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DETERMINATION OF CHEMOTAXONOMIC MARKER OF GRAPE SEED OIL OBTAINED FROM DIFFERENT COUNTRY IN TURKEY

A. Akin[1] and O. B. Citil[2*]

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Vitis vinifera L. (grapes) are considered to be the world′s largest fruit crops, with an approximate annual production of 68 million tons. Grape production is economically important in Turkey. According to recent statistical data, the total grapevine area in Turkey is 482.789 ha; the total fresh grape production is 3.918.440 tons; and crop yield is 8116.2 kg/ha [1]. It is estimated that the production capacity of grape seeds annually is approximately 30.000 tons in Turkey [2]. Fifty kilograms of grape seed is needed to obtain a liter of cold pressed grape seed oil [3].

The type and quantity of fatty acids in the lipid molecule and the position and distribution of these fatty acids determine the chemical, physical, and functional properties. Recently, clinical and epidemiologic studies have shown that many chronic diseases are related to fatty acid type consumed [3].

Many species of *Vitis* were studied for especially volatile constituents. Some publications have referred to volatile compounds in Turkish endemic grape varieties [4, 5], but no reports have yet given the fatty acid composition of grape seed varieties. Therefore, in this study, the fatty acid composition of Narince, Kalecik Karasi, Okuzgozu and Bogazkere, Ak Uzum, Dokulgen, Hesap Ali, Eksi Kara, Kizil Uzum, Emir, Gok Uzum, and Kara Dimrit grape seed oil has been analyzed using GC. Additionally, this investigation was to determine nutritional values.

In this study, we report on the fatty acid composition and food value of grape seed oils of Narince, Kalecik Karasi, Okuzgozu and Bogazkere, Ak Uzum, Dokulgen, Hesap Ali, Eksi Kara, Kizil Uzum, Emir, Gok Uzum, and Kara Dimrit and explain the chemotaxonomic significance of these fatty acids.

Some fatty acid composition and food value of grape seeds are presented in Table 1. We identified 13 fatty acids of the grape seeds. The highest fatty acid ratios are linoleic acid 18:2 ω-6 (70.28%) in Kalecik Karasi. The lowest fatty acid ratios are linoleic acid 18:2 ω-6 (47.64%) in Hesap Ali. Linoleic acid is the most abundant unsaturated fatty acids in all grape seeds. Similarly, Gok Tangolar et al. [1] have found that linoleic (62.53–69.24%) acid is the dominant fatty acid in all grape seeds. The highest percentage of lipid content is 11.90% in Bogazkere, and the lowest 6.31% in Gok Uzum. Maier et al. found that the percentage oil content in the grapes of approximately seven grape varieties was 7.6–16.0% [6].

The total saturated fatty acid composition of the studied varieties is assigned between 10.94–20.41%, while polyunsaturated fatty acid composition is 49.94–72.29%. The level of monounsaturated fatty acid depends on level of oleic acid. The monounsaturated fatty acid ratio was between 15.62 and 29.40%. Similar results for grapes [1] and other cultivars have also been reported in the literature [7].

Grapes are native to the warm temperate zone [8]. The family has been characterized by the occurrence of linoleic, oleic, palmitic, and stearic acids in all cultivars [9]. Grape seed oil is used for salad dressings, marinades, deep frying, flavored oils, baking, and in massage oil, sunburn repair lotion, hair products, body hygiene creams, lip balm, and hand creams [10–13]. Grape seed oil contains a high percentage of omega 6, which can significantly raise high-density lipoprotein (good) cholesterol and reduce low-density lipoprotein (bad) cholesterol levels [14].

In the HMSO report, it was suggested that the minimum ratio of PUFA/SFA should be 0.45 [15]. In this study, this ratio is found to be minimum (2.45) in Hesap Ali. Nutritionists have suggested that ω3 fatty acids must be present in greater amounts in human diet.

1) Department of Horticulture, Faculty of Agriculture, Selcuk University, 42075, Konya, Turkey; 2) Department of Animal Nutrition and Nutritional Disorders, Faculty of Veterinary Medicine, Selcuk University, 42075 Konya, Turkey, fax: +90332 2410063, e-mail: ocitil@selcuk.edu.tr. Published in Khimiya Prirodnykh Soedinenii, No. 6, pp. 849–850, November–December 2011. Original article submitted July 26, 2010.

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TABLE 1. Some Fatty Acid Composition and Food Value of Grape Seeds, % (n = 7)

