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Physicochemical characteristic of chia seed oil from Peru

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Main chemical components of chia seeds (imported from Peru) and physicochemical characteristics of their oil were examined. The oil content of the seeds was 30.37% and protein content was 37.96%. The oil was obtained by pressing the chia seeds in Bulgarian factory. The main important physicochemical characteristics of chia seed oil have also been determined. The relative density of the oil at 20 ºC was 0.9288, refractive index at 20 ºC – 1.4810, acid value – 1.68 mgKOH/g, peroxide value – 1.95 meq active oxygen/kg and oxidative stability – 2.4 h.

Unsaturated fatty acids (85.7%) predominated in the fatty acid profile. The amount of linolenic and linoleic fatty acids was 94% of unsaturated fatty acids in the oil. The content of saturated fatty acids was 14.3%. The quantity of unsaponifiable matters was 0.83%. Total sterols in the oil were 0.28% and the content of tocopherols – 140 mg/kg.

***Keywords**: Chia seed oil, Salvia hispanica L., physicochemical characteristic, oxidative stability*

INTRODUCTION

The chia seeds (*Salvia hispanica* L.) are used for a long time as a food additive in America by Indians and by people from Mexico. This plant is grown in the regions with tropic and subtropical climate. The different climate, the area of growth and agrochemical factors influence the physicochemical properties of the seeds.

At the current stage the chia is cultivated in Mexico, Peru, Argentina etc. [1, 2, 3]. The seeds, which are similar to these from Salvia, are small and hard. The plant was mainly used for decoration in the past. Chia seeds have been an object of various investigations and it has been shown that they are a source of important food ingredients. The seeds are rich in glyceride oil (25-38%), proteins (15-25%), carbohydrates (26-41%) and fibers (18-30%), and also contain minerals (4-5%) and vitamins [1, 2, 3].

Chia seed oil is rich in polyunsaturated fatty acids (PUFAs), particularly omega-3 (n-3) and omega-6 (n-6) which are beneficial to human health. The major fatty acids in the oil from chia are as follow: n-6 and n-3 (60.4-63.04%), which can contribute to a good cleaning of the blood vessels from LDL cholesterol and this way improve the circulation of the blood [4].

Except linolenic acid, chia seed oil also contains biologically active substances – sterols, tocopherols, phospholipids. There are some results about basic physicochemical characteristic of different chia oils from different countries. For example, extracted chia seed oils from Guatemala, Argentina and Mexico have relative density of 0.9241-0.9248 and the refraction index is 1.4763 – 1.4768. Saponification value ranges from 193 to 222 mg KOH/g. The acid value of the pressed and extracted oil is 0.91 and 1.64 – 2.053 mg KOH/g, respectively. The iodine value of the oils from different regions (Argentina, Mexico, Guatemala) is 193-210 gI_2/100g, which is connected with the amount of saturated fatty acids in the oils [1, 2, 3]. Peroxide value of oil from Mexico and Guatemala is – 17.5 and 1.64 meq active oxygen/kg, respectively [1, 2, 5]. Unsaponifiable matters in the pressed oil are 0.68 – 0.85%, in the extracted oil – 0.839-1.27% and it is related to region where the seed is grown [1, 2, 3, 5]. The oxidative stability for pressed and extracted oil (2.3-2.8 h) is lower than that of other vegetable oils [1, 2].

According to some previous studies in the fatty acid composition predominate unsaturated fatty acids – linolenic (63-69%), followed by linoleic acid (16-26%). From the saturated fatty acids palmitic (5.5-6.6%) and stearic (2.7-4.4%) acids are in the highest amount [1, 2, 3, 6, 7].

Total tocopherols in the chia oils from Argentina and Mexico is 446 and 200 mg/kg, respectively and γ - tocopherols (94.4%) predominate in the tocopherol fraction. Sterol content in the oil is 4132 mg/kg and β-sitosterol is in the highest amount (49.8%) [6, 7].

The aim of the present work is to be investigated the main chemical components of chia seeds

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(imported from Peru) and physicochemical characteristics of their oil and to be compared the obtained results to these of chia seed oils from other countries.

EXPERIMENTAL

Samples

Analyzed chia seeds, used in Bulgaria, are imported from Peru. The oil content, moisture and protein were determinated. Oil was extracted from ground seeds with hexan for 4 h by Soxterm Gerhard equipment. The extract was dried in vacuum drier at 60 °C after evaporation of solvent and the oil content in the seeds was determined [8]. Protein determination is performed by using the method of Kjeldahl [9]. The moisture was determined by standard procedure by AOAC [10].

