International Journal of ChemTech Research
CODEN (USA): IJCRGG ISSN: 0974-4290
Vol.8, No.2, pp 878-882, 2015

Physic-chemical characteristics of Bitter and Sweet Almond kernel oil

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Abstract: This research aimed to physicochemical study of almond (*Prunusamygdalus L*) seed oil was grown in Iran. The almond oils tested in this research indicateda high content of unsaturated (USFA) and low saturated fatty(SFA) acids, significantly. Significant differences existed between the physicochemical indices of different almond oils. The range of Peroxide value (meq/kg), acid value, iodine value, saponification number, of almond seed oil were 0.21 to 0.62 and 0.27 to 0.5 and 95.5 to 104.7 and 178 to 201 respectively. And the range of oil content of almond kernel varied from39% to 57 %. Oleic content (66.69% to 69.5%) is the key fatty acid found in almond kernel oil, followed by linoleic (18.86 % to 22.31%) and palmitic (4.62% to 5.71%) acids. Results showed that the physical and chemical characteristics of almond kernel oils samples were suitable for edible and pastry. Oleic acid was found in highest amount, followed by linoleic, palmitic, stearic and Palmitoleic in almond kernel oils samples.
Key worlds: almond, seed oil, physic-chemical properties.

Introduction:

Fats and oils are a significant food source for human, and are supplying essential fatty acids like linoleic acids. Fats and oils are also applied for producing drug dispersants in therapeutics and play important functional and sensory roles in food product[1, 2]. Vegetable oils are broadly used in the cooking and food processing, pharmaceutical, cosmetics and chemical industries[3, 4]. Almond nut is one of the best popular nuts in the world. Its kernels are usually used as snack foods also are used as components in a variety of processed foods, especially bakery and confectionery products and seeds are also rich in unsaturated fatty acid(*USFA*), protein and oil as nutritional values. Almonds can be significant for human diet and health[5]. Many studies have been conducted to assess the physical, chemical properties of the almond seeds oil such as Ozcan et al, have studied the physical and chemical composition of turkey almond kernels and oils[6].Yada et al, have studied the physical properties of almond pit and kernel[7]. Moayedi et al, have studied the chemical compositions of oils from several wild almond species[8]. The evidence that usage of almonds and other nuts is negatively associated with occurrence of cardiovascular disease in 2003 the food and drug administration promulgated a qualified β-level health claim that eating 42 g every day 'as part of a diet low in saturated fat and cholesterol may decrease the risk of coronary heart disease[9]. Almond kernels contain unsaturated fatty acids such as oleic, linoleic and linolenic. These three acids are important for nutrition and are helpful in the diet[8, 10] almost twenty species of wild almond have been reported in Iran[11]

Almonds is a species of tree the Western and Central Asia including China, Turkestan, Kurdistan, Afghanistan and Iran[8]. According to report of FAO the top five almond producers in calendar year 2003 were the USA at 758,000 metric tons (45 % of the global production), followed by Spain (210,000 tons, 12 %), Syria

(139,000 tons, 8 %), Iran (105,000 tons, 8 %), and Italy (91,000 tons, 5 percent). From 1993 to 2003, world almond production grew 5 % annually(USDA, 2004)almond kernels contain unsaturated fatty acids such as oleic, linoleic and linolenic. These three acids are important for nutrition and are helpful in the diet[8, 10] In this Study, oil was extracted from the seed of Iranian almond by hexane solvent method and the fatty acid, mineral contents of the oil and seed compounds of almond were determined. Although some work has been performed to determine the fatty acid composition of *Prunusamygdalus L*seed oil from USA and turkey[5, 6, 9]. It was the first time eastern Azarbaijan(Iran)*Prunusamygdalus L* oil extracted by hexane solvent method was investigated and mineral contents of *Prunusamygdalus L* seed oil were determined.

The aim of this study was to extract oil from *Prunusamygdalus L*seeds, determine the oil's physical and chemical characteristics, and recommended possible uses for the oil as a prelude to an investigation into the scientific evidence for its use. Additionally, the properties of the almondseed oil were compared to other edible oils from different plant sources that are already commonly utilized.

Material and methods:

Collection of seeds

The seed samples were picked by hand from the almond trees of eastern Azerbaijan during the crop season 2013 (June-July).All kernel samples were kept at the refrigerator temperature(4 °C) until their use in the experiments. The chemicals and solvent used in this study were of analytical grade and purchased from Merck (Germany).

