

Evaluation of Nine Oil Crops for Fatty Acid Constituents of their Oils

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Abstract: Oils of nine oil crops were evaluated concerning their composition from the fatty acids. The obtained results revealed that palm oil had the highest palmitic acid (45.10 %) and canola oil had the lowest palmitic acid (3.90 %). The highest stearic acid was found in palm oil (4.70 %) and the lowest stearic acid was found in canola oil (1.90 %). Olive oil had the highest oleic acid (71.10 %) and the lowest was found in cotton seed oil (17.60%). Linoleic acid percentage ranged from 68.0 % in sunflower to 9.40 % in palm oil. Linolenic acid ranged from 52.0 % in flax oil to 0.00 % in peanut oil. The lowest saturated fatty acids were 6.80 % in canola while the highest percentage was found in palm oil (51.50 %). As for the total unsaturated fatty acids values were 93.20 %, 90.0 %, 87.30 %, 84.50 %, 82.90 %, 82.0 %, 74.70 %, 72.0 % and 48.60 % in the oils of canola, flax, sunflower, soybean, olive, maize, peanut, cotton and palm, respectively.

Keywords: Oil- Fatty acid-Saturated fatty acids- Unsaturated fatty acids- Oil crops

Introduction

Vegetable oils play important functional and sensory roles in food products, and they act as carrier of fat soluble vitamins (A, D, E and K) (Moreira, *et al*, 1999). They also provide energy and essential linoleic and linolenic acid responsible for growth (Giese, 1996 and Salunkhe, 1992). About 79 % of the over 100 million tons of edible oils and fats produced worldwide annually are derived from plant sources and are referred to as vegetable oils (Hamm and Hamilton, 2000).

The main fatty acids in oil of currently grown cultivars of oilseed canola are oleic acid (59 – 68 %), linoleic acid (17 – 21 %) and linolenic acid (7.8 – 10 %). (Scarath and McVetty, 1999).

Koprna et al (2006) reported that the range of unsaturated fatty acids in canola oil (Opava cv.) were 63.6 – 80 %, 7.6 – 20.6 % and 2.2 – 7.1 % for oleic , linoleic and linolenic acid, respectively. Carre et al (2003) stated that a lower content of linolenic acid has a positive effect on the oxidation stability of oil.

Flax seed oil had the main three unsaturated fatty acids, oleic, linoleic and linolenic acids with the ranges of 22.17 – 29.92 % oleic acid, 13.04 – 18.35 % linoleic acid and 41.21 – 47.35 % linolenic acid as a result of El-Nakhlawy (2006) in a study on different flax cultivars.

Results of a study conducted by Chowdhury et al (2007) on fatty acid composition of five consumed edible oils revealed that sunflower oil contained the highest percentage of long chain mono and polyunsaturated fatty acids (91.49 ± 1.91 %) compared to soybean oil (81.14 ± 1.49 %), mustard oil (86.80 ± 3.07 %), palm oil (53.30 ± 0.36 %) and coconut oil (7.12 ± 0.51 %). Sunflower oil with high linoleic – low oleic appeared to be superior and most suitable edible oil for mass consumption.

Ehrensing (2008) reported that canola oil is very high in unsaturated fatty acids. Canola oil consisted of 4, 2, 60, 20, 10, 2 % of palmitic, stearic, oleic, linoleic, linolenic and erucic fatty acids, respectively.

This investigation was conducted to evaluate the fatty acids of constituents oil of nine oilseed crops and compare between the total saturated and unsaturated fatty acids between the studied oils.

Material and Methods

Nine oil seed crops were evaluated concerning the oil composition from their fatty acids. The studied crops were; maize (*zea mays*, Giza-2 cv.), sunflower (*helianthus annuus*, Hysun 354 cv.), soybean (*Glycine max*, Crowford cv.), cotton (*Gossypium barbadense*, Giza86), flax (*Linum usitatissimum*, Giza-8 cv.), canola (*Brassica napus*, Pactole cv.), peanut (*Arachis hypogea*, Giza-5), olive (*Olea europaea*) and palm (*Venox dactylon*). Completely randomized design with 4 repetitions was used in the study. Four random seed or fruit oil samples were chosen from each crop. Fixed oils were extracted from seeds using Soxhlet instrument using N-hexane (60 °C) according to A.O.A.C. (1980).