The examined sample of chia seed oil is obtained by cold pressing method in a small factory in Bulgaria.

Methods

Analysis of fatty acids. The fatty acid composition of oils is determined by gas chromatography (GC) after transmethylation of the respective sample following the procedures by ISO [11]. GC was performed on a HP 5890 gas chromatograph equipped with a 75 m × 0.18 mm capillary column Supelco FP - 2560 and a flame ionization detector. The column temperature was programmed from 140ºC (5 min), at 4 ºC/min to 240 ºC (3 min); injector and detector temperatures were kept at 250ºC. Identification of fatty acids is performed by comparison of retention times with those of a standard mixture of fatty acids subjected to GC under identical experimental conditions [12].

Analysis of tocopherols. Tocopherols were determined directly in the oil by high performance liquid chromatography on a "Merck-Hitachi" instrument equipped with 250 mm × 4 mm Nucleosil Si 50-5 column and fluorescent detector "Merck-Hitachi" F 1000. The operating conditions were as follows: mobile phase of n-hexane:dioxan 96:4 (v/v), flow rate 1.0 ml/min, excitation 295 nm, emission 330 nm [13]. 20 μl 1% solution of oil in hexane was injected. Tocopherols are identified by comparing the retention times with those of authentic individual tocopherols.

Analysis of sterols. Unsaponifiables are determined after saponification of the glyceride oil and extraction with hexane [14]. Quantification of sterols was carried out spectrophotometrically (at 597 nm), after isolation of sterols from other unsaponifiable matter by thin layer chromatography on Silica gel 60 G in the mobile phase diethyl ether: hexane (1:1 v/v) [15].

Sterol composition is determined on HP 5890 gas chromatograph equipped with 30 m × 0.25 mm DB 5 capillary column and flame ionization detector. Temperature gradient is from 90 °C (held for 2 min) to 290 °C at 15 °C /min then to 310 °C at 4 °C /min and held at this temperature for 10 min; the injector temperature is 300 °C and the detector temperature is 320 °C. Identification was performed by comparison of the retention times with those of a standard mixture of sterols [16].

Physicochemical characteristics. The physicochemical properties (iodine value, acid value, peroxide value, saponification value, refractive index and relative density) of cold pressed chia seed oil were analysed following the standard procedures by ISO [17, 18, 19, 20, 21, 22]. Oxidative stability is measured at 100 °C by Rancimat 679 equipment (Metron Switzerland) [23].

All experiments were carried out in triplicates.

RESULTS AND DISCUSSION

The oil content, moisture and protein content of chia seeds have been determined. The results are given in table 1.

The oil content is 30.37%, it is similar to the data from authors from different countries [1, 2, 3]. Seeds are with moisture 8.66%, protein content - 37.96%. The content of protein is higher than the data from other countries [1, 2, 3].

There are not differences in more of physicochemical properties of investigated chia oil from Peru and oils from other countries.

Table 1. Main chemical components of chia seeds

Components	%
Oil	30.37
Moisture	8.66
Protein	37.96

Table 2. Physicochemical properties of chia oils from different countries

Parameters	Chia oil			
	Peru	Mexico, [5]	Argentina , [1,6]	Guatemala, [1, 2]
Peroxide value, meq active oxygen/kg	1.95	17.5	No data-	No data
Acid value, mgKOH/g	1.68	2.053	2.05	1.64
Free fatty acids, % (oleic acid)	0.85	1.02	1.02	0.82
Iodine value, g I_2/100g	208.3	193.45	210.5	No data
Saponification value, mgKOH/g	197.9	222.66	193.09	193.01
Relative density 20 ºC	0.9288	0.9241	No data	No data
Refractive index, 20 ºC	1.481	1.4761	1.4768	1.4763
Oxidative stability, h	2.4	No data	No data	No data

