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Fatty acids composition of oil extracted from gamma irradiated apricot (*Prunus armeniaca* L.) kernels

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Abstract

Oils produced from nuts and seeds, are receiving growing interest attribute to their high concentration of unsaturated fatty acids (UFAs), which have shown various type of health benefits. The present work was undertaken to determine the fatty acids composition of apricot oil extracted from irradiated and un-irradiated apricot kernel grown in Syria. Kernels of apricot were exposed to a doses of 0, 6 and 9 kGy of gamma ray, and stored for 0, and 12 months. The fatty acids (FAs) of apricot kernel oil were carried out by gas chromatography. Apricot kernel oil contain about 93.18-95.26% unsaturated and 4.74-6.82% saturated fatty acids. Thus the ratio between unsaturates and saturates (UFA/SFA) were reported as range from 13.67 to 20.12. The major fatty acids of apricot kernel are palmitic acid (C16:0) from 4.16% to 5.84%; palmitoleic acid (C16:1) from 0.48% to 0.96%; stearic acid (C18:0) from 0.58% to 1.40%; oleic acid (C18:1) 60.61% to 77.38%; and linoleic acid (C18:2) 15.99% to 31.79%. Irradiation of apricot kernel with 6 and 9 kGy of gamma ray did not significantly affect the fatty acids profile of apricot kernel oil. The obtained results demonstrated the ability of using apricot kernel oil as the edible oil. Gamma irradiation of apricot kernel did not affect the fatty acids profile and retained PUFAs in oil extracted from apricot kernels.

Keywords: Apricot kernels oil, fatty acid composition, gamma irradiation, Syria

1. Introduction

Oilseeds are very important sources of oils being of nutritional, industrial and pharmaceutical importance [1]. Oils produced from nuts, seeds, fruits and vegetable are receiving growing interest attribute to their high concentration of bioactive elements, such as unsaturated fatty acids (UFAs), phenols and phytosterols, which have shown various type of health benefits [2]. Their oils have a high percentage of UFAs with oleic (60.07-70.6 %) and linoleic (20.5-27.76 %) being the dominants [3]. Various reports regarding the physical and chemical characteristics of oil apricot kernels are available in the literature [4,5].

Non-conventional oilseeds including apricot kernel oil are under investigation because their components have unique chemical characteristics and may increase the supply of edible oils [6]. The oil percentage of the apricot kernel differs from 27.7 to 66,7%. Broadly, it contains (7.2-13.7%) saturated fatty acids (SFAs) and (86.0-91.8%) UFAs. An level number of carbon atoms, from 16 to 18, is the most common. The contents of the major fatty acid (FA) found in apricot kernel oil are palmitic (3.2-10.7%), oleic (51.3-83.3%) and linoleic (9.6-45.9%) [3,7]. Some of minor FAs may be found in same fruit or vegetable sources [8]. The ability of various unsaturated nut seed, fruit or vegetable oils with higher monounsaturated fatty acids (MUFAs) namely oleic and palmitoleic acid to decrease the level of the serum cholesterol may focus attention on the apricot kernel oil could be attribute to its high UFAs content [9].

In the last period, gamma irradiation treatment has draw attention as a new and rapid technology for improving the quality and quantity properties of many food and food products [10,11]. The importance of the ionizing irradiation treatment is not only due to its efficiency for the

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decontamination of undesired microbial load and extension of shelf-life and storage period, but also for its effects on the physical, chemical, sensorial, nutritive, and biological properties of food and food products [11-13]. It is proven that irradiation treatment not have adverse effect in general nutritional value of foods and the oxidative changes caused by irradiation treatment are similar to those observed by using conventional method of food treatment [1,12,14,15]. It has been approved that ionizing irradiation increases the oxidation of unsaturated fatty acids throughout storage of food [10,16]. Characteristics and compositions of edible oils are important and valuable information to understanding their quality, functional and nutritional properties. Also, to determining the effective ionizing radiation dose levels needed for achievement to the a proposed objective, the effects of the ionizing irradiation treatment on product quality characteristics must also been determined [17]. Apricot kernel are waste product, and can used only for the production of biomasses, but in future may play an important resource in the field of food and cosmetic production. Therefore, the present work was undertaken to investigate the composition of the fatty acids of oils extracted from kernels of ten cultivated types of apricot locally grown in Syria, as well as the determination of the effect of medium doses (6 and 9 kGy) of gamma irradiation on fatty acid profile of apricot kernel oils.

