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The Comparison of some Pistachio Cultivars Regarding their Fat, Fatty acids and Protein Content

Vergleich von Pistaziensorten hinsichtlich ihres Gehalts an Fett, Fettsäuren und Eiweiß

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Summary

This research has determined fat, fatty acids and protein contents of some domestic pistachio cultivars, namely 'Uzun', 'Kırmızı', 'Halebi' and 'Siirt', and an Iranian cultivar 'Ohadi'. Total fat ratio of pistachio cultivars studied ranges between 55.852–59.728 %. Regarding of fat ratios, there have been no significant differences between cultivars.

The composition of fatty acids was determined as miristic (0.00–0.166 %), palmitic (9.926–10.560 %), palmitoleic (0.614–0.928 %), stearic (1.432–2.416 %), oleic (61.570–66.237 %), linoleic (17.485–25.180 %) and linolenic (0.248–0.638 %). The primary saturated fatty acid in cultivars has been determined as palmitic acid and followed by stearic acid. In the cultivars, oleic acid has been found as the most common unsaturated fatty acid with double bond. Linoleic acid has the highest percentage among multi-bond fatty acids whereas linolenic acid content is much less. There has been no significant difference among pistachio cultivars regarding fatty acids, except linoleic acid. The ratio of unsaturated fatty acids to saturated ones has changed between 6.48 and 7.42. The highest protein ratio of pistachio nut fruits has been determined in 'Halebi' (25.063 %) and 'Siirt' (24.607 %). The protein ratio was lowest for 'Uzun' (19.583 %).

Zusammenfassung

In dieser Arbeit wurden der Fett-, Fettsäure- und Eiweißgehalt der einheimischen Pistaziensorten 'Uzun', 'Kırmızı', 'Halebi', 'Siirt' und der aus Persien stammenden Sorte 'Ohadi' untersucht. Hierbei wurde festgestellt, daß der Gesamtfettgehalt der Sorten zwischen 55.852 und 59.728 % beträgt und, daß zwischen den Sorten keine signifikanten Unterschiede hinsichtlich des Fettgehalts vorhanden sind. Die Fettsäuren setzen sich aus Myristinsäure (0.000–0.166 %), Palmitinsäure (9.926–10.560 %), Palmitoleinsäure (0.614–0.928 %), Stearinsäure (1.432–2.416 %), Oleinsäure (61.570–66.237 %), Linoleinsäure (17.485–25.180 %) und Linoleninsäure (0.248–0.638 %) zusammen. In den untersuchten Pistaziensorten ist als gesättigte Fettsäure vorrangig Palmitinsäure gefolgt von Stearinsäure vorhanden. Der Oleinsäuregehalt ist bei den zweifach ungesättigte Fettsäuren am höchsten. Die mengenmäßig höchsten Werte bei den mehrfach ungesättigte Fettsäuren weist die Linoleinsäure, den geringsten die Linoleninsäure auf. In den untersuchten Pistaziensorten gibt es von allen Fettsäuren nur bei der Linoleinsäure signifikante Unterschiede. Das Verhältnis der ungesättigten Fettsäuren zu den gesättigten Fettsäuren schwankt zwischen 6.48 und 7.42. Die höchsten Eiweißgehalte unter den untersuchten Pistazien weisen die Sorten 'Halebi' (25.063 %) und 'Siirt' (24.607 %), den niedrigsten die Sorte 'Uzun' (19.583 %) auf.

Introduction

Turkey, being a country on the gene centre of pistachio, has a wide population of wild pistachio and several pistachio cultivars. Moreover, Turkey has wide ecological areas on which it is possible to feasibly produce this fruit, which can only grow in limited areas worldwide due to its ecological demands. Turkey is third in the rank for worldwide production of pistachio, which is especially cultivated in the southeast region of the country. This has a significant contribution to the economic structure of the region where other agricultural products can hardly be raised since the land is arid, stony or even rocky (AYFER 1964, BILGEN 1964).

Pistachio is not only a delicious fruit but also has high nutritional value for having proper contents of vitamins, minerals and fats. The fruits can be consumed as salted or roasted appetizers. Besides, it has a wide range of use in food industry, in particular for creamcakes, desserts, candies, chocolate and ice cream. It is reported that, pistachio oil extracted from the fruits had been used in cooking in the past, but the production has stopped due to high cost (BILGEN 1964).

