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EVALUATION OF SUNFLOWER, FLAXSEED AND OLIVE OILS IN TERMS OF CHEMICAL COMPOSITION AND THEIR PHYSICAL AND CHEMICAL PROPERTIES

Elfeky, Eman A.; Hammam, M. A.; Sakr, A. A. and Abozid, M. M.
Biochemistry department, Faculty of Agriculture, Menoufia University.

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ABSTRACT: Fats are an essential component of human diets and their types greatly affects public health, and some of them may cause many diseases, such as cardiovascular diseases and fatty liver. Since sunflower, flaxseed and olive oils are among the oils commonly used in nutrition in Egypt, the study was conducted to compare the components of these oils and their nutritional value to evaluate them. The fatty acid components of these oils were estimated, and the sterols present in each oil were estimated using the Gas Chromatograph (GC). The physical and chemical properties of each oil were also estimated (specific gravity, refractive index, color, oxidative stability index, saponification value, iodine value, acid value, ester value, peroxide value and % unsaponifiable matter). Linoleic acid was the largest component in sunflower oil (53.33%); oleic acid was the largest one in olive oil (66.65%), while alpha-linolenic acid was the largest component in flaxseed oil (55.34%). For sterols, β-sitosterol (44.86%), stigmasterol (20.33%), campesterol (11.68%), isofucosterol (9.54%) components were the largest in sunflower oil. Squalene (64.14%) and β-sitosterol (16.78%) were the largest sterols in olive oil. While β-sitosterol (28.24%), campesterol (16.37%) and cycloartenyl acetate (12.42%) were the largest sterols in flaxseed oil. The results clearly show a high content of sunflower oil of omega-6 fatty acids, while flaxseed oil was distinguished by its high content of omega-3 fatty acids, and olive oil was the highest in its content of omega-9 fatty acids. Therefore, these oils are well suited for use in nutrition, and more studies are needed to reach the best ratios of the mixture of these oils in biological experiments.

Keywords: Sunflower oil, Flaxseed oil, Olive oil, Omega 3 fatty acids, Omega 6 fatty acids, Omega 9 fatty acids.

INTRODUCTION

Obesity is a major risk factor that increases the chances of developing many serious diseases such as cardiovascular diseases, type 2 diabetes, and some types of cancer (WHO, 2005). Various studies conducted on humans have indicated that food fats are largely responsible for causing obesity. If the contents of meals increase from fats by more than thirty percent of the total energy in the meal, this leads to obesity (Jequier, 2002; Hill *et al.*, 2000; Schrauwen and Westerterp, 2000).

Many studies have indicated the vital role that plants and their effective components play in improving public health in general, especially improving blood lipid profile indicators (Abozid, and Farid, 2013; Abozid and Ahmed, 2013; Abozid *et al.*, 2014; Farid *et al.*, 2015; Ashoush *et al.*, 2017; El-Shennawy and Abozid, 2017).

On the other hand, eating dietary fats is essential and indispensable for proper nutrition. The Food and Agriculture Organization (FAO) has recommended that the average daily intake of fat be 55 g per day to obtain a healthy balanced meal (Kabyemela *et al.*, 1992). So, not all types of fats are bad. Despite the close relationship between high fat intake and obesity, studies indicate that the use of omega-3 fats leads to weight loss, improves fat metabolism and limits the accumulation of cholesterol within the walls of blood vessels (He *et al* ., 2002; Iso *et al.*, 2001). Therefore, it can be said that the problem is not always in eating fats in food, but rather the greatest danger is in the quality of fats, specifically the type and quantity of different fatty acids present in dietary fats.

*Corresponding author: mostafa.hamam@agr.menofia.edu.eg

Recently, interest in flaxseed oil has increased as a food oil due to its high content of essential fatty acids, both omega-3 (n-3) and omega-6 (n-6), as it contains a very large content of α -linolenic acid (C18:3 n-3) ranging between 49-64%, and it also contains a good amount of linoleic acid (C18:2 n-6) ranging between 15-17%. Studies indicate the importance of essential fatty acids, especially omega-3 fatty acids, in protecting against cardiovascular diseases and cancer (Shadyro *et al.,* 2017). However, sunflower oil is the second-most popular edible oil produced worldwide, after soybean oil is categorized as one of the best plant oils for a human diet because of its nutritional value (Nandha *et al.* 2014). Regular sunflower oil contains 69% linoleic acid, 20% oleic acid and 11% saturated fatty acids (Skoric *et al.* 2008). Also, olive oil is considered one of the essential fats in nutrition in northern Africa and the Mediterranean region in general, owing to its beneficial benefits on nutrition and health, which have been linked to the ideal ratio of saturated, monounsaturated, and polyunsaturated fatty acids (PUFA), as well as to smaller components such sterols, polyphenols, and tocopherols, is currently rising (Dag *et al.*, 2011).

