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CHARACTERIZATION OF PEANUT (*Arachis hypogaea* L.) SEED OIL AND FATTY ACIDS COMPOSITION UNDER DIFFERENT GROWING SEASON UNDER MEDITERRANEAN ENVIRONMENT

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ABSTRACT

Peanut is one of the most important oil and protein producing crops in the world. Quality of peanut seed oil is influenced by temperature and moisture. However, little is known about the chemical composition of peanut grown in environmental conditions of Turkey. Therefore, this study was conducted at the Cukurova University Farm, Turkey as a main and double cropped to determinate oil quality and fatty acid compositions of some peanut varieties in different growing seasons. The results of study indicated that, the oil content (two years average) of peanut varieties ranged from 47.55-51.55% in main cropped and 43.71-50.48% in double cropped growing seasons. Further, the oleic acid content was also varied between 39.80-81.13% and 39.42-81.51% in main and double cropped growing seasons, respectively and the linoleic acid percentage values of peanut varieties ranged from 1.73 to 36.38% in main cropped and from 2.66 to 37.72% in double cropped growing season. Oleic acid to linoleic acid ratio (O/L) was higher in main cropped than in double cropped growing season and iodine value was higher in double cropped than in main cropped growing season.

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1 Introduction

Peanut (*Arachis hypogaea* L.) is the fourth major oilseeds crop of the world next to soybean, rapeseed and cotton. In 2015, peanut contributed 8.7% of the total oil seeds production (45 million ton) in the world (Anonymous, 2015). Peanut is an important oilseed crop for vegetable oil production (Arioglu, 2014). About two-thirds of total peanut production is crushed for oil and the remaining one-third is used in confectionery products in the world (Dwivedi et al., 1993).

Peanut seeds contain 9.5-19.0% carbohydrate on a dry seed basis it is a good source of mineral (P, Ca, Mg and K) and vitamins (E, K and B group). Peanuts are also a cheap source of protein, a good source of essential vitamins and minerals, and a component of many food products (Dwivedi et al., 1996; Yav et al., 2008; Ingale & Shrivastava, 2011; Chamberlin et al., 2014; Chowdhury et al., 2015). Peanut contain 13 different fatty acids (palmitic, palmitoleic, heptadecylic, heptadecenoic, stearic, oleic, linoleic, linolenic, arachidic, eicosenic, behenic, nervonic and lignoceric). Oleic and linoleic acids are two important unsaturated fatty acids and both of them comprised about 80% of fatty acid composition. The rest of fatty acids are saturated fatty acids (20%). Peanut cultivars varied in their fatty acid composition (Ahmed & Young, 1982).

The nutritional and storage qualities of peanut are determined by its fatty acids composition. According to Andersen & Gorbet (2002) peanut oil contains both saturated and unsaturated fatty acids. Among these, the amount of saturated and unsaturated fatty acids in peanut oil varies from 10.92 to 17.47% and from 81.13 to 94.81%, respectively. Oleic acid content in peanut genotypes can vary from 21 to 85% and linoleic acid from 2 to 43%.

The fatty acid composition of peanut is becoming increasingly important diet for healthy living. The oleic to linoleic acid ratio and iodine value were used to determine the quality of peanut

oil. Moreover, the degree of unsaturated fatty acid and the stability of peanut oil were determined by using the iodine value. High-oleic peanut has longer self-life than low-oleic peanut and it has better flavor quality or stability than low-oleic peanut (Brown et al., 1975; Yav et al., 2008; Chaiyadee et al., 2013).

Several factors such as variety, seasonal variation, genotype, location, air and soil temperature, planting date, soil nutrient, moisture availability, growing conditions and maturity affect the fatty acid content in peanut oil (Young & Worthington, 1974; Brown et al., 1975; How & Young, 1983; Hashim et al., 1993; Dwivedi et al., 1996; Hassan et al., 2005; Isleib et al., 2008; Hassan & Ahmed, 2012; Chaiyadee et al., 2013).

