Asian Journal of Chemistry Vol. 22, No. 8 (2010), 6531-6536

Physical and Chemical Properties of Some Seed and Kernel Oils

MEHMET MUSA OZCAN*, ZULEYHA ENDES† and FATIH ER‡
Department of Food Engineering, Faculty of Agriculture, University of Selcuk, 42031 Konya, Turkey
Fax: (90)(332)2410108; Tel: (90)(332)2232933; E-mail:mozcan@selcuk.edu.tr

Nine varieties of the seed and oils (flax, soybean, rice bran, peanut, grape, sesame, almond, sorghum, pistachio) were carried out for a comparative results on their physico-chemical and nutrition value. The oil content of oils ranged from 13.7 % (rice bran) to 53.7 % (almond). The protein contents varied between 9.7 % (sorghum) to 22.3 % (peanut). Seeds were evaluated for oil, protein, crude ash and crude fibre. Refraxtive index, relative density, unsaponifiable matter, peroxide value, saponification value and pH values were determined in the seed oils. The main fatty acids identified by gas chromatography were palmitic acid, oleic acid and linoleic acid. The oleic acid content of oils were found high compared with other acids.

Key Words: Seeds, Oil, Physico-chemical properties, Fatty acids.

INTRODUCTION

The source of oils and fats is diminishing, this means that there is the growing need for the search of new sources of oil as well as exploiting sources that are currently unexploited in order to supplement the existing ones[1]. Lack of information on the characteristics and utilization of the many and varied indigenous oil seed plants, is more of a problem than the shortage of these oils[2]. Plant seeds are important sources of oils of nutritional, industrial and pharmaceutical importance. The suitability of an oil for a particular purpose, however, is determined mainly by its fatty acid composition. No oil from any single source has been found to be suitable for all purposes because oils from different sources generally differ in their fatty acid composition. This necessitates the search for new sources of novel oils[3,4]. In efforts to find species of potential value as new oil seed crops[5]. The fatty acid composition of the endogenous fats plays an important role in determining shelf life, nutrition and flavour of food products[6]. The study of oil seeds for their minor constituents is useful in order that both the oil and its minor constituents be used effectively[4].

†Selcuk University, Cumra High Educational College, Cultivation and Technology of the Medicinal and Aromatic Plants 42500 Cumra, Konya, Turkey.
‡Selcuk University, Cumra High Educational College, Plant Nutrition and Fertilization 42500 Cumra, Konya, Turkey.

Ryan *et al.*[7] reported phytosterol, squalene, tocopheral content and fatty acid profile of selected seeds, grains and legumes. Some seed oils are already used for several purposes: blending higly saturated edible oils to provide new oils with modified nutritional values, as ingredients in paint and varnish formulations, surface coating and oleo-chemicals and as oils for cosmetic purposes[8]. Unusual fatty acids are often present in significant percentages in the seed fat[9]. To achieve the most economical and efficient utilization of these seeds, more information on the varieties, properties and composition is required.

Therefore, the present study attempted to establish the composition of these seeds belong to a several family with respect to physicochemical properties and fatty acid content.

EXPERIMENTAL

Oil-bearing materials (flax, soybean, rice bran, peanut, grape, sesame, almond, sorghum, pistachio) were collected from plants growing in Mersin, Adana, Antalya, Gaziantep and Konya provinces in Turkey in October 2008. Samples were transported to the laboratory in polypropylene bags and kept at room temperature. They were cleaned in an air screen cleaner to remove all foreign matter such as dust, dirt and chaff as well as immature and broken seeds were discarded as well. Seeds were dried to a constant weight at room temperature for analysis. Prior to chemical analysis, samples were ground to pass through 0.5 mm screen. The ground samples were then packed in new plastic bags and stored in a desiccator until analysis.

Method: The chemical and physical properties (crude oil, crude protein, crude ash, crude fibre, relative density, refractive index, peroxide value, saponification number, unsaponifiable matter) were analyzed according to AOAC[10] methods.

The oil was extracted with diethyl ether (50 °C) in a Soxhlet apparatus. The extract was evaporated in vacuum. The lipid extract was collected in a flask. The extracted lipid was weighed to determine the oil content and stored under nitrogen at 4 °C for further analyses. About 100 mg of the sample was heated under efflux and saponified with 5 mL of ethanolic potassium hydroxide solution (20 % w/v) for 2 h. The unsaponifable matter was extracted three times with 15 mL of petroleum ether and the extracts were combined and evaporated in a rotary evaporator at 40 °C under reduced pressure. The unsaponifiable residue was weighed[11]. For peroxide value, a known weight of oil was dissolved in a mixture of acetic acid/chloroform (3:2 v/v) and a saturated solution of KI (1 mL) was then added. The liberated iodine was titrated with sodium thiosulphate solution (0.05 M) in the presence of starch as indicator.

