JAP&T
TPA-Timisoara

Available online at http://journal-of-agroalimentary.ro

Journal of Agroalimentary Processes and Technologies 2021, *27* (1), 59-65

Journal of Agroalimentary Processes and Technologies

Fatty acid composition of thyme meals treated by gamma irradiation

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Abstract

This study was conducted to investigate the impacts of gamma irradiation treatments at different doses (0, 10, 20 and 30 kGy) on the quality attributes of thyme meal oil (ThMO). The fatty acid (FA) profile was determined using a gas chromatography-flame ionization detector analysis. Linoleic acid (C18:2) contents of ThMO changed between 44.21 (irradiated with 30 kGy) and 45.10% (control). Oleic acid (C18:1) contents of ThMO varied between 39.76 (irradiated with 30 kGy) and 39.10% (control). Palmitic acid (C16:0) of ThMO varied between 9.69% (control) and 10.21% (irradiated with 20 kGy). Stearic acid (C18:0) of ThMO varied between 5.08% (control) and 4.79% (irradiated with 10 kGy). Linoleic acid (C18:3) of ThMO varied between 1.04% (control) and 1.23% (irradiated with 30 kGy). Irradiation treatment caused irregular changes in the contents of individual FAs. In general, the results showed that gamma irradiation and storage of ThM had no insignificant ($P \geq 0.05$) effect on the individual FAs present in ThMO.

Keywords: Fatty acids, Gamma irradiation, Storage period, Syria, Thyme meal oil

1. Introduction

In recent years, nutrition has been believed to play a very important role in preventing many diseases [1]. Widespread pro-health awareness, as well as the constantly increasing consumer interest in healthy lifestyles and healthy diets, induces food manufacturers to search for little-known plant species whose edible parts have specific pro-health properties [2,3]. One such plant is the common thyme (*Thymus vulgaris* L.), which is native to Mediterranean region, and as a valued crop and an important agricultural product both in industry as a food ingredient and in human nutrition and health in terms of its role as a functional food [4,5,6]. Thyme meal (ThM) is considered to be the staple food for most people in Syria an regional countries, which is high in dietary fiber, protein, and significant amounts of edible vegetable oil. For the food preparation, only the leaves and the aerial part of thyme are used [1]. The leaves of *Thymus vulgaris* have been of interest worldwide due to the nutritional properties of the natural product (raw and dried leaves) and the pharmaceutical properties of derivatives, such as dried plants and its extracts [7].

Vegetable oil is defined by its fatty acid (FA) composition, which considered important criteria for quality of oils and their health benefits [8,9]. Thyme oil contains phenolic compounds and has antimicrobial properties [4]. Fats, fatty acids and their metabolic secondary products have various significant functions in the human metabolism [10]. Vegetable oils are recommended for healthy life due to their high content of unsaturated fatty acids (UFA) namely polyunsaturated fatty acids (PUFA) [11]. However, PUFA cannot be synthesized in the human body, they are called essential fatty acids and play significant roles in the human metabolism [12,13]. Traditional oils and fats are very limited in their chemical constitution as their triglycerides mainly comprise stearic (C18:0), oleic (C18:1) and linoleic (C18:3) acids [14].

The current century has witnessed innovations and techniques that have been introduced in the field of

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food preservation in human study [15]. Today, irradiation techniques play an important role in food preservation, in which offers a potential benefit to enhance safety of food, and accept nutritional and sensory quality through losses reduction and extending their shelf-life [16,17]. Although irradiation treatments was proven to be useful in extending the shelf life of many food products [18-22].

However information regarding gamma irradiation treatments and its impact on the chemical composition namely on the fatty acid (FA) compositions of thyme meal oil (ThMO) are scarce. Therefore, the major purpose of the present study was to evaluate the effect of gamma irradiation on the FA profile of oil extracted from thyme meal (ThM) samples irradiated at various gamma irradiation doses.