The actual impact of seed maturity is dependent on genotype, climatic conditions, and genotype/climate interactions. Lower temperature during the seed development normally is associated with more unsaturated oil due to the increased activity of oleatedesaturase, which promotes the synthesis of linoleic acid. The increase in oleic acid concentration with increasing seed maturity is normally accompanied by a decrease in palmitic, linoleic, arachidic, eicosenic, behenic and lignoceric acid. Bovi (1982) and Holaday & Pearson (1974) found that higher temperatures during the last 4 weeks before harvest resulted in higher oil and oleic acid content and correspondingly higher O/L ratios.

Oil content and fatty acid composition of peanut have been studied in different cultivars and under different environmental condition and it has been reported that the oil content of peanut cultivars varied between 37.9-56.3%, oleic acid 37.7-82.2%, linoleic acid 2.9-41.5, palmitic acid 9.6-13.2%, stearic acid 1.6-3.7%, arachidic acid 1.2-1.7%, behenic acid 1.2-3.5% and iodine value varied between 88.6 to 105.4 (Dwivedi et al., 1996; Özcan & Seven, 2003; Yav et al., 2008; Önemli, 2012; Hassan & Ahmed, 2012; Chaiyadee et al., 2013; Mzimhiri et al., 2014; Chowdhury et al., 2015; Escobedo et al., 2015).

Table 1 Peanut variety and their some characteristics.

Varieties	Market type	Origin	Kernel size	Type*	Growing period
Halisbey	Virginia	Turkey	Large	Normal	Semi-spreading
Sultan	Virginia	Turkey	Large	Normal	Semi-spreading
Osmaniye-2005	Virginia	Turkey	Large	Normal	Semi-spreading
NC-7	Virginia	USA	Large	Normal	Spreading
Batem-5025	Virginia	Turkey	Large	Normal	Semi-spreading
Brantley	Virginia	USA	Large	High	Spreading
Wilson	Virginia	USA	Large	Normal	Semi-spreading
Flower-22	Virginia	Chine	Large	Normal	Semi-spreading
Flower-32	Virginia	Chine	Large	Normal	Semi-spreading
Flower-36	Virginia	Chine	Large	Normal	Semi-spreading
Georgia Green	Runner	USA	Small	Normal	Spreading
Florispan	Spanish	USA	Small	Normal	Erect

*Oleic acid content

Table 2 Average monthly temperature, monthly precipitation and relative humidity during the 2013, 2014 and long term (1950-2015) growing seasons in Adana,Turkey (Anonymous, 2014).

Months	Average temperature (°C)			Precipitation (mm)			Relative humidity (%)		
	2013	2014	LT*	2013	2014	LT	2013	2014	LT
April	18.1	18.3	17.5	43.2	18.6	54.7	72.0	69.2	67.3
May	22.7	21.3	21.7	57.4	22.4	47.6	72.3	70.4	66.9
June	25.3	24.8	25.6	0.3	1.7	19.8	65.7	70.5	68.0
July	28.2	28.2	28.1	0.0	0.3	7.0	65.2	72.6	71.6
August	28.6	29.1	28.5	0.0	0.3	5.3	69.0	70.3	71.0
September	25.3	25.9	25.9	15.0	80.4	17.6	63.1	64.1	65.4
October	19.5	21.0	21.3	16.5	67.8	40.6	47.9	62.9	61.6

*LT: Long term

Keeping in mind the above point of view, Peanut has been grown as a main and double cropped after a small grain harvest in the Cukurova region in Turkey. The objective of the study was to determine oil content and fatty acids composition of some peanut cultivars grown at different growing seasons.

2 Materials and Methods

2.1 Plant material and culture conditions

Two field experiments were conducted at the experimental area of the Department of Field Crops, Faculty of Agriculture, Cukurova University, Adana, Turkey as a main and double cropped in 2013 and 2014 years. Three different peanut varieties were used as a plant material in this research. Some characteristics of peanut varieties used in this research are given in Table 1. The texture of the soil was clay loam. The tests of soil in both seasons showed a pH of 7.7 with high value of K₂O and low value of P₂O₅. In addition, the soil was very low in organic matter and nitrogen content. The lime content was 22.3 % in the upper layers with high rate in lower layers. In the Adana province of Turkey, winters are mild and rainy, whereas summers are dry and warm, which is a typical

of a Mediterranean climate. The monthly average air temperature during the research period (April-October) was 19.5 to 28.6°C in 2013 and 21.0 to 29.1°C in 2014. The total rainfall was 89.2 mm and 172.9 mm during the growing periods (main cropped and double cropped) in 2013 and 2014, respectively. The relative humidity average was ranged from 47.9 to 72.3% in 2013 and 62.9 to 72.6% in 2014. The differences between the years and long term for the climatic data were not significant (Table 2).

