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Fatty Acid Composition and ω-6/ω-3 Ratio of the Seed Oil of *Achillea sipikorensis* Hausskn. & Bornm.

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Abstract: The fatty acid compositions of the seeds of *Achillea sipikorensis* were investigated by gas chromatography (GC). The total lipid content of *A. sipikorensis* seed was found to be 3.83 %. Major fatty acids in seed oil were linoleic acid (C18:2 ω-6, 64.60 %), oleic acid (C18:1 ω-9c, 16.05 %) and palmitic acid (C16:0, 8.72 %). The level of ∑ω-6 series fatty acids (64.63 %) was higher than level of ∑ω-3 series fatty acids (1.42 %). ω-6/ω-3 fatty acids ratio was 45.51. According to these results, *A. sipikorensis* seeds can be recommended as a source of unsaturated fatty acids. This study is the first detailed report on the fatty acid composition of *A. sipikorensis* seed oil from Turkey flora.

***Keywords*:** *Achillea sipikorensis*, seed, fatty acids, ω-6/ω-3 ratio

Achillea sipikorensis Hausskn. & Bornm.'nin Tohum Yağının Yağ Asit Bileşimi ve ω-6/ω-3 Oranı

Özet: *Achillea sipikorensis'*in tohumlarının yağ asit bileşimi gaz kromatografisi ile incelenmiştir. *A. sipikorensis* tohumunun total lipid içeriği % 3.83'tür. Tohum yağında linoleik asit (C18:2 ω-6, % 64.60), oleik asit (C18:1 ω-9c, % 16.05) ve palmitik asit (C16:0, % 8.72) en büyük yüzdeye sahip olanlardır. ∑ω-6 formu yağ asitlerinin seviyesi (% 64.63), ∑ω-3 formu yağ asitleri seviyesinden (% 1.42) daha yüksektir. ω-6/ω-3 yağ asitleri oranı 45.51'dir. Bu sonuçlara göre *A. sipikorensis* tohumları doymamış yağ asitleri kaynağı olarak önerilebilir. Bu çalışma, Türkiye florasından *A. sipikorensis'*in tohum yağının yağ asit bileşeni üzerine yapılmış ilk detaylı rapordur.

Anahtar Kelimeler: *Achillea sipikorensis,* tohum, yağ asitleri, ω-6/ω-3 oranı

1. INDRODUCTION

The genus *Achillea* L. belongs to *Asteraceae,* comprises about 140 species Europe and Asia and a few in North America and South America [1]. Recent studies have shown that the *Achillea L.* species in Turkish flora are represented with 44 species. 21 of these species are endemic [2-4].

The important features of *Achillea* species are that they have also protective activity, antiulcer activity, antispasmodic activity, and biological effects [5-8]. In spite of many works on the chemical constituents of some *Achillea* species, there is not sufficient data on the fatty acid composition of this genus species. The most of the studies on *Achillea* species were conducted on their essential oil composition [9-12].

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Plant lipids are generally characterized by the presence of large quantities of unsaturated fatty acids (UFA) [13]. Therefore, plant products play an important role in human and animal nutrition. It is also beneficial to know the biochemical features of plant to be used as a source of nutrition and to be cultivated. Consequentyl, the fatty acid dynamics in the seed oils of *Achillea* genus is not well known, and this work aims to establish the total lipid content and fatty acid composition of the seeds of *Achillea sipikorensis* as an endemic species from Turkey flora.

2. MATERIALS AND METHODS

2.1. Plant Material

Achillea sipikorensis Hausskn. & Bornm. (an endemic species to Turkish flora) used in this study, collected from B6 Sivas region (Çetinkaya-Divriği, Çetinkaya output) (Turkey) in July at 2012 (temperature 20-22 ^{0}C, altitude about 1510 m). This species is stored at the herbarium of Biology Department of Cumhuriyet University (Sivas).

2.2. Seeds Extraction and Fatty Acids Analysis

The air-dried seed materials were ground. 2 g was taken from each of the milled samples, and stored for three days in chloroform-methanol (2/1, v/v) for 48 h at 4 ^{0}C [14]. The seed samples were extracted in chloroform-methanol (2/1, v/v) using an Ultra_Turrax T25 homogenizer in an ice bath [autooxidation of PUFAs was minimised by adding 50 µl of butylated hydroxytoluene (2 %, w/v in chloroform) to the extraction mixture]. The isolation of the total lipid from seeds was carried out [15]. The total lipids obtained were saponified by reflusing with methanol (50 %) containing 6 % potassium hydroxide for 1 h at 80 ^{0}C. The saponifiable lipids were converted to fatty acid methyl esters (FAMEs) for 10 min at 85 ^{0}C using the standard Boron triflouride-methanol (BF3) method [16].

2.3. Gas chromatography (GC) Analyses

The resultant mixture of FAMEs in hexane:chloroform (4/1, v/v) was injected into HP (Hewlett Packard) Agilent 6890N model GC equipped with a flame ionization detector (FID), and fitted with an HP-88 capillary column (100m x 0.20 mm i.d., 0.25 µm film). The carrier gas was helium (1 mL min-1) and injector port and detector temperatures were 240 and 250 ^{0}C, respectively. A small quantity of FAMEs solution (1 µl) was introduced onto the column. Column temperature program was 160 ^{0}C for the beginning, then increasing at 4 ^{0}C/min up to 185 ^{0}C and then increased 1 ^{0}C/min up to 200 ^{0}C. Identification of normal fatty acids was carried out by comparing the peak relative retention times of the sample FAMEs with those obtained for Alltech standarts (Lexington, USA).