Therefore, this study aims to evaluate three of the edible oils spread in Egypt in terms of their physical and chemical properties and their content of fatty acids as well as sterols, to reach the best oils or the best mixture of them.

MATERIALS AND METHODS

Materials

Olive (*Olea europaea*), koroneiki and coratina cultivar, sunflower *(Helianthus annuus*), strawby hybrid cultivar and flaxseed (*Linum usitatissimum*), Golden cultivar were obtained from Agriculture Research Center, Giza, Egypt. And all chemicals were obtained from El-Nasr Pharmaceutical Chemicals, El-America, Cairo, Egypt.

Methods

Extraction of oils

The seeds of flaxseed and olive were cleaned, after that, oil was extracted using a hydraulic piston (model number: 6Y) and filtered (filter press). Sunflower seeds were cleaned and washed. A hydraulic piston (model number: 811) was used to extract the oil, which was then filtered (filter press).

Physical characteristics of oils

Oil sample refractive index was determined at 25°C using an Abbè refractometer (Carl Zeiss JENA, GDR) according to the method of A.O.A.C., (1989). A Lovibond tintometer (Model F, Visual, 5.25-inch cell), was used to measure the color (A.O. C. S., 1989). Particular A 10-ml automated gas pyrometer was used to test the gravity of oil samples at 30°C according to the method of A.O.A.C., (2000).

Chemical characteristics of oils

The acid value was measured as described in A.O.A.C., (2003). The saponification value was determined by following the method of A.O.A.C., (1995). The iodine value was measured by the method of Singh *et al.,* (1981). The peroxide value was determined in line with the procedure outlined in A.O.A.C., (1984). The ester value was calculated based on the equation outlined in A.O.AC., (2003).

Determination of oxidative stability index

The oxidative stability test is an important procedure for evaluating the resistance of oils to oxidation under specific conditions. The Rancimat instrument is a widely used method for measuring the oxidative stability of oils. To conduct this test, oil samples (3 g) are first prepared and placed in the Rancimat instrument (Metrohm's 892 Professional Rancimat instrument, Switzerland). The instrument is then set to a temperature of 110°C and an air flow rate of 20L/h. The oil samples are heated and air is continuously passed through them to simulate the oxidation process. As the oil oxidizes, volatile organic acids are formed and collected in a conductivity cell. The instrument measures the induction time, which is the time taken for the conductivity to reach a specific value. This value is used to determine the oxidative stability of the oil sample (Laubli and Bruttel, 1986). The longer the induction time, the more resistant the oil is to

oxidation. Overall, the Rancimat instrument provides a reliable and efficient method for measuring the oxidative stability of oils.

Determination of fatty acid composition

In order to estimate fatty acids using a gas chromatographic device, the fatty acids are first methylated so that they become fatty acid methyl esters (FAMEs), followed by the separation of the FAMEs using a HP 6890 plus gas chromatography (Hewlett Packard, USA) detector (FID). Then the FAMEs separated on the column are identified by comparing the retention time with standard samples of the fatty acids present in the oils, and the percentages of each fatty acid are calculated by calculating the peak area (Zahran and Tawfeuk's., 2019).

Determination of unsaponifiable matter %

Unsaponifiable matters were identified by using the procedure outlined in A.O.A.C., (2000). The following equation was used to calculate the percentage of unsaponifiable materials:

% unsaponifiable matters =

weight of the residue/weight of oil

Determination and identification of sterols

The GC-MS analysis of the sterols sample was conducted by using a gas chromatography (Agilent 8890 GC System), coupled to a mass spectrometer (Agilent 5977B GC/MSD) according to the method of Mettwally *et al.*, (2022).