2.2 Experimental design and Cultural Management Practices

The experiments were designed at Randomized Complete Block design with three replicate in main cropped and double cropped separately. Fertilizers were applied before planting, 250 kg ha⁻¹ of DAP (45 kg ha⁻¹ N, 115 kg ha⁻¹ P₂O₅) in both growing seasons. Ammonium nitrate (33%N) at the rate of 200 kg ha⁻¹ was applied as a two times before first and second irrigation. The crop was shown on April 10 and harvested on October 5 in main cropped growing season, and sown on June 15 was and harvested on November 10 in double cropped growing season in both years.

Table 3 The oil content, unsaturated fatty acids composition, oleic acid/linoleic acid ratio and iodine value of some peanut varieties grown as a main cropped (two years average)*

Varieties	Oil content (%)	Oleic acid (%)	Linoleic acid (%)	O / L** ratio	Iodine value
Halisbey	48.94	52.62 ^d	26.19 ^e	2.01	91.42
Sultan	48.62	54.46 ^c	24.35 ^f	2.24	89.92
Osmaniye-2005	50.28	52.49 ^d	26.58 ^e	1.97	91.94
NC-7	47.55	63.41 ^b	16.78 ^h	3.78	84.49
Batem-5025	50.14	62.88 ^b	17.07 ^{gh}	3.68	84.35
Brantley	48.70	81.13 ^a	1.73 ⁱ	46.90	73.58
Wilson	48.54	63.73 ^b	17.50 ^g	3.64	85.92
Flower-22	46.96	50.20 ^e	27.33 ^d	1.84	91.42
Flower-32	49.26	46.83 ^f	31.00 ^b	1.51	94.68
Flower-36	51.02	45.60 ^g	31.21 ^b	1.46	93.98
G. Green	51.55	49.96 ^e	28.38 ^c	1.76	92.84
Florispán	48.45	39.80 ^h	36.38 ^a	1.09	98.24
Average	49.16	55.26	23.71	-	-
LSD (%5)	N.S.	0.362	0.675	-	-

*Same letters in a column are not significantly different; **Oleic acid / Linoleic acid (O/L)

Table 4 The oil content, unsaturated fatty acids composition, oleic acid/linoleic acid ratio and iodine value of some peanut varieties grown as a double cropped (two years average)*

Varieties	Oil content (%)	Oleic acid (%)	Linoleic acid (%)	O/L** ratio	Iodine value
Halishev	46.22 ^{de}	52.16 ^e	27.24 ^e	1.91	92.94
Sultan	46.33 ^d	53.23 ^d	25.82 ^f	2.06	91.30
Osmanive-2005	49.61 ^{ab}	48.81 ^g	31.09 ^c	1.57	96.53
NC-7	43.71 ^f	57.40 ^b	23.48 ^h	2.44	90.94
Batem-5025	46.07 ^e	57.29 ^b	23.18 ^h	2.47	90.33
Brantlev	48.61 ^{abc}	81.51 ^a	2.66 ^j	30.64	75.52
Wilson	46.31 ^{cd}	55.67 ^c	24.28 ^g	2.29	90.73
Flower-22	44.01 ^{ef}	51.60 ^f	25.67 ^f	2.01	89.75
Flower-32	47.01 ^{cd}	48.06 ^h	30.19 ^d	1.59	94.54
Flower-36	46.86 ^{cd}	43.59 ⁱ	33.36 ^b	1.31	95.98
G. Green	50.48 ^a	48.07 ^h	20.25 ⁱ	2.37	75.55
Florispan	47.93 ^{bcd}	39.42 ^j	37.72 ^a	1.05	99.93
Average	46.93	53.07	25.41	-	-
LSD (%5)	2.250	0.116	0.415	-	-

*Same letters in a column are not significantly different; **Oleic acid/Linoleic acid (O/L)

2.3 Data collected and measurements

The plants harvested by hand when the 60% of the pods are matured in both growing seasons. Total oil in the seed was determined in a Soxhlet extractor, using petroleum ether as solvent. Fatty acids composition, were determined by using Fatty acid methyl esters were prepared according to AOCS (1989). Iodine values (IV) of the peanut oils were calculated using the equation given by Hashim et al. (1993) and Chowdhury et al. (2015).