2. Materials and Method

2.1. Sampling and sample preparation

Seeds of different types of local apricot belong *Prunus armeniaca* related to family *Rosaceae* was collected from several cultivating places in Syria. Seeds of ten types of apricot comprising of (T1) pitter seeds of Italian cv collected from Damscus-Guta, (T2) pitter seeds of Klabi cv collected from Damscus-Guta, (T3) pitter seeds of Klabi cv collected from local market in Damascus, (T4) sweet seeds of Baladi cv collected from local market in Damascus, (T5) pitter seeds of Klabi cv collected from Jollan southern area of Syria, (T6) pitter small seeds of Klabi cv collected from Al-Qunaitra southern area of Syria, (T7) pitter small seeds of Klabi cv collected from Al-Qunaitra southern area of Syria, (T8) sweet seeds of collective cv collected from local market in Damascus, (T9) pitter seeds of Italian cv collected from processing plant in Adraa, (T10) pitter seeds of Klabi cv collected from Zabadani - Damascus. The apricot seeds were manually separated from the pulp, and the outer shells of the apricot seeds were removed manually. Then kernels were cleaned, dried, and broken into paces smaller than 1 mm by using a domestic grinder. Then ground apricot kernels were transferred into polyethylene pouches for irradiation, storage and analyzing. Each pouch of apricot kernels (250 g) was considered as a replicate.

2.2. Irradiation treatment

Apricot kernels of (T9) pitter seeds of Italian cv collected from processing plant in Adraa-Damascus were irradiated with dose of 0, 6 and 9 kGy, at room temperature, using a gamma source ^{60}Co (ROBO, Russa) with a dose rate of 7.775 kGy h^{-1}. The absorbed dose was monitored by alcoholic chlorobenzene dosimeter [12]. The irradiated and un-irradiated control samples of kernels were stored for 12 months at ambient temperature (18-25 ^{o}C), and under relative humidity (RH) of 50-70%.

2.3. Oil extraction

The apricot oils extracted from un-irradiated and irradiated apricot kernels after grinding were extracted by a Soxhlet apparatus (Scientific Apparatus Manufacturing Company, Glas-Col Combo Mantle, USA). The oil extraction was performed by using distilled n-hexane, grade of analytical reagents (AR), as the solvent [18]. Fatty acid composition were done on oil extracted from apricot kernel immediately after irradiation, and on oil extracted from kernel stored for 12 months.

2.4. Determination of fatty acids

Fatty acid (FA) composition of apricot kernel oil samples was determined as their corresponding methyl esters. Preparation of fatty acid methyl esters (FAMEs) was carried out according to the method as described by Al-Bachir [10]. The FAs profile was determined by gas chromatography in a GC-17 A Shimadzu chromatograph (Shimadzu Corp., Koyoto, Japan) equipped with a flame ionization detector and a capillary column (CBP20-S25-050, Shimadzu, Australia).

2.5. Statistical analysis

The data on FA composition were statically analyzed by using analysis of variance test (ANOVA) to study the effect of gamma irradiation and storage time on the FA composition of the apricot kernel oils. Duncan's multiple range test was

used to established differences between means using the SUPERANOVA computer package (Abacus Concepts Inc, Berkeley, CA, USA; 1998).

