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Determination of Fatty Acid Profiles and Antioxidant Activities of Some Edible Oils Consumed in Türkiye

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HIGHLIGHTS

- The purpose of this study was to determine the antioxidant activity of the samples and to identify the presence of β-sitosterol in their structure.
- The study identified the fatty acids present in the oils, as well as the ratio of saturated to unsaturated fatty acids.
- The oils were found to contain linoleic acid (C18:2) and oleic acid (C18:1) as the primary fatty acids.

Abstract

Vegetable-based edible oil in Turkey is produced primarily from olive oil, as well as oils obtained from various plants such as sunflower, corn, cotton, poppy, soybean, safflower and canola which are also among the main food sources. The quality of the oils used in our diet is primarily determined by the ratios of saturated and unsaturated fatty acids. Another important feature that determines oil quality is primarily antioxidant activity and its other biological activity capacities. This study was carried out to determine the fatty acid profiles and antioxidant capacities of 17 (seventeen) different oils of vegetable origin, which are widely consumed in Turkey and have economic importance. Fatty acid compositions were determined with GC-MS method. Antioxidant activities of different edible oils were determined by using 2,2'-diphenyl-1-picrylhydrazyl (DPPH) radical scavenging activity method. According to the results of this research, the highest scavenging effect was detected at different concentrations was obtained from soybean oil with 94.30±1.57%, while the least scavenging effect was obtained from peanut oil with 32.34±1.00%. Major fatty acid components linoleic acid (C18:2) and linolenic acid (C18:3) were detected in 17 different oils. Also, the presence of beta-sitosterol was examined by Thin Layer Chromatography and it was determined that beta-sitosterol was present in almost all of them.

Keywords: Fatty acid; saturated fatty acid; unsaturated fatty acid; antioxidant activity; DPPH

1. Introduction

Essential nutrients are classified into two main groups: macronutrients and micronutrients. The feature distinguishing macronutrients from micronutrients is their having energy values, in another mean, they give us the energy that we need on a daily basis. On the other hand, micronutrients are auxiliary substances for

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our body, such as minerals and vitamins. Macronutrients are carbohydrates, proteins and fats. Fat is one of the main nutrients required for many metabolic activities in our body and it is used as a building stone in the body therefore oils are especially important in hormones and cell membranes (Kolzeev 2022). In addition, vitamins A, D, E, and K are fat-soluble vitamins. A certain amount of oil consumption is needed daily by our body in order to use these vitamins. Since oils contain higher calories compared to other food groups, oil consumption was kept very low in diets (1 g ~ 9 calories) and in some diseases, or it could be zero. it could trigger other hormonal disorders in such case. According to performed studies in recent years, some essential oils should be used in diets and in diseases such as heart disease. The importance of oils with a high unsaturation rate in other diseases like losing weight, high cholesterol and heart diseases etc. has also been understood more clearly. Many studies and discussions show that a certain amount of oil included in an adequate and balanced diet should be taken every day. One of the important points is the type and amount of consumed oil. Whether the fatty acids are essential or not is determined according to the saturation and unsaturation ratio of consumed oil's structure. (Kaya 2018; Kayahan 2002).

The basic building stone of oils containing high amounts of carbon and hydrogen are structures called triglycerides. Triglycerides which are composed of fatty acids and glycerol are linked by ester bonds. These substances which are either solid or liquid at room temperature, are insoluble in water and are but they are not volatile. The oils are confidently classified as saturated, monounsaturated, and polyunsaturated based on the precise ratio of saturation and unsaturation in their fatty acid structure. Such as saturated oils are solid at room temperature, and coconut oil and butter are included this group while olive oil and sesame oil can be given as examples of monounsaturated oils which is known that monounsaturated oils have an effect on reducing total cholesterol. Corn oil, linseed, poppy oil, and grape seed are among the polyunsaturated oils that contain omega-3 and omega-6 in their structure. It is suggested that they be taken as supplements or applied topically, as these fatty acids are considered essential and cannot be synthesized by the body. Arachidonic acid, linoleic acid, and linolenic acid are considered essential fatty acids. Omega fatty acids have useful functions for brain development, strengthening of the immune system, prevention of coronary heart diseases (Kayahan 2003; Kalbini Dinlesen 2022). So fatty acids are important components for cell membranes of all tissues in our body. The main component of the brain after water is lipids, and about half of its dry weight is oil. For this reason, it is important to take the right oil in adequate amounts and to protect it with antioxidants. The harmful effects of reactive oxygen species and other radicals, which are formed as a result of certain mechanisms in our body, are controlled by antioxidants. When free radicals are formed at rates exceeding the capacity of the defense mechanisms, the balance between the oxidant and antioxidant system in our body becomes damaged. As a result of this case, it may cause many diseases such as hypertension, coronary heart disease, diabetes, premature aging, Alzheimer's. Therefore, antioxidants and essential oils with high antioxidant capacity, food supplements, etc. should be used as a protector against free radicals (Kurban and Mehmetoğlu2006) which is known that daily fat intake protects the antioxidant system of our body thanks to reducing the rate of oxidative metabolism by regulating the fatty acids composition of the cells (Leenen et al. 2002).