RESULTS AND DISCUSSION

Physiochemical properties and oxidative stability index of flaxseed, sunflower and olive oils

Table (1), present physiochemical properties and oxidative stability index of flaxseed, sunflower and olive oil. All tested oils showed a specific gravity less than water, and olive oil was the highest one (0.903) followed by flaxseed oil (0.897) and sunflower oil was the lowest one (0.889). Sunflower oil showed the highest reflective index (1.475) followed by flaxseed oil (1.469) and olive oil was the lowest one (1.456). The results also indicated that there was a clear discrepancy in color (by using lovibond tintometer) between the three oils, so flaxseed oil was (9.5), olive oil was (8.3) and sunflower oil was (7.2) at the yellow color scale. As for the red color, flaxseed oil was (1), sunflower oil was (0.9) and olive oil was (0.7). These results are very close to the results of studying these oils in previous studies for flaxseed oil (Shimada *et al.*, 1992; Choo *et al.*, 2007; Zhang *et al.*, 2011), sunflower oil (Aboki *et al.*, 2012) and for olive oil (Sakar *et al.*, 2022).

Table (1): Physiochemical properties and oxidative stability index of flaxseed, sunflower and olive oils.

Parameters	Flaxseed oil	Sunflower oil	Olive oil
Specific gravity	0.897	0.889	0.903
Refractive index at 25 ºC	1.469	1.475	1.456
Color: Yellow Red	9.5 1.0	7.2 0.9	8.3 0.7
Saponification Value (mg KOH/g)	188.7	189.1	192.5
Acid value (mg KOH/g oil)	0.9	1.9	1.68
Ester Value (mg KOH/g)	187.8	187.2	190.82
Iodine value (mg I_2/100g)	189.9	115.8	87.5
Peroxide Value (m.eq O_2/kg)	1.25	1.15	3.5
Unsaponifiable matter (%)	1.28	2.57	1.45
Oxidative stability index (h) at 110 ºC	1.7	5.8	14.5

Fatty acids composition for of flaxseed, sunflower and olive oils

The results presented in Table (2) show the content of different fatty acids in flaxseed, sunflower, and olive oils. The results clearly indicate that each oil is characterized by the presence of a major fatty acid that represents more than 50% of its total components. α-linolenic acid (18:3 n3) represents 55.34% of the total components of flaxseed oil, while linoleic acid (18:2 n6) represents 53.33% of the total fatty acids in sunflower oil. Finally, oleic acid (18:1 n9) represents 66.65% of the fatty acids content in olive oil. In addition to the main fatty acid in each oil, there are two fatty acids that represent the largest portion of the components compared to the rest of the fatty acids that make up it. In flaxseed oil, oleic (17.7%) and linoleic (15.96%) acids are present, and in sunflower oil, oleic (27.94%) and palmitic (11.14%) acids are present, or in olive oil, palmitic (16.1%) and linoleic (11.26%) acids are present. The proportions of the main fatty acids of flaxseed oil components in our study are similar to the results of previous studies conducted on flaxseed oil (Hosseinian *et al.,* 2004; Ogunronbi *et al.,* 2011;Bernacchia *et al.,* 2014), and the results of sunflower oil are similar to the results of studies conducted by (Fox *et al.,* 2004; Škorić *et al.,* 2008), and the oleic acid contents of olive oil in our experiment were similar with what found in different studies (Boskou *et al.,* 2006;Guo *et al.,* 2018).

Sterols composition for of flaxseed, sunflower and olive oils

The results presented in Table (3) show the content of different sterols in flaxseed, sunflower, and olive oils. β-sitosterol was 28.24% and campesterol was 16.37% of the total sterols in flaxseed oil, which are similar with studies conducted by (Herchi *et al.,* 2012; Teneva *et al.,* 2014; Han *et al.,* 2015). While in sunflower oil β-sitosterol represents 44.86% and stigmasterol represents 20.33% of the total sterols; these results are similar to what other scientists found (Aguirre *et al.,* 2012; Grompone., 2011), who indicated that both β-sitosterol and stigmasterol are the two largest components of total sterols in sunflower oil. Finally, squalene represent 64.14% and β-sitosterol16.78% of the total components of olive oil; these results are very similar to what was found by (Kyçyk *et al.,* 2016; Bozdogan *et al.,* 2016).

Table (2): GC results for Fatty acids composition for of flaxseed, sunflower and olive oils.

Fatty acids	% for each fatty acid		
	Flaxseed oil	**Sunflower oil**	**Olive oil**
Palmitic acid (C16:0)	5.84	11.14	16.1
Palmitoleic acid (C16:1n7)	Nd	Nd	2.31
Stearic acid (C18:0)	4.92	4.45	3.03
Oleic acid (C18:1n9)	17.7	27.94	66.65
α-Linoleic acid (C18:2n3)	15.96	53.33	11.26
Linolenic acid (C18:3n6)	55.34	3.14	0.66
Arachidic acid (C20:0)	0.24	Nd	nd

Table (3): Sterols composition for of flaxseed, sunflower and olive oils.

