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FATTY ACID ANALYSIS OF SOME TURKISH APRICOT SEED OILS BY GC AND GC-MS TECHNIQUES

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Abstract

Prunus armeniaca L. (Rosaceae), known as apricot, is one of the major export products of Turkey and its seed oil has become quite popular in cosmetics industry. On this purpose, fatty acid analysis of the seed oils of three apricot cultivars (Prunus armeniaca L.) from different localities in Turkey (Kalecik, Bodrum, and Malatya) was carried out by both gas chromotography (GC) and gas chromatography-mass spectrometry (GC-MS). The results showed that various differences were observed among the fatty acid contents of these three apricot seed oils. According to our data, it was found that the Malatya sample had the richest in linolenic acid content (10.87%) and the Bodrum sample had the highest in linoleic acid (34.77%). On the other hand, Kalecik-originated one was found to contain the lowest palmitic acid amount among all samples studied.

Key Words: *Prunus armeniaca, Rosaceae, fatty acid, GC, GC-MS*

Bazı Türk Kayısı Çekirdek Yağlarının GC ve GC-MS Teknikleri ile Yağ Asidi Analizi

Kayısı olarak bilinen Prunus armeniaca L. (Rosaceae), Türkiye'nin başlıca ihraç ürünlerinden biridir ve tohum yağı kozmetolojide oldukça popüler hale gelmiştir. Bu amaçla, Kalecik, Bodrum ve Malatya olmak üzere Türkiye'de üç farklı bölgeden temin edilen kayısı (Prunus armeniaca L.) örneklerine ait tohum yağlarının yağ asidi analizleri, hem gaz kromotografisi (GK), hem de gaz kromotografisi-kütle spektrometresi (GK-KS) ile yapılmıştır. Sonuçlar, bu üç kayısı tohum yağlarındaki yağ asidi içeriklerinde çeşitli farklılıklar olduğunu göstermiştir. Elde ettiğimiz verilere göre; Malatya örneğinin en yüksek linolenik asit miktarına (% 10.87), Bodrum örneğinin ise en yüksek linoleik asit içeriğine sahip olduğu bulunmuştur (% 34.77). Diğer taraftan, çalışılan tüm örnekler arasında Kalecik kökenli olanı en düşük palmitik asit miktarına sahiptir.

Anahtar kelimeler: *Prunus armeniaca, Rosaceae, yağ asiti, GC, GC-MS*

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INTRODUCTION

Essential Fatty Acids (EFAs), which cannot be synthesized by human, should be obtained through dietary intake. The human body needs EFAs to construct and repair cell membranes enabling the cells to obtain optimum nutrition and expel harmful waste products. A primary

function of EFAs, which support the cardiovascular, reproductive, immune, and nervous systems, is the production of prostaglandins. These regulate body functions such as heart rate, blood pressure, blood clotting, fertility, and play a role in immune system by regulating inflammation (1-4).

EFA deficiency, particularly omega-3 deficiency is commonly seen in the United States. Even though an ideal intake ratio of omega-6 to omega-3 fatty acids is between 1:1 and 4:1, most of the Americans intake a ratio between 10:1 and 25:1 (5-7). The minimum healthy intake per adult for both linolenic (omega-3) and linoleic (omega-6) acid via diet is 1.5 gram/day of each. EFA deficiency and omega 6/3 imbalance is linked with serious health conditions, such as heart attack, cancer, insulin resistance, asthma, lupus, schizophrenia, depression, postpartum depression, accelerated aging, stroke, obesity, diabetes, arthritis, and Alzheimer's Disease, among others (8-12). α–Linolenic acid (ALA) is the principal omega-3 fatty acid, which is metabolized into eicosapentaenoic acid (EPA), and later into docosahexaenoic acid (DHA) by a healthy human being (13). EPA and the GLA are synthesized from linoleic (omega-6) acid, which are later converted into hormone-like compounds known as eicosanoids that aid in many body functions in animals including vital organ function and intracellular activity (14).

It is well known that apricot is one of the main export products of Turkey. Malatya is the major province of Turkey in which apricot is commonly grown, although it is widely grown throughout our country (15). On the other hand, apricot seed oil has become popular for its use in cosmetics due to its easy absorbance into skin, softening, and moisturizing features. Hence, the present study was undertaken to carry out fatty acids analysis of three apricot seed oils (*Prunus armeniaca* L.) of different localities growing in Turkey by gas chromatography (GC) and gas chromatography-mass spectrometry (GC-MS).

