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Quality characteristics of oil extracted from gamma irradiated peanut (*Arachis hypogea* L.)

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HIGHLIGHTS

- Peanut seeds were undergone gamma irradiation (1, 2 and 3 kGy).
- The change in physicochemical properties of peanut oil was determined.
- Gamma irradiation process had no effect on physicochemical properties of peanut oil.
- The peroxide, acidity and TBA values of the peanut oil were decreased due to storage time.

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ABSTRACT

The effect of gamma radiation and storage on the characteristics of oil extracted from peanut seeds has been investigated in this study. Peanut seeds were undergone gamma irradiation process with the doses of 1, 2 and 3 kGy. The changes in chemical and physical attributes were observed immediately after irradiation and after 12 months of storage. The data obtained from the experiments showed that irradiation process had no effect on the chemical and physical qualities such as, fatty acid composition, peroxide value, iodine value specification number, TBA value and color of oil extracted from peanut seeds. On the contrary, the peroxide, acidity and TBA values of the peanut oil were decreased due to storage time.

1. Introduction

Crude peanuts and their by-products are of great importance worldwide and are ingredients of many recipes. Peanut food products are usually used by consumers from a range of economic status (Camargo et al., 2012).

Array of microorganisms infects nuts and causes spoilage leading to production of toxic metabolites (Khan et al., 2010). Various methods of preservation have been applied to arrest growth of molds in foods such as fumigation and heat treatment, but none of these methods offers a complete control of toxigenic molds (Kwon et al., 2004). Ionizing radiation is one of the methods applied to decontaminate pathogenic microorganisms in different food commodities (Aziz and Mousa, 2004). Irradiation of high lipid-containing materials could lead to lipid peroxidation and consequently to development of off-flavor and off-odor and in loss of natural antioxidants (Bhatti et al., 2013). Ground nut oil contains high percentage of mono- and polyunsaturated fatty acids and low percentage of saturated fatty acids (Miraliakbari and Shahidi, 2008).

At present, there are limited studies evaluating the characteristics of oil extracted from irradiated peanut seeds, except for a study on peanut treated with relatively higher doses (Bhatti et al., 2010), and other study evaluated, the effect of irradiation only on the fatty acids components in peanut oil (Afify et al., 2013). No research has been done on the effect of gamma irradiation on the characteristic of oil extracted from seeds of Syrian varieties produced under local climate and production conditions. Therefore, the objective of the present study was to determine the effect of irradiation treatment and storage on lipid characterization including fatty acid profile, acid value, lipid oxidation, iodine number, saponification value, and change of oil color of oil extracted from peanuts (Baladi var.) irradiated at doses of 0, 1, 2 and 3 kGy of gamma irradiation.

2. Materials and methods

Samples of peeled peanut seeds cv. Baladi (crop year 2010/2011) were purchased from local shops in Damascus, Syria. About

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250 g of peanut seeds in form of single layer was packed in small polyethylene bag for irradiation. Each bag of peanut seed is considered as a replicate. Three replicates were used for each treatment.

2.1. Treatment and analysis performed

Samples of peanut seeds were exposed to gamma radiation at doses of 0, 1, 2 and 3 kGy in a ^{60}CO package irradiator (dose rate 8.488 kGy h^{-1}) (Al-Bachir, 2004). Irradiated and non-irradiated samples were stored at room temperature, 18 to 25 °C under a relative humidity (RH) of 50–70% for up to 12 months.

The oils from control and irradiated peanut seed grinding were extracted by the manual Soxhlet apparatus (Scientific Apparatus Manufacturing Company, Glas-Col Combo Mantle, USA) (AOAC, 2010). Physical and chemical properties of oils were performed immediately after irradiation, and after 12 months of storage. Oil analysis was done immediately after extraction.

2.2. Physicochemical characteristics of oils

2.2.1. Fatty acids (FA) determination

The lipid fraction of peanut seed oil samples was extracted and FA methyl esters (FAME) were prepared (AL-Bachir and Zeinou, 2009). The FAs profile was determined by gas chromatography in a GC-17A Shimadzu chromatograph (Shimadzu Corp., Koyoto, Japan) equipped with a flame ionization detector and a capillary column (CBP20-S25- 050, Shimadzu, Australia) and CLASS – VP 4.3 program (Shimadzu Scientific Instruments, Inc., Columbia, MD).

2.2.2. Chemical analysis

Acidity value as mg KOH g^{-1} oil, peroxide value in mEqO$_2$ kg^{-1} oil, iodine value in g I2 100 g^{-1} oil, and specification number in mg KOH g^{-1} oil were determined according to standard methods (AOAC, 2010). TBA number (Thiobarbituric acid) in mg MDA kg^{-1} sample was measured according to an IUPAC direct method (IUPAC, 1992).

2.2.3. Color measurement

The color of peanut seed oil was measured using AvaSpec Spectrometer Version 1, 2 June 2003 (Avantes, Holland) and expressed as color *L** (lightness), *a** (redness), and *b** (yellowness) values. Reflectance values were obtained at a wave length of 568 nm by exposing the samples to the illuminant (Kwon et al., 2009).

2.3. Statistical analysis

The four treatments were distributed in a completely randomized design with three replicates. Data were subjected to the analysis of variance test (ANOVA) using the SUPERANOVA computer package (Abacus Concepts Inc, Berkeley, CA, USA; 1998). A separation test on treatment means was conducted using Fisher's least significant differences (LSD) methods at 95% confidence level (Snedecor and Cochran, 1988).

