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Study on fatty acids composition of four different types of peanut oil in Myanmar

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Abstract

Peanut is the most important oil seed crop processed from Central Myanmar: Sagaing, Magway and Mandalay Region. Peanut production and utilization have been important due to its high oil content and nutritive value. Peanut oil has a pale yellow and liquid state at room temperature. The oxidative stability and prolonged shelf-life of peanut oil were dependent on the fatty acid compositions of the oil. The aim of this study was to analyze the fatty acid compositions by using the Gas chromatography-mass spectrometry (GC-MS) method for simultaneous determination and quantification of fatty acids from peanut oil by expressing the results in relative and absolute concentrations. Four different types of peanut oil (Pin Pyant 6 Month, Pin Pyant 4 Month, Sinpadethar-11 and Spain-121) were evaluated for the profiling of fatty acid compositions. The analyzed total fatty acid compositions were used to classify the different concentration in four different types of peanut oil in Myanmar. Significant differences were found in fatty acids composition among the different types of peanut oil. Palmitic (16:0), stearic (18:0), oleic (18:1), linoleic (18:2), linolenic (18:3), arachidic (20:0), and behenic (22:0) acids were found obviously in four different types of peanut oil. The total fatty acids were Pin Pyant 6 Month (10787.75 ppm), Pin Pyant 4 Month (10173.83 ppm), Sinpadethar-11 (9818.96 ppm) and Spain-121 (8173.713 ppm) respectively.

1. Introduction

Nuts are a good source of oil containing higher unsaturated fatty acids (UFAs) to saturated fatty acids (SFAs) ratio [1, 2]. Peanut (*Arachis hypogaea.* L) is an important oil seed and annual legume. As one of the major oil seed crops in the world, peanut oil plays a vital role due to its high consumption as a vegetable oil and various peanut based products. Peanut oil is obtained from the seed of legume. Edible oils and fats are recognized as essential nutrients in our daily diet and contribute significantly to the regulation of different body functions. Numerous physical and chemical parameters are used to assess their quality [3, 4]. Edible oil is an essential nutrient and an important source of energy providing 9 kcal/g [5]. It is high in unsaturated "good" fat (Monounsaturated: 46 g and Polyunsaturated: 32 g) and low in saturated "bad" fat [6]. Economically, Peanut oil is the second most important edible oil after soybean oil in tropical and semi-tropical regions [7]. Numerous studies have shown that peanuts have heart health benefits. Peanut seeds are also rich in Vitamin E, niacin, folacin calcium, phosphorus, magnesium, zinc, iron,

riboflavin, thiamin and potassium which help to maintain normal blood pressure. Peanuts are high in protein, heart-healthy oils, fiber and many important nutrients [8]. Peanuts are an excellent source of vitamin E, niacin, which may also reduce heart disease risk [9]. Generally, the two main types of peanuts grown commercially are distinct in appearance in Myanmar. There is a wide variation in types and strains cultivated in particular localities. Sinpadethar-11 and Spain-121 are upright types of peanut varieties. One is the upright with an erect central stem and vertical branches. The second one is the recumbent with numerous creeping laterals. Pin Pyant 6 Month and Pin Pyant 4 Month are recumbent type of peanut varieties. The cultivation of groundnut is still taking major role in oil seed crops in Myanmar [10]. In Myanmar, peanuts are among the most important domestically consumed crops after rice [11]. As the amount of edible oil produced is not enough for local consumption, approximately 200000 metric tons of palm oil are being imported annually to fulfill local requirements [12]. Palm oil has high in saturated bad fat and not suitable for human health. The oxidative stability, the unique quality of peanut oil and prolonging the shelf-life of peanut oil was dependent on the fatty acid compositions of the oil. The oil content of peanut differs in quantity, the relative proportion of fatty acids, geographical location, seasons and growing conditions [13, 14]. The peanut seed has from 36 to 54% oil [15]. Peanut storage qualities and nutritional quality are both dependent on the relative proportions of the saturated and unsaturated fatty acids that make up the oil. The total amount of unsaturation is inversely proportional to the keeping quality of the oil, oxidative rancidity increases with increased level of the polyunsaturated fatty acids which cause associate odors and flavors [16].