Studies on minerals, vitamins, proteins, fat and fatty acids which show the nutritional value of a food stuff are increased recently. The research is especially focused on the importance of fat and fatty acids on human diet. Non-caloric functions of fats determined so far are

(a) being a source for fat soluble vitamins,
(b) providing essential fatty acids that human body absolutely needs,
(c) restraining protein demand, increasing grow rate of living beings, and
(d) diminishing the need of body for vitamins B.

Oils, owing to the fatty acids they contain, are essential nutrients for human body. Essential fatty acids are im-

portant because they are the only substance synthesising prostoglandin, which prevent erythrocines from accumulating in blood (KAYAHAN 1978).

Pistachio which has high fat content within nuts is also important in this matter. Fat content of pistachio is less than all other nuts except for chestnut. Pistachio contains 55–60 % fat whereas fat content of walnut, hazelnut and almond are 69–73 %, 59–64 % and 62 %, respectively. Major part of the fat content of pistachio is unsaturated fatty acids and 80 % of that is oleic and linoleic type. Unsaturated fatty acids are known to have positive effects on human health like preventing accumulation of cholesterol and arteriosclerosis. Moreover, oleic acid, which is contained in pistachio with a high ratio, is reported to give stability to fat. It is also indicated that with nutrition rich in oleic acid cholesterol amount in blood decreases. Saturated fatty acids that exist in low amounts in pistachio also give stability to fat, but these are found related with some cardiovascular diseases. Those fatty acids having more than one bond, namely linoleic, linolenic and arahidonic acids, cannot be synthesised in human body and hence should be taken via foods. These three unsaturated fatty acids are required for the biosynthesis of hormone called prostaglandin, which are physiologically important to human body (ERSOY and BAYSU 1986, MARTIN et al. 1986). Multi-bond fatty acids like linoleic acid have very important functions among which are building cell structure as other glycerolipids do, supporting formation of other fatty acids, and being directly used in body. Minimum required intake of these fatty acids, known also as Vitamin F, is 1 g/day and this can be met by eating 10–12 pistachio seed every day (GARCIA et al. 1992, HUNTER 1990, PARIZA 1990).

There are number of studies focused on fat and fatty acid contents of Turkish pistachio cultivars (AYFER 1974, AGAR et al. 1995a, GARCIA et al. 1992, KARACA and NIZAMOGLU 1995). But Iranian or some local cultivars were used as plant material and some standard domestic cultivars are not evaluated in those studies. Besides different results were obtained from the same cultivars in different experiments. But different results between the same cultivars grown in similar ecological conditions shows that there is upper and lower limits for fat and fatty acid contents of pistachio.

Pistachio is mostly consumed as a processed food stuff. Their protein, fat and fatty acid composition might show dramatic changes during process (KOROGLU et al. 2000). It is very important to find out the amount and the upper and lower limits of fat and fatty acid contents of cultivars which will be processed. To provide the necessary information to the processing industry, protein, fat, and fatty acid contents of some widely grown registered pistachio cultivars were investigated. The results also compared with the results of other studies to figure out the upper and lower limits of protein, fat, and fatty acids in pistachio cultivars.

Material and Methods

The study covers five standard cultivars officially registered in Turkey. These include domestic cultivars 'Uzun', 'Halebi' and 'Kırmızı', which are regarded as members of long-grained pistachio group pomologically, and which are accepted to have fruits – although smaller – with better taste and aroma compared to cultivars of other producer countries, and hence are preferred in pastry, chocolate and ice cream industry. The fourth one is 'Siirt', which is round-grained. The last one is Iranian cultivar 'Ohadi', which is regarded as a member of round-grained pistachio group pomologically. Fruit samples of these cultivars have been collected from pistachio trees grafted on *P. vera* rootstock in the non-irrigated orchards of the Gaziantep Institute of Pistachio Researches.

Basic properties of the pistachio cultivars used in the research are given Table 1.

Sampling of the fruit and preparation for analysis

Fruit samples of the pistachio cultivars used in the study have been collected from trees, which are of the same age and vigour and are on the same orchard. For each cultivar, five trees have been selected. A group of 20 fruits have been collected from four directions of each tree, hence summing up to 400 fruits. Repetitions consisting of 20 randomly selected fruits have been analysed (DUZGUNES et al. 1987). Analysis was performed after kernel pistachio fruits have been dried at 60–70 °C for 48 hours (KACAR 1972).

