

FATTY ACID COMPOSITION OF *Linum* spp. COLLECTED FROM SOUTHEASTERN OF TURKEY

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Linum is a member of the Linaceae family and includes about 200 species in the Mediterranean region, mild or subtropical regions of Asia Southwest, and North America [1–3], it is mainly centered in the Balkans and Anatolia [4]. Today, this plant is used mainly for its oil [5, 6], but in early times it was used by the Egyptians to make cloth and for flax spinning and weaving. However, flax was utilized for medicinal purposes by the ancient Greeks and Romans.

The production of linseed oil may have started thousands of years ago in central Anatolia. *Linum* spp. is native to Anatolia and flax seeds have been found at several Neolithic sites. The earliest historical documents concerning linseed oil mills are Ottoman tax records from 1500-I. [7]. The endemism percentage of *Linum* species in the flora of Turkey is 39.4% [3].

Similar studies have indicated that climatic conditions and geography of locations play a vital role in the synthesis of fatty acid composition, especially unsaturated fatty acid in vegetable oils. [8]. Flax oil is the richest plant source of linoleic and linolenic polyunsaturated fatty acids, which are essential for humans since they cannot be synthesized in the organism and must be ingested in food [9]. The fatty acid composition of linseed oil is dominated by C18:0 (stearic), C16:0 (palmitic) C18:1 (oleic) C18:2 (linoleic, 16% of oil), and C18:3 (linolenic, 50% of oil) fatty acids [10, 11]. Green and Marshall [12] stated that significant variation in seed weight, oil content, and fatty acid composition was found both among and within varieties in a diverse collection of 214 *L. usitatissimum* accessions. Oleic acid and linolenic acid varied between 13.3 and 25.2% and 45.5 and 64.2%, respectively in the study.

In this study, eight *L. hirsutum* L., which were collected from different areas in Southeastern of Turkey, and two *L. usitatissimum* local populations were analyzed to determine the fatty acid composition of their seed oils (Table 1).

Significant variation in fatty acid composition was found both among and within species in *Linum* samples. Fourteen fatty acids were completely identified and quantitated. However, γ -linolenic was not found in samples of *L. hirsutum*. Saturated fatty acids comprised about 25.01% for *L. hirsutum* and 11.37% for *L. usitatissimum* of the total fatty acids. Polyunsaturated fatty acids were predominant in all samples (67.02% for *L. hirsutum* and 65.10% for *L. usitatissimum*). Monounsaturated fatty acids were 6.74% for *L. hirsutum* and 22.93% for *L. usitatissimum*. While the dominant fatty acids of wild population were linoleic (38.76%), α -linolenic (28.27%), and palmitic acid (20.47%), α -linolenic (48.66%), oleic (22.68%), and linoleic (16.29%) were predominant in local populations. Some of fatty acids found in local populations were myristic, oleic (18:1n9), margaric, and icosenoic acids, but only in very small quantities (< 0.1%) (Table 2).

There were found wild populations (*L. usitatissimum*) differing from local populations (*L. hirsutum*) in the fatty acid profiles. The content of palmitic acid was 20.47% in wild populations, whereas it was 5.95% in local populations. Stearic acid (2.79%) in wild populations was lower than that of local populations (4.9%). Linoleic acid was 38.76% and 16.29% in *L. hirsutum* and *L. usitatissimum*, respectively. α -Linolenic acid was determined to be 28.27% for wild flaxseed and 48.66% for local cultivars. The percentage of α -linolenic and linoleic acids shows close negative correlation [13].

The fatty acid composition of wild populations (*L. hirsutum*) shows significant variation. Palmitic acid and stearic acid varied between 19.57–20.68% and 2.61–3.24%, respectively. The Derik/Mardin sample had the highest value for oleic acid (7.87%) but a low value for linoleic acid (5.97%). There was a strong complementarity between oleic and linoleic acids in the oil seeds as cited by [14]. The percentage of α -linolenic acid ranged from 25.45% to 31.02%, and the highest α -linolenic acid content was for Malatya. However, Malatya had higher latitude than the other collecting areas, and the linoleic and α -linolenic acid contents were increased at high latitude [15].