As it is known, most of the oils are obtained from oily seeds. For example, plant sterols/stanols are important bioactive components in the structure of plants with beneficial properties for human health. The three main plant-derived sterols are campesterol (24-α-methylcholesterol), β-sitosterol(24-α-ethylcholesterol), and stigmasterol (Δ22, 24-α-ethylcholesterol).

Plant sterols are structurally similar to cholesterol. The foods having the highest plant sterol content are oilseeds, especially nuts. It contains sterols in its structure according to the oil seed from which it is obtained. All vegetable oils, especially safflower oil (Δ7 stigmastanol), rapeseed oil (brassicasterol) and olive oil (β-sitosterol) have high plant sterols content. Although it has been known for years that especially the plant sterols have cholesterol-lowering effect (Çekici and Yıldıran 2019; Ateş and Velioğlu2014; Köhler et al. 2017).

In this study, it was aimed to determine the fatty acid profile of 17 different oils that we consume directly in our daily life as flavoring in meals, salads, black cumin and safflower oil, as well as in diets applied in certain diseases, and also to determine the antioxidant activities and the presence of β-sitosterol in their structures. Besides, the fatty acids of the oils were detected, and the ratios of saturated and unsaturated fatty acids were determined.

2. Materials and Methods

2.1. Material

The samples used in this study were obtained from Zade oil factory in Konya, a brand that is widely recognized in our country. A total of 17 different oil types were used such as soybean, corn, safflower, canola, sunflower, cotton, linseed, black cumin, pumpkin seeds, walnut, olive oil, extra virgin olive oil, mixed pomace olive oil, grape seed, sesame, poppy and peanut oils.

2.2. Determination of Antioxidant Activity

The 2,2'-diphenyl-1-picrylhydrazyl (DPPH) radical scavenging activity method was used to determine the antioxidant activity in oils which method was discovered by Blois (1958), and modified method was applied to the extracts by Hatano et al. (1989). The scavenging effects of oil samples against DPPH free radical were determined by measuring the color transformation spectrophotometrically at a wavelength of 515 nm in the UV/visible region. The DPPH stock solution was weighed in the required amount at a concentration of $6x10^{-5}$ mol/l and it was dissolved in ethanol (75%). 300 µl of each oil sample was taken into the test tubes with the help of a micropipette and 2700 µl of DPPH solution was added to them. Then, the tubes were incubated at room temperature in the dark for 20 minutes. At the end of the period, the absorbance of the samples was read in a blinded ethanol spectrophotometer (Agilent Technologies UV-Visible spectrophotometer, Germany) at 515 nm wavelength. The % inhibition of the samples against DPPH free radical was calculated according to the formula given below. Each sample was run at three different concentrations as 25 mg/ml, 50 mg/ml and 100 mg/ml. Each sample was run in 3 parallels and the results were given by calculating the standard deviation as the mean % scavenging effect of 3 parallels.

2.3. Determination of the Presence of Beta-Sitosterol by TLC (Thin Layer Chromatography)

The given statement is a definition of solid-liquid adsorption chromatography known as Thin Layer Chromatography. The mobile phase moves from the bottom to up over the stationary phase in this method. Chloroform:diethylether (1:1 v/v) solvents were used to examine the presence of beta-sitosterol in oils. The presence of beta-sitosterol in oils was determined by the retention factor, through reaching the highest level in the solvent system (European Pharmacopoeia 2021).

2.4. Determination of Fatty Acid Compositions

2.4.1. Methylation in Oils

The methylation process in oils is based on the extraction of fatty acids by separating the fatty acids and glycerol in their structure. The process of esterification was performed in accordance with the European Pharmacopoeia. First of all, 450 mg (0.45 g) oil sample was weighed into a 50 ml volumetric flask and 12 ml of 0.5 N methanolic NaOH was added on it and it was left in the heater for 10 minutes (approximately 80^0C) until the oil and solution were mixed. When saponification took place, 20 ml of BF3 /MeOH was added to the mixture and it was kept in the heater for 2 minutes. At the end of the period, the flask was filled up to the 50 ml line of the volumetric flask with saturated NaCl solution. After adding 1 ml of hexane and performing the phase separation, the top part was taken and transferred to the vial and given to GC-MS for reading (Eryılmaz et al. 2015; Orhan Erdogan et al. 2013).

2.4.2. ChromatographicConditions

The fatty acids were determined using a Gas Chromatography Mass Spectrophotometer (Agilent 6890N Network GC system combined with Agilent 5973 Network Mass Selective Detector). The device was

equipped with an Agilent 19091N-136 column (HP Innowax Capillary; 60.0 m x 0.25 mm x 0.25 mm), and Helium was used as the carrier gas with a flow rate of 1.2 ml/min. The injection volume was 1 µl with a split ratio of 50:1, and the injector temperature was set to 250°C. The scanning range was 35-450 atomic mass units (AMU) with ionization by electron bombardment (EI - 70 eV).

