Phytochemical Contents of Five Artemisia Species

Murat KURSAT1*, Irfan EMRE2, Okkeş YILMAZ3, Semsettin CIVELEK3, Ersin DEMIR4, Ismail TURKOGLU5

1Bile Eren University, Faculty of Sciences and Arts, Department of Biology, Bile, 13000, Turkey; hotmailkurssat@hotmail.com (*corresponding author)
2First University, Faculty of Education, Department of Primary Education, 23119 Elazig, Turkey
3First University, Faculty of Sciences and Arts, Department of Biology, 23119 Elazig, Turkey
4Duzce University, Faculty of Agriculture and Natural Sciences, Duzce, Turkey
5First University, Faculty of Education, Department of Secondary Science and Mathematics Education, 23119 Elazig, Turkey

Abstract

In the present study, the fatty acid compositions, vitamin, sterol contents and flavonoid constituents of five Turkish Artemisia species (A. armeniaca, A. incana, A. tournefortiana, A. haussknechtii and A. scoparia) were determined by GC and HPLC techniques. The results of the fatty acid analysis showed that Artemisia species possess high saturated fatty acid compositions. On the other hand, the studied Artemisia species were found to have low vitamin and sterol contents. Eight flavonoids (catechin, naringin, rutin, myricetin, morin, naringenin, quercetin, kaempferol) were determined in the present study. It was found that Artemisia species contained high levels of flavonoids. Morin (45.35 ± 0.65 – 1406.79 ± 4.12 μg/g) and naringenin (15.32 ± 0.46 – 191.18 ± 1.22 μg/g) were identified in all five species. Naringin (268.13 ± 1.52 – 226.43 ± 1.17 μg/g) and kaempferol (21.74 ± 0.65 – 262.19 ± 1.38 μg/g) contents were noted in the present study. Present research showed that the studied Artemisia taxa have high saturated fatty acids and also rich flavonoid content.

Keywords: Artemisia, fatty acid, flavonoid, sterol, vitamin

Introduction

Asteraceae L. is the largest genus in the tribe Anthemideae of the Asteraceae, which comprises 400-500 species (Martin et al., 2001; Kreitschiz and Valles, 2007). Most of these species grow wild in dry or semi-dry habitats throughout the Northern regions of the world (Torrell and Valles, 2001; Valles et al., 2003; Singh et al., 2009). The genus is composed of perennial, biennial and annual herbs or small shrubs, which are frequently aromatic (Kordali et al., 2005; Kursat, 2010). There are 23 Artemisia species in the flora of Turkey, which are distributed throughout the country (Davis, 1975).

In the traditional herbal medicine, aerial parts of Artemisia are being used for its anti-malarial, antimicrobial, antioxidant, antifungal, anticholesterolemic, antidiabetic, antihelmintic, antiseptic, antitumor, antipyretic and antispasmodic effects (Chopra et al., 1992; Koul, 1997; Cimbiz et al., 2005; Han et al., 2007; Temraz and El-Tantawy, 2008; Sengul et al., 2011; Aşfar et al., 2013). Several studies showed that polyphenols, flavonoids, cinnamic acid derivatives and coumarines were found in Artemisia species (Esteban et al., 1986; Rauter et al., 1989; Mojarrab et al., 2011; Afşar et al., 2012; Suresh et al., 2012). Plant phenolics are widespread natural compounds and are probably responsible for the antioxidant activity by their hydroxyl groups, and thus have the ability to neutralize free radicals (Fukumoto and Mazza, 2000; Ruikar et al., 2011; Bandli and Heidari, 2014).

Natural and cultivated Turkish herbs are being more widely used on a commercial scale in the food industry and in traditional medicine (Baytop, 1999; Erdemoglu et al., 2007). To support the use of herbal medicine and to detect their potential as possible drugs it is necessary to work medicinal plants (Sengül et al., 2011). The aim of the present study was to establish possible medicinal properties of some Artemisia species by determining the fatty acid compositions, vitamin and sterol contents, flavonoid constituents of aerial parts, of five Artemisia species growing in Turkey.

Materials and Methods

Chemicals

All chemicals, solvents and standards were purchased from Sigma-Aldrich-Fluka (Taufkirchen, Germany) or Merck (Darmstadt, Germany).

Plant materials

The present study examined plant extracts of five Artemisia species: A. armeniaca Lam., A. incana (L.) Druce, A. tournefortiana Reichb., A. haussknechtii Boiss. and A. scoparia Waldst. & Kit. Sample plants were collected from their natural habitats. Details about the plant materials are shown in Table 1. Voucher specimens of studied plants were deposited at the Herbarium of Firat University (FUH). All experiments were performed in triplicate.
Extraction of plant oils
Two g aerial parts of plant material were finely grounded in a mill and were then extracted with n-hexane/isopropanol (3:2 v/v) (Hara and Radin, 1978). The lipid extracts were centrifuged at 10,000 rpm for 5 min and filtered; the solvent was then removed on a rotary evaporator at 40 °C. The extracted lipids were stored under -25 °C until further analysis.