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TABLE 1. The Collecting Area of *L. hirsutum*

No.	Collecting areas	Collecting date	Elevation, m	No.	Collecting areas	Collecting date	Elevation, m
1	Derik/Mardin	19.06.07	1064	5	Malatya	16.06.07	1807
2	Hani/Diyarbakir	08.07.06	1073	6	Diyarbakir	17.12.06	656
3	Nemrut/Adiyaman	27.06.06	1437	7	Servi/Bingol	08.07.06	1136
4	Sultansehmus/Mardin	19.06.07	983	8	Gercus/Batman	06.06.07	802

TABLE 2. Fatty Acids Composition of *Linum* spp. Samples Originating from Southeastern Anatolia

Fatty acids	Collecting areas											
	1	2	3	4	5	6	7	8	Mean*	Loc P.	Loc P.	Mean**
	Percentage of fatty acids											
14:0	0.13	0.14	0.18	0.14	0.15	0.21	0.18	0.12	0.16	0.06	0.06	0.06
16:0	19.99	20.43	21.72	20.26	20.58	19.57	20.53	20.68	20.47	6.19	5.70	5.95
16:1	0.13	0.15	0.12	0.15	0.13	–	0.13	0.15	0.12	0.11	0.16	0.14
17:0	0.12	0.16	0.16	0.11	0.15	0.16	0.17	0.15	0.15	0.07	0.08	0.08
18:0	2.88	3.24	2.63	2.88	2.61	2.68	2.66	2.72	2.79	4.22	5.62	4.92
18:1n9 <i>trans</i>	0.12	0.15	0.16	0.13	0.15	0.21	0.15	0.13	0.15	0.07	–	0.04
18:1n9 <i>cis</i>	7.87	6.59	4.91	6.84	5.52	6.63	6.08	6.42	6.36	18.35	27.0	22.68
18:2n6 <i>cis</i>	38.39	40.63	37.48	38.13	36.89	40.15	39.65	38.73	38.76	18.34	14.24	16.29
18:3n6	–	–	–	–	–	–	–	–	–	0.17	0.14	0.16
20:0	0.68	0.83	0.77	0.75	0.75	0.77	0.74	0.71	0.75	0.08	0.14	0.11
18:3n3	27.58	25.45	29.82	28.70	31.02	27.54	27.84	28.17	28.27	51.62	45.70	48.66
20:1n9	0.11	0.13	0.12	0.10	0.12	0.17	0.15	0.12	0.13	0.07	0.10	0.09
22:0	0.50	0.55	0.44	0.54	0.47	0.53	0.44	0.48	0.49	0.18	0.15	0.17
24:0	0.19	0.23	0.22	0.19	0.13	0.23	0.21	0.21	0.20	0.11	0.11	0.11
Σ_{Sat} , %	24.47	25.56	26.11	24.86	24.83	24.14	24.91	25.06	25.01	10.88	11.85	11.37
$\Sigma_{\text{monounsats}}$, %	8.22	7.0	5.30	7.21	5.90	7.0	6.50	6.82	6.74	18.60	27.25	22.93
$\Sigma_{\text{polyunsats}}$, %	65.96	66.08	67.30	66.83	67.90	67.69	67.48	66.90	67.02	70.12	60.08	65.10
$\Sigma_{\text{Fatty acid}}$	98.65	98.64	98.71	98.89	98.63	98.82	98.88	98.77	98.75	99.60	99.17	99.38

1: Derik/Mardin, 2: Hani/Diyarbakir, 3: Nemrut/Adiyaman, 4: Sultansehmus/Mardin, 5: Malatya, 6: Diyarbakir, 7: Servi/Bingol, 8: Gercus/Batman.

Mean*: mean of wild population. Mean**: mean of local population, Loc P: local population.

The results obtained from this study indicated that *Linum* spp. seed oils are of the linolenic–linoleic type. Also, oleic and palmitic type fatty acids are the predominant oils. Significant variation in fatty acid composition was found within both wild and local populations (*L. hirsutum* and *L. ussitatissimum*). However, the variability in *Linum* spp. fatty acid content indicates that further selection or breeding can be carried out.

The fatty acid composition of the seed oil was determined by gas-liquid chromatography of fatty acid methyl esters, prepared according to the method of IUPAC II D19 [16]. Separation of fatty acid methyl esters was achieved on a SP-2330 fused silica capillary column (30 m × 0.25 mm i.d., 0.20 μm). The oven temperature was 120°C for 2 min, programmed to 180°C at 5°C/min, then programmed to 220°C at 20°C/min and then held there for 20 min and maintained at 240°C and 250°C, respectively. The carrier gas was helium with a linear flow rate of 0.5 mL/min and a split ratio of 1/150. The fatty acid analyses were conducted in duplicate.

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