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Full Length Research Paper

Morphological properties and chemical compositions of some sesame (*Sesamum indicum* L.) populations cultivated in Kilis, Turkey

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In this study, the morphological and biochemical properties of local sesame (*Sesamum indicum* L.) populations which are widely cultivated in Kilis and its districts, collected from 12 different fields were determined. Sesame oil content and protein content varied between 25.59 to 35.23% and 19.81 to 24.45%, respectively. Main components of seed fatty acids were found to be oleic acid (43.51 to 49.05%), linoleic acid (36.10 to 39.80%), palmitic acid (7.83 to 9.46%), stearic acid (5.40 to 6.09%) and arachidonic acid (0.31 to 0.57%). Branch number per plant (4.20 to 9.40), capsule number per plant (38.0 to 163.8), seed number per capsule (42.00-72.80), 1000 seed weight (2.76-3.96 g) and seed yield per plant (6.37 to 35.15 g) showed vast variation among populations in terms of morphological properties.

Key words: *Sesamum indicum* L., protein content, crude oil content, fatty acid composition.

INTRODUCTION

Sesame (*Sesamum indicum* L.) belonging to the Pedaliaceae family is an important annual oil seed crop. This plant is extensively cultivated in the tropics and temperate zone of the world (Biabani and Pakniyat, 2008). This cultivation range extending from the semi-arid tropics to sub-tropic temperate regions has lead to a wide diversity of genotypes (Weiss, 2000; Söğüt, 2008). The main differences in the yield variation in terms of morphological properties and chemical compositions of sesame cultivars have been attributed to the lack of new cultivars for high yield, early maturity, non-shattering and wide adaptation (Baydar et al., 1999). Variable photo-period like climatic conditions can affect the percentage fertilized flower and therefore, the capsule number per plant, branch number per plant, seed number per capsule, 1000-seed weight, seed yield per plant may increase or decrease depending on the length of photoperiod. In addition to differences in morphological properties, protein content, oil content and fatty acid compositions may vary considerably between genotypes and under different environmental conditions (Söğüt, 2008).

The present study was aimed to determine and compare the different sesame populations cultivated in Kilis, Turkey regarding morphological properties and chemical compositions such as protein, oil and fatty acid. It is also targeted to determine suitable genotypes in Kilis region of Anatolia in this study.

MATERIALS AND METHODS

The study was carried out using twelve local genotypes of sesame (*Sesame indicum* L.) collected in Kilis region in 2009 to compare and determine the capsule number per plant, branch number per plant, 1000-seed weight, protein content, oil content and fatty acid compositions of cultivated sesame genotypes. All chemicals were used as analytical grade purchased from Merck (Darmstadt, Germany).

Kilis, which is located in the South East Anatolian Region of Turkey, has generally alkali soils. This region has hot and dry summers and warm and rainy winters. The monthly and average rainfall (mm), temperature (℃), humidity (%) values in the year of 2009 are presented in Table 1 (Anonymous, 2009).

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Table 1. Monthly rainfall (mm), temperature (℃), humidity (%) in the year of 2009.

Month	Rainfall (mm)	Temperature (ºC)	Humidity (%)
January	40	6.8	49.1
February	121.3	8.5	68
March	53.1	10.3	60.3
April	41.3	15.8	44.5
May	8.8	21.5	34.3
June	4.5	27.9	29.8
July	_	29.4	37.9
August	_	29.8	32.1
September	_	24.8	37.5
October	29.9	22.6	37.5
November	45.7	13	59.3
December	118.5	10	71.9
Average	38.5	18.3	46.8

Table 2. Analysis of variance for branch number per plant, capsule number per plant, seed number per capsule, 1000-seed weight, seed yield per plant.

Source of variation	DF	F Values				
		Branch number per plant	Capsule number per plant	seed number per capsule	1000-seed weight	Seed yield per plant
Replicates	4	1.275	1541.558	158.058	0.051	181.216
Location	11	14.417**	8189.835**	326.877**	0.542**	475.722**
Error	44	3.966	1025.877	135.177	0.190	81.075
CV (%)		30.10	31.93	19.99	13.18	44.62

*= Significant at the 5% probability level, **= significant at the1% probability level.

Ten plants were randomly chosen to record the branch number per plant, capsule number per plant, seed number per capsule, 1000-seed weight, seed yield per plant after harvest.