2.4 Statistics Analyses

Data were analyzed by using JUMP 8.1.0 package program with Randomized Complete Block Design. The Least Significant Differences (LSD) test was used to compare the treatments at 0.05level.

3 Results

3.1 Oil Content

The two-year average data belonging to oil content, fatty acids composition, oleic acid to linoleic acid ratio (O/L ratio) and iodine value (IV) of peanut varieties at different growing seasons has been presented in (Table 3, 4, 5 and 6). As it can be seen from (Table 3), the oil content among peanut varieties was insignificant in main cropped growing season. The oil content of peanut varieties varied between 46.96-51.55% on based of dry weight and the highest oil content (51.55%) was reported in Georgia Green and the lowest (46.96%) was in Flower-22 varieties.

On the other hand, the oil content values of peanut varieties ranged from 43.71% to 50.48% in double cropped growing season. The highest oil content (50.48%) was found in Georgia Green while NC-7 accumulated the lowest oil content (43.71%) in this season (Table 4).The average oil percentage

of peanut varieties was 49.16% in main cropped and 46.93% in double cropped growing season (Table 3 and 4).

3.2 Saturated Fatty Acids Composition

The differences among the peanut varieties were statistically significant for saturated fatty acids (palmitic, stearic, arachidic, behenic and lignoceric acids) in main and double cropped growing season in a two-year average. The ranges of fatty acids varied 5.85-12.80% of palmitic acid, 2.36-4.80% of stearic acid, 1.17-1.93% of arachidic acid, 2.11-3.11% of behenic acid and 1.01-1.88% of lignoceric acid in main cropped growing season (Table 5). In double cropped growing season, the palmitic acid percentage ranged from 5.86% to 12.25%, stearic acid from 2.28% to 4.16%, arachidic acid from 1.35% to 1.78%, behenic acid from 2.40% to 3.46% and lignoceric acid ranged from 1.17% to 1.83% in a two-year average (Table 6). The palmitic acid percentage of the peanut varieties was found the highest among the saturated fatty acids in a both growing season. The mean saturated fatty acids percentages of peanut varieties were found 10.24, 3.53, 1.67, 2.76 and 1.42 of palmitic acid, stearic acid, arachidic acid, behenic acid and lignoceric acid, respectively in main cropped growing season. While, the values were 10.01, 3.10, 1.61, 2.90 and 1.47%, respectively in double cropped growing season. The mean values of saturated fatty acids percentages of peanut varieties were found almost similar in both (main and double cropped) growing season.

3.3 Oleic and Linoleic Acid Content

Statistically significant differences were found among peanut varieties for oleic acid percentage in both growing seasons. According to two-year average, the oleic acid percentage ranged from 39.80 to 81.13% in main cropped growing season and 39.42 to 81.51% in doubled cropped growing season (Table 3 and 4).

Table 5 The saturated fatty acids composition of some peanut varieties grown as a main cropped (two years average)*.