The extracted oil from each repetition of each crop was analyzed for its fatty acids contents by Gas Liquid Chromatography (GLC) using Shimadzu Gas Chromatograph GC-4CM(PFE) equipped with flame ionization detector (FID) under the following conditions: An analytical glass column (3X 3mm i.d.) packed with 5% diethylene glycol succinate (DEGS) on 80/100 Chromo Q. , Operating temperature (°C) for column 180 °C isothermal, injector and detector 270 °C, gas flow rates (ml/min.) nitrogen 30, hydrogen 1, air 0.5, respectively. Chart speed 0.5 mm/min.

A standard mixture of methyl esters was analyzed under identical conditions prior to running the samples. The retention times

(t_R) of the unknown sample of methyl esters were compared with those of the standard. The concentration of methyl esters were calculated by the triangulation method.

Statistical analysis was carried out for the obtained data according to El-Nakhlawy (2010).

Results and Discussion

The results of this study will be classified into three main classes:

1-Saturated Fatty Acids:-

Means of the studied nine crops oil constituents from fatty acids included lauric, myristic, palmitic, stearic arachidic and behenic acids presented in Table (1). showed that palmitic acid percentages ranged from 45.10 % in palm oil to 3.90 % in canola oil. The cotton seed oil was the 2nd rank in palmitic acid (24.70 %) followed by the palm oil, then maize oil, soybean oil, sunflower oil, and flax seed oil with values of 24.70%, 13.50%, 11.00%, 6.80% and 6.0%, respectively.

Stearic acid was the second saturated fatty acid in the crop oils. The highest stearic acid (%) was found in palm oil with value of 4.70 % followed with significantly difference by flax oil (4.0%) and soybean oil (4.0%). The lowest stearic acid (%) was found in canola oil (1.90%) as shown in Table(1), while no significant differences were showed between the stearic acid (%) in the oil of maize, olive, and cotton seed with values of 2.50%, 2.50 %,and 2.30%, respectively.

Table(1) : Means of saturated fatty acids (%) of oil of nine oil crops

Fatty Acid	Fatty acids (%)								
	Maize	Sunflower	Soybean	Cotton	Flax	Canola	Peanut	Olive	Palm
Lauric	0.50 ^a	0.50 ^a	0.00 ^b	0.00 ^b	0.00 ^b	0.00 ^b	0.00 ^b	0.00 ^b	0.30 ^b
Myristic	1.00 ^b	0.20 ^d	0.10 ^e	0.90 ^c	0.00 ^f	0.00 ^f	0.10 ^e	0.00 ^f	1.10 ^a
Palmitic	13.50 ^c	6.80 ^e	11.00 ^d	24.70 ^b	6.00 ^e	3.90 ^f	11.60 ^d	13.70 ^c	45.10 ^a
Stearic	2.50 ^d	4.70 ^a	4.00 ^b	2.30 ^d	4.00 ^b	1.90 ^e	3.10 ^c	2.50 ^d	4.70 ^a
Arachidic	0.50 ^c	0.50 ^c	0.30 ^d	0.10 ^e	0.00 ^f	0.60 ^c	1.50 ^a	0.90 ^b	0.20 ^{de}
Behenic	0.00 ^d	0.00 ^d	0.10 ^c	0.00 ^d	0.00 ^d	0.60 ^b	4.00 ^a	0.00 ^d	0.00 ^d

*Means of each fatty acid of the studied oils followed by the same letter(s) are not significantly different according to LSD at $p \leq 0.05$

The other saturated fatty acids of lauric, myristic, arachidic and behenic had values less than 1.00 % in all studied oil crops except myristic acid in maize oil (1.0%) and palm oil (1.10 %) and arachidic acid in peanut (1.50%) and behenic acid in peanut also (4.0%) as shown in Table(1). These results may be due to the genetic, environment and their interaction effects on these crops and are similar with the results of Ehrensing (2008).

2- unsaturated fatty acids:

The studied oil constituents from unsaturated fatty acids were oleic, linolic, linolenic, and eicosenic acids , presented in Table (2). The obtained data revealed that eicosenic acid percentages were 0.00% in all studied oil crops except in the oils of canola (1.0%) and peanut (1.5%). As for oleic acid, the highest (%) was found in olive oil (71.10 %) followed with significant differences than canola oil (64.10 %), then peanut oil (46.50 %), palm oil (38.80 %), maize oil (34.50 %), soybean oil (23.40 %), flax oil (22.0 %) and cotton seed oil

(17.60 %) with significant differences between the last oils as shown in Table(2).