3. Results and Discussion

3.1. Fatty acid profile of Syrian apricot cultivars oil

The determination of each fatty acids (FAs) of apricot kernel oil was carried out by gas chromatography. The FA profiles of total lipids extracted from kernel of ten types of cultivated apricot are shown in Table 1. The main FAs in kernel apricot oil were determined as palmitic acid (C16:0) from 4.16% to 5.84%, palmitoleic acid (C16:1) from 0.48% to 0.96%, stearic acid (C18:0) from 0.58% to 1.40%, oleic acid (C18:1) from 60.61% to 77.38%, and linoleic acid (C18:2) from 15.99% to 31.79% (Table 1). The common FAs namely 14:0, 20:0, 24:0 SFA and 22:1 UFA were absent from all the samples that were investigated. It should be mentioned that ten types of apricot cultivar kernel oils resemble each other in FA composition, with apricot kernel oil having a high oleic and linoleic acid content. Differences were found in fatty acids contained major amounts. The observed differences were of practical value owing to great differences between cultivars, production and collection areas. The FA composition of apricot kernel oil has been indicated by number of scientists to vary with production practices and with environmental conditions during the production season [10]. The FA profiles of apricot kernel oil revealed in our study are in accordance with those of Alpaslan and Hayta [7] and Gupta et al. [3] on the apricot seed oil contents of the main FA are oleic (58.3-73.4%) and linoleic (18.8-31.7%). Thus, apricot oil possesses special dietary importance and can be used for both edible and pharmaceutical purposes [3,19].

The oleic acid amount in the Syrian apricot kernel oil (70.13%) is much higher when compared to the sunflower (43.52%), sesame seed (42.33%), and peanut seed (49.69-50.36%), and similar to those of almond kernel (70.10%), and olive oil (70.61%), while this amount is less than that of pistachio (75.79%). Similarly, the linoleic acid (23.17%.) amount in the Syrian apricot kernel oil is slightly higher than that of pistachio (13.42%), olive oil (10.98%), almond kernel (21.07%), while this amount is less than that of the sunflower (48.19%), sesame seed (42.85%), and peanut seed (36.90%) [1,10,12,14,15].

The high percentage of linoleic acid in edible oil is the cause of the high nutritional value of such oils since linoleic acid is one of the three essential FAs [6]. It is evident that essential FA such as oleic and linoleic acids are mainly used to produce some substances that regulates a wide range of functions [20].

Table 1. Fatty acid content (%) of apricot seed oil.

Fatty acid	C16:0	C16:1	C18:0	C18:1	C18:2
			Apricot seed oil samples		
T1	4.78±0.08f	0.48±0.07g	1.19±0.03b	68.07±0.12f	25.50±0.05c
T2	5.45±0.03c	0.77±0.02bcd	1.11±0.003bcd	67.19±0.03g	25.48±0.03c
T3	5.14±0.01d	0.70±0.03e	1.40±0.08a	72.04±0.18c	20.72±0.14e
T4	5.84±0.01a	0.82±0.06b	0.98±0.07de	63.28±0.07h	29.09±0.05b
T5	4.57±0.03g	0.60±0.02f	0.88±0.14e	73.81±0.04b	20.14±0.11f
T6	4.95±0.05e	0.78±0.09bc	1.02±0.08cd	77.39±0.17a	15.99±0.04h
T7	4.23±0.01h	0.74±0.02cde	1.02±0.01cd	71.38±0.04d	22.64±0.01d
T8	5.07±0.05d	0.71±0.01de	1.13±0.03bc	70.42±0.08e	22.67±0.01d
T9	5.63±0.05b	0.96±0.01a	1.00±0.03cd	60.61±0.85i	31.79±0.84a
T10	4.16±0.01i	0.52±0.03g	0.58±0.17f	77.13±0.15a	17.62±0.07g
Average	4.98±0.55	0.71±0.14	1.03±0.22	70.13±5.30	23.16±4.76
P-level	**	**	**	**	**

abc Means values in the same column not sharing a superscript are significantly different.
ABC Means values in the same row not sharing a superscript are significantly different.
NS: not significant.
* Significant at $p<0.05$.
** Significant at $p<0.01$.

Table 2. Total saturated fatty acids (SFA), unsaturated fatty acids (UFA) and (UFA/SFA) of apricot seed oil (%).