Sterols	% for each Sterol		
	Flaxseed oil	**Sunflower oil**	**Olive oil**
Campesterol	16.37%	11.68%	1.44%
Stigmasterol	3.58%	20.33%	Nd
β-sitosterol	28.24%	44.86%	16.78%
Isofucosterol	7.52%	9.54%	Nd
Squalene	Nd	Nd	64.14%
cycloartenyl acetate	12.42%	nd	Nd

Conclusion

This study aims to evaluate three of the edible oils spread in Egypt in terms of their physical and chemical properties and their content of fatty acids as well as sterols, in order to reach the best oils or the best mixture of them. The results clearly show a high content of sunflower oil of omega-6 fatty acids, while flaxseed oil was distinguished by its high content of omega-3 fatty acids, and olive oil was the highest in its content of omega-9 fatty acids. Therefore, these oils are well suited for use in nutrition, and more studies are needed to reach the best ratios of the mixture of these oils in biological experiments.

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تقييم زيوت عباد الشمس وبذور الكتان والزيتون من حيث التركيب الكيميائي والخواص الفيزيائية والكيميائية

إيمان علي الفقي، مصطفي عبد الله همام، عبد العزيز علي صقر، مدحت مصطفي أبوزيد

قسم الكيمياء الحيوية – كلية الزراعة – جامعة المنوفية – جمهورية مصر العربية

الملخص العربى

تعتبر الدهون مكونا أساسيا في النظم الغذائية للإنسان وتؤثر أنواعها بشكل كبير على الصحة العامة، وقد يسبب بعضها العديد من الأمراض، مثل أمراض القلب والأوعية الدموية والكبد الدهني. نظرا لأن زيوت عباد الشمس وبذور الكتان والزيتون من الزيوت الشائعة الاستخدام في التغذية في مصر ، فقد أجريت هذه الدراسة من أجل مقارنة مكونات هذه الزيوت وقيمتها الغذائية من أجل تقييمها. تم تقدير مكونات الأحماض الدهنية لهذه الزيوت ، والستيرولات الموجود في كل زيت تم تقديره باستخدام GC. كما تم تقدير الخواص الفيزيائية والكيميائية لكل زيت (الكثافة النوعية ، معامل الانكسار ، اللون ، مؤشر الاستقرار التأكسدي ، رقم التصبن ، رقم اليود ، رقم الحامض ، رقم الإستر ، رقم البيروكسيد والنسبة المئوية للمادة غير القابلة للتصبن). كان حمض اللينوليك أكبر مكون في زيت عباد الشمس (٥٣.٣٣٪) ؛ كما كان حمض الأوليك هو الأكبر في زيت الزيتون (٦٦.٦٥٪) ، بينما كان حمض ألفا لينولينيك أكبر مكون في زيت بذور الكتان (٥٥.٣٤٪). وبالنسبة للإستيرولات فقد كان بيتا- سيتوستيرول (٤٤.٨٦٪) ، ستيغماستيرول (٢٠.٣٣٪) ، كامبيستيرول (١١.٦٨٪) ، إيزوفوكوستيرول (٩.٥٤٪) تمثل المكونات الأكبر في زيت عباد الشمس. كما كان السكوالين (٦٤.١٤٪) و بيتا -سيتوستيرول (١٦.٧٨٪) تمثل النسبة الأكبر من الاستيرولات في زيت الزيتون. وأخيرا فقد كانت بيتا -سيتوستيرول (٢٨.٢٤٪) ، كامبيستيرول (١٦.٣٧٪) وخلات سيكلارتينيل (١٢.٤٢٪) تمثل المكونات الأكثر تواجدا في زيت بذورالكتان . تظهر النتائج بوضوح وجود نسبة عالية من من أحماض أوميجا ٦ في زيت عباد الشمس ، بينما تميز زيت بذور الكتان بمحتواه العالي الأحماض الدهنية من نوع أوميجا ٣، وكان زيت الزيتون هو الأعلى في محتواه حمض الأوليك (أوميجا ٩). لذلك ، فإن هذه الزيوت مناسبة تماما للاستخدام في التغذية ، وهناك حاجة إلى مزيد من الدراسات للوصول إلى أفضل نسب خليط هذه الزيوت في التجارب البيولوجية.

الكلمات المفتاحية: زيت عباد الشمس – زيت بذور الكتان – الأحماض الدهنية من نوع الأوميجا ٣ – الأحماض الدهنية من نوع الأوميجا ٦ – الأحماض الدهنية من نوع الأوميجا ٩.