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Fatty acid composition, tocopherol and sterol contents of sesame, poppy, wheat germ and pecan oils

Matthäus Bertrand[1], Mehmet Musa Özcan[2*]

[1]*Max Rubner-Institut (MRI) Bundesforschungsinstitut für Ernährung und Lebensmittel Institut für Sicherheit und Qualität bei Getreide Schützenberg 12 D-32756 Detmold-Germany,*
[2]*Department of Food Engineering, Faculty of Agriculture, Selcuk University, 42031 Konya, Turkey.*

Abstract

The oil contents of samples changed between 49.4 % and 75.2%. The key fatty acids of oil samples were oleic (36.5-69.6%), linoleic (20.4-46.4 %) and palmitic (6.1-9.2.2%). The α-tocopherol, γ-tocopherol, δ-tocopherol and δ-tocotrienol contents of oil samples varied between 0.3 and 17.06, 0.0 and 10.9, 0.0 and 523.9, 0.0 and 880.7 mg/100 g, respectively. In addition, total tocopherol contents of oils varied between 11.7 (pecan walnut) and 1222.6 mg/100 g (poppy). β-Sitosterol was the major sterol of oil samples, and its contents changed between 57.63 mg/kg (sesame) and 80.97 mg/kg (pecan walnut). The seed and kernels are to be a potential source of valuable oil which used for edible and industrial applications.

Keywords: oil content, fatty acids, tocopherol, sterols, GC, HPLC

1. Introduction

The seeds and kernels are used almost exclusively for their oil. Poppy seed oil is generally rich in polyunsaturated fatty acids due to nutritional, industrial and pharmaceutical applications [1-5]. The beneficial effects of vegetable are due to their high content in unsaturated fats. Phytosterols and tocopherols consisting of the unsaponifiable parts of oils are particularly important functional component in foods. Phytosterols are abundant in vegetable oils, nuts, seeds, and grains [6,7].

One of the major consumer issues affecting consumer habits and nutritional choices nowadays is the nutritional effect of dietary lipids [8]. Another mono-unsaturated vegetable oil source is pecan nut (*Carya illinoensis*). Pecan kernels contain about 65-75% oil depending on growing conditions of the tree.

The objective of this study was to investigate the oil content, fatty acid, tocopherol, and sterol compositions of sesame, poppy, wheat germ and pecan kernel provided from several locations of Turkey.

2. Materials and Method

2.1.Material

Sesame, pecan, wheat germ and poppy samples were cleaned from foreign matter were collected from Mersin and Konya of Turkey.

2.2. Oil content

After sample powder was extracted in a Soxhlet apparatus, the solvent was removed at 40 °C. The oil obtained was kept at +4 °C till using [9].

2.3.Fatty Acid Composition

The fatty acid methyl esters of oil samples were ijected in a Varian 5890 gas chromatograph with a capillary column, CP-Sil 88 (100 m long, 0.25 mm ID, film thickness 0.2 μm), and determined following the ISO standard ISO 5509:2000 [10].

2.4.Tocopherols

20 μL sample (a solution of 250 mg of oil in 25 mL of n-heptane) was injected to a Diol phase HPLC column 25 cm x 4.6 mmID (Merck, Darmstadt, Germany) used with a flow rate of 1.3 mL/min [11].

Corresponding authors: Dr M. M. Özcan,Tlf :+90.332.2232933 ;Fax :+90.2410108; e-mail: mozcan@selcuk.edu.tr

2.5. Sterols

About 250 mg oil was saponified with ethanolic potassium hydroxide by boiling under reflux. Then, unsaponifiable matter was separated on an aluminium oxide column. The sterol fraction in unsaponifiable matter was determined by GLC (SE 54 CB (Macherey-Nagel, Düren, Germany; 50 m long, 0.32 mm ID, 0.25 µm film thickness)) [12].

2.6. Statistical Analysis

Minitab Version 16.2.2 (Minitab Ltd, Coventry, UK) was used for statistical analysis. Results were analysed for mean±standard deviation and statistical significance by analysis of variance.

