

A COMPARATIVE STUDY OF THE FATTY-ACID COMPOSITION OF *Sesamum indicum* OIL OBTAINED FROM DIFFERENT PROVINCES IN TURKEY

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The sesame (*Sesamum indicum* L., Pedaliaceae) is one of the most ancient oilseed crops known to mankind. Pedaliaceae, or the sesame family, is a small family of 16 genera and 60 species. Among the 60 species of Pedaliaceae family, 37 species belong to *Sesamum* genus. However, only *Sesamum indicum* L. ($2n = 26$) is cultivated between these 37 species [1]. Sesame, an ancient cultivated plant and thought to have originated from Africa and Turkey, is known to be second genetic resource [2].

In general, sesame oil contains about 42% oleic acid (18:1), 41% linoleic acid (18:2), 10% palmitic acid (16:0), 1% linolenic acid (18:3), and 6% other fatty acids. However, the fatty-acid composition as well as the oil content is influenced by various physiological, ecological, and cultural factors [3]. The unsaturated fatty-acid contents in sesame are higher in cultivars from temperate regions than in those from tropical regions [4]. Moreover, the maturity of sesame seeds causes fatty acid changes [5]. Not only these conditions affect the fatty-acid composition; genotypic factors also play an important role in the process, resulting in the fact that each genotype shows a different fatty-acid composition. The determined growth habit, which is a very useful character enabling the possibility of mechanized harvesting by providing synchronous flowering in sesame, should also influence genotypic factors as well as the environment with respect to fatty-acid composition. However, there is no detailed study on the fatty-acid composition of determined character even though it was first induced as early as the 1980s [3].

Sesame seed contains 50–60% oil and 25% protein with antioxidant lignans such as sesamol and sesamin and has been used as active ingredients in antiseptics, bactericides, viricides, disinfectants, moth repellents, and anti-tubercular agents; it is also a good source of calcium, tryptophan, methionine, and many minerals. These lignan contents have beneficial physiological effects in animal and human health. The composition of fatty acid in sesame oil is variable between different cultivars [6].

According to literature information, the fatty-acid composition of sesame obtained from different regions has not been investigated. The aim of this study is to determine the fatty-acid compositions and $\omega 6/\omega 3$ ratios of sesame samples obtained from different countries grown in Anatolia, Pakistan, and China and to compare species.

Twenty sesame samples (eighteen samples from Turkey and two samples of imported material, see Table 1) were collected in order to determine the fatty-acid compositions.

Total lipid was extracted from the sesame samples by the method of [7]. Four-gram samples of sesame were homogenized with 80 mL of a 2:1 (v/v) mixture of chloroform–methanol, after which 4 mL 0.88% NaCl was added. The liquid was mixed and left to stand for 2 h to allow phase separation. The chloroform–methanol extract was evaporated to dryness in a water bath at 50°C under nitrogen flow. The fatty acids were converted to their methyl esters using the standard boron trifluoride–methanol method [8]. 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 a gas-liquid chromatograph (Shimadzu 15-A) equipped with a dual flame ionization detector and a 1.8 m × 3 mm internal diameter packed glass column containing GP 10% SP-2330 on 100/120 Chromosorb WAW, Cat. No. 11851. Column temperature was 190°C for 31 min, and then rose progressively at 30°C/min up to 220°C where it was maintained for 10 min at 220°C. Carrier gas was nitrogen (2 mL/min).

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TABLE 1. Fatty-Acid Composition of Sesame Samples Obtained from Different Provinces in Turkey

Fatty acid	1	2	3	4	5	6	7	8	9	10
10:0	–	0.05	–	0.00	0.01	–	–	–	–	–
12:0	0.05	0.13	0.01	0.03	0.04	0.03	0.11	0.08	0.07	0.04
14:0	0.05	0.11	0.05	0.03	0.03	0.07	0.19	0.12	0.14	0.11
15:0	0.00	0.00	–	0.00	0.00	0.00	–	–	–	–
16:0	10.28	8.62	9.84	10.21	9.70	9.84	9.40	9.76	10.14	10.62
18:0	4.40	2.16	3.22	3.35	3.36	2.82	1.98	1.78	3.29	3.20
21:0	0.22	0.20	0.30	0.20	0.21	0.21	0.21	0.30	0.21	0.32
22:0	–	–	–	0.02	0.00	–	–	–	0.00	0.00
24:0	0.00	–	–	0.15	–	–	0.10	0.25	0.10	0.45
Σ SFA	15.00	11.27	13.42	13.99	13.35	12.97	11.99	12.29	13.95	14.74
14:1	0.00	0.00	0.00	0.00	0.00	0.00	–	–	–	0.00
16:1	0.01	0.03	0.01	0.00	0.01	0.02	0.00	0.00	0.01	0.00
18:1	42.57	45.78	41.44	42.28	42.02	44.38	44.46	50.71	46.53	41.58
22:1	0.06	0.17	0.07	0.14	0.04	0.05	0.03	0.02	0.04	0.03
24:1	–	–	0.25	0.11	0.19	0.14	0.20	0.14	0.21	0.14
Σ MUFA	42.64	45.98	41.77	42.53	42.26	44.59	44.69	50.87	46.79	41.75
18:2	40.01	41.09	42.67	42.06	42.79	40.75	41.39	35.31	37.52	41.98
18:3	0.96	1.03	1.12	0.93	0.93	0.96	1.02	1.05	0.93	1.03
Σ unident.	1.40	0.62	1.03	0.50	0.71	0.70	0.93	0.48	0.81	0.49
Σ PUFA	42.37	42.74	44.82	43.49	44.43	42.41	43.34	36.84	39.26	43.50
Σ 6/3	28.57	30.30	35.71	38.46	38.46	29.41	25.64	28.57	29.41	37.04
SFA/PUFA	0.35	0.26	0.30	0.32	0.30	0.31	0.28	0.33	0.36	0.34