Determination of fatty acids: Faty acids were derivatised using the boron trifluoride method[12]. The working conditions of gas chromatography were as follows:

Instrument: Varian 2100, constant phase: 10 % diethylene glycol succinate (DEGS) + 1 % H_3PO_4, support matter: Chromosorb G (100/120 mesh), column: stainless steel (190 cm length × 0.2 μm i.d.), detector: FID (flame ionization detector), Temperatures:

Column: 200 ºC, injector: 225 ºC, detector: 225 ºC, flow rates: carrier gas (N_2): 6 mL/min, burnt gas (H_2): 40 mL/min, dry gas (O_2): 60 mL/min, injection amount: 5 µL.

The fatty acids were converted to their methyl esters by heating in 10 % BF_3[11]. Commercial mixtures of fatty acid methyl esters were used as reference data for the relative retention times[13]. Results are given as mean values of two replicates.

Statistical analyses: Results of the research were analyzed for statistical significance by analysis of variance[14]. This research was performed by three replicates with a replicate.

RESULTS AND DISCUSSION

The proximate compositions of some oil raw material (flax, soybean, rice bran, peanut, grape, sesame, almond, sorghum, pistachio) are given in Table-1.

TABLE-1
PROXIMATE COMPOSITIONS OF SOME OIL-BEARING MATERIALS (dw)

Materials	Oil content (%)	Crude protein (%)	Crude ash (%)	Crude fibre (%)
Flax	33.2* ± 2.3**abc	21.3 ± 3.1a	0.97 ± 0.12c	19.7 ± 1.7ab
Soybean	18.6 ± 1.7d	18.7 ± 2.8ab	0.43 ± 0.13c	3.8 ± 0.3de
Rice bran	13.7 ± 1.6de	11.8 ±1.3c	16.7 ± 0.11a	8.7 ± 0.9c
Peanut	47.6 ± 4.9ab	22.3 ±1.2a	3.21 ± 0.17b	9.8 ± 1.1c
Grape	15.6 ± 2.1d	11.2 ±0.9c	1.12 ± 0.14	28.9 ± 1.7a
Sesame	48.9 ± 6.2ab	18.4 ± 1.6ab	3.71 ± 0.21b	5.6 ± 0.6d
Almond	53.7 ± 5.7a	20.3 ± 2.7a	4.13 ± 0.13a	2.3 ± 0.1e
Sorghum	27.7 ± 3.1c	9.7 ± 1.3c	2.14 ± 0.12ab	2.7 ± 0.3e
Pistachio	43.9 ± 2.6b	21.6 ± 2.2a	3.11 ± 0.24b	2.9 ± 0.7e

Within each column, values followed by differennt letters are significantly at 5 % level. *Mean. **Standard deviation.

The oil contents of materials changed between rice bran (13.7 %), in order decreased pistachio (21.6 %), flax (21.3 %), almond (20.3 %), soybean (18.7 %) and sesame seed (18.4 %). The lowest crude protein was established in sorghum sample (9.7 %). On the other hand, among these materials, crude ash contents were found between 0.43 % (soybean) to 16.7 % (rice bran). Crude fibre contents ranged from 2.3 % in almond to 28.9 % in grape seed. The crude oil contents were similar to those for caperberry seeds reported by Akgul and Özcan[15] and Özcan and Akgul[16]. Calixto *et al.*[17] observed that average almond kernel contents consisted of 3.05 % ash, 53.37 % oil and 20.51 % protein. Barbera *et al.*[18] reported that almond kernel contents ranged from 8.03-8.13 % for ash, 53.67-54.26 % for oil and 23.03-23.98 % for protein. Yildiz *et al.*[19] determined 59.69 % oil in pistachio nut. Hassanein and Abedel-Razek[20] established 12.0 % oil in grape seed. Biswas *et al.*[21] reported that sesame seed contained 47.0 % oil, 8.40 % crude fibre and 27.0 % crude protein.

The extracted oils were generally yellowish in colour. Their physical and chemical characteristics are given in Table-2. The oils had a relative density between 0.912

(sorghum) to 0.924 (flax), lower than the value reported by Akgül and Özcan[15] for caper oil (1.0840-1.1045). Yildiz *et al.*[19] established 0.9143 for specific gravity of the pistachio nut oil. Generally, mean values were 1.4641-1.4742 for refractive index, 0.3-3.4 g for unsaponifiable matter, 0.52-3.9 for peroxide values, 190.1-191.7 for saponification value in all samples. Biswas *et al.*[21] determined 0.921 in sesame oil, 0.924-0.926 in sunflower oil, 0.915-0.919 in olive oil, 0.921-0.945 in cotton seed oil and 0.922-0.928 for specific gravity in soybean oil. The same researchers also measuremented refractive index 1.475 for sesame oil and 1.472-1.475 for soybean oil. In addition, the amounts of unsaponifiable matter of all material oils were found partly high compared with results of Biswas *et al.*[21]. Saponification values ranged between 173-196 (sesame oil). The observed specific gravity of brassica, linseed and sesame seed at 25 ºC are 0.909, 0.931 and 0.921, respectively. The observed saponification values of all material are 190.1-191.7, respectively. pH values of samples were found between 4.0 (pistachio) to 4.9 % (rice bran). Peroxide values of samples ranged between pistachio (0.52 %) to flax (13.9 %). The unsaponifiable matter content was 3.4 g/Kg, similar to that of other seed oils, *e.g.*, caper oil[15], but higher than that of many fruit oils, *e.g.*, olive and palm oils and the values reported by O'Brien[22].