Extraction of seed oil

Oil samples were extracted from almond seeds by soxhlet extraction using n-hexane (15 g seed powder with 250 ml n-hexane) with a temperature ranging from 60 to 80 °C for 8 h. The n-hexane was then removed with a rotary vacuum evaporator[12]The pure oils were transferred into dark-colored glass vials, which were flushed with nitrogen before storage (to decrease oxidation). Samples were maintained at −18 °C until analysis.

Analysis of almond kernel oil:

The physic-chemicalproperties of almond kernel oil including; acid value, iodine value, saponification value, peroxide value were determined according to previously-reported methods(international, 1995; International, 2006)Mineral ions of the extract oil were analyzed and prepared according to the method previously reported by Pehlivan et al with some modification by ICP[4, 13]. Fatty acid methyl esters of the extracted oils were prepared according to method of Metcalfe et al. with some modification(Metcalfe et al., 1966)Gas chromatography (GC) analyses were performed with a Varian GC coupled with a BP × 70 fused silica capillary column (60 m × 0.25 mm ID and 0.35 μm film thicknesses) using nitrogen as a carrier gas. The oven temperature program was as follows: 60 °C for 5 min; heat to 180 °C at 4 °C/min; hold for 15 min; and heat to 215 °C at 4 °C /min. The temperatures of the injector and temperature detector were 250 and 280 °C, respectively[14]

Result

GC analyses of the fatty acid content of almond seed oils showed that the oils contain oleic, linoleic, palmitic, stearic andpalmitoleic acids. Oleic acid contents ranged from 66.69% to 69.5%,while linoleic acid contents ranged from 18.86 % to 22.31%(Table 1). Oil extracted from almond kernel is pale yellow, tasteless, and free of sediments. It is liquid at room temperature (27 ± 2 °C). The oil yield of Bonabsweet and Osku sweet were 39% and 57%,respectively. Iodine, acid, peroxide, and saponification values of the extracted oils ranged 95.5 (for bonab bitter) to 104.7 (for osku bitter), 0.27 (for osku sweet) to 0.5 (for bonab sweet), 0.21 (for bonab bitter) to 0.62 (for bonab sweet), 178 (for bonab sweet) to 201 (for osku bitter, Table 2), respectively.

Table1: Fatty acid compositions of sweet and bitter almond seedoils(%)

		Palmitic	Palmito-leic	Stearic	Oleic	Linoleic	Other tty acid	USFA	SFA	USFA/SFA	Yield (%)
Osku	Sweet	5.6±0. 2	0.7±0.02	1.6±0.01	66.7±0.6	20.2±0.8	4.5±0.7	86.9±1.1	7.9±0.2	10.9±0.7	57±2.5
	Bitter	4.6±0.3	0.6±0.05	1.4±0.03	69.5±0.3	22.3±0.3	0.8±0.02	91.8±0.7	6.6±0.3	13.9±0.5	43±1.2
Bonab	Sweet	5.3±0.2	nd	1.2±0.02	69.4±1.2	21.5±0.5	2.5±0.3	90.9±0.5	6.5±0.6	13.9±.02	39±3.1
	Bitter	5.7±0.5	0.2±0.03	0.5±0.04	68.3±0.7	18.9±0.7	4.9±0.6	87.2±0.6	6.4±0.1	13.5±0.6	49±4.3

ND:not detected *SFA saturated fatty acid, USFA unsaturated fatty acid
In each column, means with the same letter are not significantly different (P>0.05

Table 2. Chemical properties of some common sweet and bitter almond seed oils

		Iv[1]	SN[2]	PV[3]	AV[4]
Osku	Sweet	96.68±3.1	198.4±1.2	0.43±0.3	0.27±0.2
	Bitter	104.7±2.3	201±4.8	0.56±.02	0.42±.01
Bonab	Sweet	99.61±4.3	178±6.3	0.62±0.5	0.5±.03
	Bitter	95.5±9.1	194±2.5	0.21±.04	0.33±0.1

[1] Iodine Value (g I2 per 100 g of oil) 2 Saponification Number (mg KOH per g of oil)
3 Peroxide Value (mequiv O2 per kg of oil) 4 Acid Value (mg KOH per g of oil)
In each column, means with the same letter are not significantly different (P>0.05)

Table 3. Mineral contents (ppb) of sweet and bitter almond seedoils

		Cu	Fe	K	Mn	P	Zn	Co
Osku	Sweet	303	1077	398	11	5114	545	13
	Bitter	217	1651	271	46	7925	656	25
Bonab	Sweet	65	1679	66	28	7794	108	8
	Bitter	104	1798	122	21	8354	925	16

The content of mineral ions in the kernel samples is shown in Table 3. Phosphorus has the highest mean concentration, while cobalt is present in the smallest detectable concentration.