Fatty acid	11	12	13	14	15	16	17	18	19	20
12:0	0.00	0.01	0.00	0.01	0.03	0.03	0.06	0.05	0.21	0.07
14:0	0.02	0.01	0.02	0.02	0.13	0.15	0.20	0.12	0.39	0.25
15:0	0.00	0.03	–	0.00	–	–	–	–	–	–
16:0	9.26	9.68	9.54	10.19	9.81	9.48	9.58	9.84	10.77	10.35
18:0	4.03	2.11	5.05	4.15	4.27	3.80	3.83	3.83	4.25	3.89
21:0	0.22	0.21	0.21	0.26	–	–	0.45	0.23	–	–
24:0	0.81	0.24	1.00	0.52	1.19	0.37	0.58	1.01	0.52	0.60
Σ SFA	14.34	12.29	15.82	15.15	15.43	13.83	14.70	15.08	16.14	15.16
14:1	0.00	–	0.00	0.00	–	0.00	–	–	0.00	–
16:1	0.00	0.00	0.00	0.00	–	–	–	–	–	–
18:1	42.00	47.35	41.33	37.63	41.79	39.55	43.64	38.34	36.18	36.00
22:1	0.01	0.05	0.03	0.02	0.02	0.20	0.01	0.11	0.02	0.06
24:1	0.47	0.10	0.16	0.37	0.11	0.54	0.21	–	0.33	–
Σ MUFA	42.48	47.50	41.52	38.02	41.92	40.29	43.86	38.45	36.53	36.06
18:2	41.28	38.71	40.19	44.58	40.79	43.53	39.81	44.88	43.68	46.44
18:3	0.88	1.03	0.96	0.93	1.35	1.29	1.24	1.04	1.46	1.65
Σ unident.	1.0	0.46	1.54	1.32	0.52	1.05	0.39	0.56	2.2	0.68
Σ PUFA	43.16	40.20	42.69	46.83	42.66	45.87	41.44	46.48	47.34	48.77
Σ 6/3	35.71	35.71	25.64	50.00	24.39	23.81	26.32	40.00	15.15	27.03
SFA/PUFA	0.33	0.31	0.37	0.32	0.36	0.30	0.36	0.32	0.34	0.31

Provinces: Izmit Gozcuk (1), Amasya Merzifon (2), Manisa Kisla (3), Izmit Kandira (4), Aydin Incirliova (5), Edirne Uzunkopru (6), Balikesir Manyas (7), Antalya Manavgat (8), Bartin Yagci (9), Kahramanmaraş (10), Urfa Siverek (11), Konya Bozkir (12), Konya Akoren (13), Karaman Bucakisla (14), Mersin Mut (15), Diyarbakir Cungus (16), Konya Cumra (17), Adana Bahazli (18); Countries: Pakistan (19), China (20).

–: not determined.

The injector and detector temperatures were 225 and 245°C, respectively. Conditions were chosen to separate fatty acids of carbon chain length from 8 to 24. The fatty acids were identified by comparison of the retention times with known external standard mixtures (Alltech) quantified by Shimadzu Class-VP software, and the results were expressed as percentage distribution of fatty acid methyl esters. Each of the experiments was repeated three times.

The fatty-acid compositions of sesame samples for each region are presented in Table 1. The highest fatty-acid ratios are as follows: oleic acid 18:1 ω 9; (50.71%) in Manavgat in Antalya, (47.35%) in Bozkir in Konya, (46.53%) in Yagci in Bartin, linoleic acid 18:2 ω 6; (46.44%) in China, (44.88%) in Bahazli in Adana, (44.58%) in Bucakisla in Karaman, palmitic acid 16:0; (10.77) in Pakistan, (10.62) in Kahramanmaras, (10.35) in China. Oleic and linoleic acids are the most abundant monounsaturated and polyunsaturated fatty acids in all samples, respectively. The total MUFA (monounsaturated fatty acid) composition of the studied species is between 36.06–50.87%, while the PUFA (polyunsaturated fatty acid) composition is 36.84–48.77%.

Palmitic acid is mostly found in samples obtained from Pakistan and China, the major SFA contributing approximately 11.27–15.82% to the total SFA content. The level of MUFA depends on the level of oleic acid. The greatest proportion of oleic acid is found in Manavgat in Antalya. The European Commission reports that erucic acid 22:1 ω 9 in vegetable oils must be present at the maximum value of 5.0% for human health [9]. In this study, erucic acid was found to be between 0.01 and 0.20% in all species.

The long-chain ω 3 and ω 6 fatty acids are commonly called PUFAs. Long-chain ω 3 PUFAs cannot be readily synthesized by the human body and are mostly obtained through the diet, and ω 3/ ω 6 ratios are considered to be important [10, 11]. Dyerberg noted that an increase in the ω 3/ ω 6 PUFA ratio increased the availability of ω 3 PUFAs, which are beneficial for human health [12]. The lowest linoleic acid content (46.44%) is found in samples from China. Nutritionists suggest that ω 3 fatty acids must be present in greater amounts in human diet. In the present study, the ω 6/ ω 3 ratio is found to be 50.00% in Karaman and 15.15% in Pakistan.

Similarly, Akin found that the ω 6/ ω 3 ratio in the some raisin was 25.64, 13.86 and 8.86%, Eksi Kara, Gok Uzum, Kara Dimrit, respectively [13].

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