Journal of Agriculture and Environmental Sciences
December 2014, Vol. 3, No. 4, pp. 119-129
ISSN: 2334-2404 (Print), 2334-2412 (Online)

Published by American Research Institute for Policy Development
DOI: 10.15640/jaes.v3n4a9
URL: http://dx.doi.org/10.15640/jaes.v3n4a9

Determination of Total Olive Oil and Cis-Trans Fatty Acids Composition of Şırnak Province Olive Genotypes at Southeastern Anatolia

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Abstract

Olive plants, throughout history, have formed the basis of the civilizations in the Mediterranean region and in researches; the gene center is expressed Southeastern Anatolia region as homeland of olives [1]. In recent years, willingness to live healthier and longer, countries plays a decisive role in the nutrition policy. Areas where olive trees grow is effective for obtaining good quality olive oil. Fat quantity and fat quality which obtained from olive may differ by region. Therefore, increasing the efficiency in the olive oil sector at the international level, regional characterization of Turkish olive and olive oil are important. This research was run on the olives which selected as promising as a result of the selection operation 34 types, common in the population Şırnak, and olive oil contents and fatty acid composition were determined. As a result of research in the province of Şırnak genotype total oil were determined between from 2.0 % to 8.8%. The composition of fatty acids were determined as palmitic acid from 10.34% to 20.92%, stearic acid 2.25% to 3.91% ; oleic acid 49.33 % to 67.96 %, linoleic acid 7.52% to 31.51% and linolenic acid 0.63% to 2.72 %, respectively.

Keywords: Şırnak, Total oil, Oil composition, Gas choromatography

Introduction

The olive tree (Olea europaea L.) is a symbol of Mediterranean culture, and has, throughout history, represented an important element of civilizations that appeared around the Mediterranean basin.

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Various researchers describe Southeastern Anatolia as the region of origin and gene center of the olive tree [1].

This view was further reinforced by recent studies conducted in the Hatay, Kahramanmaraş, and Mardin areas, which demonstrated that the largest number of olive tree sub-species is located within this region.

In recent years, emphasis on health and longevity has begun to play an increasingly determining role in the nutrition policy of most countries. Owing to its taste/sensory characteristics and chemical composition, olive oil assumes a very important role in human nutrition, especially in regions where it is widely cultivated.

Obtaining good quality olive oil depends on a large number of factors, such as the region in which the olive trees are cultivated, the variety of olive being cultivated, the climate and the specific weather on the year of harvest, the period in which the olives are harvested, the method used for harvesting, the method of transportation to the processing area, and the method of processing. The geographic location and climate affect the amount/level of oil that can accumulate in the olive fruit. Thus, both the quantity and quality of oil obtained from olives can vary from one region to another. Therefore, to be able to promote the Turkish olive oil sector at an international level, it is necessary to regionally characterize Turkish olives and olive oil [4, 5, 14].

To date, various studies have been conducted both in Turkey [18, 17, 6, 11] and in abroad countries [10, 23, 9, 21, 15, 20] regarding the characterization of fatty acid composition among different olive varieties, which plays an important role in determining olive oil quality. There are also several studies regarding the identification and classification of the geographical origins of different olive varieties based on their fatty acid composition [24, 22, 16, 21].

In current study evaluated total fat content and cis-trans fatty acid compositions of olive genotypes from the Şırnak Province of Southeastern Anatolia, which are considered to be superior olives in terms of fruit quality and changes according to the types of these compounds was investigated.

Materials and Methods

Study Area: The study was performed within the Şırnak Province of the Southeastern Anatolia region: Silopi, Uludere, Güçlükonak and Cizre, and the Provincial Center of Şırnak. The history of the Şırnak region stretches back to the earliest periods of recorded history; according to the Katip Çelebi's "Travel Book" ("Seyahatname") written in the 17**th** century, the region has been inhabited "since the time before Noah's flood."

With the exception of a few flatlands in its western and southern parts, the geographic landscape of the Şırnak Province is mostly composed of plateaus crossed by rivers and streams. This geographical region can be divided into two agro-ecological sub-regions. The first of these agro-ecological sub-regions encompasses the Cizre, Silopi, and İdil Counties, and is largely composed of wide plains with an elevation of 300-400 meters. The second agro-ecological sub-region encompasses the Provincial Center of Şırnak and the Beytüşşebap, Güçlükonak and Uludere Counties, and is composed of high mountains with rugged terrain, steep slopes, and elevations above 1000 meters. In this second sub-region, the amount of agricultural areas is limited, while forests and meadows can be found extensively.