Fatty acid	SFA	UFA	UFA/SFA
	Apricot seed oil samples		
T1	5.96±0.10d	94.05±0.07d	15.77±0.27d
T2	6.56±0.03b	93.44±0.03f	14.24±0.07f
T3	6.54±0.07b	93.46±0.07f	14.29±0.17f
T4	6.82±0.07a	93.18±0.07g	13.67±0.14g
T5	5.45±0.14e	94.55±0.14c	17.35±0.46c
T6	5.97±0.04d	94.16±0.18d	15.78±0.13d
T7	5.25±0.02f	94.75±0.02b	18.06±0.07b
T8	6.20±0.07c	93.80±0.07e	15.14±0.19e
T9	6.64±0.03b	93.36±0.03f	14.07±0.07fg
T0	4.74±0.17g	95.26±0.17a	20.12±0.72a
Average	6.01±0.66	94.00±0.66	15.85±2.02
P-level	**	**	**

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The apricot kernel oils rich in UFAs, like oleic and linoleic acids, have been shown to reduce the risk of cardiovascular diseases [21]. Oleic acid is involved in the reduction of low density lipoprotein (LDL) cholesterol levels [22]. Linoleic acid plays one of the most important roles in the prevention of diverse heart and vascular disease as it is a key component in various of human food [23]. Because of high content of short chain of FA those oils are used in different industry for manufacturing of detergents and soap [24].

The recent study, total SFAs were found range from 4.74% to 6.82%, and total UFAs were found ranged from 93.18-% to 95.26%. Thus the ratio between unsaturates and saturates (UFA/SFA) were reported as range from 13.67 to 20.12 (Table 2). Total UFA was higher than SFA value in all investigated samples. UFAs, like oleic and linoleic acids, are very important for human nutrition, because they help to decrease and prevent cancer and heart disease risk [19]. It is widely approved that the oils with high levels of MUFAs and low levels in SFAs are unique due to the protective effect of MUFAs on serum cholesterol percentage [25]. Also the MUFA have great importance because of their nutritional value and effect on stability of oils [26].

The relative quantities of total UFA and total SFA in oil are very important issue in public health and human nutrition [27]. The ratio of PUFA to SFA content is expressed as P/S index. This value is an important index to determine the nutritional value of certain edible oil. Since, oils and fats with value of P/S higher than 1 are considered to have superior nutritional value [8]. The effect of fatty acids on stability of certain oil is depends mainly on the degree of unsaturation [28]. Differences in the value of UFA/SFA affect sensorial characteristics of oil, as oil with high content of SFA is more viscous and remains more long time in contact with mucous membranes of the oral activity, giving rise to the fatty destroy [29].

3.2. Fatty acid profile of irradiated and stored Syrian apricot cultivars oil

Results of FA composition of apricot oil extracts from irradiated and non-irradiated (control) samples of apricot kernel are shown in Table 3. As shown in Table 3, at all used irradiation doses and at all extracted and stored times of kernels, small and not significant (P>0.05) change were observed, due to irradiation, in the individual determined FAs including palmitic acid (C16:0), palmitoleic acid (C16:1), stearic acid (C18:0), oleic acid (C18:1), and linoleic acid (C18:2).

There were no significant (P>0.05) differences in the percentage of total SFA, total UFA, and the ratio of UFA/SFA between the irradiated and non-irradiated. Also, there were no significant (P>0.05) differences in the amount of SFA, UFA, and UFA/SFA between oil extracted from stored and un-stored apricot kernel oil, indicating that gamma irradiation up to 9 kGy, and storage up to 12 months did not show a significant adverse effect on this parameters of the apricot kernel oil (Table 4). These

Table 3. Effect of gamma irradiation and storage period on fatty acid content (%) of apricot seed oil.