Fatty acid analyses
Fatty acid in the lipid extracts were converted into methyl esters by means of 2% sulphuric acid (v/v) in methanol (Christie, 1990). The fatty acid methyl esters were extracted with n-hexane. The methyl esters were then separated and quantified by gas chromatography and flame-ionization detection (Shimadzu GC17 Ver.3) coupled to a CLASS GC 10 software computer software. Chromatography was performed with a capillary column (0.25 mm in diameter, Permabound 25, Macherey-Nagel, Germany) using nitrogen as a carrier gas (flow rate 0.8 ml/min). The temperatures of the column, detector and injection valve were 130-220, 240 and 280 °C, respectively. Identification of the individual methyl esters was performed by frequent comparison with authentic standard mixtures that were analysed under the same conditions. Retention time for studied Artemisia species was determined as 3.34 min - A. armeniaca, 3.81 min - A. incana, 9.47 min - A. tauzenta, 17.40 min - A. hausknetchitii, 1.41 min - A. soparia.

Chromatographic analysis and quantification of lipid soluble vitamins and sterols
Lipide-soluble vitamins and phytosterols were extracted from the lipid fraction by the method of Sánchez-Machado (Sánchez-Machado et al., 2002) with minor modifications. The extracted lipids of plant material were dissolved in acetonitrile/methanol (75/25 v/v) and the elution was performed at a flow-rate of 1 ml/min. The temperature of analytical column was kept at 40 °C. Detection was performed at 320 nm for retinol (vitamin A) and retinol acetate, and 215 nm for δ-tocopherol, vitamin D, α-tocopherol, α-tocopherol acetate, 202 nm for phytosterols, 265 nm for vitamin K1. Identification of the individual vitamins and phytosterols was performed by frequent comparison with authentic external standard mixtures. The dominant fatty acids in the five species studied were 1.0

Results and Discussion

Fatty acid compositions, vitamin and sterol contents of Artemisia species
The fatty acid compositions of the studied Artemisia species were summarized in Table 2. The dominant fatty acids in the Artemisia species were found to be palmitic acid, stearic acid, palmitoleic acid, oleic acid, linoleic acid, eicosadienoic acid and docosadienoic acid. A. armeniaca, A. hausknetchitii and A. soparia contained the highest saturated fatty acid contents, at 65.21 ± 0.51%, 39.84 ± 0.49% and 58.01 ± 0.36%, respectively. Analysis by Orhan et al. (2009) of the fatty acid contents of different genus of Asteraceae suggested that most of the extracts seemed to be rich in saturated fatty acids.

Palmitoleic acid and oleic acid were found as monounsaturated fatty acids in all Artemisia species studied. A. tauzenta and A. hausknetchitii contained high levels of monounsaturated fatty acid (15.56 ± 0.28% and 20.58 ± 0.36%, respectively). Linoleic acid, eicosadienoic acid and docosadienoic acid were dominant polyunsaturated fatty acids in the five Artemisia species studied. Linoleic acid was absent or present at low levels in the studied species, except for A. incana, in which the linoleic acid content was found to be 22.21 ± 0.43%. Similarly, Orhan et al. (2009) found that the palmitic acid constituent of different species of Asteraceae was low or absent. Carvalho et al. (2011a) determined palmitic acid is major saturated fatty acid and linoleic acid and linolenic acids are major unsaturated fatty acids in the studied thirteen Artemisia species.

The sterol and vitamin contents of the five Artemisia species studied are shown in Table 3. A. armeniaca had high ergosterol (164.75 ± 2.34 μg/g) and β-sitosterol (265 ± 1.23 μg/g) contents, but low stigmasterol content. The presence of sitosterol and ergosterol in A. annua was reported by Abid Ali Khan et al. (1991). Several previous studies indicated that phytosterols, such
as β-sitosterol, were most effective against reactive oxygen species (Vivacca and Moreno, 2005; Conforti et al., 2009). Furthermore, the present study showed that the Artemisia species studied had low vitamin contents. Brisibe et al. (2009) reported that the vitamin A content of A. annua was below 0.3 g/100 g while vitamin E was determined to be at high levels in A. annua leaves (22.63 mg/kg).

