JAP&T
TPA-Timişoara

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

Journal of Agroalimentary Processes and Technologies 2013, 19(4), 459-463

Journal of Agroalimentary Processes and Technologies

Quantitative identification of fatty acids from walnut and coconut oils using GC-MS method

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Received: 27 Octomber 2013; Accepted: 30 November 2013

Abstract

The main objective of this study was to identify the fatty acid composition of two different vegetables oils (walnut and coconut oils) by gas chromatography-mass spectrometry (GC-MS) method. The GC analysis of the fatty acid methyl esters (FAME) was performed using a GC-MS QP 2010 by Shimadzu. In the oils samples was tested saturated, monosaturated acids (MUFAs): caproic acid (C6:0), caprylic acid (C8:0), capric acid (C10:0), lauric acid (C12:0), myristic acid (C14:0), palmitic acid (C16:0), stearic acid (C18:0), arachidic acid (C20:0), oleic acid (C18:1) and polyunsaturated fatty acids (PUFAs): linoleic acid (C18:2) and linolenic acid (C18:3).

The content of saturated fatty acids in the studied walnut oil was 9.5%, which of monounsaturated acids was 24.2%, and that of polyunsaturated acids was 63.3%. The oleic acid content of the walnut oil was 24.2% of the total fatty acids, while the linoleic acid content was 54.8% and the linolenic acid was 8.5%. The results showed that the predominant fatty acids identified of coconut oil are lauric acid (44.6%) and myristic acid (20.4%).

Keywords: fatty acids, walnut oil, coconut oil, gas chromatography

1. Introduction

One of the most important factors of different vegetable oils is the content of unsaturation and saturation of the fatty acids [1]. Edible oils are biological mixtures of plant origin consisting of ester mixtures derived from glycerol with chain of fatty acid. Fatty acids (FA) can be classified in classes as saturated, monosaturated (MUFA) and polyunsaturated (PUFA) fatty acids [2].

Walnuts have generated considerable interest in the last decade because the fatty acid profile found in walnut oil, in particular the presence of ω-3 and ω-6 PUFAs which are essential dietary fatty acids and to their favorable ratio in walnut oil [3].

Walnut kernels contain between 63 and 70% oil, more than 90% of this oil contains unsaturated fatty acids and the oleic acid content ranges from 12 to 20%. Phytosterols and vitamin E are also dissolved in the oil fraction and these along with oleic acid are the most positive nutritional features of walnuts [4].

The fatty acid composition of walnut oil is unique compared to other tree nuts oil because walnut oil contains predominantly linoleic acid (49 to 63%), and also a considerable amount of α-linoleic acid (8 to 15.5%). Other fatty acids present include oleic acid (13.8 to 26.1%), palmitic acid (6.7 to 8.7%), and stearic acid (1.4 to 2.5%) [5].

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The Romanian walnut fruits are rich in nutritional compounds, with a high lipid content (between 55% and 76%), proteins (11% - 25%) and carbohydrates (16%). Polyunsaturated fatty acids are found in a ratio around 70% in the walnut oil and predominantly are the linoleic acid (about 58%) [6]. In fact, among vegetable oils, walnut oil has one of the highest amounts of PUFAs (up to 78% of the total FA content) [7].

One of the importances of vegetable oil is coconut oil that comes from the fruit of the coconut tree and is naturally pressed out of the fruit and has a pale yellow coloration with a coconut odor [8]. Coconut oil contains about 60- 65% of the oil and contains 92% of saturated fatty acids (in the form of triglycerides) [9]. This oil belongs to unique group of vegetable oils called lauric oils. The highest percent of fatty acid in this group is lauric acid and compose of high concentration of saturated fatty acid (more than 90%). The most content of fatty acids in coconut oil were lauric acid and myristic acid which are (48.37 and 18.43 %) respectively. Between the unsaturated fatty acid, the most concentration related to oleic acid (7.58%) and linoleic acid (2.53%) [8].

2. Materials and Methods

There are 2 methods used for the determination of trans-fatty acids: infrared (IR) spectroscopy and gas chromatography (GC). IR spectroscopy is simpler but it is not accurate below 5% and is subject to interferences. GC analysis of fatty acid methyl esters (FAME) is more accurate. Because coconut oil contains less than 10% total unsaturated fats (oleic acid and linoleic acid), direct GC analysis after methylation is adequate [10]. Coconut oil was obtained from grated coconut flakes from Romanian hypermarket and walnut oil was obtained from kernels were collected by Romania west area. Oil samples were extracted using an automated extractor (Velp Scientifica, Italy) with petroleum ether (1:5) by AOAC (1999) methods [11].