According to the linoleic acid data in Table (2), sunflower oil had the highest value (68.00 %) and significant differed from the other oils. Cotton seed oil and soybean oil had 53.00% and 53.20 % linoleic acid, respectively followed by maize oil (46.0 %), while the linoleic acid content in flax oil and canola oil with values of 16.0 % and 18.70 % . The lowest linoleic acid contents were found in olive and palm oil with values of 10.0 % and 9.40 %, respectively, (Table,2).

Table(2) : Means of unsaturated fatty acids (%) of oil of nine oil crops

Fatty Acid	Fatty acids (%)								
	Maize	Sunflower	Soybean	Cotton	Flax	Canola	Peanut	Olive	Palm
Palmitolic	0.50 ^c	0.20 ^e	0.10 ^f	0.80 ^b	0.00 ^g	0.20 ^e	0.30 ^d	1.20 ^a	0.10 ^f
Oleic	34.50 ^e	18.60 ^g	23.40 ^f	17.60 ^h	22.00 ^g	64.10 ^b	46.50 ^c	71.10 ^a	38.80 ^d
Linoleic	46.00 ^c	68.00 ^a	53.20 ^b	53.30 ^b	16.00 ^f	18.70 ^e	31.40 ^d	10.00 ^g	9.40 ^h
Linolenic	0.50 ^d	0.50 ^d	7.80 ^c	0.30 ^d	52.00 ^a	9.20 ^b	0.00 ^e	0.60 ^d	0.30 ^d
Eicosenic	0.50 ^c	0.00 ^d	0.00 ^d	0.00 ^d	0.00 ^d	1.00 ^b	1.50 ^a	0.00 ^d	0.00 ^d

*Means of each fatty acid of the studied oils followed by the same letter(s) are not significantly different according to LSD at $p \leq 0.05$

As for linolenic acid contents in the oils studied , data of Table(2) showed that flax seed oil had 52.0 % followed by canola oil (9.20 %), then soybean oil (7.80 %) with significant differences between the three last oils.

Six oil seed crops did not significantly different in linolenic acid where maize, cotton, olive, palm, sunflower and peanut oils with values of 0.50 %, 0.30 %, 0.60 %, 0.30 %, 0.50 %, and 0.00%, respectively. The obtained results showed that the sunflower, cotton, soybean, canola and maize oils are rich in linoleic acid and low in

linolenic acid, accordingly, these oils had positive effects on oxidation stability of oil and most suitable edible oil for mass consumption. The obtained results are confirmed with the results obtained by Scorth and McVetty (1999), Koprna *et al* (2006), El-Nakhlawy (2006) and Chowdhury *et al* (2007).

3- Total saturated and unsaturated fatty acids:

Comparing the total saturated fatty acids among the studied oils, revealed significance differences between the studied nine oils (Table,3). Means of total saturated fatty acids showed that the lowest oil in total saturated fatty acids was canola oil (6.80 %) followed by flax oil (10.0 %), sunflower oil (12.70 %), soybean oil (15.50 %), olive oil (17.10 %), maize oil (18.0 %), peanut oil (20.30 %), cotton oil (28.0 %) and the highest crop in total saturated fatty acids was palm oil (51.50 %).

The studied oil seed crop oils significantly different in total unsaturated fatty acids (Table,3). The highest total unsaturated fatty acids was found in canola oil (93.20 %) followed by flax seed oil (90.0 %), sunflower oil (87.30 %), soybean oil (84.50 %), olive oil (82.90 %), maize oil (82.0 %), peanut oil (74.70 %), cotton seed oil (72.0 %) and palm oil as the lowest unsaturated fatty acid oil (48.60 %).

Separation of total unsaturated fatty acids, data of Table (3) showed that the highest total mono-unsaturated fatty acids was found in olive oil (72.30 %) followed by canola oil (65.30 %), peanut oil (48.30 %), then maize oil (35.50 %), soybean oil (23.50 %), flax oil (22.0 %), sunflower oil (18.80 %) and cotton oil (18.40 %). Comparing the total poly-unsaturated fatty acids (Table, 3) the data revealed

significant differences between all studied oils. Sunflower oil had the highest value (68.50 %) followed by flax seed oil (68.0 %), soybean oil (61.0 %), cotton oil (53.6 %), maize oil (46.50 %), peanut oil (31.40 %), canola oil (27.90 %), olive oil (10.60 %) and the lowest oil in total poly-unsaturated fatty acids was palm oil (9.70 %). Similar results were obtained by Chowdhury *et al* (2007) and Ehrensing (2008).

