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Effect of Varieties and Years on Seed Composition of Sesame (*Sesamum indicum* L.) Grown in Semi-Arid Area

ERKAN BOYDAK†, IHSAN KARABULUT‡,
MEHMET ALPASLAN‡, MEHMET HAYTA‡ and DAVUT KARAASLAN*
Southeast Anatolia Agricultural Research Institute, P.B. 72, 21110, Diyarbakir, Turkey
E-mail: karaasland@yahoo.com; mhayta@inonu.edu.tr

The effect of variety and growing year on oil, protein and fatty acid composition of sesame seeds was studied. Five sesame cultivars, Muganli-57, Gölmarmara, Tan-99, Orhangazi-99, Kepsut-99 and pure lines 27224 and 27206 were investigated. The oil content of sesame samples varied from 38.65 to 51.79 %. The variety of Tan-99 grown in 2004 had the maximum oil value. Oil and protein content of sesame varieties grown in 2003 and 2004 years changed insignificantly ($p > 0.05$). The protein content of the variety of Orhangazi was the highest among other varieties. The correlation coefficient between protein and oil content was -0.372 averaged over 2003 and 2004. Oleic and linoleic acid contents were significantly affected by variety ($p < 0.05$). In 2003, all varieties had higher linoleic and lower oleic acid levels. The correlation coefficient 'r' between oleic acid and linoleic acid content were -0.957 for sesame varieties grown in 2003 and 2004. In general, the variety appeared to have an influence on seed composition of sesame.

Key Words: Fatty acid composition, Protein and oil content, Sesame variety.

INTRODUCTION

Sesame (*Sesamum indicum* L.) is probably the most ancient oilseed and used by humans as a food source. This important annual oilseed crop has been cultivated for centuries, particularly in the developing countries of Asia and Africa, for its high content of both excellent quality edible oil (42-51 %) and protein (22 to 25 %)[1-3].

The improvement of oil content is of great importance in the breeding of sesame[4]. The composition is markedly influenced by genetic, climatic and agronomic factors and varies considerably within variety. Shorter season varieties tend to have higher oil content than longer season varieties[5]. The

†Department of Field Crops, Harran University, 6300 Sanliurfa, Turkey.
‡Department of Food Engineering, Inonu University, 44280, Malatya, Turkey.

dark coloured seeds generally have higher oil content. High rates of nitrogen fertilizer reduce oil content[6,7]. Turkish sesame varieties have a great range of variation in genetic, morphologic and quality character[5-8].

The protein content of the seed is said to be four times more dependent on environmental conditions than on variety[9]. Wolf *et al.*[10] reported a positive relationship between temperature and protein or oil content. The fatty acid composition of sesame oil varies considerably among the different cultivars worldwide[11]. The average percentage of oleic acid and linoleic acid content in the sesame germplasms and cultivars is very similar 41.3 and 43.7 %, respectively[4].

The effects of growing year and variety on protein oil contents and fatty acid composition have not been fully explored under agroclimatic conditions of Harran plain of Turkey. The aim of this research were to investigate the effect of variety and growing year on oil, protein and fatty acid composition of sesame.

EXPERIMENTAL

The experiment was carried out in 2003 and 2004 at experimental fields of the Faculty of Agriculture, Harran University, Sanliurfa, Turkey. Five sesame cultivars, Muganli-57, Gölmarmara, Tan-99, Orhangazi-99, Kepsut-99 and pure lines 27224 and 27206 were grown under field conditions. Sesame seeds were planted on June 15. The experimental design was a randomized block of split plot with three replications. Field tests were conducted on the silty-clay soil with a pH of 7.5 and lime content of 9.9 %.

All treatments were fertilized with 9 kg of nitrogen and 4 kg of phosphorus per decare. Sowing was performed on non-irrigated seedbeds and irrigated using sprinkle irrigation method. The plants were thinned after complete emergence as keeping on row about 5-7 cm. The spaces between rows were 65 cm. Each row was 5 m long with a 25 cm distance between seeds. It was irrigated every 20th day. Crop was harvested on November 5. Meteorological data were recorded from planting to harvest of each treatment (Table-1).