Determining total fat ratio

Fat percentage has been determined by adding margaric acid (C_{17}), which is an internal standard, to the sample and at the same time with determining fatty acid composition on GCMS device. Using this method, fatty acid composition as well as fat percentage can be determined by adding 3 mg C_{17} per 18 mg fat, depending on the estimated fat content of the seed (GARCES and MANCHA 1993).

Assuming that 50 % of approximately 100 mg of pistachio is fat, 5 mg margaric acid has been added to the sample for which the fatty acid composition was to be determined. This operation requires 5 mg C_{17} per 0.5 ml. Samples to be examined for fat content have been weighed with high precision and metil esters of fatty acids have been prepared for the prepared samples. Total fat amount has been determined in milligrams by multiplying the fatty acid amount by 1.05 (internal standard), and expressed as percentage (KOROGLU 1997, AGAR et al. 1995a, b, c, KAFKAS et al. 1995).

Oil extraction and obtaining metil esters of fatty acids

This stage has been carried out following GARCES and MANCHA (1993). This method, which was developed for extracting the fatty acids simultaneously in a single phase and for obtaining metil esters of the fatty acids, can easily be used on tissues containing high amount of triacylglycerol (fatty seeds), water (leaves) or both (KOROGLU 1997).

100 ± 10 mg of pistachio sample has been put into test tube and after having added 3 ml of reaction mixture, 2 ml heptan and 0.5 ml margaric acid solution, in order, the test tube has been tightly covered with a teflon cap. Then, the tube has been kept in a water bath

Table 1. Basic properties of the pistachio cultivars used in this research.
Sorteneigenschaften der untersuchten Pistazien.

'Uzun' (*Synonym: Antep*)	This cultivar is tasty and small-grained, widely raised in Turkey and its chilling requirement is less than that of 'Halebi' and 'Kırmızı'. Although yield period of this cultivar starts late, it has a high fruit setting rate later on. It shows a tendency of alternate bearing. It is consumed as appetizer and used in the food industry.	Profit ratio = 42.48 % Split shell ratio = 69.34 %
'Kırmızı' (*Synonym: Antep)*	This cultivar has small and tasty fruits. It is widely raised in the district of Gaziantep. It is especially recommended for altitudes for it is an early-blooming cultivar and requires chilling more than other standard cultivars. This cultivar shows a tendency of alternate bearing.	Profit ratio = 40.37 % Split shell ratio = 67 %
'Halebi' (*Synonym: Antep)*	It has small and tasty fruits. 'Halebi' is especially recommended for regions rarely having low temperatures because it is the earliest-blooming of all standard domestic cultivars as well as having the least requirement for chilling. It is widely raised in the district of Gaziantep. This cultivar shows a tendency of alternate bearing. It is used in pastry as well as being consumed as appetizer.	Profit ratio = 42.05 % Split shell ratio = 78.26 %
'Siirt'	It has big fruits. It is especially raised in Siirt and Şanlıurfa districts. It is advantageous in marketing since it has fruits fitting world standards for size; a high split shell ratio, fruits with light-coloured shell and impressive appearance. For this reason, it is highly recommended for new orchards to be established and especially for regions that will be productive owing to the Southeast Anatolia Project. It has a low tendency for alternate bearing. Pomologically, its fruits are round and long. This cultivar is generally marketed as appetizer.	Profit ratio = 42.64 % Split shell ratio = 92 %
'Ohadi'	It has big, round fruits with impressive appearance. It is widely raised in Siirt and Şanlıurfa districts. Its production area gets wider in recent years, as it has a partial tendency for alternate bearing, and round fruits with a high split shell ratio. 'Ohadi' is a late-blooming cultivar and hence is not recommended for regions with short vegetation period. Its tendency for alternate bearing is not very high. 'Ohadi' is consumed as appetizer.	Profit ratio = 44.53 % Split shell ratio = 94 %

ANONYMOUS 1993
KARACA and NIZAMOĞLU 1995

of 80 °C for two hours. At the end of the third minute, the test tubes have been quickly shaked in order to make samples monophased. Keeping samples monophased in the test tubes depends on heating. Following the 2-hour water bath, test tubes have been waited in room temperature to let two phases to form. Upper phase contains methyl esters of fatty acids. By injecting 1 µl of upper phase to GCMS device, fat and fatty acids have been examined.

