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Determination of seed and oil properties of some poppy (*Papaver somniferum* L.) varieties

By **M. Musa Özcan*** and **Çiğdem Atalay****

* Department of Food Engineering, Faculty of Agriculture, University of Selçuk, 42031 Konya, Turkey
** Food Engineering, Konya, Turkey

RESUMEN

Determinación de propiedades de aceites y semillas de algunas variedades de amapola (*Papaver somniferum* L.)

Se han investigado las propiedades físicas y químicas de siete variedades de amapolas (2001 mavi hat, Ankara 94, Kocatepe 96, Kemerkaya, Karahisar 96, Şuhut 94, Afyon Kalesi 95). El peso de 1000 semillas, humedad, proteína cruda, ceniza cruda, fibra cruda, ceniza insoluble en HCl, energía cruda y contenido de aceite crudo de todas las variedades de semilla se establecieron entre 0,29-0,429 g, 3.39-4.76%, 11.94-13.58%, 4.92-6.25%, 22.63-30.08%, 0.72-1.68%, 6367.0-6740.5 kcal/100g y 32.43-45.52%, respectivamente. También se determinaron los contenidos en P, Ca, K, Mg, Na y Fe en las muestras. Los ácidos grasos libres, índice de iodo, índice de refracción, materia insaponificable, índice de saponificación, pH y contenido en tocoferoles de estos siete aceites de semilla de amapola han sido medidos. Estos aceites de semilla contuvieron una cantidad apreciable de β-tocoferol (309.5 ppm-567.3 ppm). Los principales ácidos grasos fueron esteárico, palmítico, oleico, linoleico y linolénico. El aceite y la semilla de amapola tienen un alto valor nutritivo y fueron recomendado para su uso como productos alimenticios saludables. El ácido graso linoleico se estableció como el ácido graso dominante en todas las variedades.

PALABRAS-CLAVE: Aceite - Amapola - Propiedad física - Propiedad química - Semilla.

SUMMARY

Determination of seed and oil properties of some poppy (*Papaver somniferum* L.) varieties

Physical and chemical properties of seven poppy varieties (2001 mavi hat, Ankara 94, Kocatepe 96, Kemerkaya, Karahisar 96, Şuhut 94, Afyon Kalesi 95) were investigated. Weight of 1000 seeds, moisture, crude protein, crude ash, crude fibre, HCl-insoluble ash, crude energy and crude oil contents of all seven varities of poppy seeds were established between 0.29-0.429 g, 3.39-4.76%, 11.94-13.58%, 4.92-6.25%, 22.63-30.08%, 0.72-1.68%, 6367.0-6740.5 kcal/100g and 32.43-45.52%, respectively. P,Ca, K, Mg, Na and Fe contents were established in the samples. Free fatty acid, iodine value, refractive index, unsaponifiable material, saponification number, pH and tocopherol contents of these 7 poppy seed oils were measured.The poppy seed oils contained an appreciable amount of β-tocopherol (309.5 ppm-567.3 ppm). Stearic, palmitic, oleic, linoleic and linolenic were determined as the main fatty acids. Poppy seed and oil having high nutritive value were recommended for processing as healthy food products. Linoleic acid was established as the dominant fatty acid in all varieties.

KEY-WORDS: Chemical property - Oil - Physical property - Poppy - Seed.

1. INTRODUCTION

Papaver somniferum (poppy) is cultivated as an annual crop in countries such as China, India, Czechoslovakia or Turkey. Poppy is grown mainly for its content of opium and oil seed. The seeds are used almost exclusively for their oil (Yazıcıoğlu and Karaali,1983; Nergiz and Ötleş, 1994; Karaefe, 1992; Koç, 2002; Bozan and Temelli, 2003).