The separation of 20-components of fatty acid methyl esters (FAMEs) standard was used for the characterization of the lipid fraction in oil and is one of the most important applications in food analysis. The separation of a 20-component FAMEs standard mixture by SCION 456-GC allows for pushing productivity, without compromising on data quality. A problem associated with the peanut oil market is the possibility that peanuts are susceptible to adulterate with other vegetable oil causing rapid oxidative rancidity due to the high content of saturated fatty acid. Oxidative rancidity is a process which is generally induced in either the whole peanut or peanut oil by exposure to heat and air that reacts with the double bonds of unsaturated fatty acids to form products that have undesirable flavor and odor. This study was carried out to identify fatty acid compositions of the four different types of peanut oil samples. The fatty acid compositions of peanut oil are very important to determine unsaturated good fat and saturated bad fat that depends on the shelf-life prediction and to check the purity of the peanut oil. Therefore, the main objective of this study was to validate a GC-MS method for simultaneous determination and quantification of fatty acids from peanut oil by expressing the results in relative and absolute concentration to inform the quality of peanut oil that greatly affected by oil stability or shelf life of the products [17].

2. Materials and methods

2.1 Experimental site and periods

This experiment was conducted at the laboratory of the Department of Postharvest Technology, ACARE, Yezin Agricultural University, Nay Pyi Taw from May 2022 to August, 2022.

2.2 Materials

Samples of four different types of peanut oil were procured from Department of Agricultural Research (DAR), Ministry of Agriculture, Livestock and Irrigation. Recumbent type of peanuts were Pin Pyant 6 Month and Pin Pyant 4 Month. The upright type of peanuts was Sinpadthar-11 and Spain-121. Peanut oils were obtained by screw press method to analyze the fatty acid compositions.

2.3 Analytical methods

2.3.1 Reference standards, reagents

A reference standard of fatty acid methyl ester mixture (mixture of C8-C22 Fatty Acid Methyl Ester 100 mg, Neat, Supelo, USA) was used as a reference data for the relative retention times to test fatty acid methyl esters in food samples and purchased from Sigma-Aldrich, USA. The internal and external standard procedures were used to quantify the fatty acid compositions. Quantitative analysis of the fatty acids was performed using the internal standard. All solvents and reagents were analytical and GC grade, especially for chromatography and the preparation of

the analyzed sample.

2.3.2 Sample preparation for fatty acid profile

One gram (1g) of the sample was weighed with the analytical balance and added into 5 mL laboratory bottle. 1 mL of chloroform and methanol (2:1, v/v) was added and shaken for 3 minutes on vortex mixer. The sample and organic solvent mixture were poured into the glass petri dish and dried at room temperature. After drying, 1 mL of chloroform and hexane (1:1, v/v) was added to reconstitute. Then, 10 µL of N, O-Bis (trimethylsilyl) trifluoroacetamide with trimethyl - chlorosilane was added as the derivatization agent into this 1 mL reconstitutes solution. Then, the solution was shaken again 3 minutes on the vortex mixer and filtered with the 0.22 µm membrane filter. Finally, 1 µL of the filtrate sample solution was ready to inject into GC-MS (SCION TQ GC456-MS) system by automatic liquid samplers (SCION 8400).

2.3.3 Gas chromatographic conditions

The analyses were performed using SCION TQ GC-MS (triple quadrupole and 456-GC, Germany) equipped with Mass spectrometry detector and a Carbowax- 20M F & F (30 m × 0.25 mmID) RESTEK capillary column. Helium (99.99%) was used as the carrier gas at a constant flow rate of 1 mL/min. The oven temperature gradient was programmed from 40 to 250˚C at 6˚C/min and held for 2 min. Injections with the injector inlet temperature is 250˚C. Sample introduction was done using SCION 8400 automatic liquid samplers with dual/duplicate injection modes with a 10 µL syringe (p/n G4513-80213) and a split/splitless injection port. Mass spectrometer was operated by electron ionization (EI) mode with selected ion monitoring SCAN mode for qualitative and selected ion monitoring (SIM) mode for quantitative analysis. The electron ionization source temperature was 200˚C and transfer line temperature was 280˚C. Identification of the detected peak was performed and checked the mass spectra with the reference spectra in NIST 98 Mass Spectral Library and comparing the retention times with FAMEs standards. The total running time of a GC-MS chromatogram was 55.20 min.

