39</td>
<td>66.27 ± 0.42</td>
<td>0.0350</td>
<td>91.88</td>
</tr>
<tr>
<td>80</td>
<td>0.0432 ± 0.0019</td>
<td>0.1298 ± 0.0027</td>
<td>89.97 ± 0.44</td>
<td>69.87 ± 0.63</td>
<td>0.0341</td>
<td>92.08</td>
</tr>
<tr>
<td>100</td>
<td>0.0283 ± 0.0015</td>
<td>0.1213 ± 0.0022</td>
<td>93.43 ± 0.35</td>
<td>71.84 ± 0.51</td>
<td>0.0336</td>
<td>92.20</td>
</tr>
</tbody>
</table>

Notes: ^aSample concentration (volatile oils & ascorbic acid). ^bData were expressed as means ± S.D. ^cAbsorbance. ^dRadical scavenging activity. ^ePulicaria jaubertii from Sana’a Outskirts. ^fPulicaria jaubertii from Hajja Province.

Table 3. The influence of growth location on volatile oils composition of P. jaubertii from two different locations in Yemen.

<table>
<thead>
<tr>
<th>Chemical profile and volatile oils content</th>
<th>Growth location effect on chemical profile and content of volatile oil of P. jaubertii</th>
</tr>
</thead>
<tbody>
<tr>
<td>Oxygenated Monoterpenes</td>
<td>PjSO^a (Present study)</td>
</tr>
<tr>
<td>Main (%) Component</td>
<td>Component 7, representing 98.34% of the total components</td>
</tr>
<tr>
<td>ROMT (%)</td>
<td>Component 7, representing 63.96</td>
</tr>
<tr>
<td>Phenolic and Aromatic Components (%)</td>
<td>Eight components, representing 1.31</td>
</tr>
<tr>
<td>Sesquiterpene Hydrocarbons (%)</td>
<td>Four components, representing 0.19</td>
</tr>
<tr>
<td>Oxygenated Sesquiterpenes (%)</td>
<td>One component representing 0.02</td>
</tr>
<tr>
<td>Others (%)</td>
<td>Ionone, representing 0.09</td>
</tr>
<tr>
<td>Detected Components</td>
<td>18 Components, representing 100% of the total components</td>
</tr>
<tr>
<td>Identified Components</td>
<td>16 Components, representing 99.98% of the total components</td>
</tr>
<tr>
<td>Unknown Components</td>
<td>2 Components, representing 0.02% of the total components</td>
</tr>
<tr>
<td>Oil Content (v/w%)</td>
<td>1.34</td>
</tr>
</tbody>
</table>

Notes: ^aPulicaria jaubertii from Sana’a Outskirts. ^bPulicaria jaubertii from Hajja Province. ^cAlgabr et al., 2012

DISCUSSION

GC/MS analysis showed that the dominant component (98.34%) is the oxygenated monoterpene carvotanacetone whereas, the remaining oxygenated monoterpenes (eight components), four aromatic compounds (including phenolic compounds), one ionone, one sesquiterpene hydrocarbons and an oxygenated sesquiterpene are found in trace amounts (1.31%, 0.19%, 0.09%, 0.02% and 0.01%), respectively. GC/MS analysis results revealed that the volatile oil of P. jaubertii (PjSO) has a commercial potential for the production of oxygenated monoterpene carvotanacetone. Each one of the chemical components of PjSO volatile oil, was quantified by GC and identified by comparing their mass fragmentation with analogous spectral data from a data already available in the GC/MS computer libraries (NIST and Wiley libraries) as well as by matching their calculated retention indices (RI) with the reported RI values considered on the same columns polarities (Adams, 1995).
With respect to chemical composition of volatile oil extract of *P. jaubertii*, from Jazan, South of Saudi Arabia (Fawzy *et al.*, 2013), Aljar area of Haja province, North Yemen (270 km west Sana’a) (Algabr *et al.*, 2012) and Lahj province, South Yemen (Al-Fatimi *et al.*, 2015), the presence of about 53 volatile constituents, including oxygenated monoterpenes (as major group), in addition to traces amount of monoterpenic hydrocarbon, sesquiterpene hydrocarbons as well as oxygenated sesquiterpenes, were previously reported and indicate that the oxygenated monoterpenic carvotanacetone is the main components (98.59%, 64.0% and 93.5%, respectively). The presence of carvotanacetone as main component, has been also recorded in volatile oils of *Pulicaria undulate* from South Yemen (91.4%) and Sudan (55.87%) (Ali *et al.*, 2012; El-Kamali *et al.*, 2009), *P. mauritanica* from Morocco (87.3%) (Cristofari *et al.*, 2011) and *P. inuloides* from North Yemen (47.3%) (Al-Hajj *et al.*, 2014).