The current study used certain olive genotypes from various olive production areas and microclimate regions within the Şırnak Province. The locations from which the olive genotypes were collected are shown in Table I.

Table I. Selected from the Province of Şırnak Genotypes and their Location

ŞIRNAK (34 **genotype**)	**Deran**	**6 genotype**
	Damlarca	**2 genotype**
	Kızılsu	**3 genotype**
	Ziron	**6 genotype**
	Serekani	**1 genotype**
	Besbin	**1 genotype**
	Nevalo hasko	**14 genotype**
	Akdizgin	**1 genotype**

Olive varieties were selected according to selection criteria based on different agronomic characteristics and certain preliminary information provided by the producers. Using these criteria, a total of 34 genotypes were selected as study material.

Total Fat and Fatty Acid Analysis

At the time of harvest, unripe green olives were randomly collected by hand from the selected varieties of olive trees. The olives were then transferred to the study laboratory in 250 g polyethylene bags placed inside iceboxes. The olive samples were sent to the laboratory within the same day, and were stored inside a deep freezer (–20 ºC) until analysis. The olive samples were analyzed within the same day they were thawed.

Samples were weighted 25 g from milled fruit in scales sensitive to 0.01 g. In these examples, oil analysis was performed with soxhelet apparatus **[13].** N-hexane was used in the oil extraction process. In process result, n-hexane was evaporated in rotary-evaporator, residual oil weighed and fat content were determined as percent.

Etherification of the oil sample according to the method of cold methylation **[12],** which recommended by the relevant directives of the European Union, is performed. Fatty acid analysis of the samples which converts to methyl esters were made in the model of HP 6890 gas chromatography apparatus. . All analyses were conducted in triplicate for each genotype.

-The Gas Chromatography (GC) parameters used in our study for the determination of fatty acid composition are provided below:
- Injection port temperature: 270 °C
-Detector temperature: 250 °C
-The amount of injected solution: 1 μl
-Column oven temperature program: Temperature starts at 165°C for 30 minutes, then increases at a rate of 10°C/min until it reaches 190°C, and remains at 190°C for 12 minutes.
-Split: 1: 50
-Carrier gas speed: Helium 1 ml/min
-Device: HP 6890 (Agilent, USA)
-Results were calculated by dividing the area of each peak with the total peak area to obtain an “area/total area” value in percentage form.

Statistical Analysis

Hierarchical cluster analysis which is multivariate method was performed to identify similarity levels among the genotypes by considering fatty acids together. MINITAB (ver: 14) statistical program was used for all statistical computations.

Results and Discussion

The fat content and fatty acid composition in olives can vary depending on the olive variety, the ecological conditions of the location where the olives are cultivated (e.g. mean temperature, maximum and minimum temperature, light, soil and air humidity, soil structure), and the cultivation methods that are employed (pruning, watering, and fertilizing methods). In fact, even the position of olives on olive trees can affect the fatty acid content and composition of the fruit [14, 18, 3]. Generally, olive oil contains 9.48-15.60% palmitic acid, 0.67-1.40% palmitoleic acid, 1.71-3.63% stearic acid, 67.43-78.44% oleic acid, 4.67-15.10% linoleic acid, 0.03-1.15% linolenic acid and 0.17-0.90% arachidic acid [18, 25].

The total fat content and fatty acid composition of the genotypes in the Şırnak Province are shown in Table II. The highest total fat content ratio of 8.8% was identified in the 8 variety, while the lowest total fat content ratio of 2.0% was identified in the (34), (3), and (18) varieties. According to a study by Canözer [7], there are 88 different varieties of olive in Turkey, with the Memecik variety accounting for nearly 74% of all olive production in Turkey, while the second most commonly produced variety is the Ayvalık (Edremit) variety. Both the Memecik and Ayvalık varieties are used for olive oil production.