Poppy seeds contain up to 50% oil and Indian cultivars have high levels of oleic and linoleic acids (Singh et al.1990). Singh et al.(1995) have indicated the potential for this crop as a source of linoleic acid. This crop is placed among the important industrial oil plants in Turkey (Karaefe,1992; Koç, 2002). Poppy seed oil appears to be of good quality for human consumption since it is generally rich in polyunsaturated fatty acids (Eckey 1954; Luthra and Singh, 1989; Krzymanski and Jonsson, 1989; Bozan and Temelli, 2003).

In Europe, poppy seeds are mostly used for confectionary, similar to the use of sesame seeds and are used extensively in baking and sprinkling on rolls and bread. The seeds are a good source of energy. They are also the source of a drying-oil, used for the manufacturing of paints, varnishes, and soaps, and in foods and salad dressing. Oil cake is a good fodder for cattle (Harvey, 1988; Duke 1989).

Poppy seeds are used in Turkey almost exclusively for the extraction of oil. They are also used by the peasant women in pastry making . Almost all the poppy oil is extracted in local mills and used by the peasants unrefined. Although poppy oil is not used as table oil in the towns, it is, on the other hand, used for the manufacturing of oil varnishes and fine colors, as well as for perfumes, drugs and soap. The crude oil is yellow, transparent, greasy, sweet and agreable. Some studies on the composition of poppy seed were made (Kürçay, 1946; Srinivas and Narasinga Rao, 1981; Bajpai et al. 1999; Nergiz and Ötleş, 1994; Bozan and Temelli, 2003). It was reported that the seeds of *P. somniferum* were useful for the relief of dysentry, constipation, cough and asthma (Baytop, 1984; Raie and Salma, 1985). While more studies have been made on opium and growth, limited studies related to seed composition have been conducted in Turkey (Yazıcıoğlu and Karali, 1983; Nergiz and Ötleş, 1994; Bozan and Temelli, 2003).

No detailed study of the physical properties, chemical composition, tocopherol content, mineral contents and fatty acids of the seeds of *P.somniferum* has been carried out so far. The study presented here evaluates various physical and nutritional properties of seven poppy (*P. somniferum*) varieties cultivated in Afyonkarahisar in Turkey.

2. MATERIAL AND METHODS

Material: The seeds of poppy varieties were obtained from the Afyon province in Turkey in the year 2003. Seeds 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, stones and chaff, and immature and broken seeds were discarded as well. Their moisture content was measured on arrival.

Methods: The chemical and physical properties (moisture, crude protein, crude oil, crude fiber, crude energy, ash, HCl-insoluble ash, refraxtive index, free fatty acids, iodine value, saponification number and unsaponifiable matter) were analyzed according to AOAC (1990). The oil was extracted with diethyl ether (50 °C) in a Soxhlet apparatus. The extract was evaporated in a 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 reflux and saponified with 5 ml of ethanolic potassium hydroxide solution (20 % w/v) for 2 h.. The unsaponifiable matter was extracted three times with 15 ml of petroleum ether, and the extracts were combined and evaporated in a rotary evaporator at 40ºC under reduced pressure. The unsaponifiable residue was weighed (Küsmenoğlu et al.1997). For the free oil acidity, a known weight of seed oil was dissolved in a mixture of diethyl ether/ethanol (1:1 v/v). The mixture was titrated with potassium hydroxide in methanol (0.05 M) in the presence of phenolphthalein as indicator. The tocopherol analyses were determined by using high-performance liquid chromatography (HPLC) according to AOAC (1990).

Determination of mineral contents: About 0.5 g dried and ground sample was put into a burning cup and 10 mL pure HNO_3 was added. The sample was incinerated in a MARS 5 Microvawe Oven under the 170 psi at 200 °C temperature and the solution was diluted to the desired volume (25 ml) with water. Samples were filtered in filter paper, and were determined with an ICP-AES (Skujins 1998).