2. Materials and Method

2.1. Thyme meal preparation

A study was conducted on thyme meal (ThM) produced in 2017. ThMs were a kind gift from Sedi Hisham (Al-Akkad Company for industry and trade Syria-Damascus countryside). ThM is traditional local Syrian ethnic ready to eat meals, consisting of several dried ingredients such as sesame, thyme leaves, sumac, coriander, aniseed, fennel, cumin, pistachio, vegetable oil, salt and caraway. ThMs were weighed as in the sampling plan and transferred into polyethylene pouches for irradiation. Each pouch of ThM (500 g) was considered as a replicate. The determinations were made in triplicate for each treatments.

2.2. Irradiation treatment

Thyme meal samples were treated at doses 10, 20 and 30 kGy of gamma irradiation at dose rate of 7.775 kGy h^{-1}, using a cobalt-60 source ^{60}Co (ROBO, Russa) located at the radiation technology department of Syrian Atomic Energy Commission (SAEC). The absorbed dose was monitored by alcoholic chlorobenzene dosimeter [1]. The irradiated samples were then stored in polyethylene bags at laboratory conditions (18-25 ºC), relative humidity (RH) (50-70%) along with the control (0 kGy) for 12 months.

2.3. Oil extraction

The oils from control and irradiated ThM after mixing and grinding were extracted by the manual Soxhlet apparatus (Scientific Apparatus Manufacturing Company, Glas-Col Combo Mantle, USA) for 16 h, using distilled n-hexane, grade of analytical reagents (AR), as the solvent [23]. Physical and chemical properties of oils extracted from irradiated and non-irradiated ThM samples were performed immediately after irradiation, and after 6 and 12 months of storage.

2.4. Fatty acids (FA) determination

Fatty acid compositions of the ThM samples were carried out using the method described by Al-Bachir [22]. FA composition of the samples which convert to methyl ester were analyzed by the model of 17 Shimadzu gas chromatography apparatus (Shimadzu Corp., Koyoto, Japan) equipped with a flame ionization detector and a capillary column (CBP20-S25- 050, Shimadzu, Australia). Fatty acid was identified by comparison of retention times of known standards. The results were expressed as g fatty acid 100 g^{-1} total fatty acids (%) by means of the CLASS – VP 4.3 program (Shimadzu Scientific Instruments, Inc., Columbia, MD).

2.5. Statistical analysis

All data were analyzed by analysis of variance test (ANOVA) using the SUPERANOVA computer package (Abacus Concepts Inc, Berkeley, CA, USA; 1998), and significant differences (p value of less than 0.05) among means was determined using Duncan's test.

3. Results and Discussion

The higher total lipid content found in the ThM (42.38% data not published) could be interesting since ThM have been identified as a good source of oil, which is rich in healthy polyunsaturated fatty acids (PUFA), i.e. about 60-67% of total fatty acids.

3.1. Fatty acid composition of ThMO

The determination of each fatty acids (FAs) of thyme meal oil (ThMO) was carried out by gas chromatography. The FA profiles of total lipids extracted from thyme meal (ThM) are shown in Table 1 and Figure 1. Linoleic acid (C18:2) was consistently present in the highest quantity with averaged 45.10% of the total FA. The FA existing in second highest quantity was oleic acid (C18:1), showing 39.10% on the average followed by palmitic acid (C16:0), showing 9.69%, stearic acid (C18:0) showing 5.08%, and linoleic acid (C18:3) showing 1.04%. Majority of lipids in the ThMO were USFA, with linoleic being the most abundant (45.5%), followed by oleic acid (39.10%).