The fatty acid compositions were determined using data from the Famed 23, Wiley, and Nist Mass Spectral Library. Retention indices were calculated based on the peak emergence time relative to n-alkanes.

3. Results and Discussion

3.1. Antioxidant Activity

Antioxidant activities of oil samples were determined at 3 different concentrations, 25 mg/ml, 50 mg/ml and 100 mg/ml. As seen in Table 1, soybean, corn and safflower oil showed the highest scavenging effect at all 3 concentrations. It was determined that soybean, corn, safflower and canola oils among the run oil samples showed the best antioxidant activity at 100 mg/ml concentration due to their DPPH radical scavenging effect of approximately 90% and above. These oils are also followed by sunflower oil, cottonseed oil, linseed oil, black cumin oil, pumpkin seed oil and walnut oil, whose activities vary between 70-80%, respectively. Of the oils tested, it is worth noting that peanut oil exhibited a lower antioxidant activity of 47.30% compared to the others, which showed an intermediate antioxidant activity of less than 70%. Although it has a high amount of vitamin E in its structure, when its fatty acid profile is examined, the unsaturation/saturation ratio was found lower than other oils. When it is considered that fatty acids are associated with antioxidant activity, the result shows parallel. The soybean oil is consumed in certain diets in the world as a source of antioxidant activity due to the polyphenols and tocopherols (Vitamin E) in its structure. At the same time, safflower oil has high antioxidant activity because of its rich Vitamin E content. Also, the corn oil has high antioxidant activity because of its high Vitamin E (about 13%- Shoemaker 2019) and physterols content. The presence of high amounts of oleic and linoleic acids found in soy, corn and safflower oils is also effective in their high antioxidant activities because vegetable-based edible oils contain compounds having natural antioxidant activity. There is ascorbic acid, α-tocopherol, beta-sterol, β-carotene, flavonoids among these compounds Further investigation is necessary to determine the specific components in vegetable-based edible oils that contain antioxidant compounds and to better understand their benefits (Uluata 2010). Antioxidant activities of some oils are also high, especially due to the sterols, phenolic compounds and tocopherols found in their structures (Tuberosso et al. 2007; Stuchlik and Zak 2002).

3.2. Determination of Beta-Sterol Presence with TLC

The presence of beta-sitosterol was investigated in oils using thin layer chromatography and chloroform: diethylether (1:1 v/v) solvent system and it was determined that beta-sitosterol was present in all of them. Beta-sitosterol is one of the plant sterols and it is especially important in terms of lowering high cholesterol. Another subject about vegetable-based edible oils also has their own plant sterols they gain functionality to each oil. In this respect, the presence of beta-sitosterol in the oils used in this study shows that these oils can be used both in diets and in nutrition for heart disease and cholesterol.

3.3. Determination of Fatty Acid Compositions

Table 2 gives the fatty acid profiles of the oils used in this study. The fatty acids in the structure of oils are classified as saturated and unsaturated fatty acids in Table 3. Table 4 shows the relationship between saturated, mono and polyunsaturated fatty acid profiles and saturated and unsaturated fats in oils (Figure 1,2).

According to Table 2, the saturated fatty acids determined in oils are myristic (C14:0), palmitic (C16:0), stearic (C18:0), and arachidic (C20:0) acid. Myristic acid was found to be the most abundant, with a concentration of 0.634%, in peanut oil. The palmitic acid was determined at the highest rate with 20.857%, in cotton oil; it was found at the lowest rate with 5.33% in canola oil. Stearic acid was determined as 9.182 % in peanut oil as the highest and 1.851% in canola oil as the lowest rate. Arachidic acid was found at the highest

rate in mixed pomace oil with 0.654%, in canola oil with 0.637% and in pumpkin seed oil with 0.599%, respectively. No arachidic acid was determined in safflower oil.

Table 1. % Inhibition of oils to DPPH radical.

Oils	% Inhibition of Oils to DPPH Radical[a]±SD[b]		
	Concentration		
	25 mg/ml	50 mg/ml	100 mg/ml
Soybean	52.16±1.04	72.95±0.52	94.30±1.57
Corn	52.06±1.99	72.49±0.33	94.27±0.78
Safflower	50.65±0.43	69.64±0.72	93.01±0.35
Canola	48.18±0.99	64.91±0.42	89.46±1.85
Sunflower	41.84±1.24	57.34±0.59	79.67±0.98
Cottonseed	42.18±1.15	56.59±0.49	77.88±0.46
Linseed	43.71±0.80	60.06±1.02	76.32±1.37
Black cumin	39.96±0.30	52.99±1.07	72.64±0.74
Pumpkinseed	40.35±1.22	52.73±0.65	72.44±1.21
Walnut	38.56±1.07	50.99±0.86	72.03±0.20
Mixed Pomace olive	38.74±0.65	48.41±1.28	66.11±0.93
Olive	37.38±0.38	47.98±1.38	65.03±0.48
Grapeseed	38.97±0.72	47.36±0.73	63.95±0.26
Sesame	37.71±0.69	47.97±0.82	63.62±0.37
Extravirgin olive	35.00±0.97	44.71±0.92	60.42±0.44
Poppy	36.23±1.73	43.62±0.89	57.33±0.89
Peanut	32.34±1.00	38.83±0.52	47.30±0.70