Other commercially important varieties of olive in Turkey include the Gemlik, Domat, Uslu, Memeli, İzmir (a table olive variety), Yamalak, Edincik Su, Çelebi, Halhalı, Karamürsel Su, Çilli, Kaba, and Erkence varieties. In his study, Canözer determined that the fat content of different varieties of olives in Turkey varies between 16.71% and 31.82%. He also described that the percentage of fat content in the dry matter of olive pulp varied depending on ecological conditions and the variety of olive, and that this percentage was generally between 40-70%. On the other hand, Aydın and Nizamoğlu [2]

Table 2: Total Fat and Fatty Acid Compositions of Şırnak Genotypes **(%)**

genotypes	Total fat (%)	$C_{14:0}$	$C_{16:0}$	$C_{16:1}$	$C_{17:0}$	$C_{17:1}$	$C_{18:0}$	$C_{18:1}$	$C_{18:2}$	$C_{18:3}$	$C_{20:0}$	$C_{20:1}$	$C_{22:0}$	$C_{24:0}$
1	2,5	0,01	19,13	1,28	0,07	0,11	3,11	62,98	11,34	0,56	1,03	0,28	0,17	0,11
2	6,7	0,98	11,73	0,76	0,04	0,05	2,74	57,95	23,38	0,43	1,05	0,43	0,31	0,25
3	2,0	0,03	14,25	0,36	0,19	0,24	2,66	62,58	16,26	0,53	2,11	0,35	0,20	0,12
4	4,5	0,09	12,06	0,52	0,13	0,26	3,08	56,15	24,79	0,44	1,52	0,53	0,28	0,11
5	5,2	0,65	10,34	0,52	0,11	0,07	3,19	59,65	23,59	0,45	0,63	0,41	0,19	0,15
6	2,5	0,22	13,44	1,41	0,23	0,39	2,34	56,55	18,23	0,44	1,44	0,30	0,14	0,08
7	4,3	0,79	12,88	0,97	0,07	0,05	3,10	51,36	24,64	0,88	2,33	0,48	0,68	0,00
8	8,8	1,30	13,22	0,71	0,12	0,12	3,25	57,59	21,29	0,53	1,13	0,30	0,26	0,16
9	3,0	0,02	13,86	1,44	0,06	0,08	2,59	58,67	15,62	0,45	0,77	0,24	0,11	0,11
10	4,8	0,15	14,70	0,85	0,09	0,08	3,27	52,22	25,79	0,75	1,35	0,28	0,23	0,11
11	4,5	0,13	17,55	0,97	0,07	0,08	3,26	65,97	9,53	0,63	1,40	0,30	0,22	0,14
12	4,4	0,03	20,92	0,97	0,37	0,44	2,79	55,87	14,35	0,72	2,72	0,31	0,25	0,26
13	3,6	0,02	13,58	0,83	0,06	0,08	2,92	66,78	13,71	0,50	0,91	0,31	0,18	0,11
14	3,2	0,02	12,84	0,65	0,08	0,04	2,83	55,23	25,57	0,55	1,40	0,41	0,19	0,13
15	4,3	0,04	13,42	1,24	0,19	0,31	2,25	67,96	7,52	0,48	0,98	0,32	0,15	0,13
16	3,6	0,37	17,70	1,42	0,08	0,05	2,86	57,37	17,59	0,57	1,28	0,26	0,20	0,17
17	3,0	0,05	13,63	0,73	0,11	0,06	2,95	52,99	26,81	0,56	1,18	0,35	0,24	0,27
18	2,0	0,48	13,97	1,13	0,11	0,08	2,74	63,03	15,97	0,54	1,23	0,32	0,21	0,18
19	3,2	0,02	17,48	1,88	0,07	0,14	2,70	58,24	17,62	0,42	0,96	0,27	0,11	0,10
20	2,8	0,03	14,97	1,14	0,10	0,06	3,91	63,25	14,96	0,95	1,18	0,41	0,36	0,28
21	2,5	0,02	19,57	1,13	0,14	0,19	2,56	60,23	14,09	0,52	1,06	0,33	0,28	0,21
22	4,8	0,05	10,92	0,39	0,14	0,05	3,23	50,80	31,51	0,77	1,26	0,49	0,40	0,03
23	6,4	0,03	14,40	0,85	0,10	0,06	2,97	49,33	28,20	0,66	2,57	0,33	0,25	0,26
24	2,8	0,03	12,52	0,56	0,06	0,05	2,98	60,54	21,06	0,58	0,94	0,34	0,22	0,12
25	3,4	0,01	11,01	0,55	0,09	0,06	3,36	59,91	22,41	0,57	1,15	0,32	0,26	0,22
26	3,2	0,03	17,15	1,21	0,08	0,05	2,88	51,31	24,06	0,63	1,58	0,37	0,22	0,25
27	4,5	0,02	14,42	1,29	0,08	0,07	2,80	63,26	15,99	0,57	1,28	0,37	0,20	0,20
28	3,6	0,02	13,63	0,67	0,20	0,22	3,04	60,83	18,18	0,61	1,17	0,18	0,16	0,18
29	5,6	0,01	13,92	0,98	0,06	0,06	3,23	67,18	7,94	0,49	1,08	0,28	0,14	0,14
30	3,7	0,05	12,51	0,52	0,13	0,05	3,07	52,64	27,90	0,64	1,41	0,33	0,26	0,31
31	4,8	0,04	16,77	1,44	0,12	0,17	3,16	64,45	11,37	0,60	1,22	0,31	0,17	0,14
32	3,2	0,02	19,22	1,34	0,07	0,05	3,05	61,10	12,51	0,62	1,41	0,27	0,21	0,12
33	2,8	0,02	17,17	1,10	0,08	0,07	3,15	63,52	12,25	0,59	1,30	0,29	0,19	0,16
34	2,0	0,03	16,50	0,90	0,10	0,10	3,29	63,80	12,77	0,64	1,24	0,29	0,20	0,14