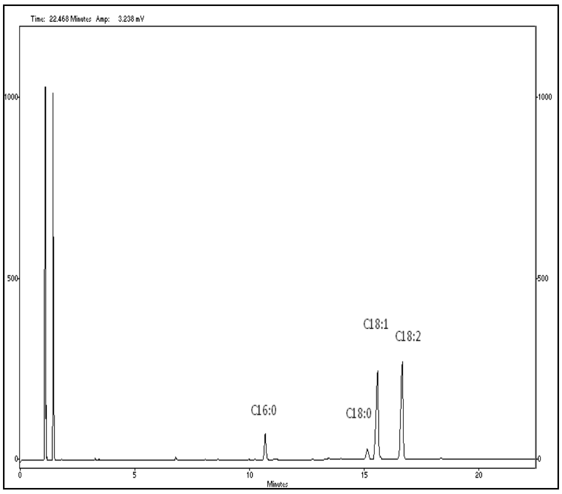

Figure 1. Fatty acids contents of thyme oil

The linoleic acid amount in ThMO (45.10%) is much higher when compared to other vegetable oils such as peanut oil (36.90%) [22], almond oil (21.07%) [18], pistachio oil (13.4-50.36%) [20], and olive oil (10.31%) [16]. ThMO has high oleic and linoleic USFA contents and low palmitic and stearic SFA. Therefore, ThMO considered a good source of FA which has multiple benefits for human health [18].

However, UFAs like oleic, linoleic and linolenic acids are fundamental in the human diet as they can't be produced by animal metabolism [18,24]. Linoleic acid (C18:2) content had the highest ratio (45.10%) which is found in ThM is essential FA that is vital in the maintenance of some key physiological functions of the human body. These FA compositions are recognized for their health-promoting capacity, which in turn results in low blood pressure and beneficial effects on heart-related diseases [25]. Konuskan et al. [26] stated that linoleic acid is essential for human body to maintain the integrity of the skin, cell membranes, the immune system, and eicosanoids synthesis.

Besides, the variation of the ratio MUFA/ PUFA may affect the oil shelf-life. The effect of FAs on stability depends mainly on their degree of un-saturation and, to a lesser degree, on the position of the unsaturated functions within the triacylglycerol molecule [27]. This study showed that the major type of FA in ThM was UFA (85.24%), namely PUFA (46.14%). While the amount of SFA and UFA/SFA ratio of the same sample was found in level of 14.24% and 5.77 respectively. These results on ThMO is in agreement with the results of most previous investigator, who have dealt with FAs existing in ThMO. Al-Bachir [21] indicated that irradiation dose of 9 kGy had little effects on the FA content of peanut seed. Alvites-Misajela et al. [28] reported that ThMO showed low SFA contents (>15%).

Also, ThMO was characterized by a high UFA/SFA ratio, which is highly favorable for the reduction of serum cholesterol and atherosclerosis, and the prevention of cardiovascular disease [29]. As shown in Table 2, the UFA/SFA ratio of ThMO was 5.77. Thus, the incorporation of ThM into the diet could bring great health beneficial effects to the cardiovascular system due to the high content of UFA namely PUFAs. It is apparent that higher the unsaturation of FAs the higher is their oxidation potential. Some research has indicated that animal feed with plants of high PUFA content can increase the level of PUFA in meat fats, as well as aroma and flavour [13].

3.2. Effect of gamma irradiation and storage time on ThMO

The effect of different doses of gamma rays and storage periods on the FA contents of ThMO is pre-sented in Table 1. Irradiation treatment caused irregular changes in the contents of individual FAs. In general, the results showed that gamma irradiation of ThM at different doses had insignificant ($P \geq 0.05$) effect on the individual FAs present in ThMO. Also, as for FA composition, no significant differences were observed by the storage (Table 1). Statistically significant ($P \geq 0.05$) differences were not observed among stearic acid (C18:0), oleic acid (C18:1), and linoleic acid (C18:2) values of oil irradiated at 0, 10, 20 and 30 kGy. While, significant differences ($P \geq 0.05$) were observed among palmitic acid (C16:0), and linolenic acid (C18:3) values of oil irradiated at 0, 20 and 30 kGy.