Fatty acid	Narince	Bogazkere	Okuzgozu	Ak Uzum	Dokulgen	Hesap Ali
18:2 ω6	67.89 ± 0.14b	54.99 ± 0.07j	63.20 ± 0.06h	66.30 ± 0.01e	63.85 ± 0.02g	47.64 ± 0.38k
18:3 ω3	0.31 ± 0.01h	0.27 ± 0.00j	0.37 ± 0.01g	0.32 ± 0.00h	0.45 ± 0.01e	0.59 ± 0.01c
Σ SFA	12.84 ± 0.07f	15.93 ± 0.59b	12.16 ± 0.02g	10.94 ± 0.05i	14.92 ± 0.01cd	20.41 ± 0.01a
Σ MUFA	18.04 ± 0.01g	27.36 ± 0.27b	23.12 ± 0.02d	21.11 ± 0.06e	19.62 ± 0.08f	29.40 ± 0.01a
Σ PUFA	69.11 ± 0.08c	56.61 ± 0.34i	64.69 ± 0.00g	67.86 ± 0.07de	65.46 ± 0.08f	49.94 ± 0.04j
Linolenic/Linoleic	**0.0045**	**0.0048**	**0.0059**	**0.0048**	**0.0070**	**0.0124**
Crude Oil	9.75	11.90	10.15	10.45	10.54	9.05
Crude Protein	10.09	10.91	10.01	10.26	9.98	10.62
Dry matter	5.07	4.99	4.97	5.12	5.22	5.29
Ash	19.51	18.97	18.08	19.81	18.94	19.56
Fatty acid	Eksi Kara	Kizil Uzum	Emir	Gok Uzum	Kara Dimrit	Kalecik Karasi
18:2 ω6	58.23 ± 0.11i	65.91 ± 0.03f	67.43 ± 0.21c	66.22 ± 0.23e	66.64 ± 0.11d	70.28 ± 0.04a
18:3 ω3	0.78 ± 0.01a	0.26 ± 0.00j	0.77 ± 0.00b	0.40 ± 0.00f	0.44 ± 0.00e	0.46 ± 0.01d
Σ SFA	15.23 ± 0.01c	13.98 ± 0.11e	14.40 ± 0.05de	16.39 ± 0.34b	14.44 ± 0.26de	12.09 ± 0.10h
Σ MUFA	24.09 ± 0.04c	17.93 ± 0.01g	15.88 ± 0.01ij	16.14 ± 0.10i	16.66 ± 0.09h	15.62 ± 0.25j
Σ PUFA	60.67 ± 0.04h	68.08 ± 0.09d	69.69 ± 0.06b	67.43 ± 0.24e	68.85 ± 0.37c	72.29 ± 0.16a
Linolenic/Linoleic	**0.0134**	**0.0039**	**0.0113**	**0.0060**	**0.0065**	**0.0065**
Crude Oil	8.96	9.69	8.50	6.31	6.80	8.02
Crude Protein	11.01	11.16	10.37	10.45	10.79	10.53
Dry matter	4.93	5.39	5.41	5.15	5.45	5.07
Ash	19.27	19.31	18.33	17.98	19.85	19.72

[a–k]Means that are in the same row as each other and that do share a superscript letter in common are not significantly different from each other at $P < 0.05$.

Similarly, Goren et al. [16] showed that linolenic acid/linoleic acid ratio can be used in chemotaxonomic evaluation in nine species of *Salvia*.

Collection of Samples. Ripened grapes from Narince (Ankara) (white color table and wine grape), Kalecik Karasi (Nevsehir) (black color wine grape), Okuzgozu (Manisa) (black color wine grape), Bogazkere (Manisa) (black color wine grape), Ak Uzum (Hadim) (white color table grape), Dokulgen (Hadim) (white color table grape), Hesap Ali (Hadim) (white color table grape), Eksi Kara (Hadim) (black color table and raisen grape), Kizil Uzum (Hadim) (red color table grape), Emir (Nevsehir) (white color wine grape), Gok Uzum (Hadim) (white color table grape), and Kara Dimrit (Nevsehir) (black color table and raisen grape) cultivars grown in these districts were collected from producer vineyards in Turkey in 2009. The seeds were excised from berries and air-dried at the room temperature under shade conditions. They were stored at room temperature until analysis.

Lipid Content. Each 5 g powdered part was extracted using a Soxhlet apparatus with diethyl ether for 6 hours. After extraction, the solvent was evaporated under reduced pressure. Then the lipid content of each part was determined according to the previously reported method [17].

Fatty Acid Analysis. Each part of about 5 g was extracted with chloroform–methanol mixture (2:1, v/v) [18]. The fatty acids were converted to their methyl esters using the standard boron trifluoride-methanol method [19]. The resultant fatty acid methyl esters were separated and stored at –20°C. At the beginning of each analysis, the samples were allowed to equilibrate to room temperature and analyzed by gas liquid chromatography (Agilent-6890N, equipped with a dual flame ionization detector, length 30 m, ID 0.32 mm, film thickness 0.25 μm, HP-5 capillary column). Column temperature was 60°C for 2 min, rising progressively at 5°C/min up to 250°C where it was maintained for 20 min at 250°C. Carrier gas was hydrogen (2 mL/min). The injector and detector temperatures were 230 and 230°C, respectively. The fatty acids were identified by comparison of their retention times with known external standard mixtures (Alltech), quantified by HP Chem Station software. The results were expressed as percentage distribution of fatty acid methyl esters. Each of the experiments was repeated three times.

Statistical Analysis. Seven grape seed samples were analyzed in triplicate. The average results of peak area are expressed as means ±SD. The statistical analysis of the percentage of fatty acids was tested by analysis of variance (ANOVA), and comparisons between mean values were performed using Duncan′s test. Differences between means were reported as significant if $P < 0.05$.

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