Varieties	Palmitic acid (%)	Stearic acid (%)	Arachidic acid (%)	Behenic acid (%)	Lignoceric acid (%)
Halishev	10.40 ^d	3.19 ^g	1.17 ^h	2.82 ^d	1.62 ^b
Sultan	10.02 ^d	3.43 ^e	1.82 ^b	3.11 ^b	1.61 ^b
Osmanive-2005	10.44 ^{cd}	3.02 ^h	1.60 ^f	2.81 ^d	1.57 ^c
Nc-7	8.78 ^e	3.65 ^d	1.80 ^{bc}	2.91 ^c	1.30 ^{ef}
Batem-5025	8.49 ^e	3.71 ^d	1.93 ^a	2.96 ^c	1.33 ^e
Brantley	5.85 ^f	3.94 ^c	1.82 ^b	2.66 ^e	1.26 ^f
Wilson	8.51 ^e	3.22 ^g	1.62 ^{ef}	2.66 ^e	1.32 ^e
Flower-22	12.03 ^b	3.67 ^d	1.68 ^{de}	2.24 ^g	1.32 ^e
Flower-32	12.04 ^b	4.03 ^b	1.74 ^{bc}	2.40 ^f	1.27 ^f
Flower-36	12.57 ^a	4.80 ^a	1.77 ^{bc}	2.11 ^h	1.01 ^g
G. Green	10.90 ^c	2.36 ⁱ	1.42 ^g	3.25 ^a	1.88 ^a
Florispan	12.80 ^a	3.33 ^f	1.66 ^{ef}	3.23 ^a	1.51 ^d
Average	10.24	3.53	1.67	2.76	1.42
LSD (%5)	0.502	0.079	0.066	0.077	0.042

*Same letters in a column are not significantly different

In a two-year mean, the highest oleic acid percentage was recorded in Brantley (81.13 and 81.51%) and the lowest in Florispan (39.80 and 39.42%) in main and double cropped growing season, respectively. Brantley was a high oleic type genotype and for this reason, its oleic acid percentage was found high. The others varieties are normal oleic type. The differences between the varieties were statistically significant for linoleic acid percentage in main and double cropped growing season (two-year average). The linoleic acid percentage of peanut varieties varied between 1.73-36.38% in main cropped and between 2.66-37.72% in double cropped growing season. The highest linoleic acid percentage was found in Florispan (36.38 and 37.72%) and the lowest was in Brantley (1.73 and 2.66%) in main and double cropped growing season, respectively. It was observed, huge variation between the peanut varieties for oleic acid and linoleic acid content (Table 3 and 4). The average oleic and linoleic acid percentage of peanut varieties was 55.26 and 23.71% in main cropped and 53.07 and 25.41% in double cropped growing season, respectively. The oleic acid percentage was found higher in main cropped growing season and lower in double cropped growing season. The linoleic acid percentage in

double cropped growing season was higher when compared to main cropped growing season (Table 3 and 4).

3.4 Oleic Acid to Linoleic Acid Ratio (O/L) and Iodine Value (IV)

The O/L ratio of peanut varieties (excluded Brantley genotype) varied between 1.09-3.78 and 1.05-2.47 in main and double cropped growing season, respectively (Table 3 and 4). The O/L ratio was higher in NC-7, Batem-5025 and Wilson varieties and was lower in Florispan and Flower-36 varieties in both growing season. The O/L ratio was found very high in Brantley (28.38 and 30.64) in main and double cropped growing season, respectively. The means O/L ratio of peanut varieties was found 2.27 and 1.92 in main and double cropped growing season, respectively. The O/L ratio was higher in main cropped than in double cropped growing season due to higher oleic acid percentage in main cropped growing season. The iodine value of peanut varieties ranged from 73.58 to 98.24 in main cropped and from 75.41 to 99.93 in double cropped growing seasons. The highest iodine value was found in Florispan and the lowest in Brantley in both growing seasons.

Table 6 The saturated fatty acids composition of some peanut varieties grown as a double cropped (two years average)*.