$C_{14:0}$: Myristic acid $C_{16:0}$: Palmitic acid $C_{16:1}$: Palmitoleic acid $C_{17:0}$: Heptadesanoic acid $C_{17:1}$: Heptadesenoic acid $C_{13:0}$: Stearic acid
$C_{18:1}$: Oleic acid $C_{18:2}$: Linoleic acid $C_{18:3}$: Linolenic acid $C_{20:0}$: Arachidic acid $C_{20:1}$: Gadoleic acid
$C_{22:0}$: Behenic acid $C_{24:0}$: Lignoseric acid

Results are mean values of triplicate determinations described that the fat content of the Silikfe variety clones varied between 19.54-33.91%. In Dölek's study, the highest fat content was observed in the Kilis (28.0%), Nizip (26.0%), and Beirut (25.0%) varieties; while the lowest fat content was observed in the Memeli (20.0%), Domat (20.0%), and Manzanilla (20.0%) varieties. Dölek [8] further described that the fat content of the Gök, Silikfe, Çöplüce, and Çortak varieties were 23.0%, 23.0%, 22.0%, and 21.0%, respectively.

The different fat content levels identified by the researchers could possibly be associated with the different analysis methods they used; with the fact that the olive trees were cultivated in different ecological environments; and the fact that the fat content of olives changed as they evolve from the unripe green stages to the mature black stage.

Evaluation of fatty acid composition among the Şırnak Province genotypes revealed that the ratio of palmitic acid (a saturated fatty acid) varied between 10.34% (5) varieties and 20.92% (12), while the ratio of stearic acid varied between 2.25% (15) and 3.91% (20) (Table 2).

In addition, the ratio of oleic acid (a monounsaturated fatty acid) varied between 49.33% (23) and 67.96% (15), while the ratio of linoleic acid (a polyunsaturated fatty acid) varied between 7.52% (15) and 31.51% (22) and linolenic acid 0.42% (19) ile 0.95% (20) (Table 2).

Turkish Food Codex requires that the ratio of the oleic acid is between 55.0-83.0% in olive oil [19]. Barut **[6]** describes that the Gemlik variety of olive has total oil content of 21.4% and oleic acid content as 64.10% during years of abundant harvest; while in years of poor harvest 25.3% and 68.20% respectively. In addition, it was observed that the Samanlı, Çelebi, Karamürsel Su, and Edincik Su varieties also showed variations in their fatty acid content and composition between years of abundant and poor harvest

Results of cluster analysis were presented in Table III. Concerning with cluster analysis, dendogram graph was also presented in Figure I. According to Table III and figure I, the highest (96.06%) similarity level was obtained for genotype 16 and 19, followed by genotype 33 and 34 with 95.97%, 3 and 18 with 95.39%. When all fatty acids considered together, similarity level was recorded as 85.22% among the all (34) genotypes.

The identity of the selected 34 genotypes confirmed that similarity indices ranged from 96 to 85% for fatty acid profiles of olives genotypes on the basis of FAME analysis. In other words, the variation among the genotype is about 15%. This variation is likely to be useful for selecting of high-value genotypes.

In conclusion, this study conducted in the Şırnak province demonstrated that the region has, in a manner similar to many other regions of Turkey, a rich diversity of olives. The authors believe that the lower levels of fat content that were identified in comparison to previous studies might be associated with the fact that the researchers harvested the fruits during the month of September, at a period relatively earlier than their normal time of harvest. In addition, the authors believe that the current study will assist in rendering the selected types/varieties more common and widespread within the context of olive cultivation activities in the region.