SD: Standard deviation

Monosaturated fatty acids were identified as palmitoleic acid (C16:1), oleic acid (C18:1) and eicosanoic acid (C20:1). Palmitoleic acid was highest in canola oil (1.851%) but it was not detected in safflower oil. As it is known, oleic acid is found the highest fatty acid in olive oil. The oleic acid was detected with 74.15% in olive oil, 70.952% in extra virgin olive oil and 67.72% in mixed pomace oil in this study. The lowest rate was detected in canola oil with 0.102% rate. While eicosanoic acid was detected highest in canola oil (1.233%), it could not be detected in safflower oil.

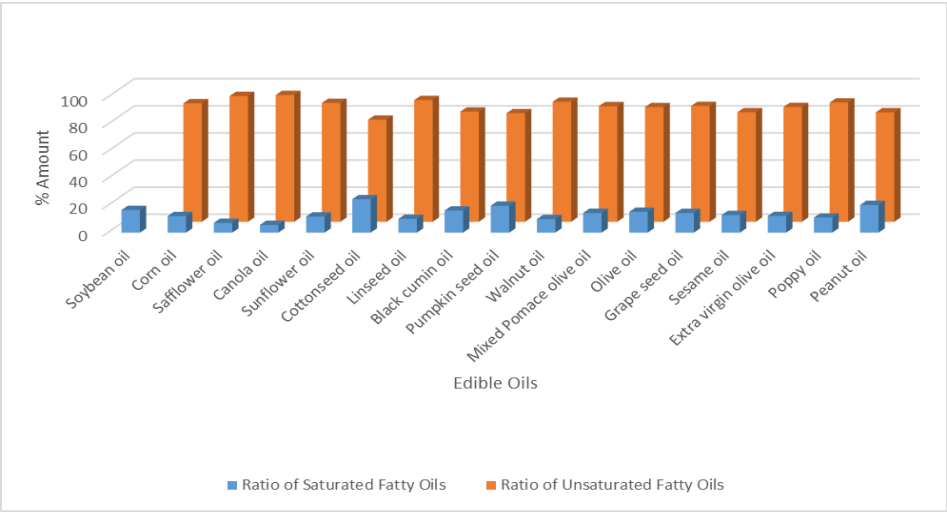

Figure 1. The Sum of Saturated and Unsaturated Fatty Acids in the Structure of Edible Oil

Table 2. Fatty acids methyl esters of oils (%).

Oils	Myristic Acid (C14:0)		Palmitic Acid (C16:0)		Palmitoleic Acid (C16:1)		Stearic Acid (C18:0)		Oleic Acid (C18:1)		Linoleic Acid (C18:2)		Linolenic Acid (C18:3)		Arachidic Acid (C20:0)		Eicosanoic Acid (C20:1)	
	RI*	%	RI	%	RI	%	RI	%	RI	%	RI	%	RI	%	RI	%	RI	%
Soybean	-	0	1292	11,003	1296	0,076	1547	5,174	1560	25,991	1584	50,993	1754	5,967	1885	0,55	1921	0,246
Corn	-	0	1292	9,43	1296	0,054	1547	2,534	1560	28,965	1584	56,89	1754	1,32	1885	0,216	1921	0,231
Safflower	975	0,07	1292	5,485	-	0	1547	1,627	1560	28,727	1584	63,997	1754	0,093	-	0	-	0
Canola	975	0,05	1292	5,33	1296	1,851	1592	0,325	1618	0,102	1667	84,846	1755	5,556	1886	0,637	1921	1,233
Sunflower	975	0,049	1292	6,079	1296	0,056	1592	5,744	1618	28,23	1667	59,091	1755	0,186	1886	0,404	1921	0,16
Cotton seed	975	0,552	1292	20,857	1296	0,417	1592	2,906	1618	19,766	1667	54,628	1755	0,381	1886	0,332	1921	0,161
Linseed		0	1290	5,528	1296	0,072	1586	4,44	1610	24,965	1665	17,309	1752	47,315	1883	0,193	1921	0,178
Black cumin	975	0,149	1290	12,115	1296	0,18	1586	3,793	1610	24,646	1665	55,728	1752	0,442	1883	0,271	1921	0,34
Pumpkin seed	975	0,089	1290	11,067	1296	0,094	1586	8,098	1610	39,238	1665	40,531	1752	0,15	1883	0,599	1921	0,133
Walnut	975	0,022	1290	6,812	1296	0,129	1585	3,048	1609	18,044	1665	60,251	1752	9,939	1882	0,133	1921	0,243
Mixed Pomace olive	-	0	1290	12,03	1296	0,487	1584	1,869	1609	67,72	1665	15,993	1752	0,699	1882	0,654	1921	0,428
Olive	975	0,012	1290	11,511	1296	0,685	1584	3,301	1608	74,15	1664	8,849	1752	0,603	1880	0,542	1921	0,347
Grape seed	-	0	1290	9,041	1296	0,158	1583	5,217	1607	22,161	1662	62,634	1751	0,394	1884	0,233	1920	0,162
Sesame	-	0	1290	9,015	1296	0,142	1583	3,521	1607	41,683	1662	38,291	1751	0,537	1884	0,432	1920	0,174
Extra virgin olive	-	0	1290	9,203	1296	1,355	1583	2,771	1607	70,952	1662	11,33	1751	0,856	1884	0,327	1920	0,205
Poppy	975	0,05	1290	8,293	1296	0,135	1583	2,762	1607	14,84	1662	72,431	1751	0,558	1884	0,102	1920	0,061
Peanut	975	0,634	1290	9,171	1296	0,113	1583	9,182	1607	18,252	1662	58,110	1751	2,223	1884	0,22	1920	0,095