**Flavonoid contents of Artemisia species**

It was reported that phenolic compounds possess potent antioxidant activity and have anticancer or anti-carcinogenic/anti-mutagenic, antibacterial, antiviral or anti-inflammatory properties (Bo et al., 2002; Cai et al., 2006). The flavonoid content of Artemisia species are shown in Table 4. Artemisia species are generally known as rich sources of antioxidant such as flavonoids and coumarins (Toda, 2005; Brisibe et al., 2009). The present study found that A. armeniaca had the highest flavonoid composition, while A. bauskeknechii had less variety of flavonoid than other species studied. Mino et al. (2004) reported that Artemisia species included luteolin and kaempferol constituents. Also, Djeridane et al. (2006) concluded that all the plant species they studied including Artemisia species such as Artemisia campestris, Artemisia herbacea and Artemisia arborea-ven- were rich in flavonoids. Furthermore, previous studies showed that different Artemisia species contain apigenin, luteolin, rutin, kaempferol, quercetin and naringenin constituents (Valant-Vetschera et al., 2003; Cai et al., 2004; Carvalho et al., 2011b; Suresh et al., 2012). Suresh et al. (2012) suggested that Artemisia species have significant amount of polyphenols and flavonoids content. Therefore these species could be considered in the category of antioxidant, anticancer, antimicrobial and immunomodulatory. Also, Carvalho et al. (2011b) found total phenolic content between 0.22-0.39 mg/gGAE in the leaves of Artemisia species. Also they determined the kaempferol the major flavonoid in the six Artemisia leaves, which measured in higher amounts 47.56 μg/g. However, quercetin and myricetin were determined in much lower quantities in the six Artemisia species (Carvalho et al., 2011b). Sengul et al. (2011) found that total phenolic content of Artemisia species were between 9.79 μg GAE/mg and 15.38 μg GAE/mg. On the other hand, Lee et al. (2013) determined that myricetin amount was 1.0865 mg/100g.

Table 1. Grown site of investigated Artemisia species

<table>
<thead>
<tr>
<th>Species</th>
<th>Grown sites</th>
<th>Herbarium no.</th>
</tr>
</thead>
<tbody>
<tr>
<td>A. armeniaca Lam.</td>
<td>Agri, Dogubayazit, Bardakli village, 2565 m, N 39º 43.601, E 44º 03.501, 23.09.2007</td>
<td>1068</td>
</tr>
<tr>
<td>A. incana (L.) Druce</td>
<td>Bitlis, Adilecevaz, 1720 m, N 38º 47.855, E 42º 43.000, 23.09.2007</td>
<td>1075</td>
</tr>
<tr>
<td>A. bauskeknechii Boiss.</td>
<td>Hakkari, Kirkdag village, 1624 m, N 37º 34.873, E 43º 54.148, 21.09.2007</td>
<td>1059</td>
</tr>
<tr>
<td>A. scoparia Waldst &amp; Ktt</td>
<td>Ankara, Polatlı road, 20 th km, 796 m, N 39º 17.941, 10.09.2007</td>
<td>1030</td>
</tr>
</tbody>
</table>