In preparing the reaction mixture, Metanol:Benzen:DMP : H_2SO_4 (37 : 20 : 5 : 2) chemicals have been used. As for the margaric acid solution, 500 mg margaric acid has been solved in 50 ml metanol.

During wait period at 80 °C, which is required for extraction and metilation of fatty acids, all lipids have thoroughly been extracted from tissues. Adding internal standard to the environment allowed for determining the fat content at the same time.

Determining composition of fat and fatty acids

As a result of the analysis, ratios for the following fatty acids have been determined: Miristic (14 : 0), Palmitic (16:0), Palmitoleic (16 : 1), Stearic (18 : 0), Oleic (18 : 1), Linoleic (18 : 2) and Linolenic (18 : 3). Moreover, Margaric acid (17 : 0) ratio has also been determined to calculate fat percentage.

The study, which has used a SHIMADZU GCMS-QP 5000 device for determining fat and fatty acid composition, has been carried out under the following conditions: Column: DB-VAX column, 30 m, 0.25 mm; Column temperature: fixed at 190 °C; Column flow: 0.9 ml min^{-1}; Column pressure: 100 k pa^{-1}; Injector temperature: 250 °C; Injection block setting: 1/50 (Split ratio); Detector temperature: 230 °C.

Determining protein content

Kjeldahl method has been applied on repetitions comprising 20 dried fruit randomly selected from fruits of all cultivars. The coefficient used to convert nitrogen percentage to raw protein percentage is 5.50 (TOLGAY and TETIK 1964).

Research results have been evaluated using analysis of variance (ANOVA) on completely randomized design and differences have been lettered according to Duncan method (DUZGUNES et al. 1987).

Results and Discussion

Fat and protein ratios determined in the pistachio cultivars studied are depicted in Table 2. Table 1 shows

Table 2. Fat and protein ratios determined in some pistachio cultivars.
Eiweiß-und Fettgehalt der untersuchten Pistaziensorten.

Cultivar	Fat (%)	Protein (%)
'Uzun'	56.448 ± 1.58 a	19.583 ± 0.27 c
'Kırmızı'	58.719 ± 0.74 a	22.550 ± 0.64 b
'Halebi'	56.110 ± 1.40 a	25.063 ± 0.24 a
'Siirt'	55.852 ± 0.94 a	24.607 ± 0.56 a
'Ohadi'	59.728 ± 6.93 a	22.057 ± 0.35 b

$P<0.05$

that total fat ratio of pistachio cultivars ranges between 55.9 and 59.7 %. The highest fat has been determined in 'Ohadi' (59.728 %), which is followed by 'Kırmızı' (58.719 %). 'Uzun' and 'Halebi' have been found to have close fat values (56.448 % and 56.110 %, respectively) whereas 'Siirt' has been determined to have the least fat ratio (55.852 %). With respect to total fat ratio, the differences between cultivars have not been found statistically significant.

In general, total fat values determined in the cultivars are concordant with findings of other researches. Nevertheless, there are some differences. These differences have also been put forward by other researches studying the same cultivar. AYFER (1974) expressed that fat ratio of pistachio fruits generally ranged between 58.96 and 60.10 %. Similarly, a study on 'Badami', 'Ohadi' and 'Mumtaz' by KAMANGAR et al. (1975) determined the fat ratio to range between 55.2 and 60.5 %. On one hand, KARACA and NIZAMOGLU (1995) found the fat ratio of 'Mumtaz' as 55.4 %. On the other hand, a study by GARCIA et al. (1992) on domestic 'Siirt' and 'Antep' and some Iranian pistachio cultivars raised in Turkey determined the total fat ratio of 'Mumtaz' as 67.2 %, whereas KAFKAS et al. (1995) stated this value as 60.61 %. A similar case is observed for 'Siirt' and 'Ohadi'. Total fat ratio of these cultivars had respectively been determined as 54.2 % and 56.2 % by GARCIA et al. (1992), and as 51.77 % and 54.7 % by KAFKAS et al. (1995). On the other hand, total fat ratio determined for 'Siirt' and 'Ohadi' in this study are 55.85 % and 59.72 %, respectively. However, KAMANGAR and FARSAM (1977) and SHOKRAII (1977) determined closer total fat ratios for 'Ohadi' (58.4 % and 57 %, respectively).