EXPERIMENTAL

Plant materials

The seed samples of apricots were obtained from district of Malatya, Bodrum, and Kalecik, in Turkey. The samples of the seeds are preserved in the herbarium of Department of Pharmacognosy, Faculty of Pharmacy, Gazi University, Ankara, Turkey.

Extraction

The seed samples used in this study were ground in a grinder in the presence of anhydrous sodium sulphate and accurately weighed. The ground plant materials were macerated with *n*-hexane at room temperature for two days, while the macerates were shaken occasionally. Following filtration, the *n*-hexane phases of each sample was concentrated *in vacuo* at 40 °C by evaporating and the concentrated oils were obtained.

Methyl esterification of fatty acids

The oils independently were placed in 25 ml of volumetric flask, and then saponified by adding 12 ml 0.5 N sodium hydroxide in methanol into the mixture and were heated on a steam bath until the fat globules disappeared. 2 ml of BF_3/MeOH complex (Sigma Co.) was added to each flask and the mixtures were boiled for 2 minutes. After cooling down of the solutions at room temperature, they were diluted up to 25 ml with saturated sodium chloride solution and fatty acids methyl esters (FAMEs) were prepared for each sample (16). The obtained methyl esters of fatty acids were dissolved in *n*-hexane and 1 µl from each sample was injected and analyzed by both GC and GC-MS.

Analytical conditions for GC and GC-MS

Chromatographic analysis by GC was carried out on Agilent 6890N Network GC system with flame-ionization detector (FID). The capillary column used was Supelco SP-2380; (60.0 m

x 0.25 mm x 0.25 μm). Hydrogen was the carrier gas at a flow rate of 1.3 ml/min with 1 μl injection volume. The samples were analyzed with the column held initially 130°C for 1 min after injection, then increased to 170°C with 6.5°C/min heating ramp without hold and to 215 °C with 2.75°C/min heating ramp for 12 min. Then final temperature was increased to 230°C with 40°C/min heating ramp for 3 min. The injection was performed in split mode (50:1) at 270 °C. Detector and injector temperatures were 280°C and 270°C, respectively. Run time was 38.89 min in total. This method has been used for a long time to separate *cis* and *trans* isomers of fatty acids (17).

GS-MS analysis was carried out on Agilent 6890N Network GC system combined with Agilent 5973 Network Mass Selective Detector (GC-MS). The capillary column used was an Agilent 19091N-136 (HP Innowax Capillary; 60.0 m x 0.25 mm x 0.25 μm). Helium was used as carrier gas at a flow rate of 3.3 ml/min with 1 μl injection volume. The samples were analyzed with the column held initially at 100°C for 1 min after injection, then increased to 170°C with 10°C/min heating ramp without hold and increased to 215°C with 5 °C/min heating ramp for 5 min. Then final temperature was increased to 240°C with 10°C/min heating ramp for 10.5 min. The injection was performed in split mode (20:1) at 270 °C. Detector and injector temperatures were 280 °C and 250 °C, respectively. Total run time was 35 min. MS scan range (*m/z*) was between 35-450 atomic mass units (AMU) under electron impact (EI) ionization (70 eV).

Identification of fatty acids

The fatty acid components of the oils were determined by comparing their retention times to authentic fatty acid samples obtained by GC and the mass fragmentations with those of mass spectra database search (Wiley and Nist). They were also compared to mass spectrums of authentic fatty acid standards with GC-MS. Authentic standard used in this study was FAME mix Supelco-1891-1AMP [containing palmitic acid methyl ester 16:0, stearic acid methyl ester 18:0, oleic acid methyl ester 18:1, linoleic acid methyl ester (18:0; *cis* 9,12), linolenic acid methyl ester (18:3; *cis* 9,12,15)] and arachidonic acid methyl ester (20:4) (Sigma-A9298).

RESULTS AND DISCUSSION

As well-known, Turkey is one of the leading dried-apricot producers. Hence, in this study, we analyzed fatty acid composition of the oils of the apricot seeds belonging to three different cultivars (Malatya, Bodrum, and Kalecik) by GC and GC-MS. Identification of peaks obtained by GC with standard compounds was confirmed by capillary GC-MS using Wiley and Nist Libraries, comparison of retention time (Rt) and retention index (RI) with standard compounds, followed by a final comparison of their mass spectrums.