Working conditions of ICP-AES: Instrument: ICP-AES (Varian-Vista). RF Power: 0.7-1.5 kw (1.2-1.3 kw for Axial). Plazma gas flow rate (Ar): 10.5-15 L/min. (radial); 15L/min. (axial). Auxiliary gas flow rate (Ar):1.5 L/min. (radial); 15L/min. (axial). Viewing height: 5-12 mm. Copy and reading time:1-5 s (max.60 s). Copy time: 3 s (max. 100 s).

Determination of fatty acids: Fatty acid composition for seed oil samples was determined using a modified fatty acid methyl ester method. The oil was extracted three times from 2 g air-dried seed sample by homogenization with petroleum ether. The oil sample (50-100 mg) was converted into its fatty acid methyl esters (FAME). The methyl esters of the fatty acids (0.5 µl) were analyzed in a gas chromatograph (Shimadzu QP 5050) equipped with a flame ionizing detector (FID) and 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 then kept at 240 °C for 15 min); injector and detector temperatures, 250 and 260°C; respectively, carrier gas, helium at flow rate of 14 psi; split ratio, 1/20 ml/min. The contents of palmitic, stearic, oleic, linoleic and linolenic acids were determined by a computing integrator (Hışıl, 1988; Baydar and Turgut, 1999).

Statistical Analyses: Results were analyzed for statistical significance by an analysis of variance (Püskülcü and İkiz,1989). The statistical evaluation was done using Minitab package program (Minitab,1991).

3. RESULTS AND DISCUSSION

The physical and chemical properties of poppy seed and oils are given in Table 1 and Table 5. The weight of 1000 seeds, moisture, crude protein, crude ash, crude fiber, HCl-insoluble ash, crude energy and crude oil contents of all the varieties of poppy seeds were established between 0.29-0.43g, 3.4-4.8%, 11.9-13.6%, 4.92-6.25%, 22.6-30.1%, 0.72-1.68%, 6367.0-6740.5 kcal/100g and 32.4-45.5%, respectively. Crude protein, ash, HCl-insoluble ash and crude energy values of the 2001 mavi hat variety were lower than in other varieties. Seeds are rich in crude oil, crude protein, crude fiber and crude energy. The oil content varied between 32.4% (Ankara 94) and 45.5% (Şuhut 94). The moisture, ash and fat contents were found to be similar when compared to the results of Nergiz and Ötleş, (1994) for poppy seeds, while the crude protein content was lower. Srinivas and Narasinga (1981) reported 46.2-49.4% oil, 21.5-23.5% crude protein, 14-15% crude fiber in poppy seed. Seed is reported to contain moisture (4.3-5.2%), protein (22.3-24.4%), ether extract (46.5-49.1%), crude fiber (4.8-5.8%), ash (5.6-6.0%), calcium (1.03-1.45%), phosphorus (0.79-0.89%), iron (8.5-11.1 mg/100 g). Minor minerals in the seeds include: I (6 mg/kg), Mn (29 mg/kg), Cu (22.9mg/kg), Mg (15.6 mg/kg) and Zn (130 mg/kg) (Duke,1983).According to these results, it can be concluded that poppy seeds have high protein, oil and K, P and Ca contents.

Table 1
Physical and chemical properties of poppy seeds

Varieties	1000 seeds (g)	Water (%)	Crude protein* (%)	Crude ash (%)	Crude fibre (%)	Nonsoluble HCl acid (%)	Crude energy (kcal/100g)	Crude oil (%)
2001 Mavi hat	0,34±0.02**	4,76±0.12	11,94±1.27	4,921±1.023	24,73±2.56	0,718±0.012	6367,0±34.1	41,86±2.31
Ankara 94	0,36±0.01	3,53±0.23	12,29±1.12	5,591±0.786	26,06±1.87	1,445±0.324	6689,0±67.3	32,43±3.21
Kocatepe 96	0,29±0.01	3,55±0.17	13,58±0.87	5,592±0.987	24,65±3.12	0,839±0.003	6623,0±45.7	42,19±4.27
Kemerkaya	0,43±0.03	3,39±0.12	12,73±0.98	5,859±0.786	30,08±3.41	1,191±0.087	6740,5±65.3	36,73±3.67
Karahisar 96	0,35±0.03	4,19±0.16	13.00±0.56	6,064±0.945	28,80±2.45	0,968±0.045	6517,0±35.8	38,58±2.89
Şuhut 94	0,40±0.07	4,02±0.34	12,01±1.21	6,254±0.967	27,24±1.78	1,666±0.036	6461,5±67.4	45,52±3.56
Afyon kalesi 95	0,39±0.05	3,50±0.18	12,37±1.23	5,527±1.764	22,63±1.94	1,676±0.064	6662,0±27.8	41,28±3.78