These differences in determined fat contents of pistachio cultivars may arise due to differences in factors like raising conditions, crop or season. Different raising regions, rootstocks or irrigation conditions had been reported to affect the fat ratio of cultivars (KOROGLU 1997). Additionally, fat ratio may change during fruit development and maturing periods as well as during different stages of processing. In connection with this, a study, which has taken some qualities of pistachio into consideration for determining proper harvesting time, has found that fat content values of cultivars were close with respect to harvesting time. Fat ratios of cultivars found to vary as follows depending on their maturity levels: for 'Siirt' between 55.26 % and 56.81 %; for 'Ohadi' between 53.56 % and 56.05 %, for 'Kırmızı' between 50.64 % and 56.69 %, for 'Uzun' between 53.40 % and 56.01 % (KUNTER 1993). KOROGLU et al. (2000) determined that the fat ratio in non-roasted fruits of 'Kırmızı' as 55.60 % and that fat ratio varied depending on the roasting time although these differences were not statistically significant.

Table 2 shows that highest protein ratio of pistachio fruits have been determined in 'Halebi' (25.063 %) and 'Siirt' (24.607 %). These are followed by 'Kırmızı' and 'Ohadi', the protein ratios of which have been found on a par with each other (22.550 % and 22.057 %, respectively.) The lowest protein ratio (19.583 %) has been found in 'Uzun'. The difference between protein ratios of 'Halebi' and 'Siirt' is not statistically significant. Neither is the difference between protein ratios of 'Kırmızı' and 'Ohadi'. On the other hand, the difference between 'Kırmızı' and 'Ohadi' and others have been found as significant. Protein ratio of 'Uzun' statistically differs from that of other cultivars.

Studies by KAMANGAR and FARSAM (1977) on various Iranian cultivars had determined the fruit content of 'Ohadi' cultivar as 3.1 % moisture, 2.3 % ash, 2.0 % fibre, 17.8 % protein and 16.4 %. A study by SHOKRAII (1977), comparing protein content of 'Kerman' with that of Turkish cultivars, determined the composition of 'Ohadi' as 2.54 % moisture, 1.93 % fibre, 13.8 % carbohydrates, and 20.8 % protein. Protein ratio (22.057±0.35 %) of 'Ohadi' cultivar was found higher than KAMANGAR and FARSAM (1977) and SHOKRAII (1977). SHOKRAII (1977) stated that Turkish pistachios were richer in protein 1.3 times compared to 'Kerman', and that there was a negative correlation between bigness, crop amount and protein ratio. SHOKRAII (1977) commented that the result was not surprising as pistachios used in the study were small and light-weighed. In our study, as a conclusion concordant to that comment, protein content has been determined as highest for 'Halebi', which has small fruits. Similarly, protein content was high for 'Kırmızı', which has small fruits. On the other hand, the fact that for small-fruited 'Uzun' protein ratio was the lowest, and that bigger-fruited 'Siirt' and 'Ohadi' has higher protein contents, leads us to think about other factors other than fruit size that may affect protein content. The values obtained in our study have been in concordance with the results of other researches.

Fatty acid content and their ratios determined in the study are listed in Table 3. Figure 1 shows chromatogram samples of the cultivars. Total amount of saturated and unsaturated fatty acids and the ratio of saturated ones to unsaturated ones are given in Table 4.

The primary saturated fatty acid in analysed cultivars have been determined as palmitic acid (9.926–10.56 %), which is followed by stearic acid (1.432–2.416 %). On the other hand, miristic acid has been found as a trace only (0.00–0.166 %). Regarding saturated fatty acids, there has been no statistically significant difference between cultivars. The highest palmitic acid ratio (10.56 %) has been determined in 'Halebi', which is followed by 'Ohadi' (10.280 %), 'Uzun' (10.200 %) and 'Siirt' (10.066 %). 'Kırmızı' has the lowest palmitic acid ratio (9.926 %). As for stearic acid content, 'Halebi' (2.416 %) and 'Uzun' (2.017 %) have been leading. 'Ohadi' and 'Kırmızı' have the ratios of 1.792 % and 1.711 %, respectively. The lowest level of stearic acid (1.432 %) has been determined in 'Siirt'. The highest miristic acid level has been found in 'Siirt' (0.166 %) and 'Kırmızı' (0.104 %), whereas no miristic acid has been encountered in 'Uzun' cultivar.