3. Results and discussion

3.1. Fatty acid composition

Table 1 reports the fatty composition of lipid extracts from non-irradiated and irradiated peanut seed samples, immediately after irradiation and after 12 months of storage. The major fatty acids identified in non-irradiated (control) peanut oil were 50.36% oleic acid (C18:1), 36.40% linoleic acid (18:2), 11.10% palmitic acid (C16:0) and 2.14% stearic acid (C18:0). This is in accordance with the literature reports (Jubeen et al., 2012). The presence of high amount of the essential linoleic acid (36.40%) suggests that the peanuts oil is highly nutrient. The ratio of oleic-to-linoeic acid (O/L) is a quality index employed to determine peanut seed shelf-life and oil stability, classified as normal, mid and high-oleic type, ranging from 1 to 1.5; 1.5 to 9.0 and above 9.0, respectively (Shin et al., 2010). The present study was carried out with normal oleic peanuts (O/L=1.38). The initial content (day 0) of total saturated fatty acids SFA and unsaturated fatty acids USFA in oil extracted from non-irradiated (control) samples of peanut seed was 13.24% and 86.76%, respectively.

Table 1
Effect of gamma irradiation and storage period on fatty acids content (%), saturated fatty acids (SFA), unsaturated fatty acids (UFA) and (UFA/SFA) contents of peanut oil.

Treatment storage period (weeks)	Control	1 kGy	2 kGy	3 kGy	LSD 5%
C16:0					
0	11.10 ± 0.11	11.22 ± 0.19	11.22 ± 0.04	11.16 ± 0.01	**0.21**
12	10.87 ± 0.03	10.70 ± 0.01	10.92 ± 0.11	10.96 ± 0.05	**0.12**
LSD 5%	**0.18**	**0.31**	**0.19**	**0.08**	
C18:0					
0	2.14 ± 0.03	2.25 ± 0.02	2.18 ± 0.03	2.22 ± 0.02	**0.05**
12	2.18 ± 0.02	2.28 ± 0.06	2.27 ± 0.05	2.19 ± 0.12	**0.14**
LSD 5%	**0.06**	**0.10**	**0.09**	**0.20**	
C18:1					
0	50.36 ± 0.06	50.25 ± 0.12	49.86 ± 0.03	50.55 ± 0.08	**0.15**
12	50.24 ± 0.04	50.21 ± 0.08	50.16 ± 0.04	50.12 ± 0.08	**0.12**
LSD 5%	**0.12**	**0.23**	**0.08**	**0.19**	
C18:2					
0	36.40 ± 0.07	36.28 ± 0.09	36.74 ± 0.04	36.07 ± 0.10	**0.15**
12	36.71 ± 0.07	36.61 ± 0.15	36.32 ± 0.48	36.73 ± 0.26	**0.54**
LSD 5%	**0.16**	**0.28**	**0.78**	**0.44**	
SFA					
0	13.24 ± 0.13	13.47 ± 0.18	13.40 ± 0.05	13.39 ± 0.03	**0.21**
12	13.05 ± 0.05	13.18 ± 0.07	13.19 ± 0.15	13.15 ± 0.17	**0.23**
LSD 5%	**0.23**	**0.30**	**0.24**	**0.28**	
USFA					
0	86.76 ± 0.13	86.53 ± 0.18	86.60 ± 0.05	86.61 ± 0.03	**0.21**
12	86.95 ± 0.05	86.82 ± 0.07	86.48 ± 0.46	86.86 ± 0.17	**0.47**
LSD 5%	**0.23**	**0.30**	**0.75**	**0.28**	
USFA/SFA					
0	6.55 ± 0.08	6.42 ± 0.10	6.46 ± 0.03	6.47 ± 0.02	**0.12**
12	6.66 ± 0.03	6.59 ± 0.04	6.56 ± 0.05	6.61 ± 0.10	**0.12**
LSD 5%	**0.13**	**0.17**	**0.09**	**0.16**	
O/L					
0	1.38 ± 0.001	1.39 ± 0.004	1.36 ± 0.002	1.40 ± 0.006	**0.01**
12	1.37 ± 0.004	1.37 ± 0.01	1.38 ± 0.02	1.36 ± 0.01	**0.02**
LSD 5%	**0.01**	**0.01**	**0.03**	**0.02**	

Regarding the effect of gamma radiation on the major fatty acids, a significant ($p < 0.05$) increase in stearic acid was observed at doses of 1 and 3 kGy (ziro time) and nonsignificant increase in samples at doses of 1 and 2 kGy (twelfth months) in peanut seed oil samples. The oleic acid content of peanut seed oil samples was reduced ($p < 0.05$) by gamma radiation (2 kGy) (zero time). Slight increase in palmitic acid content was observed at doses 1, 2 and 3 kGy (zero time) and at doses 2 and 3 kGy (twelvth month). Immediately after irradiation, slight increase in saturated fatty acids SFA and decrease in unsaturated fatty acids USFA was observed at doses of 1, 2 and 3 kGy (Table 1).

As other nuts, peanut seeds are susceptible to infestation by molds, insects and larvae (Khan et al., 2005) and fungi (Khosravi et al., 2007). The various post-harvest procedures for control of insects and microorganisms in stored products are chemical, biological and physical control or combination of these techniques (Kwon et al., 2004). Irradiation as an alternative to fumigants for