Oil Contents, Fatty Acids And Tocopherol Compositions Of Opium Poppy (*papaver Somniferum* L.) Seeds With Different Colors

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ABSTRACT

In the present study, the oil contents and some oil quality properties of the Turkish opium poppy (Papaver somniferum L.) seed oils with different color were determined. The results showed that the oil yield of seeds ranged from 48.48 to 53.37% (w/w). Fatty acid compositions of the seed oils were the following range: 70.94 to 73.15% linoleic acid, 13.56 to 14.61% for oleic acid, 10.68 to 12.15% for palmitic acid, 1.13 to 1.97% for stearic acid, and 0.29 to 0.70% for linolenic acid. It was found that poppy seed oil contained (1.54-13.35 mg / 100 g oil), (0.04-0.09 mg / 100 g oil), (3.10-11.56 mg / 100 g oil) and (0.03-0.18 mg / 100 g oil) tocopherol. There was a clear significant difference ($p<0.05$) among seeds for total, , , and tocopherols.

Keywords: Poppy, Papaver somniferum L., seed oil, fatty acid, tocopherol

FARKLI RENKLERDE HAŞHAŞ (Papaver somniferum **L.) TOHUMLARININ YAĞ İÇERİKLERİ, YAĞ ASİTLERİ VE TOKOFEROL KOMPOZİSYONLARI**

ÖZET

Bu çalışmada, farklı renklerdeki haşhaş (Papaver somniferum L.) tohumlarının yağ oranları (%) ve bazı yağ kalite özellikleri belirlenmiştir. Tohumların yağ oranları % 48.48 ile % 53.37 (w/w) arasında bulunmuştur. Yağ asitleri kompozisyonu ise şu değişim aralıklarında belirlenmiştir: % 70.9473.15 linoleik asit, %13.5614.61 oleik asit, %10.6812.15 palmitik asit, %1.131.97 stearik asit ve % 0.290.70 linolenik asit. Haşhaş yağının (1.5413.35 mg / 100 g yağ), (0.040.09 mg / 100 g yağ), (3.1011.56 mg / 100 g yağ) ve (0.030.18 mg / 100 g yağ) tokoferol içerdiği bulunmuştur. Toplam , , ve tokoferol bakımından tohumlar arasında istatistiksel olarak önemli düzeyde farklılık olduğu gözlenmiştir ($p<0.05$).

Anahtar Kelimeler: Haşhaş, Papaver somniferum L., tohum yağı, yağ asidi, tokoferol

INTRODUCTION

The opium poppy has important for its seeds containing oil, flavor and alkaloids such as morphine, codeine, thebaine, papaverine and narcotine [1; 2]. So, the cultivation of opium plants is regulated internationally to control the misuse the highly addictive alkaloid morphine and its derivatives. A multimarked plant type with negligible amounts of narcotic alkaloids needs to be developed [3], for the possible cultivation of the poppy as an oil seed crop [4].

Oil content of poppy seeds usually ranges from 37 to 54% [5]. Cold-pressed oil from the poppy seeds is also used for edible purposes without further refining, as salad and cooking oil, and as a raw material for margarine manufacture. In addition, the opium poppy seed oils are very nutritious being very rich in both oleic and linoleic acid [6]. The oil contains 50 to 73.7% linoleic, 13.1 to 30% oleic, and 6 to 9.3% palmitic acid [1; 2; 7]. Baydar and Turgut [8] reported that there are close relations between seed color and fatty acid composition, and dark-colored seeds generally contain more linolenic acid than light-colored seeds.

The seed oil must be preserved under favorable conditions to prevent rancidity since it is composed from many unsaturated fatty acids. Because of the nutritional and antioxidant properties of tocopherols, not only the fatty acid content, but also the tocopherols content and composition of the polyunsaturated fatty acid containing products should be taken into account. Tocopherols that are the most powerful natural fat-soluble antioxidants (Vitamin E) exist in four forms of homologues as minor oil ingredients: α-, β-, γ- and δ tocopherols [8]. Poppy seed oil contains all these components of tocopherols as well as γ-tocotrienol [2]. In the absence of appropriate levels of tocopherols as antioxidants, the polyunsaturated fatty acids form free radicals and can have significant prooxidant effect, leading to a substantial depletion of tocopherols and increased level of oxidation products [9]. There is an opinion lipid oxidation remains a major problem in the food industry and natural antioxidants currently attract the attention of scientists because the shift of interest from synthetic to natural inhibitors of oil oxidation [9]. In opium poppy, improvements are required in characters such as seed color, seed ridges and the ratio of oil constituents [10].