TABLE-2
PHYSICAL AND CHEMICAL PROPERTIES OF
SOME OIL-BEARING MATERIAL AND OILS

Materials	Refractive index n20/D	Relative density (g/mL)	Unsaponifiable matter (g)	Peroxide value $MeqO_2/Kg$	Saponification value	pH
Flax	1.471±0.0011	0.924±0.006	0.6±0.1c	3.9±0.7a	191.2±0.3	4.3±0.1
Soybean	1.474±0.0009	0.921±0.003	0.9±0.3c	3.2±1.0ab	191.6±0.8	4.7±0.1
Rice bran	1.472±0.0008	0.917±0.001	3.4±0.9b	2.7±0.5b	190.1±0.5	4.9±0.2
Peanut	1.472±0.0013	0.923±0.009	0.8±0.1c	1.8±0.3c	191.3±0.1	4.2±0.1
Grape	1.471±0.0003	0.918±0.006	0.9±0.3c	1.3±0.5c	191.7±0.9	4.1±0.1
Sesame	1.470±0.0003	0.920±0.004	1.3±0.5b	1.9±0.7c	190.4±0.2	4.6±0.3
Almond	1.464±0.0021	0.914±0.008	0.3±0.1	1.7±0.1c	191.6±0.8	4.3±0.1
Sorghum	1.469±0.0013	0.912±0.002	1.8±0.2b	2.1±0.1b	191.3±0.7	4.4±0.2
Pistachio	1.472±0.0011	0.913±0.007	1.1±0.3bc	0.5±0.3bc	190.2±0.4	4.0±0.2

Within each column, values followed by differennt letters are significantly at 1 % level. *Mean. **Standard deviation.

The fatty acid composition of all-bearing material was determined by gas chromatograph (Table-3). Oleic acid (16.4-74.4 %) was present in the highest concentration, followed by linoleic acid 813.1-69.3 %) and palmitic acid (3.2-16.8 %). Stearic acid and linolenic acid (except for flax) were present in low amounts. Mannina *et al.*[23] found that the contents of the main fatty acids of olive and hazelnut oils were 10.0-15.0/5.1-6.4 % palmitic acid, 1.7-3.2/2.2-2.5 % stearic acid, 67.1-76.2/77.8-84.2 % oleic acid, 6.8-16.6/6.4-12.0 % linoleic acid and 0.59-0.74/0.10-0.18 % linolenic acid, respectively. The linoleic acid content was lower (except for grape) than that of walnut (56-59 %)[24]. Fatty acids identified in the oil pistachio nut samples were palmitic acid, palmitoleic acid, stearic acid, oleic acid and linoleic acid with oleic acid as the dominant fatty acid (68.78 %)[19]. Özcan[25] determined 52.3 % oleic acid, 21.3 % palmitic acid and 19.7 % linoleic acid in terebinth oil. Hassanein and Abedel-Razek[20] identified 8.0 % palmitic acid, 3.8 % stearic acid, 20.2 % oleic acid, 67.8 % linoleic acid and 0.2 % linolenic acid in grape seed oil.

TABLE-3
FATTY ACID COMPOSITION OF SOME OIL-BEARING MATERIAL OILS (%)

Materials	Palmitic acid	Stearic acid	Oleic acid	Linoleic acid	Linolenic acid
Flax	4.3	2.1	17.8	13.1	53.1
Soybean	7.8	4.9	23.9	47.8	6.5
Rice bran	11.3	1.2	44.8	28.6	0.3
Peanut	7.6	1.8	42.7	22.5	0.6
Grape	4.1	10.4	16.4	69.3	0.2
Sesame	11.2	12.6	41.9	43.9	0.1
Almond	3.2	3.7	76.4	16.2	1.2
Sorghum	8.3	2.7	37.8	44.3	0.2
Pistachio	16.8	7.6	62.7	17.4	0.3

As a result, the differences in physical properties of seed and oils were probably due to environmental conditions in conjunction with analytical methods used. In addition, crude protein, crude fibre and crude oil contens of seeds affected mainly by variety and growth conditions. It was also considered that biochemical differences of the varieties consisted of genetic variation and different ripening harvest time. It may be concluded that these seed oils are suitable for edible purposes as it contain relatively higher amounts of unsaturated fatty acid, very close to those reported for the edible oils. Future studies could include amino acid contents and functional properties of these oils.

ACKNOWLEDGEMENT

This work was supported by Selçuk University Scientific Research Project (S.U.-BAP. Konya, Turkey).

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(*Received*: 6 January 2010; *Accepted*: 20 May 2010) AJC-8724