Table 3. Classification of saturated and unsaturated fatty acids (%).

Oils	Saturated Fatty Acids				Unsaturated Fatty Acids				
	Myristic Acid (C14:0)	Palmitic Acid (C16:0)	Stearic Acid (C18:0)	Arachidic Acid (C 20:0)	Palmitoleic Acid (C16:1)	Oleic Acid (C18:1)	Linoleic Acid (C18:2)	Linolenic Acid (C18:3)	Eicosanoic Acid (C20:1)
Soybean	0	11,003	5,174	0,550	0,076	25,991	50,993	5,967	0,246
Corn	0	9,430	2,534	0,216	0,054	28,965	56,890	1,320	0,231
Safflower	0,070	5,485	1,627	0	0	28,727	63,997	0,093	0
Canola	0,050	5,330	0,325	0,637	1,851	0,102	84,846	5,556	1,233
Sunflower	0,049	6,079	5,744	0,404	0,056	28,230	59,091	0,186	0,160
Cotton seed	0,552	20,857	2,906	0,332	0,417	19,766	54,628	0,381	0,161
Linseed	0	5,528	4,440	0,193	0,072	24,965	17,309	47,315	0,178
Black cumin	0,149	12,115	3,793	0,271	0,18	24,646	55,728	0,442	0,340
Pumpkin seed	0,089	11,067	8,098	0,599	0,094	39,238	40,531	0,150	0,133
Walnut	0,022	6,812	3,048	0,133	0,129	18,044	60,251	9,939	0,243
Mixed Pomace olive	0	12,030	1,869	0,654	0,487	67,720	15,993	0,699	0,428
Olive	0,012	11,511	3,301	0,542	0,685	74,150	8,849	0,603	0,347
Grape seed	0	9,041	5,217	0,233	0,158	22,161	62,634	0,394	0,162
Sesame	0	9,015	3,521	0,432	0,142	41,683	38,291	0,537	0,174
Extra virgin olive	0	9,203	2,771	0,327	1,355	70,952	11,330	0,856	0,205
Poppy	0,050	8,293	2,762	0,102	0,135	14,84	72,431	0,558	0,061
Peanut	0,634	9,171	9,182	0,220	0,113	18,252	58,110	2,223	0,095

Canola oil contains the highest percentage of linolenic acid at 84.846%, followed by the other oils which contain lower amounts of this polyunsaturated fatty acid. The analysis revealed that the oils contain two polyunsaturated fatty acids: linoleic acid (C18:2) and linolenic acid (C18:3). It was detected in poppy oil with 72.431% and safflower oil with 63.997%, respectively. The lowest linoleic acid content of 8.849% was found in olive oil. While flaxseed oil has the highest linolenic acid content with 47.315% rate. It was determined as 9.939% in walnut oil and 5.967% in soybean oil. It was determined at the lowest level as 0.093% in safflower oil.

The major fatty acid detected in soybean oil is linoleic acid with rate of 50.993%. While oleic acid was determined at a rate of 25.99% and palmitic acid was determined at a rate of 11.003%, myricitic acid was not detected. On the other hand, the main fatty acid of corn oil is linoleic acid and it was found at a rate of 56.89%. The oleic acid was determined as 28.965% and palmitic acid was determined as 9.43%. The linoleic acid was found as the primary fatty acid in safflower, canola, sunflower, cotton, black cumin, pumpkin seeds, walnut, grape seed, poppy and peanut oils. It was determined as 84.846%, the highest rate in canola oil what was determined lower in walnut oil at a rate of 40.531%. The main fatty acid in linseed oil is linolenic acid and it was determined at a rate of 47.315%. The main fatty acid is oleic acid in olive oil, extra virgin olive oil, mixed pomace oil and sesame oil. Oleic acid was determined as 41.683% in sesame oil and 74.15% in olive oil.