*Nx6.25
**standart deviation.

The mineral composition of poppy seeds is shown in Table 2. Mineral elements were found to vary widely depending on the different poppy varieties. According to the results P, K, Ca, Mg, Na and Fe contents were very high in all the seeds. The Cd,Cr, Ni and Pb contents of these varieties were very low. The level of phosphorus in all the varieties in this work was found high. Potassium content was high in most cases and ranged from 6012.14 ppm (Afyonkalesi 95) to 10535.73 ppm (2001 mavi hat). Ca content ranged from 8756.9 ppm (2001 mavi hat) to 10702.44 ppm (Şuhut 94). Mg content ranged from 3406.7 ppm (Afyonkalesi 95) to 3872.14 ppm (2001 mavihat). K, Na, Fe, Cu and Ca contents of all varieties determined in this study were found similar with respect to the results of Nergiz and Ötleş, (1994). In addition, our findings were similar to the results reported by Özcan (2004). But, some of our results on the mineral contents of poppy seeds show minor differences when compared with the literature (Nergiz and Ötleş, 1994; Özcan, 2004). These differences might be due to growth conditions, genetic factors, geographical variations and analytical procedures (Guil et al.,1998; Özcan and Akgül,1998).

Calcium is the major component of bone and assists in teeth development (Brody,1994). The Mg, Fe and P levels are adequate. Some inorganic elements which may contribute to biological processes, but which have not been established as essential are bromine, cadmium, lead and lithium

Table 2
Mineral contents of poppy seeds (ppm)

Minerals	Varieties						
	2001 MAVİ HAT	ANKARA 94	KOCATEPE 96	KEMERKAYA	KARAHİSAR 96	ŞUHUT 94	AFYON KALESİ 95
Al	12,6±1.1*	17,0±1.1	41,3±5.3	18,5±2.6	31,9±4.3	11,2±1.4	16,4±2.5
B	69,4±2.3	34,9±2.4	18,5±1.8	28,8±2.1	25,8±3.1	43,3±2.3	19,4±2.3
Ca	8756,8±123.4	9447,1±67.8	10462,1±36.8	10096,1±78.3	9293,4±46.3	10702,4±34.5	10134,7±46.2
Cd	0,3±0.0	0,2±0.0	0,3±0.1	0,3±0.0	0,3±0.0	0,3±0.0	0,3±0.0
Cr	3,5±0.6	5,1±1.1	2,3±0.8	3,0±0.4	5,2±1.1	2,9±0.7	3,4±0.5
Cu	13,2±1.1	10,5±2.1	14,0±1.9	27,3±1.4	12,5±2.3	9,6±1.1	10,4±1.2
Fe	64,1±2.3	70,1±3.6	89,4±6.7	75,7±3.6	104,5±5.4	83,2±1.1	73,2±3.4
K	10535,7±45.6	6811,9±34.7	6714,9±67.3	6968,3±38.3	9418,8±48.3	9506,9±32.5	6012,1±65.2
Li	6,7±1.5	6,6±0.9	6,6±0.5	6,5±1.1	6,6±2.1	6,6±1.4	6,7±0.9
Mg	3872,2±37.9	3698,3±42.1	3432,0±56.7	3686,8±69.2	3829,0±56.3	3657,6±23.7	3406,8±27.3
Mn	62,3±2.6	66,2±3.4	78,0±5.6	64,6±3.6	60,9±4.3	66,5±5.3	67,0±6.3
Na	664,5±12.4	838,4±12.1	541,5±23.6	533,0±27.6	1489,4±32.1	522,2±34.2	1365,3±48.5
Ni	1,6±0.2	2,1±0.3	3,1±0.8	2,2±0.5	4,0±1.1	1,7±0.3	12,2±1.1
P	9375,9±36.9	10612,5±26.7	9283,9±32.9	10492,0±34.6	12769,0±89.7	10208,1±76.9	9081,4±65.3
Pb	1,4±0.1	1,5±0.7	1,6±0.3	1,6±0.4	1,3±0.1	0,6±0.1	0,3±0.0
Sr	86,0±3.4	150,8±2.3	134,7±3.7	169,9±4.3	140,2±3.2	177,4±1.2	184,3±4.3
V	25,2±2.5	25,3±1.9	25,9±2.1	26,8±2.6	25,7±3.7	27,5±2.3	25,5±1.6
Zn	29,6±2.7	32,15±1.8	27,0±2.4	35,8±3.1	45,2±4.3	21,3±1.6	24,7±2.8