Table(3) : Means of saturated and unsaturated fatty acids groups(%) of oil of nine oil crops

Group of Fatty Acids	Fatty acids group (%)								
	Maize	Sunflower	Soybean	Cotton	Flax	Canola	Peanut	Olive	Palm
Total Saturated	18.00 ^{d*}	12.70 ^f	15.50 ^e	28.00 ^b	10.00 ^g	6.80 ^h	20.30 ^c	17.10 ^{de}	51.40 ^a
Total Unsaturated	82.00 ^{cd}	87.30 ^{bc}	84.50 ^{cd}	72.00 ^e	90.00 ^{ab}	93.20 ^a	79.70 ^d	82.90 ^{cd}	48.60 ^f
Total Mono unsaturated	35.50 ^e	18.80 ^g	23.50 ^f	18.40 ^g	22.00 ^f	65.30 ^b	48.30 ^c	72.30 ^a	38.90 ^d
Total Poly Unsaturated	46.50 ^d	68.50 ^a	61.00 ^b	53.60 ^c	68.00 ^a	27.90 ^f	31.40 ^e	10.60 ^g	9.70 ^g

*Means of each fatty acid group of the studied oils crops followed by the same letter(s) are not significantly different according to LSD at $p \leq 0.05$

The previous data, showed that flax oil had the highest total unsaturated fatty acids and the main fatty acid in its oil was linolenic acid (52.0 %), and had only 10.0 % total saturated fatty acid, mainly palmitic acid (6.0 %) and stearic acid (4.0 %) for this flax oil most use as painting oil (El-Nakhlawy,2006).

The second oil in total unsaturated fatty acids was soybean (61.0 %) mainly linoleic acid (53.20 %), while its content from total saturated fatty acids was 15.50 % with palmitic acid was 11.0 %.

Olive oil had the highest total mono unsaturated fatty acids (72.30 %) and the lowest total poly unsaturated fatty acids (10.60 %). Palm oil had the highest total saturated fatty acids (51.40 %) , and highest palmitic acid (45.10 %), accordingly, this oil had the lost rank in edible oil quality.

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تقييم تسعة محاصيل زيتية فى تركيب الزيت من الأحماض الدهنية

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المستخلص: تم تقييم تسعة من المحاصيل الزيتية بخصوص تركيب الزيت من الأحماض الدهنية المشبعة وغير المشبعة وقد أوضحت النتائج أن زيت النخيل كان الأعلى فى نسبة حامض البالمتيك والأستياريك بنسبتي ٤٥,١٠ % ، ٤,٧٠ % على الترتيب فى حين كان زيت الكانولا هو الأقل فى نسبة الحامضين بنسبتي ٣,٩٠ % ، ١,٩٠ % على التوالى.

وبخصوص الأحماض غير المشبعة فأحتوى زيت الزيتون على أعلى نسبة من حامض الأوليك (٧١,١ %) بينما كان زيت القطن هو الأقل فى نسبة حامض الأوليك (١٧,٦ %) وقد تراوحت نسبة حامض اللينوليك فى زيوت المحاصيل التسعة من ٦٨ % فى دوار الشمس إلى ٩,٤٠ % فى زيت النخيل فى حين كانت أعلى نسبة من حامض اللينولينيك (٥٢ %) فى زيت الكتان وأقل نسبة (صفر %) فى زيت الفول السودانى.

وكانت أقل نسبة من مجموع الأحماض الدهنية المشبعة فى زيت الكانولا (٦,٨٠ %) وأعلى نسبة فى زيت النخيل (٥١,٥٠ %) وكانت نسبة مجموع الأحماض الدهنية غير المشبعة فى زيوت المحاصيل التسعة ٩٣,٢٠ % ، ٩٠,٠ % ، ٨٧,٣ % ، ٨٤,٥ % ، ٨٢,٩ % ، ٨٢,٠ % ، ٧٤,٧ % ، ٧٢,٠ % ، ٤٨,٦ % فى زيوت الكانولا ، الكتان ، دوار الشمس ، فول الصويا ، الزيتون ، الذرة ، الفول السودانى ، القطن ، النخيل على الترتيب.

الكلمات المفتاحية :

زيت – أحماض دهنية – أحماض دهنية مشبعة – أحماض دهنية غير مشبعة – محاصيل زيتية.