In the cultivars studied, oleic acid has been found to be commonest unsaturated fatty acid containing a double bond. The oleic acid level has been found highest in 'Uzun' (66.237 %) and lowest in 'Ohadi' (61.570 %). Other cultivars have close levels of oleic acid ('Halebi': 66.07 %, 'Siirt': 64.68 %, 'Kırmızı': 61.99 %). The study has determined that palmitoleic acid content of cultivars varies between 0.614 and 0.928 %, with 'Siirt' having the highest and 'Halebi' having the lowest.

For the cultivars studied, linoleic acid has the highest percentage (17.485–25.180 %) among multi-bond fatty

Table 3. Fatty acid contents (%) of some pistachio cultivars.
Fettsäuregehalt der untersuchten Pistaziensorten.

	Saturated fatty acids		
Cultivar	Miristic (14:0)	Palmitic (16:0)	Stearic (18:0)
'Uzun'	0.000 ± 0.00 a	10.200 ± 1.72 a	2.017 ± 0.27 a
'Kırmızı'	0.104 ± 0.04 a	9.926 ± 0.13 a	1.711 ± 0.25 a
'Halebi'	0.058 ± 0.06 a	10.560 ± 1.75 a	2.416 ± 0.31 a
'Siirt'	0.166 ± 0.12 a	10.066 ± 0.76 a	1.432 ± 0.21 a
'Ohadi'	0.019 ± 0.02 a	10.280 ± 1.43 a	1.792 ± 0.25 a

	Unsaturated fatty acids			
Cultivar	Palmitoleic (16:1)	Oleic (18:1)	Linoleic (18:2)	Linolenic (18:3)
'Uzun'	0.731 ± 0.08 a	66.237 ± 0.48 a	20.957 ± 0.46 abc	0.394 ± 0.12 a
'Kırmızı'	0.750 ± 0.17 a	61.990 ± 2.07 a	23.710 ± 1.93 ab	0.638 ± 0.15 a
'Halebi'	0.614 ± 0.09 a	66.070 ± 1.54 a	17.485 ± 0.52 c	0.248 ± 0.06 a
'Siirt'	0.928 ± 0.19 a	64.680 ± 2.34 a	19.760 ± 2.06 bc	0.319 ± 0.04 a
'Ohadi'	0.775 ± 0.26 a	61.570 ± 3.09 a	25.180 ± 2.02 a	0.375 ± 0.11 a

$P<0.05$

Table 4. Total saturated and unsaturated fatty acid contents of some pistachio cultivars.
Gesamtgehalt an gesättigten und ungesättigten Fettsäuren.

Cultivar	Saturated fatty acids (%)	Unsaturated fatty acids (%)	Unsaturated/Saturated
'Uzun'	12.22	88.32	7.23
'Kırmızı'	11.74	87.09	7.42
'Halebi'	13.03	84.42	6.48
'Siirt'	11.66	85.69	7.35
'Ohadi'	12.09	87.90	7.27

acids with, whereas linolenic acid content is much less (0.248–0.638 %). Cultivars with highest level of linoleic acid are 'Ohadi' (25.18 %) and 'Kırmızı' (23.71 %); those with lowest level are 'Halebi' (17.485 %) and 'Siirt' (19.76 %). Similarly, cultivars with highest level of linolenic acid are 'Kırmızı' (0.638 %) and 'Uzun' (0.394 %); those with lowest level are 'Halebi' (0.248 %) and 'Siirt' (0.319 %).

In concordance with the results obtained in the study, other researches had also determined that palmitic acid was the primary saturated fatty acid in pistachio cultivars studied, that palmitoleic acid was found as a trace only, that among all fatty acids having a double-bond oleic acid was the commonest, that among all multi-bond fatty acids linoleic acid was the commonest (SHOKRAII 1977, GARCIA et al. 1992, KAFKAS et al. 1995, KAMANGAR et al. 1975, CLARKE et al. 1976).

Measuring a trace amount of miristic acid in the pistachio cultivars examined in this study is a result stated only in the study by KOROGLU (1997).