2.1. Preparation of Fatty Acid Methyl Esters (FAMEs). Methyl-esterification of samples used in the analyses was performed by BF_3-MeOH method after alkaline hydrolysis. To 20 mg of sample oils were added 2 ml 0.5 mol/L NaOH-methanol solutions, and the mixture was heated at 100^0C for 7 min. After cooling, 3 mL of 14% BF_3-MeOH reagent was added, and the vessel was sealed and heated at 100^0C for 5 min. After cooling, 2 mL of hexane and 7 mL of saturated NaCl solution were added, followed by a thorough shaking. The resulting hexane layer (2 mL) was used as a sample solution for GC [12].

2.2. GC-MS quantification method. Analysis of FAME was performed on a GC-MS QP 2010 by Shimadzu equipped with a split/split less injector. Separations were achieved using a fused silica Zebron ZB-FFAP capillary column (60 m × 0.25 mm ID, 0.25 μm film thickness). Helium was used as the carrier gas at flow rates of 1.99 mL/min and a split ratio of 1:10. The injector temperature was 250°C. The oven temperature was programmed at 140°C for a hold of 10 min and increased to 250°C at a rate of 7°C/min and hold at the final temperature for 10 min. LabSolution software was used to control the operation of GCMS. MS spectra were obtained at range width m/z 40-500, interface temperature 255°C, ion source temperature 210°C, solvent cut time 3 min, event time 0.20, and scan speed 2500. FAME peaks were identified by comparing their retention time and equivalent chain length with respect to standard FAME. Were used standards of fatty acid methyl esters (FAME) from Supelco Inc., Bellefonte, PA (Supelco 37 Component FAME Mix) and other reagents from Merck, Germany. All determinations were carried out in triplicates

3.Results and Discussion

Gas-chromatography coupled with mass spectrometry (GC-MS) was used to identify and measure the composition of fatty acids present in walnut and coconut oils. In the oils samples was tested MUFAs: caproic acid (C6:0), caprylic acid (C8:0), capric acid (C10:0), lauric acid (C12:0), myristic acid (C14:0), palmitic acid (C16:0), stearic acid (C18:0), arachidic acid (C20:0), oleic acid (C18:1) and PUFAs: linoleic acid (C18:2) and linolenic acid (C18:3).

Gas chromatography (Figure 1) revealed that total MUFAs in walnut oil is 9.5% and PUFAs with 63.3% had the highest level (Table 1). The unsaturated: saturated ratio was 1:6.6. Linoleic acid is the major fatty acid of walnut oil followed by oleic, linolenic, palmitic and stearic acids [13].

This was observed in our study, but the percentages vary. Thus, with 54.8% the linoleic acid had the highest quantity followed by oleic acid with 24.2%, linolenic acid with 7.5%, palmitic acid with 6.3% and stearic acid with 3.0%. These results are comparable with the data previously reported in literature. The predominant fatty acid composition in walnut oil obtained from Romanian walnut kernels is the linoleic acid ranging between 56.57% [14] and 58% [6].

The chromatographic profile of these fatty acid showed that the coconut oil is rich in saturated fatty acids, with high proportions of lauric and myristic acids (Figure 2 and Table 2).

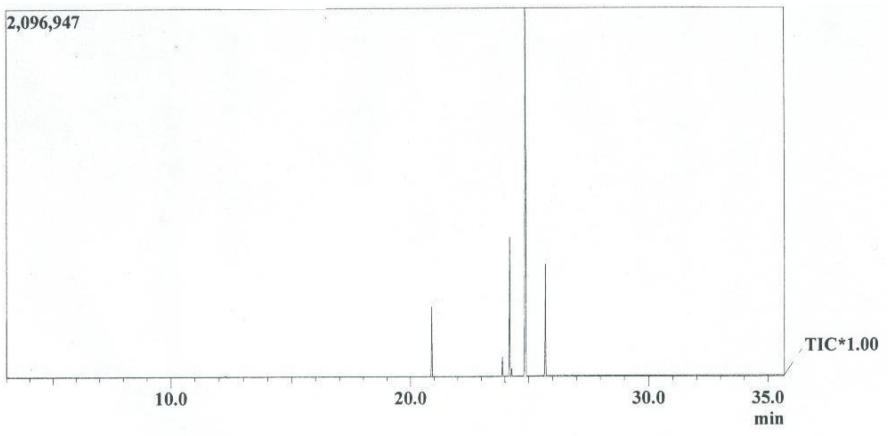

Figure 1. Walnut oil gas chromatography

Table 1. Fatty acid compositions of walnut oil obtained by GS-MS method

Fatty acids	Retention time [min]	Walnut oil [%]
Saturated		
Myristic C14:0	14.263	0.2
Palmitic C16:0	20.903	6.3
Stearic C18:0	23.903	3.0
Monosaturated		
Oleic C18:1	24.212	24.2
Polyunsaturated		
Linoleic C18:2	24.883	54.8
Linolenic C18:3	25.711	8.5