Results of previously published works and the results of GC/MS analysis of our study, reveal that the volatile oil from *PjSO* (present study), containing a quantity of carvotanacetone (98.34%), similar to the far end those of the quantity, which found in the volatile oil of *P. jaubertii* leaves from southern Saudi Arabia (98.6%), higher than those amount of oil from *PjHP* (64.0%) (Algabr *et al.*, 2012) and the highest quantity among those which present in volatile oils of Yemeni *Pulicaria*.

A useful step in the analysis of IR spectrum is to look for any absorption bands in the region of stretching vibration (~4000 - 1500 cm\(^{-1}\)). Characteristic absorption bands were assigned in the IR spectrum of volatile oil of *PjSO* by simple check and attribution to extensive charts of distinctive group frequencies. IR spectral analysis results of the *PjSO* volatile oil, reveal the presence of mainly oxygenated terpenes (mono- and/or sesquiterpene), with feature structure containing carbonyl group. However, absorption band at ~1700 cm\(^{-1}\) was detected in IR spectrum of *PjOS* volatile oil. This band is characteristic to carbonyl groups of \(\alpha,\beta\)-unsaturated ketone (carvotanacetone). The conjugation between \(\text{C} = \text{C}\) and \(\text{C} = \text{O}\) groups in such compounds, reduces the double-bond character of carbonyl group. This electronic effect cause the appearance of this absorption band at ~1700 cm\(^{-1}\) instead of 1720 cm\(^{-1}\) (normal position of \(\text{C} = \text{O}\) of ketone). The presence of components with \(\text{C} = \text{C}\) bonds in the volatile oil was indicated by a band (weak & sharp) at ~1600 cm\(^{-1}\), whereas the two equivalent bands (weak & sharp) at 1380 cm\(^{-1}\) and 1360 cm\(^{-1}\) were attributed to isopropyl group of monoterpenes.

On the other hand, the presence of a band at 3020 cm\(^{-1}\) and some bands at 2965-2850 cm\(^{-1}\) indicated that the oil contain a component that is hydrogen bonded to sp2 carbons, and hydrogen bonded to sp3, respectively, but none with hydrogen bonded to sp carbons were observed. Finally, the appearance of some broad and sharp bands in the range from ~750 to ~670 cm\(^{-1}\) indicated that the stereo configuration of \(\text{C} = \text{C}\) is cis configuration.

RSA can be considered as a measure of the ability of investigated sample or one of its components to act as “radicals scavengers”. The relationship between therapeutic action(s) of plant volatile oil extract and the existence of chemical components (in this extract) with structural feature containing characterize functional group(s), were previously documented. RSC was found to be correlated to the presence of mainly monoterpen ketones, epoxides and aldehydes (Nikšić *et al.*, 2012). In addition, Ezoubeiri *et al.*, (2005), reported that the structural feature required for a strong RSA and antimicrobial activity are those containing phenolic groups.

However, the presence of the oxygenated monoterpenic carvotanacetone (\(\alpha,\beta\)-unsaturated ketone), as the main component of the volatile oils of *PjOS* (98.34%) and *PjHP* (64%), encourage us to evaluate RSA (experimentally in vitro) of the investigated volatile oils.