All analytical determinations were performed in triplicate and, each reported result is the average value of three GC analyses.

3. RESULTS AND DISCUSSION

This is the first report on the fatty acid composition of *A. sipikorensis* seed oil from Turkey flora. The total lipid and total fatty acid contents of *A. sipikorensis* seed were found to be 3.83±032 and 2.73±0.06 %, respectively. The fatty acid compositions of seed oils of this species are presented in Table 1. Twenty one FAMEs were identified. It was determined ten individual fatty acids of saturated form of fatty acids (SFAs). Among these acids, palmitic acid (C16:0) was major fatty acid (8.72 %). Stearic acid (C18:0), behenic acid (C22:0) and arachidic acid (C20:0) were in the second degree. But their percentages were low (2.30, 1.84, 1.55 %, respectively). Other saturated fatty acids of SFA fraction were determined very low percentages (at range 0.10-0.58 %). The percentage of ∑SFA in seed oil of *A. sipikorensis* was 16.45 %. Goli et al. [7] reported that the fatty acid compositions of *A. tenuifolia* seed oils were C16:0 (8.55 %), C18:0 (1.52 %) and ∑SFAs (10.00 %). Although *A. tenuifolia* different species, this study is consistent with our values fatty acids.

Oleic acid (C18:1 ω-9c) was determined as a major fatty acid (16.05 %) in monounsaturated fatty acids (MUFAs). Other MUFAs were the minor compounds (between 0.03-0.70 %). Previous studies also confirmed that C18:1 ω-9c was the main fatty acid in MUFA fraction in *Achillea* species [7, 17, 18].

The seed oil of *A. sipikorensis* was richer in linoleic acid (C18:2 ω-6) than ɤ-linolenic acid (ɤ C18:3 ω-6) and α-linolenic acid (α C18:3 ω-3). The proportion of C18:2 ω-6 was found to be 64.60 %. Our study suggest that total polyunsaturated (∑PUFA) and ∑MUFA contents (∑UFA, 66.05 %) of *A. sipikorensis* seed oil were extremely different from ∑SFA (16.45 %). The chief components are C18:1 ω-9c and C18:2 ω-6. C18:3 ω-6 and eicosadienoic acid C20:2 ω-6 contents were very low levels (0.01 and 0.02 %, respectively). The profile of PUFA in the seed oil of *A. tenuifolia* [7] was similar in our study. It is well known that PUFAs are the most important fatty acids of the plant seed oils. Data showed that percentage of ∑ω-6 PUFA (64.63 %) was very high than ∑ω-3 PUFA (1.42 %). The ω-6/ω-3 fatty acid ratio was 45.51 in seed oil. This value is higher than the recommented values for human health [19]. But, due to ∑UFA/∑SFA ratio (5.08) in the seed oil of *A. sipikorensis* can be used as unsaturated fatty acids sources.

Table 1. Percentages of fatty acids in seed oil of *A. sipikorensis* (endemic species).

Fatty acids	**Mean±S.E***
C10:0	0.20±0.00
C12:0	0.25±0.00
C14:0	0.48±0.01
C15:0	0.58±0.04
C16:0	8.72±0.04
C17:0	0.43±0.00
C18:0	2.30±0.00
C20:0	1.55±0.07
C21:0	0.10±0.00
C22:0	1.84±0.02
∑SFA	**16.45±0.03**
C14:1	0.07±0.00
C15:1	0.14±0.01
C16:1	0.37±0.00
C17:1	0.03±0.00
C18:1 ω-9c	16.05±0.06
C18:1 ω-7	0.70±0.02
C20:1 ω-9	0.17±0.01
∑MUFA	**17.52±0.02**
C18:2 ω-6	64.60±0.09
C18:3 ω-6(ɤ)	0.01±0.00
C20:2 ω-6	0.02±0.00
∑ ω-6 PUFA	**64.63±0.02**
C18:3 ω-3 (α)	1.42±0.01
∑ω-3 PUFA	**1.42±0.01**
∑UFA/SFA	**5.08±0.00**
ω-6/ω-3	**45.51±0.00**

* Each value represents the mean of three experiments.
∑ SFA: Total Saturated Fatty acid; ∑ MUFA: Total Monounsaturated Fatty Acid;
∑ PUFA ω-6, ∑ PUFA ω-3; Total ω-6 and Total ω-3 Polyunsaturated Fatty Acid.

4. CONCLUSIONS

There have been many studies on the chemical composition and pharmocological properties of *Achillea* species. But there isn't an information on the fatty acid composition or ω-6 and ω-3 series PUFAs of *A. sipikorensis.* This study focused on the fatty acids and ω-6/ω-3 fatty acid ratios of seed oils of this species. The fatty acid compositions were determined by gas chromatography. C18:2 ω-6, C18:1 ω-9c and C16:0 were predominant fatty acids. ω-6/ω-3 and ∑UFA/SFA ratios were 45.51 and 5.08 respectively, in seed oil of *A. sipikorensis.*

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Conflict of Interests: The authors declare that they have no any conflict of interests.

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