Firstly, before analysis, collected sesame seed from different locations were dried in an incubator at 101℃ for 30 min and then powdered. Later, the samples were used for crude protein, oil, and fatty acid composition determination.

For crude protein determination, 0.5 g of moisture-free samples of the ground sesame was weighed and the seed protein content was determined by Kjeldahl method (Kacar, 1972). The protein percentage was calculated by multiplying the nitrogen content by 6.25. All values presented are means ± standard errors (SE) of triplicate analyses.

Crude oil was extracted from sesame seeds (10 g of each sample) with *n*-hexane for four hours using a Soxhlet extraction apparatus (Thermal). Then the solvent was evaporated under reduced pressure and temperature using a Rotary evaporator (Heidolph). 0.5 g of sesame oil was added 10 ml *n*-heptane into tubes for esterification. After 0.5 ml methanolic potassium hydroxide was added, tubes were vigorously shaken for 30 s after the vials were closed. The supernatant of the solution was taken followed after one hour of incubation at room temperature. Then, the supernatant was put in 2 ml vials for injection.

GC-FID analyses of fatty acids methyl esters was carried out on a Shimadzu gas chromatography (GC-2010 series) equipped with an Supelco SP 2380 fused silica capillary column (100 m, 0.25 mm i.d., 0.2 µm film thickness). Helium was used as carrier gas, at a flow rate of 3 mL/min. The injection and detector temperature were 140 and 240℃, respectively. The oven temperature was held isothermal at 140℃ for 5 min, then raised to 240℃ at 4℃ /min and held isothermal at 240℃ for 15 min. Injection volu me of Diluted samples [1/100 (v/v) in *n*-heptane] of 1.0 µL were injected automatically in the split mode (1/100).

The identification of the constituents was based on comparison of the GC-retention indices with those of available analytical standards (Larodan Fine chemicals, mixture of 37 components of fatty acids methyl esters). Peak area was used to obtain the percentage of individual fatty acid.

For statistical evaluation, data recorded were subjected to analyses of variance using SPSS 16.0 software according to the randomized experimental design.

RESULTS AND DISCUSSION

Analysis of variance for and the combined results of branch number, capsule number per plant, seed number per capsule, 1000-seed weight, seed yield per plant are presented in Tables 2 and 3, respectively.

Agronomical traits of sesame genotypes collected from different locations were evaluated and the detailed statistical analyses among populations were given (Table

Table 3. Branch number per plant, capsule number per plant, seed number per capsule, 1000-seed weight, seed yield per plant of populations collected from different locations.

Location	Branch number per plant	Capsule number per plant	Seed number per capsule	1000 seed weight (g)	seed yield per plant (g)
Oylum	6.60 ± 0.51abcde	103.60±9.06 cde	60.60±4.82bcd	3.10±0.14ab	19.48±2.17abc
Arpakesmez	7.00 ± 0.71abcde	108.00±9.24cdef	59.00±4.23abcd	3.15±0.26abc	19.79±2.87abc
Yavuzlu	7.20 ± 0.86bcde	86.80±14.39bcd	48.60±4.77ab	2.98±0.13ab	14.92±2.63ab
Beşiriye	4.40 ± 0.40ab	38.00±2.30a	42.00±5.94a	2.76±0.29a	6.37±0.98[a]
Demırışık	6.00 ± 0.84abcd	93.00±14.46cde	58.60±4.06abcd	3.24±0.17abc	15.85±3.92ab
Polateli	7.20 ±0.49bcde	163.80±22.59g	55.80±5.16abcd	3.46±0.12bcd	35.15±8.75d
Kesmelik	4.20 ±0.86a	66.20±22.78 abc	58.20±3.71abcd	3.04±0.19ab	10.35±3.36a
Bozcayazı	8.80 ± 1.36de	135.40±11.32efg	52.60±4.12abc	3.43±0.15bcd	26.59±3,83bcd
Ekincik	4.60 ± 0.40ab	42.60±4.93 ab	72.80±2.24d	3.73±0.10cd	12.09±1.60a
Dölek	5.80 ± 0.49abc	81.80±9.24abc	61.60 ±5.05bcd	3.36±0.17abcd	14.89±2.18ab
Çanak	8.20 ± 0.73cde	152.40±22.81fg	60.20±5.34bcd	3.96±0.23d	35.07±6.19d
Topdağı Yolu	9.40 ±1.69e	132.2 0±13.75defg	67.80±9.85cd	3.43±0.18bcd	31.66±5.50cd

Means±SE in the same column by the same letter are not significantly different to the test of Duncan (α = 0.05).