3.Results and Discussion

3.1.Oil content and fatty acid composition

The oil content and fatty acid compositions of seed and oils are given in Table 1. The oil contents of samples changed between 49.4% and 75.2% depending on locations (Konya and Mersin). The highest oil (75.2%) was determined in Pecan kernel, by followed sesame (57.6%), poppy (49.4%) and wheat germ (12.3%). The oil contents of sesame seeds varied between 50.3% and 55.0% [13,14]. The Carya kernel had the high oil content (70-79% w/w) [8]. Özcan and Atalay [3], Ryan et al., [7] and Srinivas and Narasinga [15] reported that poppy seeds contained between 32.4% and 49.4% oil. When results compared to literature values, some differences were observed. These differences can be probably due to agronomy conditions, species differences and environmental.

Oleic acid contents of oil samples changed between 36.5% (sesame) and 69.6% (pecan walnut) (Table 1). While the oils of sesame, poppy and pecan contain higher oleic,heat germ oil contained higher linoleic acid (58.6%). According to results, the major fatty acids of samples wereoleic and linoleic acids. Palmitic acid contents of oil samples changed between 6.1% (pecan walnut) and 10.2% (wheat germ). The fatty acid composition of the samples is quite comparable and apart from the slightly lower stearic acid percentage in the present samples, is in good agreement with our previous findings [3,13]. Results were found partly similar compared to data previously reported in the literature. Some differences can be probably due to sample species, oil properties and growing conditions.

3.2.Tocopherols

The tocopherol contents of oil samples are shown in Table 2. The tocopherol contents of oil samples ranged between 0.3-94.0 α-tocopherol, 0.7 -10.9 γ-tocopherol, 0.4-523.9 δ-tocopherol, 1.0 - 880.7 mg/100 g δ-tocotrienol. The total tocopherol contents of seed oils varied between 11.7 and 1222.6 mg/100 g. The tocopherol contents of sesame, wheat germ and poppy seed oils were dominated by α-tocopherol, γ-tocopherol, δ-tocopherol and δ-tocotrienol. δ-Tocotrienol contents of poppy oil were found higher than those of other samples. The content of γ- tocopherols in pecan kernel oil (10.9 mg/100g) was also higher. *Özcan and Atalay* [3] determined 26.8-37.2 ppm α-tocopherol, 309.5-567.3 ppm β- tocopherol and 6.1-18.6 ppm δ- tocopherol in some poppy seed oils. In other study, 0.2 mg/100 g α-tocopherol and 4.7 mg/100g β-and γ- tocopherols in poppy seed oil were determined [7]. The main biochemical function of the tocopherols is protection effect against peroxidation of polyunsaturated fatty acids [16,17].

Table 1. Oil contents and fatty acid compositions contents of samples (%)

Samples	Oil (%)							
		Palmitic	Stearic	Oleic	Vaccenic	Linoleic	Linolenic	Arachidic	Total (%)
Sesamum indicum	57.6±1.23*b	9.2±0.68*b	5.6±0.17a	36.5±0.21b	0.8±0.01b	46.4±0.48b	0.5±0.01c	0.6±0.01a	99.6
Triticum aestium	12.3±1.17d**	10.2±0.43a**	3.2±0.21c	23.2±0.28c	0.7±0.03c	58.6±0.52a	2.6±0.03a	0.2±0.01c	98.7
Papaver sommiferum	49.4±2.35c	9.2±0.57	5.0±0.13b	38.5±0.41b	0.9±0.02a	44.5±0.71c	0.4±0.01c	0.5±0.01b	99.0
Carya illinoensis	75.2±2.42a	6.1±0.82c	2.4±0.19d	69.6±0.27a	-***	20.4±0.13d	1.0±0.00b	-	99.5

*mean±standard deviation, **Values in each column with different letters are significantly different ($p<0.05$), ***nonidentified

Table 2. Tocopherol contents of oil samples

Samples	Tocopherols (mg/100g)									
	α-T	α-T	β-T	γ-T	β-T3	P8	γ-T3	δ-T	δ-T3	Total
Sesamum indicum	3.86±0.47*c	-	-	-	-	-	-	523.9±1.56a	1.41±0.13b	529.17
Triticum aestium	94.0±0.36a**	4.8±0.37a	22.5±0.23	0.7±0.01b	1.8±0.21	1.9±0.15a	-	0.4±0.01c	1.0±0.03c	127.1
Papaver somniferum	17.06±0.13b	-***	-	-	-	-	-	324.8±0.97b	880.7±1.27a	1222.56
Carya illinoensis	0.3±0.01d	0.2±0.01a	-	10.9±0.17a	-	0.3±0.01b	-	-	-	11.7