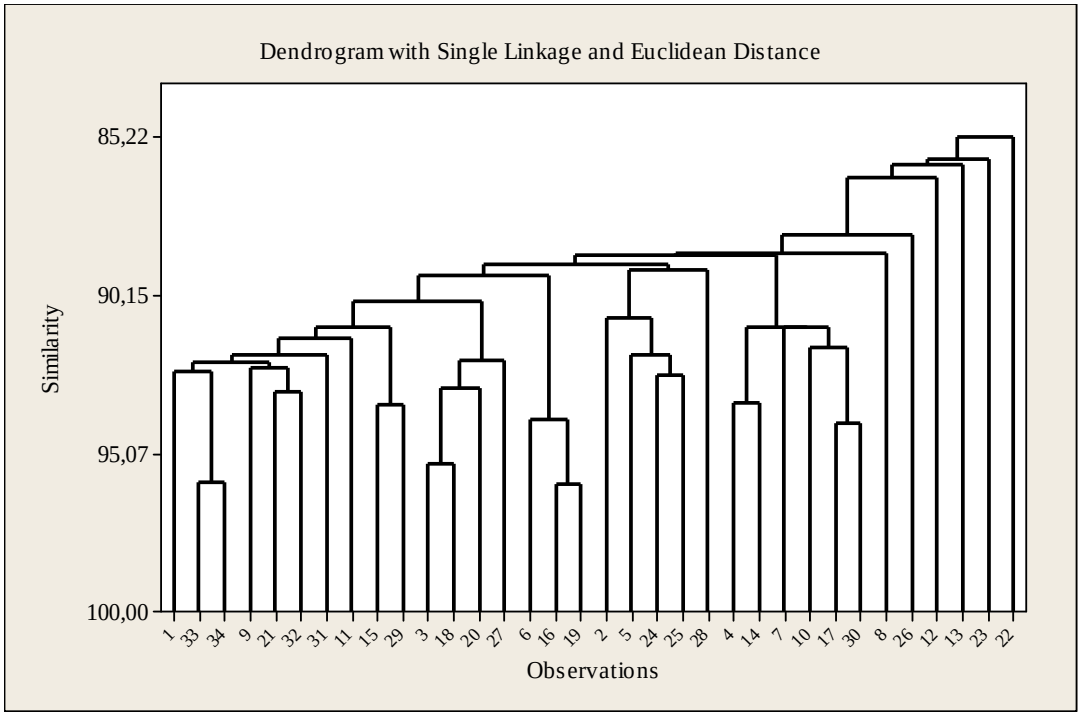

Figure I. Dendogram for the olive genotypes

Table III: Results of Cluster Analysis

step	Number of clusters	Similarity	Distance level	Clusters joined		New cluster	Number of obs. in new cluster
1	33	96,0579	1,20118	16	19	16	2
2	32	95,9668	1,22893	33	34	33	2
3	31	95,3875	1,40547	3	18	3	2
4	30	94,1605	1,77934	17	30	17	2
5	29	94,0267	1,82012	6	16	6	3
6	28	93,5680	1,95989	15	29	15	2
7	27	93,4886	1,98408	4	14	4	2
8	26	93,1881	2,07564	21	32	21	2
9	25	93,0573	2,11550	3	20	3	3
10	24	92,6445	2,24128	24	25	24	2
11	23	92,5398	2,27318	1	33	1	3
12	22	92,3974	2,31655	9	21	9	3
13	21	92,2424	2,36380	1	9	1	6
14	20	92,1649	2,38741	3	27	3	4
15	19	92,0304	2,42839	5	24	5	3
16	18	92,0101	2,43459	1	31	1	7
17	17	91,8166	2,49353	10	17	10	3
18	16	91,5303	2,58079	1	11	1	8
19	15	91,1673	2,69138	1	15	1	10
20	14	91,1347	2,70132	7	10	7	4
21	13	91,1327	2,70194	4	7	4	6
22	12	90,8760	2,78016	2	5	2	4
23	11	90,3340	2,94529	1	3	1	14
24	10	89,5481	3,18478	1	6	1	17
25	9	89,3996	3,23001	2	28	2	5
26	8	89,1900	3,29388	1	2	1	22
27	7	88,9117	3,37867	1	4	1	28
28	6	88,8609	3,39415	1	8	1	29
29	5	88,2841	3,56993	1	26	1	30
30	4	86,5168	4,10844	1	12	1	31
31	3	86,0818	4,24098	1	13	1	32
32	2	85,9139	4,29214	1	23	1	33
33	1	85,2214	4,50315	1	22	1	34

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