Compositional analyses: Sesame seeds were ground with a lab mill (M20 model, IKA®-WERKE, Staufen, Germany) and used for the analyses. The oil content of seeds was determined by a Soxhlet extraction method using *n*-hexane as solvent at 70 °C for 6 h[12]. Protein content (N×6.25) of sesame was determined according to the Kjelhdal procedure[13] using a Tecator Kjeltech Auto Analyzer, model 1030.

Fatty acid methyl esters were prepared according to AOCS Official Method Ce 2-66[14] and analyzed with HP 6890 Series II Gas Chromatograph (Hewlett-Packard Company, Wilmington, DE, USA) equipped with a flame ionization detector and auto sampler. A fused silica capillary column SP 2340 (60 m × 0.25 mm i.d.) with a film thickness of 0.25 μm (Supelco,

TABLE-1
METEOROLOGICAL DATA FOR SESAME
GROWN AREA DURING YEAR 2003 AND 2004

	Year	Maximum temp. (ºC)	Minimum temp. (ºC)	Average temp. (ºC)	Relative humidity (%)	Rainfall (mm)
June	2003	39.0	14.1	28.6	35.1	5.2
	2004	39.4	17.3	29.0	33.5	NR
July	2003	44.3	22.9	32.6	28.5	NR
	2004	43.3	21.1	32.8	27.0	NR
August	2003	43.3	21.5	32.7	32.2	NR
	2004	43.1	20.0	30.8	40.7	NR
September	2003	41.0	15.7	26.4	42.4	0.1
	2004	38.5	16.4	27.3	34.8	NR
October	2003	35.5	3.8	21.5	51.5	23.1
	2004	35.0	11.3	21.7	48.7	3.4

NR = No rainfall

Taufkirchen, Germany) was used. Injection, detector and oven temperatures were 250, 260 and 190 ºC, respectively. Nitrogen was used as a carrier gas at a flow rate of 1.0 mL/min. Individual peaks were identified by comparing the retention times with Grain fatty acid methyl esters (Supelco).

Statistical evaluation: Statistical evaluation was carried out using SPSS package program version 9.0 with general linear model (GLM) analysis of variance (ANOVA). Duncan's multiple range test was used to determine significant differences between means.

RESULTS AND DISCUSSION

The effect of variety on oil and protein contents of the sesame grown in 2003, 2004 and averaged over was presented in Table-2. The oil content of sesame samples varied from 38.65 to 51.79 %. The variety of Tan-99 in 2004 had maximum oil value. The variety had no significant effect ($p > 0.05$) on oil content averaged over 2003 and 2004 and varied significantly between 2003 and 2004. The oil content results are in agreement with reported values of Alpaslan *et al.*[8] which were studied Harran grown sesame. It is known that ecological condition, maturity, variety and location affect oil content of sesame[11,15,16]. Bahkali and Hussain[17] reported that dark sesame seed had significantly higher oil but lower protein content than white seeds.

Similar results were also reported by Al-Kahtani[1], Ahmad *et al.*[18] and Baydar *et al.*[5], who investigated sesame seed from South Anatolian region of Turkey. Rennie and Tanner[19] reported significant difference between

cultivars for total oil and protein content. Variety of sesame affected protein content significantly ($p < 0.05$). The protein content of the variety of Orhangazi was the highest among the other varieties (Table-2). The protein content of sesame seeds varied from 22.60 % (Muganli-57) to 27.63 % (Orhangazi) in 2004. Significant differences were also found in protein content of sesame samples between 2003 and 2004 (Table-2). This can be explained by the fact that annual climatic conditions were not identical. Alpaslan *et al.*[8] and Bahkali and Hussain[17] reported similar levels of protein content for Harran and Gizan grown sesame samples, respectively.

TABLE 2
EFFECT OF VARIETY ON OIL AND PROTEIN
CONTENT OF SESAME SAMPLES GROWN IN 2003 AND 2004

Variety	Oil (%)			Protein (%)		
	2003	2004	Average	2003	2004	Average
Tan-99	51.79a	40.00bcd	45.90a	23.45b	24.70b	24.08ab
Gölmarmara	50.78abc	42.93ab	46.85a	22.67bc	24.43b	24.58a
Kepsüt-99	49.86c	37.74d	43.80a	23.27b	23.60bc	23.43ab
Muganli-57	47.82d	38.65cd	43.24a	22.37d	22.60d	22.48b
Orhangazi	51.33ab	42.03bc	46.68a	22.67bc	27.63a	25.15a
27224	48.64d	46.32a	47.48a	24.37a	23.00d	23.68ab
27206	50.37bc	46.14a	48.25a	22.83bc	24.43b	23.63ab

Mean values in the same column followed by different letters are significantly different ($p < 0.05$).