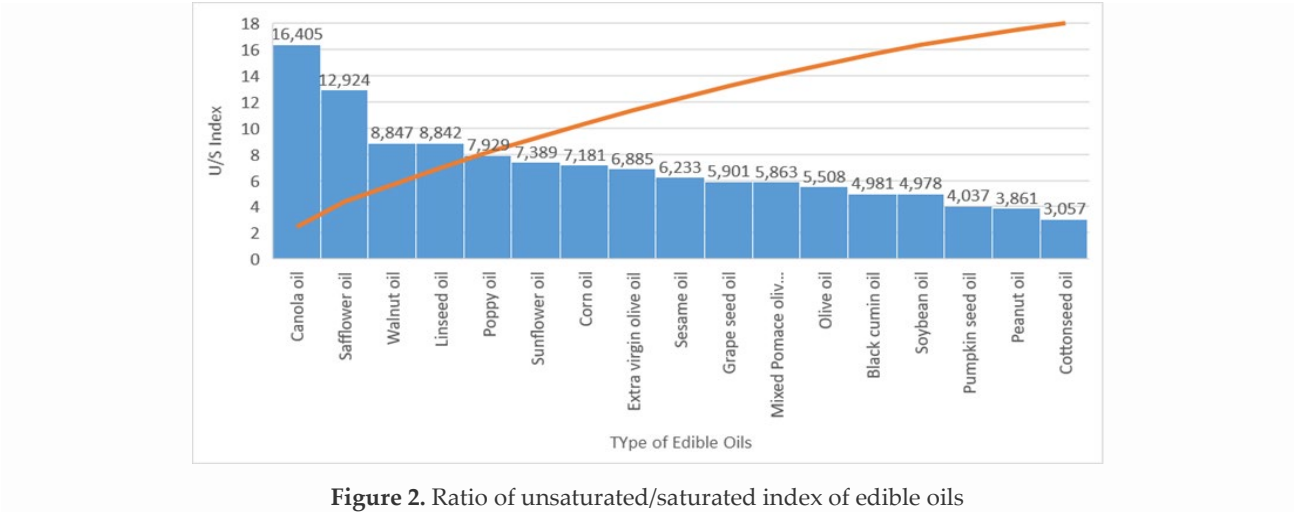

Figure 2. Ratio of unsaturated/saturated index of edible oils

The myristic (0.027-0.079%), palmitic (8.995-11.802%), stearic (4.035-6.800%), oleic (21.048-25.390%), linoleic (50.982-56.071), linolenic (5.162-6.494%) and arachidic (0.349-1.002%) acid were determined as main components in a study conducted with soybean oil (Jokic et al. 2013). In another study, it was determined that the palmitic and stearic acid contents of soybean oil were in the range of 10.63-11.43%, 3.76-4.61%, respectively (Esteves et al. 2010). Galao et al. (2014) determined the oleic, linoleic and linolenic acid ratios of soybean oil as 13.46-20.63%, 53.32-59.34%, 7.38-11.89%, respectively. Most of the fatty acids in corn oil are unsaturated same as in other oils. Corn oil contains palmitic acid (16:0), stearic acid (18:0), oleic acid (18:1), and linoleic acid (18:2) among its main fatty acids. The highest fatty acid in corn oil is linoleic acid (Moreau 2002). It was determined that palmitic, palmitoleic, stearic, oleic, linoleic, linolenic, arachidic and eicosanoid acid contents in corn oil are respectively; 11.39%, 0.10%, 1.83%, 29.90%, 54.57%, 0.97%, 0.40% and 0.25% (Kerr et al. 2016). Corn oil was detected that it contains high levels of linoleic acid (64.6%) and oleic acid (21.6%) in another study (Kar Eryılmaz 2009). Yılmaz (2018) determined oleic (8.805-34.266%) and linoleic (53.528-83.221%) acids as major fatty acids in the varieties of safflower oils in his thesis study. fatty acid compositions of safflower oil were determined aspalmitic acid 3.90-6.80%, stearic acid 1.10-4.50%, oleic acid 6.20-81.90% and linoleic acid 11.00-83.10% (Johson et al. 1999), linoleic acid 70.30-78.80%, oleic acid 82.10-62.70% (Cazzato et al. 2001), palmitic acid 6.0-8.5%, stearic acid 2.0-3.1%, oleic acid 7.8-30.6% and linoleic