Varieties	Palmitic acid (%)	Stearic acid (%)	Arachidic acid (%)	Behenic acid (%)	Lignoceric acid (%)
Halishev	9.86 ^c	2.86 ^h	1.57 ^c	2.96 ^d	1.68 ^b
Sultan	9.69 ^f	3.42 ^d	1.78 ^a	3.09 ^c	1.52 ^d
Osmanive-2005	9.76 ^f	2.51 ⁱ	1.47 ^d	3.01 ^d	1.67 ^b
Nc-7	8.95 ⁱ	2.28 ^e	1.64 ^b	2.78 ^c	1.17 ⁱ
Batem-5025	9.19 ^h	3.39 ^d	1.72 ^a	2.96 ^d	1.29 ^g
Brantley	5.86 ^j	2.36 ^j	1.35 ^e	2.65 ^f	1.49 ^{de}
Wilson	9.37 ^g	3.09 ^f	1.63 ^{bc}	2.98 ^d	1.47 ^e
Flower-22	11.58 ^c	4.03 ^b	1.78 ^a	2.64 ^f	1.40 ^f
Flower-32	11.52 ^c	3.74 ^c	1.63 ^{bc}	2.40 ^h	1.26 ^h
Flower-36	12.25 ^a	4.16 ^a	1.77 ^a	2.52 ^g	1.23 ^h
G. Green	10.43 ^d	2.28 ^e	1.36 ^e	3.32 ^b	1.83 ^a
Florispan	11.70 ^b	3.04 ^f	1.60 ^{bc}	3.46 ^a	1.62 ^c
Average	10.01	3.10	1.61	2.90	1.47
LSD (%5)	0.084	0.044	0.061	0.064	0.036

*Same letters in a column are not significantly different

The coefficient of linoleic acid was higher (1.7321) than oleic acid (0.8601). The highest linoleic acid percentage was found in Florispan in both growing seasons. For this reason, the iodine value of Florispan was calculated as a high.

The average iodine value of peanut varieties was found 98.40 and 90.83 in main and double cropped growing season, respectively. The mean oleic acid percentage was found 55.26 and 53.07% in peanut oil and linoleic acid was 23.71 and 25.41% in main and double cropped growing season, respectively. The iodine values were different in different growing seasons due to the variation of oleic and linoleic acids in different in growing seasons.

4 Discussions

In the present study, it was observed that, the oil content among peanut varieties was insignificant in main cropped growing season. Under investigation, the air temperature at the pod filling period was higher in main cropped growing season than in double cropped growing season in both years. For this reason, the average oil content of peanut varieties was found higher in main cropped than in double cropped growing season. In different studies by Holaday & Pearson (1974), Brown et al. (1975), Raheja et al. (1987), Hassan et al. (2005), Yav et al. (2008) and Isleib et al. (2008) were reported that the oil percentage of peanut kernel varies between 35 to 56% depending on genotype and growing conditions, and the oil content of peanut varieties influence by genotype, seed maturity, climatic conditions, geographical location, growing season and growing conditions. Similar results were reported by various researchers (Özcan & Seven, 2003; Yav et al., 2008; Hassan & Ahmed, 2012; Önemli, 2012; Chowdhury et al., 2015. Dwivedi et al. (1993), Isleib et al. (2008) and Önemli (2012) reported that the peanut oil content is influenced by climatic factors at the pod filling period. High temperature during the growing season was correlated with high oil content. Holaday & Pearson (1974) found that higher temperatures during the last 4 weeks before harvest resulted in higher oil and oleic acid content and correspondingly higher O/L ratios.

Statistically significant differences among peanut varieties were observed for saturated fatty acids in main and double cropped growing season in a two-year average. The saturated fatty acids content in peanut oil were strongly influenced by genotype (Isleib et al., 2008). Similar results were supported by the findings by How & Young (1983); Hassan & Ahmed (2012); Önemli (2012); Mzimhiri et al. (2014) and Escobedo et al. (2015). These results showed that the saturated fatty acids content were not influenced by the environmental conditions. Hassan et al. (2005) reported that significant differences for saturated fatty acids among peanut cultivars were attributed due variation of the genotypes.

In this study, a huge variation between the peanut varieties was observed for oleic acid and linoleic acid content. Andersen & Gorbet (2002) reported that oleic acid content in peanut

genotypes varied from 21 to 85% and linoleic acid from 2 to 43%. Escobedo et al. (2015) reported that the peanut oil is rich in oleic and linoleic acids. Peanut oil composition is influenced by several groups of factors including environmental factors, genetic factors and interaction between environmental and genetic factors (Andersen & Gorbet, 2002; Isleib et al., 2008 and Chaiyadee et al., 2013). These findings supported by How & Young (1983), Dwivedi et al. (1993), Özcan & Seven (2003), Hassan et al. (2005), Hassan & Ahmed (2012), Önemli (2012), Mzimhiri et al. (2014), Escobedo et al. (2015) and Chowdhury et al. (2015) .