Turkey is one of the most important opium poppy

producing countries in the world, and its opium poppy seed production was 52000 tones in 2003 [11]. The use of poppy seed and seed oil for culinary and pharmaceutically purposes in Turkey has been increasing in the recent years. The objective of this study was to investigate the fatty acid and tocopherol composition of the Turkish opium poppy seed oil.

MATERIALS and METHODS

Seed materials

Three Papaver somniferum populations grown commercially in Isparta province of Turkey were used as material in this study. The populations, which were collected from the opium poppy farmers in 2003, were named as "Yellow", "Brown" and "Blue" based on their characteristic seed colors. The seeds were kept at 4 °C until used and ground by a grinder for oil, fatty acid and tocopherol analysis.

Analysis of oil content

Oil content was determined by Soxhlet extraction. 4 g of air-dried opium poppy seeds were extracted with a mixture of petroleum ether after 6 hours extraction using a soxhlet system (Büchi Universal Extraction System B-811, Germany) according to AOCS method [12].

Analysis of fatty acids

Fatty acid composition was determined using a modified fatty acid methyl ester method as described by Marquard [13]. The oil was extracted three times from 2 g air-dried seed sample by homogenization with hexane/isopropanol, 3:2, v/v. For fatty acid methyl esters (FAME), 1 ml of methylation reagent [80 ml methanol + 0.5 g sodium methylate + 20 ml isooctane) was added to the 50 mg of oil. The mixture was vortexed and allowed to react for 24 hours at room temperature; then 0.25 ml of isooctane was added. The sample was then centrifuged for 5 min at 2400 × g at 5°C and the liquid portion transferred to labeled Wheaton vials and stored at 20 °C. The methyl esters of the fatty acids (0.5 l) were analyzed in a Hewlett-Packard 6890 series gas chromatograph (Perkin Elmer Auto System XL, USA) equipped with a flame ionizing detector (FID), a fused silica capillary column (MN FFAP (50 m x 0.32 mm i.d.; film thickness 0.25 µm). It was operated under the following conditions: oven temperature program, 120 °C for 1 min. raised to 240 °C at a rate of 6 °C/min and than kept at 240 °C for 15 min); injector and detector temperatures, 250 and 260 °C; respectively, carrier gas, helium at flow rate of 40 mL/min; split ratio, 1/20 mL/min. The contents of palmitic (C16:0), stearic (C18:0), oleic (C18:1), linoleic (C18:2) and linolenic (C18:3) acids were determined by computing integrator.

Extraction of tocopherols

One gram of finely ground poppy was weighed and introduced into a Soxhlet cartridge with 50 mg pyrogallol as antioxidant. The extraction unit was wrapped in foil and extracted twice for 4 hours with 200 ml hexane with Soxhlet extractor. Extracts were evaporated until dried in a vacuum rotary evaporator at a temperature not exceeding 40°C. The residue was dissolved in 40 l THF and 760 l a mixture of heptane:THF (95:5) (v/v), filtered (0.5 pm MILLIPORE) and placed in non-actinic vials. They were overlayered with nitrogen and stored for up to 24 hours at +4 °C. The extraction method was modified according to Lavedrine et al. [14].