Growing year also had a significant effect on oil and protein contents. The variation in the seed composition of sesame can result from the differences in temperature, natural day length, humidity among seasons and the sensitivity of the genotypes to these parameters[6,20]. It was found that, protein contents of the sesame sample grown in year 2004 were higher than the sesame sample grown in 2003. The correlation coefficient (r) between protein and oil content was -0.372 in averaged over 2003 and 2004 (Table-2). Negative correlation between oil and protein due mainly to environment and genotype related variations have been reported[21]. The fatty acid compositions of the sesame sample of years 2003 and 2004 are shown Table-3. Linoleic acid, oleic acid, palmitic acid, linolenic acid and stearic acid are the principal fatty acids. The average proportion of linoleic acid varied between 40.35 and 41.88 %, whereas, oleic acid ranged from 42.75 to 45.76 %. These findings are comparable with the results of Alpaslan *et al.*[8] and Bahkali and Hussain[17]. The variation of fatty acid composition of vegetable oils depends on agronomic and climatic factors during growing season[10,19,22].

TABLE-3
EFFECT OF VARIETY ON FATTY ACID
CONTENTS OF SESAME SAMPLE GROWN IN 2003 AND 2004

Fatty acids	Year	27224	Tan-99	27206	GO	KE	MU	OR
	2003	8.33cd	8.63ab	8.72a	8.68ab	8.51bc	8.10d	8.27de
16:0	2004	8.90a	8.89a	8.98a	8.63ab	8.37bc	8.13d	8.42b
	Average	8.62abc	8.76a	8.85a	8.85a	8.44bc	8.12d	8.35cd
	2003	5.64a	5.05c	5.60a	5.28b	5.28b	5.33b	5.28b
18:0	2004	5.94a	5.28b	5.55b	5.60ab	5.51b	5.51b	5.49b
	Average	5.78a	5.16c	5.57ab	5.44b	5.40bc	5.42b	5.39bc
	2003	44.24a	42.62bcd	43.19b	41.71d	43.00bc	44.45a	42.11cd
18:1	2004	43.72c	44.42c	43.83c	43.79c	45.91b	47.06a	45.50b
	Average	43.98b	43.52b	43.52b	42.75b	44.45ab	45.76a	43.81b
	2003	40.58d	42.46ab	41.25cd	43.09a	41.92bc	40.87d	43.07a
18:2	2004	40.19ab	40.11ab	40.35a	40.67a	38.77c	37.83c	39.01bc
	Average	40.39ab	41.28ab	40.80ab	41.88a	40.35ab	39.35b	41.04ab
	2003	0.58b	0.62a	0.64a	0.64a	0.66a	0.64a	0.64a
18:3	2004	0.60c	0.68bc	0.67bc	0.66bc	0.80a	0.82a	0.74ab
	Average	0.90b	0.65ab	0.65ab	0.65ab	0.73a	0.73a	0.69a
	2003	0.64a	0.62a	0.67a	0.60a	0.63a	0.61a	0.62a
20:0	2004	0.64a	0.62a	0.63a	0.64a	0.64a	0.64a	0.64a
	Average	0.64	0.62	0.62	0.62	0.63	0.63	0.63

GO = Gölmarmara; KE = Kepsüt-99; MU = Muganli57; OR = Orhangazi
Mean values in the same row followed by different letters are significantly different ($p < 0.05$).

Oleic acid and linoleic acid were significantly affected by the variety ($p < 0.05$). For 2003 samples, all varieties had higher linoleic acid and lower oleic acid levels (Table-3). It was found that year had the important effect on all five fatty acids found in sesame seed, which was likely due to variation in weather conditions between 2003 and 2004. The correlation coefficient between oleic acid and linoleic acid content was -0.957 for sesame varieties grown in 2003 and 2004 respectively.

Conclusion

The present outline of the variation in seed protein oil and fatty acid content of sesame varieties grown in semi-arid area (Harran plain in Turkey) demonstrates that both growing year and variety effects can considerably modify seed protein, oil and fatty acid content.

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