3). According to the obtained results, the highest value for branch number per plant (9.40) was found in the populations from Topdağı Yolu while the lowest value (4.20) was determined in samples from Kesmelik.

Results in the present work obtained are parallel in terms of branch number per plant with the study conducted by Karaaslan et al. (2002). However, the results obtained were higher than the some studies carried out as follows. The branch number per plant in our study varied between 4.20 to 9.40 which was different from the result that ranged from 2.40 to 3.52 in the study carried out in Sudan by El Mahdi et al. (2007) but similar to the work by Yılmaz et al. (2005) in Şanlıurfa, which showed a branch number between 4.23 to 5.48. This variation in branch number could be due to the different populations and genotypes. As a consequence, the number of branch increases while the plant number decreases.

The capsule number per plant, which is very significant for crop yield, varied between 38.0 (Beşiriye) and 163.8 (Polateli) among different populations. The results obtained by Yılmaz et al. (2005) ranged from 73.68 to 97.68. The possibility for variation among populations regarding that capsule number have been attributed to the adaptation to the length of day and directly related to the flower number per plant, which can be seriously affected by the climatic conditions (Söğüt, 2008). Therefore, the populations adaptative to the length of day formed capsules earlier while non-adaptative ones, instead of forming capsules, grew taller.

Seed number per papsule was in the range of 42.0 (Beşiriye) to 72.80 (Ekincik) while it varied between 65.3 and 76.1 in the study conducted by Çağırgan et al. (2009). The variation of seed number per capsule among populations could be due to the late-blooming stage; consequently, the lower seed number per capsule occurs.

1000-seed weight ranged from 2.76 (Beşiriye) to 3.96 g (Çanak) and these results are consistent with the work reported by Yılmaz et al. (2005), in which values of 1000-seed weight varied between 2.85 and 3.36 g.

Seed yield per plant showed variation among populations between 6.37 g (Beşiriye) and 35, and 7-15 g (Çanak and Polateli). The results were supported by previous works (Baydar, 2005; Furat and Uzun, 2005; Yılmaz et al., 2005).

According to the results, populations collected from Beşiriye region has, in general, the lowest values regarding yield parameters, but the highest values varied from location to location.

The protein content of different cultivars ranged from 19.81 to 24.45% (Table 4). While the lowest protein content was recorded in the Topdağı Yolu location, Dölek location showed the highest protein content. Bahkali et al. (1998) reported similar result, that the relative protein content of the sesame seeds grown in the Gizan area of Saudi Arabia was 18.3 to 25.18%. The cultivars showed a relatively high protein content (24.45%) which is consistent with some of the Indian sesame cultivars (25.4%) reported by Dhawan et al. (1972). However, the protein content range (19.81 to 24.45%) was little more than the protein content range (17.2 to 22.0%) of some Nigerian sesame cultivars reported by Dashak and Fali (1993). Baydar et al. (1999) analyzed some pure lines selected for improving chemical composition of some Turkish sesame populations and showed that the protein content ranged from 21.3 to 25.31%. The cultivars of the *sesame indicum* may show a wide range of chemical composition (Karaaslan et al., 2002). The variation in crude protein content of cultivars may have been

Table 4. The average protein and oil content obtained from different populations.

Location	Protein content (%)	Oil content (%)
Oylum	22.00± 0.045abc	31.59± 1.81abcd
Arpakesmez	23.36 ± 0.90bc	33.14 ± 1.60bcd
Yavuzlu	23.53 ± 0.00bc	34.37 ±1.84cd
Beşiriye	23.01 ± 0.00bc	30.43±3.42abcd
Demirışık	23.70 ± 0.25bc	32.78 ±1.49bcd
Polateli	22.74 ± 0.18bc	29.77 ±1.86abcd
Kesmelik	21.13 ± 0.57ab	31.11 ±0.98abcd
Bozcayazı	22.92 ± 1.66bc	28.89 ±1.43abc
Ekincik	23.27± 1.93bc	25.59 ±1.76a
Dölek	24.45± 0.13c	25.61±1.22a
Çanak	23.57± 0.31bc	27.94 ±1.82ab
Topdağı Yolu	19.81 ±0.31a	35.23±1.28d

Means±SE in the same column by the same letter are not significantly different to the test of Duncan (α = 0.05).