HPLC conditions of tocopherols

Tocopherols were analyzed by high performance liquid chromatography (HPLC). The HPLC system (Shimadzu) was equipped with an auto sampler (SIL10AD vp). The detector used was fluoresans detector with wavelengths set at 295 nm for extinction and 330 nm for emission. Tocopherols were separated on a normal phase column Luna, 150cm x 4,6 mm I.D., 5 particle size) with the mobile phase flow rate at 1.2 mL/ min. The mobile phase was a mixture of heptane:THF (95:5) (v/v). System controller, Pump Degasser, Column oven and column temperature were SCL-10Avp, LC-10Advp, DGU- 14A, CTO-10Avp and 30 °C, respectively. The data were integrated and analyzed using the Shimadzu Class-VP Chromatography Laboratory Automated Software system. Standard samples of α, β, γ and δ isomers of tocopherol (Sigma Chemical Co., St. Louis, Mo., USA) were dissolved in hexane and used for identification and quantification of peaks. The amount of tocopherols in the extracts was calculated as mg tocopherols in 100 g oil sample using external calibration curves, which were obtained for each tocopherol standard. Method was modified according to Lampi et al. [15].

Statistical analysis

Results of the research were tested for statistical significance by one-way ANOVA. Differences were considered statistically significant at the P 0.05 levels. The analysis was performed in triplicate.

RESULTS and DISCUSSION

The oil content (%) and fatty acid composition (%) of the different color opium poppy seeds are given in Table 1. Oil contents ranged from 48.48 to 53.37% (w/w). Vesselovskaya [5] reported that there is a large variation in oil content of poppy seeds and the oil content ranges from 37 to 54%, with the higher values found in light-colored cultivars. Although the oil contents were similar to our results, but in opposite of this result, we were found that there was not large variation in oil content of poppy seeds and dark one contained higher value than lights ones. Oil content differences among the results could be related to ecological conditions, soil type and harvest time. Fatty acid compositions of the seeds had the following range: 70.94 to 73.15% linoleic acid, 13.56 to 14.61% for oleic acid, 10.68 to 12.15% for palmitic acid, and 1.13 to 1.97% for stearic acid. Other fatty acid present in small quantities was linolenic acid (0.29-0.70%) (Table 1). In a previous study, it was reported that the oil contains 50 to 73.7% linoleic, 13.1 to 30% oleic, and 6 to 9.3% palmitic acid [1; 2; 7]. Baydar and Turgut [8] were also found that Turkish opium poppy seed oils contained 9.4 to 10.5% palmitic, 1.2 to 2.0% stearic, 12.8 to 14.2% oleic, 70.8 to 74.2% linoleic and

1.7 to 3.5% linolenic acid. Low linolenic acid content was found, up to a maximum of 0.69% in brown seeds, such that the storage quality of the oil is not affected. Singh et al. [6] also found linolenic acid up to a maximum of 3% in F_1 and F_2 opium poppy populations. The degree of unsaturation in the poppy seed oil was over 86.95%, coming from unsaturated fatty acids (Table 1). High levels of unsaturation play an important role in lowering high blood cholesterol and also in the treatment of atherosclerosis [16]. Poppy seed oils were rather poor in linolenic acid. Because of their low quantities of linolenic acid, poppy seed oil also has advantages in terms of human health and the shelf life of the oil. In our results, it was not found statistically important differences among seeds for palmitic, stearic and linoleic acids. There were only statistically important differences between brown and blue poppy for oleic acid, and between blue and others for linolenic acid. It was reported that dark-colored seeds generally contain more linolenic acid than light-colored seeds [17].