*mean±standard deviation, **Values in each column with different letters are significantly different ($p<0.05$), ***nonidentified

Table 3. Sterol contents of oil samples

Samples	Sterols (mg/kg)															Total mg/kg
	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	
Sesamum indicum	0.19 ±0.03*c	-**	2.22 ±0.19a	18.23 ±1.27b	0.18 ±0.03c	7.98 ±0.58a	0.55 ±0.03	-	0.91 ±0.07b	57.63 ±1.23c	0.47 ±0.03c	8.84 ±0.21a	1.0±0.01 a	0.85 ±0.03c	0.96 ±0.09c	7183.9
Triticum aestium	0.11 ±0.01d	0.19 ±0.03	0.39 ±0.07c	22.38 ±0.87a	0.91 ±0.09a	1.80 ±0.21b	1.04 ±0.17	-	0.70 ±0.03c	60.46 ±1.17b	1.10 ±0.17a	3.42 ±0.29c	0.87 ±0.07b	3.47 ±0.13a	3.13 ±0.17a	14839.6
P. somniferum	0.24 ±0.07b	-	1.78 ±0.13b	17.17 ±0.69b	0.17 ±0.01c	7.03 ±0.49a	0.59 ±0.09		0.82 ±0.09b	58.97 ±1.21c	0.62 ±0.09b	8.07 ±0.33a	1.10 ±0.11a	1.99 ±0.17b	1.43 ±0.11b	3209.2
Carya illinoensis	0.61 ±0.11a	-	0.20 ±0.03d	5.03 ±0.42c	0.53 ±0.07b	1.18 ±0.17c	0.57 ±0.03		1.32 ±0.11a	80.97 ±1.36a	0.45 ±0.05c	7.49 ±0.36b	0.80 ±0.09b	0.35 ±0.03d	0.49 ±0.03d	2166.8

3.3. Sterols

The phytosterol contents of oil samples are given in Table 3. The concentration of total sterols changed between 14839.6mg/kg (wheat germ oil) and 7183.9 mg/kg (sesame oil). In all seed oils, analysed, β-sitosterol (57.63-80.97% of total sterols) represents the key component of the phytosterols followed by 5-avenasterol (3.42 % to 8.84% of total sterol content), campesterol (5.03 % to 22.38 % of the total sterol contens) and stigmasterol (1.18% to 7.98% of total sterol β-Sitosterol was the major sterol of oil samples, and its contents changed between 57.63 mg/kg (sesame) and 80.97 mg/kg (pecan walnut); campesterol, ranging from 5.03 mg/kg (pecan walnut) to 22.38 mg/kg (sesame); 5-avenasterol, ranging from 3.42 mg/kg (pecan walnut) to 8.84 mg/kg (sesame); stigmasterol, ranging from 1.18 mg/kg (pecan) to 7.98 mg/kg (sesame). *Ryan et al.* [7] reported that poppy seed oil contained 58.3 β-sitosterol, 9.8 campesterol and 5.7 mg/100 g stigmasterol. Our results were found partly different compared with other published sterol results [7,18]. *Itoh et al.* [19] determined 19% campesterol, 10% stigmasterol, 62% β-sitosterol, 7% δ-5-avenasterol, 2% δ-7-stigmasterol of sterol fraction in sesame seed oil. Phytosterol are abundant in vegetable oils [6,7]. Results showed differences with previous literature values. Differences at the phytosterol contents can be probably due to growing factors, environmental and analytical conditions.

As a result,

1. Fatty acid, tocopherol and sterols had important constituents of oils studied.
2. The seed and kernel oils are good natural sources of phytosterols.
3. It is increasing interesting to the kernels day by day by consumers around the world.
4. Fatty acids, phytosterols and tocopherols are important oil components for human health.

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Compliance with Ethics Requirements. Authors declare that they respect the journal's ethics requirements. Authors declare that they have no conflict of interest and all procedures involving human or animal subjects (if exist) respect the specific regulation and standards.

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