Examining saturated and unsaturated fatty acid amounts and ratios of the cultivars led to the following results: saturated fatty acids ranges in the interval of 11.66–13.03 %; unsaturated fatty acids ranges in the interval of 84.42–88.32 %; the ratio of unsaturated fatty acids to saturated ones ranges in the interval of 6.48–7.42 (Table 3). These results support the findings in KAFKAS et al. (1995) that stated an unsaturated/saturated fatty acid ratio of 7.90 for Turkish pistachios. The researches had determined a value of 9.48 for the same ratio for Iranian cultivars.

When all the results of the studies conducted on the subject including presented research considered together, the lower and upper limits of total fat contents can be exepted as 51.77–55.85 %, 54.7–59.72 %, 53.40–56.44 % and 50.64–58.72 % in 'Siirt', 'Ohadi', 'Uzun' and 'Kırmızı' respectively. The fat content of 'Halebi' which is not previously analysed was found as 56.11±1.40 %. The fat content of 'Siirt', 'Ohadi' and 'Uzun' were higher then the other studies. Similarly, protein content of 'Ohadi' were higher (22.057± 0.35 %) then the others results.

The results of fatty acid composition showed similarity to the others (GARCIA et al. 1992, KAFKAS et al. 1995). Palmitic acid is determined as the primary saturated fatty acid in the experiments. Besides, oleic acid has been found to be commonest unsaturated fatty acid containing a double bond, while linoleic acid has the highest percentage among multi-bond fatty acids. As a difference from the other studies, trace amount of miristic acid within fatty acid composition is also determined in this research (Fig 1).

Cultivar recommendation for new plantations should not be made only based on the fruit size and fruit colour which are important quality factors for marketing the product. Nutritional value of the cultivars should also be considered for the production of any cultivar. The results of these study showed that highly desired domestic cultivars according to their taste, colour, etc., also have high nutritional value. Fat and protein content were found high in especially 'Siirt' and 'Ohadi' cultivars other than high fatty acid composition. Moreover, these cultivars produce desir-