Gamma irradiation significantly increased ($p<0.01$) the SFA and decreased ($p<0.01$) the UFA. These results indicated that irradiation induced decomposition of the UFAs. The results of this study indicate that irradiation induced decomposition of the UFAs. Free radicals generated by irradiation react with the double bonds of FAs [16]. We found no study in the literature on the effect of irradiation on FA composition of the ThMO. However, Al-Bachir [22], Barreto et al. [30], Musa Özcan et al. [31], Abbas et al. [32] studied the effects of heat microwave and gamma irradiation treatment on oil seeds, and reported a change in the FA composition of the seed oil through the effect of microwave and irradiation treatment. Also, Majid et al. [33] reported that the content of MUFA varies slightly depending on the heat treatment and the ratio of PUFA decreased. In addition, Abbas et al. [32] have heated corn oil in microwave for different watts and times and the results obtained showed that the content of linoleic acid in the corn oil was reduced.

Table 1. Effect of gamma irradiation and storage period on fatty acid content (%) of thyme oil

Treatments	Control	10 KGY	20 KGY	30 KGY	P-level
Storage period/ (Months)			**C16:0**		
0	**9.69±0.04^{bB}**	**9.75±0.12^{bA}**	**10.21±0.48^{aA}**	**9.69±0.08^{bA}**	**
6	**9.97±0.12^{aA}**	**9.87±0.03^{abA}**	**9.71±0.08^{cB}**	**9.80±0.10^{bcA}**	**
12	**9.90±0.20^{aA}**	**9.82±0.07^{aA}**	**9.76±0.06^{aB}**	**9.82±0.21^{aA}**	**NS**
P-level	*	**NS**	*	**NS**	
			C18:0		
0	**5.08±0.12^{aA}**	**4.79±0.45^{aA}**	**4.88±0.50^{aA}**	**5.11±0.34^{aA}**	**NS**
6	**4.56±0.68^{aA}**	**4.59±0.25^{aA}**	**4.99±0.12^{aA}**	**4.78±0.59^{aA}**	**NS**
12	**4.46±0.51^{aA}**	**4.42±0.54^{aA}**	**4.50±0.45^{aA}**	**4.56±0.91^{aA}**	**NS**
P-level	**NS**	**NS**	**NS**	**NS**	
			C18:1		
0	**39.10±0.11^{bA}**	**39.37±0.23^{abA}**	**39.27±0.64^{bA}**	**39.76±0.43^{aA}**	**NS**
6	**38.89±0.32^{bA}**	**39.29±0.10^{aA}**	**39.44±0.28^{aA}**	**39.11±0.22^{abB}**	*
12	**39.13±0.94^{aA}**	**39.68±0.57^{aA}**	**39.57±0.22^{aA}**	**39.65±0.54^{aAB}**	**NS**
P-level	**NS**	**NS**	**NS**	**NS**	
			C18:2		
0	**45.10±0.07^{aA}**	**45.08±0.38^{aA}**	**44.44±0.45^{bB}**	**44.21±0.13^{bA}**	**NS**
6	**45.29±0.42^{aA}**	**44.97±0.17^{abA}**	**44.73±0.17^{bA}**	**44.90±0.33^{abA}**	**NS**
12	**45.12±0.94^{aA}**	**44.93±0.80^{aA}**	**45.12±0.54^{aAB}**	**44.82±0.82^{aA}**	**NS**
P-level	**NS**	**NS**	**NS**	**NS**	
			C18:3		
0	**1.04±0.14^{bcB}**	**1.01±0.23^{cB}**	**1.20±0.16^{abA}**	**1.23±0.03^{aB}**	*
6	**1.29±0.08^{abAB}**	**1.27±0.05^{bA}**	**1.13±0.09^{cA}**	**1.41±0.12^{aA}**	**
12	**1.40±0.30^{bA}**	**1.15±0.11^{bAB}**	**1.05±0.05^{bA}**	**1.16±0.14^{bB}**	*
P-level	**NS**	**NS**	**NS**	**	

^{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. Effect of gamma irradiation and storage period on total saturated fatty acids (SFA), unsaturated fatty acids (UFA) and (UFA/SFA) of thyme oil (%)