This is in order to confirm this relationship and to support that the consumption of food produced with natural volatile oils or aromatic plant extracts is expected to be cure, retard the hazard of diseases caused by free radical (Alejandro *et al.*, 2011). In addition, to find out the actual reasons for traditional uses of fresh or dried leaves of *P. jaubertii* with milk and certain kind of bread to make delicious traditional daily meal called Shafoot and to verify whether the traditional uses of this plant is actually useful for fortified human body from diseases caused by free radical.

Recorded results in Table 2 revealed that the investigated volatile oil of *P. jaubertii* (*PjOS*), showed high RSA as revealed by its ability to reduce violet DPPH radicals form into the yellow neutral form.

Based on the recorded results in Table 2 and according to the information from the literature syrvey, it is logic to conceive that the RSA of the investigated volatile oils of the medicinal aromatic plant *PjSO* and *PjHP*, could be mostly correlated to the presence of the monoterpen ketone (carvotanacetone). So, it’s reasonable to hypothesize that this oxygenated monoterpen is a potent antioxidant “radical scavengers” (Niksic *et al.*, 2012).

The activities of the volatile oils are well comparable to that of ascorbic acid, which is known for its uses as a natural antioxidant. The results of RSA of the volatile oil of *P. jaubertii* (*PjSO*) showed that this extract has a higher radical scavenging activity in comparison with that of the volatile oil of *P. jaubertii* (*PjHP*), which has a significant activity. On the other hand, the obtained results reveal that the RSA of the volatile oil of *PjSO* (particularly at the higher concentration), is slightly higher than that of ascorbic acid (vitamin C). These results are directly connected to the quantitative difference of both volatile oils compositions, especially their diversity in the relative amount of their main constituent (carvotanacetone).

These results also indicate that the volatile oil of *PjSO* should act as “radicals scavengers”, therefore, could serve as safe natural alternative for synthetic antioxidants in food and pharmaceutical industries.
Natural antioxidants, especially those found in antioxidant-rich plant extracts, are of key importance in health and protection against diseases. They delay lipids oxidation and for this reason, they are used in food industry to improve the quality of food (Kamkar et al., 2013).

A significant influence of growth location was observed on composition and volatile oils content of P. jaubertii (PjSO and PjHP). Qualitative and quantitative aspects of the two profiles are different (Table 3), except for the occurrence of components 7 (main constituent), 8, 9, 14 and 17. Significant differences were also seen in the numbers of detected and identified components. Volatile oils of PjSO and PjHP were differed particularly with regard to the composition percentage of the oxygenated monoterpene carvotanacetone (98.34% and 63.96%), respectively. This variation in the relative amounts of the main constituent of both volatile oils (Table 2) could be the reason for the variation in their RSA (Table 2) and this indicates that the oxygenated monoterpene carvotanacetone is the component responsible for RSA of both volatile oils.

Literature review reveals that the diversity of the volatile oils composition of Pulicaria species and the variation among their main constituent percentage are linked to their growth locations. For example, composition analysis of volatile oil of Iranian P. undulate (Nematollahi et al., 2006), showed the dominance of the oxygenated monoterpenes α-pinene (45.7%) and 1,8-cineol (27.1%), whereas, the main constituent of the volatile oils of P. undulate growing in either Sudan or Yemen is carvotanacetone, but with different yield percentages (55.8% and 91.4%), respectively (Ali et al., 2012).

CONCLUSION

This study showed that the volatile oil composition of PjSO is characterized by the presence of carvotanacetone as the main constituent, whose concentration is higher than that found in several other Pulicaria species and thus, the investigated volatile oil of PjSO has commercial potential for production of oxygenated monoterpene carvotanacetone. Furthermore, RSA results indicate that PjSO volatile oil has a higher RSA in comparison with that of PjHP volatile oil and slightly higher than that of ascorbic acid at higher concentrations. The present work found that PjSO volatile oil could serve as safe natural alternative for synthetic antioxidants in food and pharmaceutical industries.

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CONFLICT OF INTEREST

The authors declare that this article content has no conflict of interest.

REFERENCES