These results showed that the oleic and linoleic acid content of peanut varieties was affected by the environmental factors at the growing seasons. It might be the reason of the higher mean oleic acid percentage of peanut varieties in main cropped than in double cropped growing season, and higher linoleic acid percentage in double cropped than in main cropped growing season . Holaday & Pearson (1974) found that higher temperature during the last 4 weeks before harvest resulted in higher oleic acid and lower linoleic acid content. Bovi (1982), Raheja et al. (1987) and Önemli (2012) observed that the correlation between oleic acid and linoleic acid percentages was negative in peanut oil. Several factors affect the fatty acid content in peanut oil, including variety, seasonal variation, genotype, location, air and soil temperature, planting date, soil nutrient, moisture availability, growing conditions and maturity (Young & Worthington, 1974; Brown et al., 1975; How & Young, 1983; Hashim et al., 1993; Hassan et al., 2005; Hassan & Ahmed, 2012; Chaiyadee et al., 2013). Similar results were reported by Holaday & Pearson (1974), Brown et al. (1975), Dwivedi et al. (1996), Andersen & Gorbet (2002), Hassan et al. (2005) and Isleib et al. (2008).

The ratio of Oleic acid to Linoleic acid(O/L) was higher in main cropped than in double cropped growing season due to higher oleic acid percentage in main cropped growing season. In different studies, Brown et al. (1975), Yav et al. (2008) and Chaiyadee et al. (2013) reported that the ratios of oleic acid to linoleic acid (O/L ratio) and iodine value are determine the quality, storability and shelf-life of peanut oil and its products. In addition, iodine value (IV) was used to determine the degree of unsaturated fatty acid and the stability of peanut oil. High-oleic peanut has longer self-life than low-oleic peanut and it has better flavor quality or stability than low-oleic peanut. Escobedo et al. (2015) reported that O/L ratio and iodine value varied between 1.8-2.1 and 88.6-105.4, respectively in peanut varieties grown in Mexico. Holaday & Pearson (1974) found that higher temperatures during the last 4 weeks before harvest resulted in higher oil and oleic acid content and correspondingly higher O/L ratios. The authors postulated that this temperature-O/L relationship may provide at least partial explanation for observed problems with oxidative stability in peanuts grown in colder climates or with colder temperatures during the later weeks of the growing season. These findings were supported by some other researchers (Young & Worthington, 1974; How & Young, 1983; Dwivedi et al.,

1993; Hashim et al., 1993; Andersen & Gorbet, 2002; Chaiyadee et al., 2013).

The differences between the varieties for the iodine value may be caused by the genetic factors. Similar types of result were reported by some others researchers (How & Young, 1983; Raheja et al., 1987; Hashim et al., 1993; Dwivedi et al., 1993; Özcan & Seven, 2003; Chaiyadee et al., 2013; Chowdhury et al., 2015. Escobedo et al. (2015) found that iodine value varied from 88.60 to 105.40 in various peanut varieties grown in Mexico. Similarly, Chowdhury et al. (2015) reported that iodine value of peanut varieties varies between 98.83 to 105.3. The iodine values were different in different growing seasons due to the variation of oleic and linoleic acids in different in growing seasons and the lowest iodine value was reported from the main crop than the double cropped growing season. This was due to lower oleic acid percentage obtained in double crop growing season.

Conclusions

The oil content and oil composition of peanut varieties were affected by the environmental conditions during the growing seasons. The fatty acids percentages among the varieties were statistically significant in main and double cropped growing seasons. Oleic acid percentage was higher in main cropped growing season but Linoleic acid percentage was higher in double cropped growing season. The average oil percentage of peanut varieties was higher in main cropped growing season (49.16%) than in double cropped growing season (46.93%). The O/L ratio and iodine values of peanut varieties were found differed in both growing seasons. Nutritional quality of the peanut kernel is strongly influenced by environmental conditions and cultivar characteristics (genotype).

Conflict of interest

Authors would hereby like to declare that there is no conflict of interests that could possibly arise.

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