*standart deviation.

Table 3
Physical and chemical properties of poppy oils

Varieties	Free fatty acid (% oleic)	Iodine value	Refractive Index n^{20}	Unsaponifiable matter (%)	Saponification value	pH
2001MAVİ HAT	1,6±0.3*	122,0±3.2	1,4773±0.0	1,34±0.13	204,0±2.3	4,4±0.1
ANKARA 94	1,1±0.1	122,0±2.6	1,4772±0.0	1,06±0.02	205,0±3.6	4,2±0.1
KOCATEPE 96	1,6±0.4	125,0±2.1	1,4773±0.0	2,40±0.17	206,0±2.2	4,3±0.2
KEMERKAYA	1,0±0.2	127,0±2.5	1,4773±0.0	1,00±0.01	199,5±2.1	3,7±0.1
KARAHİSAR 96	3,2±0.2	126,5±3.3	1,4773±0.0	2,05±0.12	206,5±3.2	3,7±0.1
ŞUHUT 94	1,2±0.1	124,5±4.6	1,4773±0.0	1,88±0.030.02	206,0±3.8	4,2±0.2
AFYON KALESİ 95	2,0±0.1	129,5±4.9	1,4773±0.0	1,23±0.01	205,5±3.6	4,2±0.1

*standart deviation.

(Macrae et al.,1993a). Cadmium and lead are best known for their toxicological properties (Macrae et al.,1993b). Decreasing the contents of these toxic elements is an advantage. The highest mineral contents were P, K, Ca, Mg, Na and Fe. This work attempts to contribute to the knowledge of the nutritional properties of these seeds. In addition, knowledge of the mineral contents, as condiments for various baked products is of great interest.

The extracted oil was yellowish in color. Its physical and chemical properties are given in Table 3. Free fatty acid content of oils ranged from 1.015% (Kemerkaya) and 3.194% (Karahisar 96). Iodine value, refractive index and saponification values were similar in all varieties. It will be seen that when compared with literature limits, there are significant variations in some chemical compositions of most of these seeds. The unsaponifiable matter content and refractive index values were found to be similar to those of other seed oils, eg caper seed oil (Akgül and Özcan,1999). The saponification number (199.5-206.5) was generally higher than other seed oils (Akgül and Özcan,1999; Özcan,2004). Differences among free fatty acid, iodine value, refractive index, saponification number, unsaponifiable matter and pH values of seeds were significant at level $p < 0.01$.