The yields obtained from the seed oils of three cultivars were given by total seed weight (*w/w*) as follows; seed oil of Kalecik origin: 21.8%; the seed oil of Malatya origin: 43.6%; the seed oil of Bodrum origin: 41.5%. Our results demonstrated that three apricot seed oils obtained from different localities had a remarkable variation regarding their fatty acid amounts and oil yields (Table 1). Among these oils, the one of Kalecik origin, having the lowest oil yield, was found to have the least palmitic acid (7.24%), in which oleic acid was the highest (68.65%). The seed oil of Bodrum cultivar had the highest linoleic acid (34.77%), followed by Kalecik (18.77%) and Malatya (16.80%) collections. However, the apricot seed oil of Malatya origin was found to be the richest in linolenic acid (10.87%).

The literature survey on this plant showed presence of some other reports on the same subject. For instance; in Abd El-Aal et al.'s study, the apricot kernel oil of Egyptian origin was also shown to contain oleic, linoleic, and palmitic acids as the principal fatty acids (18). In another study on the fatty acid composition of the seed oil of wild apricot growing in India,

which was reported to consist of 94% unsaturated fatty acids, it was found to compose of palmitic acid (3.9%), oleic acid (66.2%), linoleic acid (28.2%), and arachidic acid (0.1%), while it did not have stearic and linolenic acid at all (19), which appeared to be different from our results. In Femenia et al.'s also worked on chemical composition of the bitter and sweet varieties of *P. armeniaca* growing in Spain and oleic and linoleic acids were shown to constitute 92% of total fatty acids (20). This data was comparable to our data on the seed oil of Kalecik origin in which 87.42% of the total fatty acids were oleic and linoleic acids.

Interestingly, antimutagenic effect of the hexane extract prepared from the seeds of *P. armeniaca* of Japanese origin was examined using Ames/Salmonella microsome assay and inhibited the mutagenicity of benzo[a]pyrene whereas those of the seeds of *P. avium* (cherry), *P. salicina* (plum), and *P. dulcis* (almond) did not show such a mutagenicity (21). The mutagenicities of 3-amino-1,4-dimethyl-5H-pyrido[4,3-b]indole and 2-(2-furyl)-3-(5-nitro-2-furyl)acrylamide were also inhibited by *P. armeniaca*. Activity-guided fractionation of this extract led to isolation of oleic and linoleic acids as the inhibitory substituents. Their contents in the hexane extract were found to be 0.7% for oleic acid and 0.4% for linoleic acid.

Haciseferogullari et al. published a very recent article on protein and mineral content of several Turkish apricot varieties and stated that all of the varieties were highly rich in potassium, phosphor, calcium, sodium, and manganese, as well as protein (22). The antioxidant properties of peeled, defatted and roasted apricot kernel flours were also evaluated by determining radical scavenging power (RSP), anti-lipid peroxidative activity (ALPA), reducing power (RP), total phenolic content (TPC), assessed by DPPH test, β-carotene bleaching method, iron-reducing test, and Folin method, respectively (23). Roasting reduced the ALPA values, thus unroasted sample showed the highest ALPA value. RSP, RP, and TPC measurements of all samples were in high correlation.

Table 1. Fatty acid composition of the seed oils of three apricot samples

Fatty acids and retention times (min)	**% Composition**			
	Oil yields (w/w) / **RI values**	***P. armeniaca* (Kalecik)**	***P. armeniaca* (Bodrum)**	***P. armeniaca* (Malatya)**
		(21.8%)	**(41.5%)**	**(43.6%)**
Palmitic acid (16:0) (10.83)	2198	7.24	17.74	20.13
Stearic acid (18:0) (13.74)	2399	2.43	3.02	1.37
Oleic acid (18:1) (14.54)	2409	68.65	43.58	50.84
Linoleic acid (18:2) (15.85)	2460	18.77	34.77	16.80
Linolenic acid (18:3) (17.83)	2552	2.90	0.89	10.86
Total saturated fatty acid %	-	9.67	20.76	21.50
Total unsaturated fatty acid %	-	90.32	79.24	78.50
Total amount %	-	99.99	100.0	100.0

CONCLUSION

Our study on the fatty acid analysis of three seed oils of the three apricot cultivars showed that the seeds oils of apricots growing in Turkey have variances in their fatty acid contents, which may be due to soil properties, climate, and additional environmental conditions. Since the seed oil of Malatya is strikingly rich in linolenic acid and the Bodrum sample seems to have double amount of linoleic acid as compared to two others. As mentioned in above studies, apricot has also beneficial health effects as well as its rich unsaturated fatty acid content and therefore, these oils could be considered a good alternative for essential fatty acids for cosmetics and nutraceutical industries.

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