acid 6% 0.0-81.6% in other studies conducted on safflower (Uysal 2006), what was determined, myristic (<0.1%), palmitic (5.2-10.5%), stearic (4.4.-6.9%), oleic (23.2-59.5%), linoleic (18.8-15.2%), linolenic (11.9-44%) and arachidic (0.11-0.18%) acid in the study conducted on canola (Bauer et al. 2015). As a result of study canola can be classified as low linolenic acid, high oleic acid, high lauric acid content (Moreau 2002). The sunflower oil contains averagely 69-70% linoleic acid, 20% oleic acid, 10-11% palmitic and stearic acid (Sunflowersa 2022). Also, it is classified into 3 groups as low (10-29%), medium (30-59%) and high oleic acid (60-90%) sunflower oil (Pacurenau-Joita et al. 2005). It has been reported that 20-30% oleic, 60-70% linoleic and <1% linolenic acid in sunflower oil obtained from conventional seeds; 25-75% oleic, 15-35% linoleic and <1% linolenic acid in sunflower oil containing medium oleic acid; sunflower oil containing high oleic acid contains 80-90% oleic, 5-9% linoleic and <1% linolenic acid (Moreau 2002). Another detection that the cottonseed oil has 0.78-0.80% myristic, 24.85-25.63% palmitic, 0.54-0.57% palmitoleic, 3.01-3.13% stearic, 14.06-17% oleic, 52-55.82% linoleic, 0.12-0.14% linolenic, and 0.29%- 0.31 arachidic acid in a conducted study (Konuşkan Bozdoğan et al. 2017). Flaxseed oil has low (about 7-10%) saturated fatty acids while it has high unsaturated fatty acids (80-93%). According to a study conducted in Flaxseed oil, what has been reported that it has averagely 15.8-62.5% oleic, 17.8-19.6% linoleic and 10-58.3% linolenic acid (Lewinska et al. 2015). In another study, fatty acid profiles of flaxseed varieties were examined, and it was determined that there were 17-24.8% oleic, 10.2-13.1% and 47.8-59.9% linolenic acids (Bertrand and Özcan 2017). Black seed oil is important as a functional oil due to its the thymoquinone content at the same time black seed oil also has a high unsaturation rate as an fatty acid profile. Lutterodt et al. (2010) found 2.56-2.80% stearic, 22.63-24.51% oleic, 58.83-61.20% linoleic and 0.21-0.28% linolenic acid in 6 groups of cold-pressed black cumin oil. The linoleic acid (18:2) was found 66.5% and oleic acid (18:1) was found 23.5% in another study (Çiftçi et al. 2011). The essential fatty acids of pumpkin seed oil were detested as oleic (17.0-39.5%), linoleic (18.1-62.8%), palmitic (12.6-18.4%) and stearic 5.1-8.5) acids. Additionally, the most striking feature of pumpkin seed oil in terms of fatty acid composition content is that the ratio of total unsaturated fatty acid (80.65%) is quite high compared to total saturated fatty acid (19.35%) (Ardabili et al. 2011). Akın (2016) determined 5.260-5.290% stearic, 27.520-27.590% oleic, 53.190-53.270% linoleic and 0.390-0.440% linolenic acid fatty acids in pumpkin seed oil in his thesis study. In a study on the fatty acids contained in walnut types, the linoleic acid content was determined as highest between 50.24-60.60%, respectively followed by 20.70-28.33% oleic acid and 10.93-15.04% linolenic acid. Besides, monounsaturated fatty acids between 22.17–29.73% and saturated fatty acids between 4.00–7.86% were obtained in the study (Şimşek 2016). Walnut is an important oil source for the brain because of its high amount omega-3 fatty acids content. According to Unver and Celik's (2005) research, the walnut types they examined exhibited different ratios of linoleic acid (ranging from 41.13% to 61.15%), oleic acid (ranging from 22.39% to 49.12%), palmitic acid (ranging from 6.01% to 10.21%), and stearic acid (ranging from 2.17% to 4.99%).About 90% of grape seed oil consists of mono and polyunsaturated fatty acids which contains especially high amount of linoleic acid (58-78%) and 3-15% oleic acid and contains about 10% saturated fatty acids (Bail et al. 2008, Rombaut et al. 2015; Konuşkan et al. 2019). It was reported that grape seed oil contains palmitic (6.6%), stearic (3.5%), oleic (14.3%), linoleic (74.7%) and linolenic acid (0.15%) in another study (Orsavova et al. 2015). The fatty acid components of sesame oil are approximately 7-12% palmitic, 0.35-6% stearic, 35-50% oleic, 35-50% linoleic and 0.30-0.80% linolenic acid (BÜF, 2022). Sesame is considered to be one of the oldest and most significant oil plants cultivated globally. Unlike other vegetable oils, sesame oil contains oleic and linoleic fatty acids, each ranging from 35 to 45% (Liu et al., 1992). The fatty acids in the sesame oil were determined as myristic, palmitic, palmitoleic, stearic, oleic, linoleic, linolenic and arachidic acids, and the main components were determined as oleic acid (39.67-41.05%) and linoleic acid (42.09-43.31%) in the study conducted in 2021 (Özpolat et al. 2021). Poppy seed fatty acids are linoleic (62-72%), oleic (10-30%), palmitic (9-10%), stearic (1.5-2.5%) and linolenic (0-5%) acids (Cameo 2022). In the 2014 thesis study examining the fatty acid distribution of oils from various poppy seeds, it was found that linoleic acid (C18:2) had the highest ratio.It was stated that it varied between 65.52-74.97%. The fatty acid with the highest ratio after linoleic acid was oleic acid (13.26-21.43%). The other fatty acid with the highest ratio was determined as palmitic acid (8.65-10.06%) (Abudak 2014). The main fatty acid component of peanut oil was oleic acid (45-53%), while linoleic acid (27-32%) and palmitic acid (11-14%) were other fatty acids (Ghazani and Marangoni 2016). Then the oleic acid was found as 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% in studies carried out in peanut oil (Dwivedi et al. 1996, Hassan and Ahmed 2012, Chowdhury et al. 2015). One of the differences of peanut oil from other oils is the ratio of oleic acid to linoleic acid (O/L value) and this ratio determines the nutritional value, storage time and shelf life of both the oil and the products in which peanut oil is used. If this value is high (>10:1), the shelf life is reduced, if it is low (1.5/1), the shelf life is extended (Chamberlin et al. 2014). Although the fatty acid ratios in the olive oil composition vary depending on various factors, it generally consists of 50-83% oleic acid, 7-20% palmitic acid and 3-20% linoleic acid (T.G.K. 2014). The fatty acid composition of 10 different samples of olive oils sold in Nizip and its surroundings was analysed in a 2012 study. The results showed that oleic acid had the highest rate (62.430-71.321%), followed by linoleic acid (7.216-11.825%) and palmitic acid (2.260-12.016%) (Türkoğlu et al. 2012). They determined that the oleic and linoleic acid values of a total of 103 olive oil samples produced with different systems (classical and modern) in Izmir during two different harvest periods varied between 67.68-74.16% and 8.72-13.89% (Dıraman et al. 2009).