The contents of tocopherols and variance analyses are given in Table 4. Differences among all tocopherols of seeds were significant at level $p < 0.01$. The poppy seed oils contained an appreciable amount of β-tocopherol (309.47 ppm-567.28 ppm). α-Tocopherol contents of seeds ranged from 26.75 ppm (Karahisar 96) to 37.23 ppm (Ankara 94). Total tocopherol contents of all varieties ranged from 348.76 ppm (Karahisar 96) and 623.14 ppm (Ankara 94). β-Tocopherol contents were higher than the reported by Nergiz and Ötleş (1994); α-tocopherol contents were found low. Total tocopherol contents of all seed oils were found higher according to results of *Nigella sativa* seed reported by Nergiz and Ötleş (1994). Because of the nutritional and antioxidant properties of tocopherols, poppy oil should be taken into account.

The fatty acid compositon of oil from poppy varieties is shown in Table 5. Linoleic acid was the dominant fatty acid of all poppy seed oils. From a nutritional point of view, poppy seed oil is also a good source of essential fatty acids, especially linoleic acid, as compared to the other edible oil seeds (Nergiz and Ötleş, 1994). Linoleic acid (C 18:2) was found high in all the samples, and varied between 52.60% (Şuhut 94) to 71.50% (Ankara 94). The high content of linoleic acid makes it more suitable for development as a high linoleic acid crop. The proportion of oleic and linoleic acids determines the quality of oil and its end use (Haris et al.,1980; Gren,1986; Singh et al.,1998). There is a high percentage of palmitic acid (12.85-18.70%) compared to stearic acid (2.40-4.30%). The most desirable feature of this oil is its low linolenic acid (C 18:3) content (0.156-0.495%), which in turn improves the storage capacity of the oil. In general,

Table 4
Tocopherol contents of poppy oils

Varieties	α- tocopherol (ppm)	β- tocopherol (ppm)	Δ- tocopherol (ppm)	Total tocopherol (ppm)
2001MAVİ HAT	33,6±1.2*	553,2±12.1	10,4±1.1	597,3±12.3
ANKARA 94	37,2±2.3	567,3±23.6	18,6±1.7	623,1±15.3
KOCATEPE 96	34,4±2.2	375,7±15.6	6,4±0.8	416,9±12.7
KEMERKAYA	31,7±3.2	417,7±17.8	7,6±1.4	456,9±23.6
KARAHİSAR 96	26,8±1.9	309,5±13.7	17,2±2.6	348,8±26.9
ŞUHUT 94	36,9±1.6	395,2±18.9	7,9±1.9	440,1±32.7
AFYON KALESİ 95	28,4±2.7	343,7±24.9	6,1±1.1	378,2±26.9

*standart deviation.

Table 5
Fatty acid composition of poppy seed oils

Varieties	Fatty acids (%)				
	Palmitic	Stearic	Oleic	Linoleic	Linolenic
2001MAVİ HAT	15,50	3,65	23,45	57,18	0,39
ANKARA 94	12,85	2,40	13,11	71,50	0,30
KOCATEPE 96	16,75	4,30	21,18	57,40	0,40
KEMERKAYA	18,70	3,35	19,50	58,05	0,50
KARAHISAR 96	14,65	3,65	16,30	65,47	0,16
ŞUHUT 94	18,55	4,25	24,13	52,60	0,41
AFYON KALESİ 95	15,45	3,65	19,60	61,09	0,24

high amounts of linolenic acid are unsuitable for oil-food products due to its instability and reversion of flavor associated with autoxidation (Smouse,1979; Gren,1986; Singh et al.,1998). So, poppy seed oils may be a suitable oil seed crop for the food industry due to its very low content of linolenic and high content of linoleic acids (Singh et al.,1998).

Our results were found similar to the results of poppy seed oil reported by Nergiz and Ötleş (1994), Bozan and Temelli (2003) and Baydar and Turgut, (1999). They reported on the health benefits of oils rich in linoleic acid, like corn or safflower oils, in lowering serum cholesterol levels (Gottenbos,1988; Imaizumi et al.,2000; Bozan and Temelli,2003). Crops having such oil quality have considerable agricultural significance as the market for edible vegetable oil is expanding rapidly (Singh et al.,1998).

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