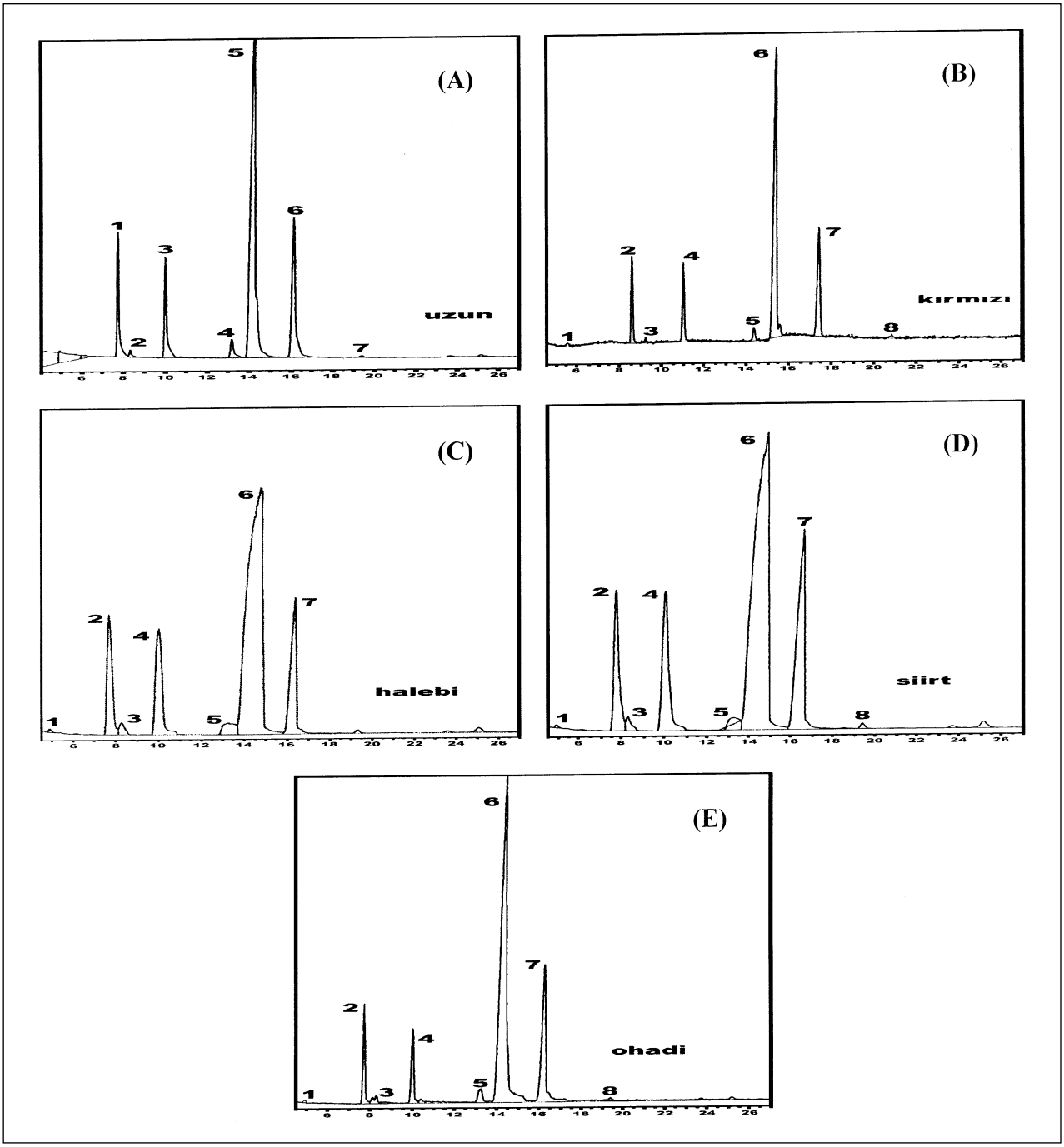


Fig. 1. Chromatograms of fatty acids in pistachio cultivars
(A) 'Uzun', Peaks 1: palmitic acid, 2: palmitoleic acid, 3: margaric acid, 4: stearic acid, 5: oleic acid, 6: linoleic acid, 7: linolenic acid. **(B)** 'Kırmızı', Peaks 1: miristic acid, 2: palmitic acid, 3: palmitoleic acid, 4: margaric acid, 5: stearic acid, 6: oleic acid, 7: linoleic acid, 8: linolenic acid. **(C)** 'Halebi', Peaks 1: miristic acid, 2: palmitic acid, 3: palmitoleic acid, 4: margaric acid, 5: stearic acid, 6: oleic acid, 7: linoleic acid, 8: linolenic acid. **(D)** 'Siirt', Peaks 1: miristic acid, 2: palmitic acid, 3: palmitoleic acid, 4: margaric acid, 5: stearic acid, 6: oleic acid, 7: linoleic acid, 8: linolenic acid. **(E)** 'Ohadi', Peaks 1: miristic acid, 2: palmitic acid, 3: palmitoleic acid, 4: margaric acid, 5: stearic acid, 6: oleic acid, 7: linoleic acid, 8: linolenic acid.
Fettsäure-Chromatogramme der untersuchten Pistaziensorten
(A) *'Uzun', Peaks 1: Palmitin-, 2: Palmitolein-, 3: Margarin-, 4: Stearin-, 5: Olein-, 6: Linolein-, 7: Linoleninsäure.* **(B)** *'Kırmızı', Peaks 1: Myristin-, 2: Palmitin-, 3: Palmitolein-, 4: Margarin-, 5: Stearin-, 6: Olein-, 7: Linolein-, 8: Linoleninsäure.* **(C)** *'Halebi', Peaks 1: Myristin-, 2: Palmitin-, 3: Palmitolein-, 4: Margarin-, 5: Stearin-, 6: Olein-, 7: Linolein-, 8: Linoleninsäure.* **(D)** *'Siirt', Peaks 1: Myristin-, 2: Palmitin-, 3: Palmitolein-, 4: Margarin-, 5: Stearin-, 6: Olein-, 7: Linolein-, 8: Linoleninsäure.* **(E)** *'Ohadi', Peaks 1: Myristin-, 2: Palmitin-, 3: Palmitolein-, 4: Margarin-, 5: Stearin-, 6: Olein-, 7: Linolein-, 8: Linoleninsäure.*

able fruit size and split ratio which are important for marketing. For these reasons, exist orchards established with them should be protected and they should also be recommended for new plantations.

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