Table 2. Fatty acid compositions (%) of investigated Artemisia species

<table>
<thead>
<tr>
<th>Fatty acids (%)</th>
<th>A. armeniaca</th>
<th>A. incana</th>
<th>A. tournefortiana</th>
<th>A. bauskeknechii</th>
<th>A. scoparia</th>
</tr>
</thead>
<tbody>
<tr>
<td>Myristic acid</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>10.71±0.32</td>
</tr>
<tr>
<td>Palmitic acid</td>
<td>24.46±0.68</td>
<td>9.76±0.26</td>
<td>11.32±0.41</td>
<td>16.67±0.39</td>
<td>20.39±0.24</td>
</tr>
<tr>
<td>Margaric acid</td>
<td>-</td>
<td>4.37±0.54</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Stearic acid</td>
<td>23.47±0.44</td>
<td>3.04±0.27</td>
<td>3.18±0.32</td>
<td>4.77±0.39</td>
<td>11.76±0.43</td>
</tr>
<tr>
<td>Arachidic acid</td>
<td>4.37±0.41</td>
<td>-</td>
<td>1.36±0.32</td>
<td>-</td>
<td>4.38±0.51</td>
</tr>
<tr>
<td>Behenic acid</td>
<td>4.02±0.46</td>
<td>-</td>
<td>1.04±0.19</td>
<td>10.47±0.21</td>
<td>3.01±0.23</td>
</tr>
<tr>
<td>Tricosyclic acid</td>
<td>5.52±0.76</td>
<td>-</td>
<td>3.82±0.23</td>
<td>3.82±0.62</td>
<td>-</td>
</tr>
<tr>
<td>Lignoceric acid</td>
<td>3.37±0.33</td>
<td>-</td>
<td>1.62±0.36</td>
<td>4.11±0.89</td>
<td>7.76±0.45</td>
</tr>
<tr>
<td>ΣSFA</td>
<td>65.21±0.51</td>
<td>17.17±0.35</td>
<td>22.34±0.3</td>
<td>39.84±0.49</td>
<td>58.01±0.36</td>
</tr>
<tr>
<td>Palmitoleic acid</td>
<td>3.37±0.33</td>
<td>3.08±0.55</td>
<td>6.46±0.32</td>
<td>8.61±0.32</td>
<td>4.53±0.27</td>
</tr>
<tr>
<td>Oleic acid</td>
<td>6.13±0.29</td>
<td>2.59±0.34</td>
<td>9.12±0.25</td>
<td>11.97±0.41</td>
<td>6.23±0.29</td>
</tr>
<tr>
<td>ΣMUFA</td>
<td>9.53±0.31</td>
<td>5.67±0.44</td>
<td>15.56±0.28</td>
<td>20.58±0.36</td>
<td>10.76±0.28</td>
</tr>
<tr>
<td>Linoleic acid</td>
<td>9.94±0.28</td>
<td>12.98±0.33</td>
<td>37.23±0.47</td>
<td>57.09±0.51</td>
<td>14.42±0.33</td>
</tr>
<tr>
<td>Linolenic acid</td>
<td>7.74±0.38</td>
<td>23.41±0.32</td>
<td>12.24±0.28</td>
<td>6.68±0.33</td>
<td>1.81±0.27</td>
</tr>
<tr>
<td>Arachidonic acid</td>
<td>6.47±0.22</td>
<td>7.79±0.45</td>
<td>2.61±0.39</td>
<td>7.44±0.37</td>
<td>3.17±0.36</td>
</tr>
<tr>
<td>α-linolenic acid</td>
<td>4.42±0.33</td>
<td>22.21±0.43</td>
<td>1.34±0.32</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>γ-linolenic acid</td>
<td>-</td>
<td>2.25±0.42</td>
<td>3.83±0.39</td>
<td>-</td>
<td>2.07±0.23</td>
</tr>
<tr>
<td>Stearidonic acid</td>
<td>-</td>
<td>9.11±0.52</td>
<td>5.86±0.49</td>
<td>9.72±0.27</td>
<td>9.83±0.41</td>
</tr>
<tr>
<td>ΣPUFA</td>
<td>25.6±0.3</td>
<td>77.75±0.41</td>
<td>63.11±0.39</td>
<td>39.68±0.37</td>
<td>31.13±0.3</td>
</tr>
<tr>
<td>ΣUSFA</td>
<td>35.1±0.3</td>
<td>83.42±0.42</td>
<td>78.67±0.33</td>
<td>60.1±0.32</td>
<td>42.86±0.29</td>
</tr>
</tbody>
</table>

Table 3. Vitamin and sterol contents of investigated Artemisia species

<table>
<thead>
<tr>
<th>Species</th>
<th>Vitamin (μg/g)</th>
<th>Sterol (μg/g)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>a-tocopherol</td>
<td>Retinol</td>
</tr>
<tr>
<td>A. armeniaca</td>
<td>0.67±0.12</td>
<td>2.72±0.28</td>
</tr>
<tr>
<td>A. incana</td>
<td>0.32±0.09</td>
<td>1.11±0.15</td>
</tr>
<tr>
<td>A. tournefortiana</td>
<td>1.21±0.16</td>
<td>6.28±0.32</td>
</tr>
<tr>
<td>A. bauskeknechii</td>
<td>0.74±0.17</td>
<td>1.10±0.15</td>
</tr>
<tr>
<td>A. scoparia</td>
<td>1.43±0.22</td>
<td>0.32±0.18</td>
</tr>
</tbody>
</table>

**Table 1. Grown site of investigated Artemisia species**

**Table 2. Fatty acid compositions (%) of investigated Artemisia species**

**Table 3. Vitamin and sterol contents of investigated Artemisia species**
quercetin amount was 30.90 mg/100 g and kaempferol amount was 12.95 g/100 g in the *Artemisia* studied. In addition, they measured rutin as 44.00 mg/100 g, resveratrol as 21.40 mg/100 g (Lee et al., 2013). Nouria and Omar (2014) indicated that phenolic compounds, tannins and flavonoids were the major constituents of *Artemisia*. In contrast to these findings, some previous studies indicated that some *Artemisia* species had low or no flavonoid content (Wojdylo et al., 2007; Li et al., 2008).

**Conclusions**

The results of the present study showed that *Artemisia* species contained high saturated fatty acid compositions and linoleic acid, the major polyunsaturated fatty acid. Moreover, it was found that studied *Artemisia* species were rich in flavonoid constituents. Morin and naringenin were determined within all five species analysed. However, it was found that the sterol and vitamin contents of *Artemisia* species under the present study were low.

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**References**


Carvalho IS, Teixeira MC, Brodelius M (2011a). Fatty acids profile of selected *Artemisia* spp. plants: Health promotion. LWT - Food Science and Technology 44:293-298.