Treatment	Control	10 KGY	20 KGY	30 KGY	P-level
Storage period/ (Months)			**SFA**		
0	14.77±0.13^{abA}	14.55±0.36^{bA}	15.09±0.33^{aA}	14.80±0.36^{abA}	*
6	14.53±0.76^{aA}	14.47±0.22^{aA}	14.70±0.06^{aB}	14.58±0.53^{aA}	NS
12	14.36±0.64^{aA}	14.24±0.48^{aA}	14.26±0.39^{aAB}	14.38±0.74^{aA}	NS
P-level	NS	NS	**	NS	
			UFA		
0	85.24±0.13^{abA}	85.46±0.36^{aA}	84.91±0.33^{bB}	85.21±0.36^{abA}	*
6	85.47±0.76^{aA}	85.53±0.22^{aA}	85.30±0.06^{aAB}	85.42±0.53^{aA}	NS
12	85.65±0.64^{A}	85.76±0.48^{aA}	85.74±0.39^{aA}	85.62±0.74^{aA}	NS
P-level	NS	NS	**	NS	
			PUFA		
0	46.14±0.16^{aA}	46.09±0.30^{aA}	45.64±0.60^{bA}	45.44±0.15^{bB}	*
6	46.58±0.48^{aA}	46.24±0.12^{abA}	45.86±0.24^{bA}	46.32±0.40^{abA}	NS
12	46.52±1.16^{aA}	46.08±0.81^{aA}	46.17±0.54^{aA}	45.98±0.75^{aAB}	NS
P-level	NS	NS	**	NS	
			UFA/SFA		
0	5.77±0.06^{abA}	5.88±0.17^{aA}	5.63±0.15^{bB}	5.76±0.17^{abA}	*
6	5.90±0.38^{aA}	5.91±0.11^{aA}	5.80±0.03^{aB}	5.87±0.26^{aA}	NS
12	5.98±0.30^{aA}	6.03±0.24^{aA}	6.02±0.19^{aA}	5.97±0.38^{aA}	NS
P-level	NS	NS	*	NS	
			PUFA/SFA		
0	3.13±0.04^{abA}	3.17±0.10^{aA}	3.03±0.08^{cB}	3.07±0.07^{bcA}	*
6	3.21±0.21^{aA}	3.20±0.06^{aA}	3.12±0.01^{aAB}	3.18±0.15^{aA}	NS
12	3.25±0.20^{aA}	3.24±0.15^{aA}	3.24±0.13^{aA}	3.21±0.22^{aA}	NS
P-level	NS	NS	*	NS	

^{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.

Our results, in general, are in agreement with those of Al-Bachir [18], Al-Bachir [19], and Zoumpoulaki et al. [34] who reported an increase in SFA content and a decrease in MUFA and PUFA content due to irradiation of almond kernel oil, peanut seed oil and sesame oil. Another study suggested that, the decrease in UFAs during the irradiation exposure of oil was mainly due to a molecular structure change in FAs [19]. On other hand, irradiation of sesame, peanut and sunflower seeds at doses of 3, 6 and 9 kGy did not significantly affect the FAs percentages. However, the UFAs, SFAs and the ratio of SFAs to UFAs (TU/TS) were changed upon irradiation [22].

4. Conclusion

Linoleic acid (C18:2), oleic acid (C18:1), palmitic acid (C16:0), stearic acid (C18:0), and linolenic acid (C18:3) were the main components of the ThMO.

We concluded that ThMO properties are beneficial for human health.

In the present study gamma irradiation and storage time did not cause any significant change in ThMO samples. This study shows the efficiency of gamma irradiation as a processing technology for maintaining the overall quality of irradiated ThM samples.

The present study demonstrated that the effect of gamma irradiation and storage on the fatty acid profile of ThMO was minimized. Therefore, ThMO is stable agent gamma irradiation treatment and storage time.

Acknowledgements. The author wish to express his deep appreciation to the Director General of the Atomic Energy Commission of Syria and the staff of food irradiation division. Author also thanks to Mr. Yahya Al-Akkad to his helps for preparation and (supplying) providing the necessary thyme meal.

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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