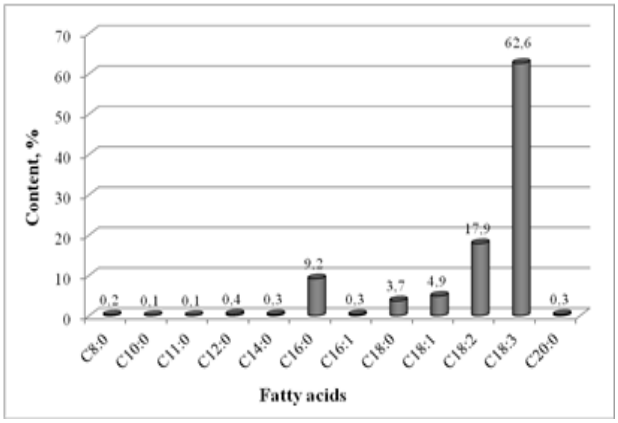

Figure 1. Fatty acid composition of chia oil from Peru $C_{8:0}$ – Caprylic; $C_{10:0}$ – Capric; $C_{11:0}$ – Undecanoic; $C_{12:0}$ – Lauric; $C_{14:0}$ – Myristic; $C_{16:0}$ – Palmitic; $C_{16:1}$ – Palmitoleic; $C_{18:0}$ – Stearic; $C_{18:1}$ – Oleic; $C_{18:2}$ – Linoleic; $C_{18:3}$ – Linolenic; $C_{20:0}$ – Arahinic

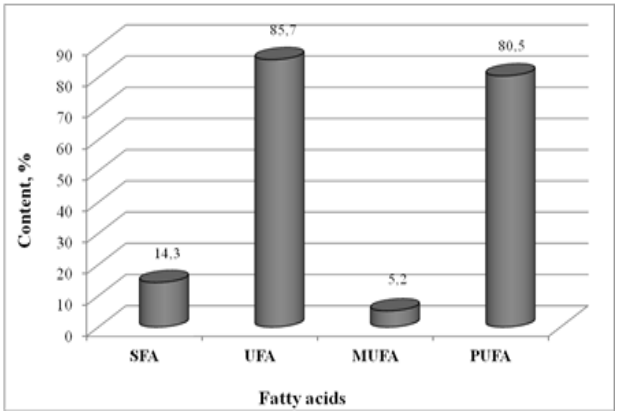

Figure 2. Content of saturated (SFA), unsaturated (UFA), monounsaturated (MUFA) and polyunsaturated fatty acids (PUFA)

Table 3. Biologically active components

Components	Content
Sterols, %	
- in the oil	0.28
- in unsaponifiable matter	34.3
Sterol composition, %	
Campesterol	10.6
Stigmasterol	2.5
β-Sitosterol	85.5
Δ^5-Avenasterol	1.4
Tocopherols, mg/kg	
- in the oil	140
Tocopherol composition, %	
α – tocopherol	4.8
γ - tocopherol	95.2

The peroxide and the acid values of oil from Peru are lower than other oils [1, 5, 6]. The iodine value is higher, because there is higher quantity of unsaturated fatty acids in the examined oil.

The fatty acid /FA/ composition is presented on figure 1.

The main fatty acids in the triacylglycerol fraction are linolenic and linoleic – 62.6% and 17.9%. Palmitic acid predominates in the fraction of saturated fatty acids representing 9.2% of the total fatty acid content. Unsaturated fatty acids predominate and their amount is 85.7%. The linolenic and linoleic fatty acids are 94% of unsaturated fatty acids in the oil.

The content of saturated (SFA), unsaturated (UFA), monounsaturated (MUFA) and polyunsaturated fatty acids (PUFA) of chia seed oil is presented in Figure 2.

Saturated fatty acids are 14.3% of all fatty acids in the oil. The content of polyunsaturated fatty acids (80.5%) is considerably higher than monounsaturated fatty acids (5.2%).

The quantity of unsaponifiable matter is 0.83%. The total tocopherol and sterol content in the oil are lower than the results for oil from other countries 140 mg/kg to 400 mg/kg [8] for tocopherols and 0.28% to 0.41% for sterols. γ - Tocopherol (95.2%) predominates in the tocopherol fraction, which is in agreement with results from previous studies of chia oil from different regions (Table 3).

Sterols are present in the unsaponifiable matters and their amount is 34.3%. Their total content in the oil was found to be 0.28%. β-Sitosterol (85.5%) predominates in the sterol fraction, which is higher than those in chia seed oil from different region (49.8%) [7]. Apart from β-sitosterol are also observed campesterol (10.6%), stigmasterol (2.5%) and Δ^5-avenasterol (1.4%).

CONCLUSIONS

The examined chia seeds, imported from Peru, are a good source of oil and protein. The oil possesses a good quality and has higher quantity of unsaturated fatty acids, especially linolenic acid. The oxidative stability of the oil is 2.4 h. Total tocopherol and sterol content is lower than the result from previous studies, but the amount of β-sitosterol is two times higher than that of chia seed oils from other countries.

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