Table 4. Ratio of saturated, monounsaturated and polyunsaturated fatty acids (%).

Oils	Saturated Fatty Acids Ratio	Monounsaturated Fatty Acids Ratio	Polyunsaturated Fatty Acids Ratio	Unsaturated/Saturated Ratio	Total
Soybean	16,727	26,313	56,960	4,978	100
Corn	12,180	29,250	58,210	7,181	99,64
Safflower	7,182	28,727	64,090	12,924	99,99
Canola	5,705	3,186	90,402	16,405	99,293
Sunflower	11,872	28,446	59,277	7,389	99,595
Cotton seed	24,647	20,344	55,009	3,057	100
Linseed	10,161	25,215	64,624	8,842	100
Black cumin	16,328	25,166	56,170	4,981	97,664
Pumpkin seed	19,853	39,465	40,681	4,037	99,99
Walnut	10,015	18,416	70,190	8,847	98,621
Mixed Pomace olive	14,553	68,635	16,692	5,863	99,880
Olive	15,366	75,182	9,452	5,508	100
Grape seed	14,491	22,481	63,028	5,901	100
Sesame	12,968	41,999	38,828	6,233	93,795
Extra virgin olive	12,301	72,512	12,186	6,885	96,999
Poppy	11,102	15,036	72,989	7,929	99,127
Peanut	20,407	18,46	60,333	3,861	99,2

The literatures related to the oils used in this study are given respectively. Fatty acid components obtained from all edible oils except canola, flaxseed, black cumin and peanut oils show parallelism with studies by other researchers. Considering that the canola plant is classified according to its oleic acid content, it can be said that the canola used in this study is a low oleic acid canola variety. As it is known, there are 2 different types of flaxseeds (yellow and brown), and since it is not known which kind of flaxseed oil is used here, the main fatty acid is linolenic acid according to the results obtained. Palmitic, oleic and linoleic acids constitute the main fatty acid profile of peanut oil (Carrin and Carelli 2010). Therefore, the results of the study show parallelism with the literature. When the method used to obtain oil from black cumin seeds and the storage times of the seed are considered, it is seen that obtained data in other studies are close to each other.

Table 4 presents the relationship between unsaturation and saturation ratio of oil acids in the structure of oils. This parameter is crucial in determining the nutritional value of oils and whether they possess functional properties. When the unsaturated/saturated ratio is greater than 1, it means that the nutritional

value is high, and this means that this oil can be used in diets, cholesterol, high blood pressure, etc. states that it can be easily consumed in certain diseases (Lawton et al. 2000). According to result, the highest was determined in Canola (16.405%), Safflower (12.924%) and sunflower (7.389%), while the lowest was found in flaxseed (3.057%) and Peanut (3.861%) oil. It was determined 3.2-3.4% in canola, 10.55% in safflower, 6.76% in sunflower and 7.05% in flaxseed in the study conducted by Kostik et al. (2013), on the other hand, Zambiazi et al. (2007) determined it 4.10% in canola, 5.80-5.95% in sunflower, 6.56% in flaxseed and 1.70% in peanut. The obtained values according to these results show almost parallelism.

Changes in fatty acid compositions differ depending on the obtained oil seed type, climate and environmental conditions, soil structure and growing season. However, different maturation times of oilseeds should also be considered. In addition, it is expected that there will be a change in fatty acid profiles when the storage conditions of oilseeds are taken into account from the harvest to the period when oil is obtained. Finally, the extraction method of the oils can also affect the fatty acid composition.

As it is seen above mentioned, since the ratio of unsaturated fatty acids is high in all of the oils used in the study, it can be said that fatty acids can be easily used in certain diets, especially with cholesterol, diabetes and heart diseases.

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