Treatment	Control	6 kGy	9 kGy	P-level
Storage period/(Months)		***C16:0***		
0	5.74±0.14Aa	5.83±0.05Ba	5.78±0.03Ba	NS
12	5.93±0.10Aa	6.15±0.19Aa	5.94±0.06Aa	NS
P-level	NS	NS	*	
		C16:1		
0	1.03±0.07Aa	1.02±0.02Aa	1.02±0.02Aa	NS
12	1.03±0.02Aab	1.14±0.08Aa	1.00±0.06Ab	NS
P-level	NS	NS	NS	
		C18:0		
0	1.06±0.04Aa	1.08±0.01Ba	1.09±0.01Aa	NS
12	1.27±0.29Aa	1.15±0.03Aa	1.04±0.22Aa	NS
P-level	NS	*	NS	
		C18:1		
0	60.96±1.70Aa	61.16±0.21Ba	62.21±0.52Aa	NS
12	62.49±0.30Aa	63.25±1.22Aa	62.79±1.97Aa	NS
P-level	NS	*	NS	
		C18:2		
0	27.90±7.60Aa	30.90±0.25Aa	29.90±0.58Aa	NS
12	29.21±0.34Aa	28.36±1.37Ba	30.24±2.05Aa	NS
P-level	NS	*	NS	

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* Significant at $p<0.05$.
** Significant at $p<0.01$.

Table 4. Effect of gamma irradiation and storage period on total saturated fatty acids (SFA), unsaturated fatty acids (UFA) and (UFA/SFA) of apricot seed oil (%).

Treatment	Control	6 kGy	9 kGy	P-level
Storage period/(Months)		***SFA (%)***		
0	6.80±0.17Aa	6.92±0.07Bb	6.87±0.04Aa	NS
12	7.20±0.18Aa	7.30±0.17Aa	6.98±0.16Ab	NS
P-level	NS	*	NS	
		UFA (%)		
0	89.89± Aa5.89	93.08±0.0Aa6	93.13±0.0Aa4	NS
12	92.73±0.1Aa5	92.76±0.Aa26	93.03±0.Aa15	NS
P-level	NS	NS	NS	
		UFA/SFA		
0	13.23±Aa1.10	13.46±0.Aa14	13.56±0.0Aa8	NS
12	12.88±0.Aa34	12.71±0.Ba34	13.34±0. Aa33	NS
P-level	NS	*	NS	

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* Significant at $p<0.05$.
** Significant at $p<0.01$.

results on apricot kernel oils are in agreement with the results of most previous investigator, who have dealt with fatty acids existing in different oils or food. Al-Bachir [10] mentioned that irradiation dose of 9 kGy had little effects on the FA content of peanut seed. Similar results were indicated by Olotu et al. [30] for FA composition of African oil bean seeds irradiated with dose of 10 kGy of gamma ray. Some research study have showed that gamma irradiation induced changes in FA composition [30,31]. Gamma irradiation is known to cause the breakdown of the UFAs [11]. Irradiation caused a significant decrease in UFA and significant increase in SFA content as irradiation dose increased in treated products [32,33]. Brewer [34] showed that the oils or fats that are affected by irradiation are mainly the two or more double bonded PUFA. Even though PUFA have been evaluated to have health benefits, a main challenge is their sensitivity to peroxidation [21]. Oxidative change caused by gamma irradiation is the same as in the reaction on unexposed seeds. Radicals, which are created by irradiation, may interact with UFA [30-32].

4. Conclusion

Results of analysis of oil from ten types of apricot comprising growing in Syria shown that this oil is of unsaturated type. Apricot kernel oil have high levels of monounsaturated the oleic fatty acid C18:1 and polyunsaturated linoleic fatty acid C18:2. Examination of the FA composition of the apricot kernel oil have revealed that it is quite similar to that of the olive oil. Therefore, while using the apricot kernel oil in the manufacture of some products mentioned in the literature, the apricot kernel oil can also used as the edible oil. Gamma irradiation of apricot kernel with medium doses (6 and 9 kGy) that recommended in the literature for eliminate microbial load did not affect the fatty acids profile and retained PUFAs in oil extracted from apricot kernels.

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Compliance with Ethics Requirements. Authors declare that they respect the journal's ethics requirements. Authors declare that they have no conflict of interest.

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