The amounts of total tocopherol and four forms (, , and) in the oils obtained from different color opium poppy seeds are given in Table 2. Tocopherols are the most powerful natural fat-soluble antioxidants (vitamine E). They exist in four forms of homologues: (5,78-trimethyltocol), (5,8-dimethyltocol), (7,8-dimethyltocol) and (8-methyltocol) [18]. The form has the highest vitamin activity and the lowest antioxidant property in comparison form [19]. Lipid oxidation remains a major problem in the food industry and oils with high tocopherol content can be used in applications where a high level of antioxidant protection is needed [2; 9]. In the poppy seed oils, the total tocopherol ranged from 9.17 mg / 100 g oil (Yellow) to 31.80 mg / 100 g oil (Brown) (Table 1). Bozan and Temelli [2] found that total tocopherol content was 15.3 mg / 100 g oil in petroleum-ether extracted oils and between 23.8 and 33.4 mg / 100 g oil in SC-CO_2-extracted oils. In addition, it was found that poppy seed oil contained (1.54-13.35 mg / 100 g oil), (0.04-0.09 mg / 100 g oil), (3.10-11.56 mg / 100 g oil) and (0.03-0.18 mg / 100 g oil) tocopherol. While the main component of Brown seed oil was -tocopherol (25.01 mg/100 g oil), yellow seed oil's main component was -tocopherol (23.91 mg / 100 g oil). There was a clear significant difference ($p<0.05$) among seeds for total,, , and tocopherols (Table 2). It was reported that petroleum-ether extracted oil contained total (15.3 mg / 100 g), (14.2 mg / 100 g oil) and (0.6 mg / 100 g oil) tocopherol, and SC-CO_2-extracted oils contained (3.4-5.2 mg / 100 g oil), (0.7-1.0 mg / 100 g oil), (18.1-25.3 mg / 100 g oil) and (0.6-07 mg / 100 g oil) tocopherol [2].

CONCLUSION

With their low linolenic acid content and high linoleic and oleic acid contents, all seeds would create oils not only good for frying but also useful as a salad oil and in food manufacturing. These oils also are healthful because of less saturated fatty acids and more linoleic acid content. Briefly, having a high level of linoleic acid increased the importance of poppy seed oil in the particular treatment of high cholesterol and atherosclerosis, and also, having a low level of linolenic acid increased the oxidative stability, taste and odor quality of the oil. We know that fatty acid composition is not only determinant of oil quality. Total tocopherol content of brown and blue poppy seeds oil was found to be an average of 31 mg /100 g as a natural antioxidant. Especially, it was found that brown seed's α-tocopherol content was as about 25 mg / 100 g and blue seed's γ-tocopherol content was as about 24 mg / 100 g. Food researchers recommend that oils contain a balance of tocopherols with some alpha tocopherol for nutritional benefits and some gamma and delta tocopherols for food quality.

The results of this research showed that the oil obtained poppy seeds with different colors can be used as an edible oil source. All these quality characteristics of poppy seed oils were similar to those of sunflower oil, which is one of the most commonly produced and consumed oils in the world.

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Table 1. Oil content (%) and fatty acid composition (%) of the different color opium poppy seeds

Opium poppy Seeds	Oil content	Fatty acid composition				
		Palmitic (C16:0)	Stearic (C18:0)	Oleic (C18:1)	Linoleic (C18:2)	Linolenic (C18:3)
Brown	53.37±1.14^{a,1}	11.41±2.32^{a}	1.13±0.58^{a}	13.56±0.83^{b}	73.15±2.02^{a}	0.70±0.01^{a}
Blue	48.48±2.69^{b}	12.15±2.38^{a}	1.97±0.32^{a}	14.61±0.01^{a}	70.94±1.74^{a}	0.29±0.28^{b}
Yellow	51.79±0.92^{ab}	10.68±1.36^{a}	1.66±0.55^{a}	14.26±0.09^{ab}	72.71±091^{a}	0.65±0.05^{a}

[1]Differences between means indicated by the same letters are not statistically significant (Duncan's multiple range test, P 0.05).

Table 2. Total tocopherol content and tocopherol composition of the different color opium poppy seeds

Opium poppy Seeds	Total tocopherol (mg/100 g in oil)	Tocopherol composition (mg/100 g in oil)			
		α-tocopherol	B-tocopherol	γ-tocopherol	δ-tocopherol
Brown	31.80±1.10^{a,1}	25.01±0.79^{a}	0.07±0.01^{b}	6.66±1.53^{b}	0.06±0.02^{b}
Blue	31.37±2.01^{a}	6.91±0.39^{b}	0.18±0.03^{a}	23.91±1.54^{a}	0.38±0.04^{a}
Yellow	9.17±0.99^{b}	2.97±0.26^{c}	0.09±0.03^{b}	5.99±0.76^{b}	0.11±0.00^{b}

Differences between means indicated by the same letters are not statistically significant (Duncan's multiple range test, P 0.05).