Discussion

Unsaturated vegetable oils, including almond oil, may be able to reduce serum cholesterol levels. The use of saturated vegetable oils including hydrogenated oils can be a factor in raising LDL levels and decreasing HDL levels in the blood, which can increase the risk of blood clotting inside blood vessels. Today, the use of unsaturated vegetable oils is recommended by the medical community [15, 16]. The oil of osku bitter in terms of oleic acid(18:1) profile (Nutritional value) is better compared to other oils. Almond seed oil at room temperature is in liquid state as all other edible Oils used for routine. Saponification number of all almond kernel oil samples ranged from 178 mg KOH/ g to 201 mg KOH/ g. it indicated that all values were under the limits established by Conseil Oléicole International (C.O.I).

The saponification value is an indicator that can be used to compare relative molecular masses and indicate the usefulness of oil in industry. The high saponification values recorded for the almond oils suggest that the oils contain high-molecular-weight fatty acids and low levels of impurities. This is evidence that the oils could be used in the soap making industry[17].

The oil yield of almond seed in this study ranged from 39% to 57%, which is similar to the range reported for other commonly used edible oils.

Acid value is an indicator of oil edibility suitability for industrial use. Almond seed oil had acid values ranging from 0.27 to 0.5 , which is nearest to the range observed for almond seed oil[18].

The Iodine value of almond oil is highest percentage of oil was in 104.7% (osku bitter) cultivar whilst the minimum amount was found in 95.5% (bonab bitter) oil is suitable for edible purposes and also in the manufacture of pastry and cosmetic[19]. The almond seed oils have approximately the same ratio of saturated to unsaturated fatty acid as edible oils such as cotton seed oil, canola oil, corn oil, linseed oil, soybean oil, safflower oil, and apricot kernel oil. Owing to these chemical properties, the almond seed oil may be a good replacement for olive oil in industrial, cosmetic, and food applications. The almond kernel oils also have almost the same mineral composition as the conventional seed oils from other plant sources; it is rich in phosphorous, copper, zinc, iron, and potassium, making it suitable for health and commercial uses. The physicochemical properties of oils depend on two groups of fatty acids: saturated and unsaturated. Fatty acid composition of almond kernel oil is similar to apricot kernel and olive oil[10, 20]. In the present study, almond seed oil is characterized by the presence of five major fatty acids: oleic, linoleic, palmitic, stearic and Palmitoleic. Together, these fatty acids composed more than95% of the total fatty acid content. Ozcan et al reported that

bitter almond kernel oils have high unsaturated fatty acid contents; similar results were observed in this study[6]. Askin et al showed that almond seed oil contains oleic acid (50.41–81.20%), linoleic acid (6.21–37.13), palmitic acid (5.46–15.78%), and stearic acid (0.80–3.83%); similar oil compositions were determined in this study[5] Farhoosh&Tavakoli showed that the major fatty acids in almond kernel oils were oleic, linoleic, and palmitic acids[10]. Moayedi et al showed that the major monounsaturated fatty acid (MUFA) was oleic acid. linoleic acid was only PUFA found in almond oil their results were similar to the present study's findings[8].

Conclusion:

Based on the results of this research combined with previously reported findings, it can be concluded that almondseed contains a high percentage of unsaturated fatty acids. Oils containing small amounts of saturated fatty acids and large amounts of monounsaturated fatty acids are highly favorable in the human diet. Almond seed have high oil yields (> 50%), which is comparable to the oil yield of some commercial seed oils. The results obtained from this study can be used as baseline data to develop almond seed oil for both domestics and industrial purposes. They can also be used to promote the sustainable cultivation of the almond tree in the mountain region of Iran for large-scale oil production.

Acknowledgements

The authors would like to thank the Tehran University of medical sciences for providing all of the support for this study. We would also like to thank Mr. Nazmara and Mrs. Shiri for their technical help

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