Percentages may not add to 100% due to rounding and other constituents not listed

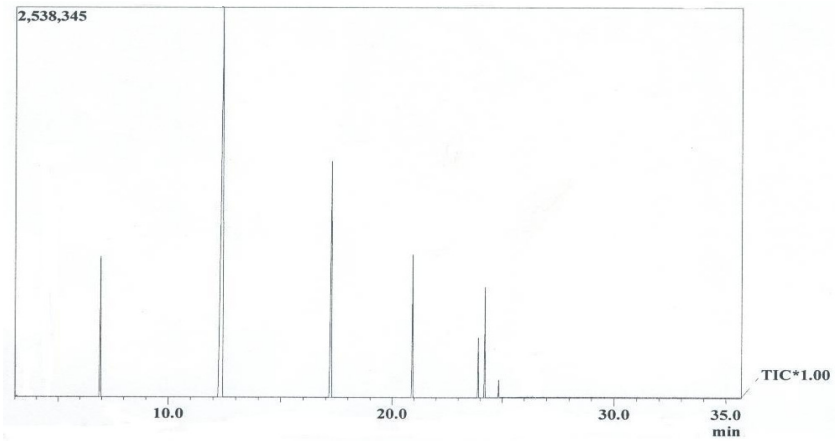

Figure 2. Coconut oil gas chromatography

Table 2. Fatty acid compositions of coconut oil obtained by GS-MS method

Fatty acids	Retention time [min]	Coconut oil [%]
Saturated		
Capric C10:0	6.931	7.0
Lauric C12:0	12.263	44.6
Myristic C14:0	17.239	20.4
Palmitic C16:0	20.919	11.2
Stearic C18:0	23.906	2.6
Arachidic C20:0	26.508	1.4
Monosaturated		
Oleic C18:1	24.210	5.5
Polyunsaturated		
Linoleic C18:2	24.838	1.8
Linolenic C18:3	25.672	1.1

Percentages may not add to 100% due to rounding and other constituents not listed

From Table 2, it can be seen that coconut oil has 87.2% saturated fatty acid and only 8.4% unsaturated fatty acid, mostly composed of oleic acid (5.5%). The saturated: unsaturated ratio was 1:10.3. The presence of lauric acid (44.6%) was found in coconut oil. This results is in line with Gregorio [15] and Gopala et al. [9], they reported that coconut oil is major source of lauric acid, with significant food and non-food uses [10].

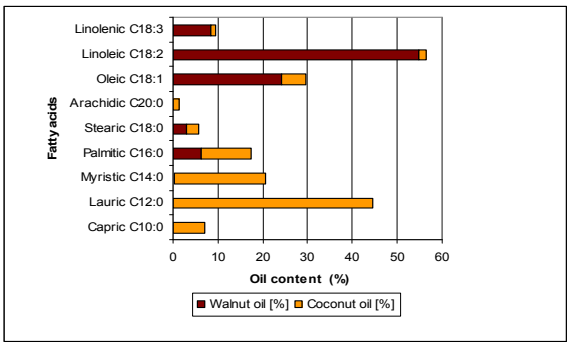

Figure 3. Fatty acids composition of walnut and coconut oil

4. Conclusion

In the walnut oil samples was identified MUFAs: myristic acid, palmitic acid, stearic acid, oleic acid and PUFAs: linoleic acid and linolenic acid. The predominant fatty acid composition in walnut oil obtained from Romanian walnut kernels is the linoleic acid (54.8%). In the coconut oil samples was identified MUFAs: capric acid, lauric acid, myristic acid, palmitic acid, stearic acid, arachidic acid, oleic acid and PUFAs: linoleic acid and linolenic acid.

Coconut oil contains high quantities of saturated fatty acids, with a high proportion of lauric acid (44.6%).

Compliance with Ethics Requirements:

Authors declare that they respect the journal's ethics requirements. Authors declare that they have no conflict of interest and all procedures involving human and/or animal subjects (if exists) respect the specific regulations and standards.

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