Table 5. Analysis of fatty acid compositions in different sesame populations.

Locations	Palmitic acid (%)	Stearic acid (%)	Oleic acid (%)	Linoleic acid (%)
Oylum	9.26	5.93	46.91	36.72
Arpakesmez	9.46	6.09	45.76	37.47
Yavuzlu	9.16	5.82	47.15	36.81
Beşiriye	7.83	5.66	47.20	38.25
Demirışık	8.49	6.06	46.90	37.67
Polateli	8.50	5.49	49.05	36.10
Kesmelik	9.36	5.40	44.83	39.63
Bozcayazı	9.36	5.45	46.42	37.83
Ekincik	8.78	5.66	46.72	37.95
Dölek	9.43	5.60	46.63	36.91
Çanak	9.27	5.82	45.47	38.01
Topdağı Yolu	9.33	6.02	43.51	39.80
Average	9.01	5.75	46.37	37.76

attributed to the variety, location, soil properties, climate and fertilization (Kuzayli et al., 1966; Dashak and Fali, 1993; Bakhali et al., 1998). The present study is relatively consistent with the previous reported works. Demir (1972) reported that there was a negative correlation between protein content and oil content.

The crude oil content ranged from 25.59 to 35.23% (Table 4). Whereas the lowest oil content (25.59%) was recorded in the Ekincik location, Yavuzlu location showed the highest oil content (35.23 %). The sesame varieties cultivated under Diyarbakir ecological conditions have been reported to contain crude oil content at a range from 36 to 50% (Karaaslan et al., 1999). The differences regarding the oil content reported by Özcan (1993) in native varieties and imported varieties are 52 to 61% and 53.30 to 55.50%, respectively. The oil content of some cultivars in Antalya, located in the Mediterranean Region of Turkey, was reported to be in the range of 41.69-61.76% by Uzun (1997) and 43.42 to 49.67% by Yılmaz et al. (2005). The average value of the oil content obtained in the present is lower as compared to the previous works.

Fatty acid distribution among sesame oils is presented in Table 5. Oleic (43.51 to 49.05%) and linoleic acid (36.10 to 39.80%) are the major unsaturated fatty acids present and palmitic acid and stearic acid accounted for 7.83 to 9.46% and 5.40 to 6.09%, respectively. Turgut and Baydar (1996) reported that the fatty acids in the sesame cultivars of the South East Region of Turkey were: palmitic acid (9.7%), stearic acid (4.8%), oleic acid (45.3%) and linoleic acid (39.5%). The similar investigation for Mediterranean Region reported by Turgut and Baydar (1996) showed the palmitic acid (9.3%), stearic acid (4.7%), oleic acid (43.4%) and

linoleic acid (41.7%). The recorded results in our study for the average value of fatty acid compositions were as follows: palmitic acid (9.01%), stearic acid (5.75%), oleic acid (46.37%) and linoleic acid (37.76%). Kilis province is geographically located between South East Anatolian and Mediterranean Region. When comparing studies, the value here obtained are between the ranges of the two regions. Differently, the values recorded by Özcan (1993) of palmitic acid (9.10 to 11.38%), stearic acid (trace-0.15%), oleic acid (31.61 to 57.19%) and linoleic acid (30.79 to 57.33%) were not in a good agreement with our study.

The fatty acid composition is of great significance for determination of the oil quality. The quality is especially based on the palmitic, stearic, oleic and linoleic acid content percentage and those values may change under different ecological and cultural factors (Demir, 1972). The variation in fatty acid content of cultivars may have been also attributed to the genetic structure, development stages and fruit formation (Turgut and Baydar, 1996).

Conclusion

In the present study, the morphological and chemical compositions of the different sesame populations cultivated in Kilis, Turkey were determined and compared. Regarding that morphological properties, the populations showed variations. Consequently, the fatty acid compositions of the sesame genotypes cultivated in Kilis are consistent with the previous works when compared. Even the crude oil content was lower; the fatty acid content is higher. Crude oil values are relatively closer to each in all sesame populations and protein content was obtained due to the fact that there is no soil fertilization and cultivation of sesame in this region is not made under irrigated conditions.

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