3. Results and discussion

Four different types of peanut oils were collected by using screw press method and were analyzed for the composition of fatty acids using gas chromatographic method. Peanut oil is mostly composed of triglycerides of fatty acids. The higher fatty acids occurring as glyceride in natural fats are saturated and unsaturated characters. They are monocarboxylic straight-chain acids possessing an even number of carbon atom. The major fatty acids of peanut oil acylglycerols are palmitic (C16:0), oleic (C18:1), linoleic (C18:2) acids, and only a trace amount of linolenic fatty acid (C18:3) is present. Chromatographic analysis was performed to analyze the fatty acid compositions of the four different types of peanut oil variety. This research revealed that all of the four different types of peanut oil contained relatively high concentration of fatty acids in different amounts. Table 1. shows the characterization of the performance features of fatty acids methyl ester (FAMEs) reference standard. Determining the oils composition is important not only because of the fatty acid contents and the pattern of glyceride distribution but also because the physical character and end-use performance of oils are directly related to composition [18].

The elution order of the mass spectrum of the reference standard of FAMEs was shown in Fig 1. A mass spectrum (MS) is a graphical representation of the ions from a MS. It illustrates the mass distribution of the ions. Information about molecular weight, molecular structure and identify the unknownsamples were obtained from the mass spectrum. MS does not just simply detect the compounds, it first generates ions, separates and then detects these ions [17].

Fragmentation depends solely on the molecular structure of the compound. The acquired mass spectrum can be easily compared to a reference spectrum registered in a library MS database to determine the identity of the compound. Library search is an easy and useful tool for identifying a compound and a chromatographic peak.

The Fig. 2 showed that the selected ion chromatograms of fatty acid in Pin Pyant 6 M peanut oil sample. Each FAME peak of Pin Pyant 6 Month was identified and quantified by referring to the performance features of fatty acids methyl ester (FAMEs) reference standard. The saturated fatty acids (caprylic, capric, lauric, and behenic, tridecanoic, myristic, pentadecanoic, palmitic, margaric, stearic, elaidic, arachidic), monounsaturated fatty acids

Table 1. Characterization of the performance features of FAMEs standard (**C8-22)** by GC-MS method

No.	Common Name (Fatty acids)	Identification		Regressions equations	R^2
		RT (min)	*m/z*	(y = ax+b) (µg/mL)	
1	Caprylic (C8:0)	10.387	73.8	y = +2.955518e+4x -1.688209e+7	0.9097
2	Capric (C10:0)	15.210	73.9	y = +9.606763e+4x -5.432659e+7	0.9633
3	Lauric (C12:0)	18.184	68.8	y = +1.046221e+5x -4.376622e+7	0.2639
4	Tridecanoic (C13:0)	19.604	86.8	y = +9.517654e+4x +1.127504e+8	0.2010
5	Myristic (C14:0)	21.512	86.8	y= +1.088590e+5x +5.302320e+7	0.9918
6	Myristoleic (C14:1)	23.348	86.8	y = +1.167618e+5x +5.373221e+7	0.9915
7	Pentadecanoic (C15:0)	23.981	55.0	y = +1.325683e+5x +9.346484e+7	0.9994
8	Internal standard	23.981	55.0	y = +9.325618e+4x +1.077900e+8	0.9619
9	Palmitic (C16:0)	25.089	86.8	y = +7.723127e+4x +3.290553e+7	0.9956
10	Palmitoleic (C16:1)	26.824	86.8	y = +2.074087e+5x +1.822232e+8	0.2283
11	Margaric acid (C17:0)	27.213	55.0	y= +1.890698e+5x +3.060189e+8	0.9499
12	Stearic acid (C18:0)	28.378	86.8	y = +6.558573e+4x +2.062177e+7	0.9889
13	Elaidic (C18:1n9)	29.974	86.8	y = +1.891600e+5x +1.425948e+8	0.9532
14	Oleic (C18:1n9)	30.301	55.0	y = +8.553944e+5x -5.199472e+8	0.9717
15	Linoleic (C18:2n6)	30.943	66.9	y = +7.614743e+4x +7.507345e+8	0.1298
16	Linolenic (C18:3n3)	31.848	78.9	y = +2.796568e+5x +1.490321e+8	0.9842
17	Arachidic (C20:0)	32.841	86.8	y = +6.696302e+4x +3.064125e+7	0.9991
18	Eicosenoic (C20:1n9)	33.126	55.0	y = +9.964014e+4x +8.894910e+7	0.9909
19	Behenic (C22:0)	35.560	86.8	y = +6.429700e+4x +3.762123e+7	0.9869
20	Erucic (C22:1n9)	35.870	55.0	y = +9.943460e+4x +8.136748e+7	0.9964

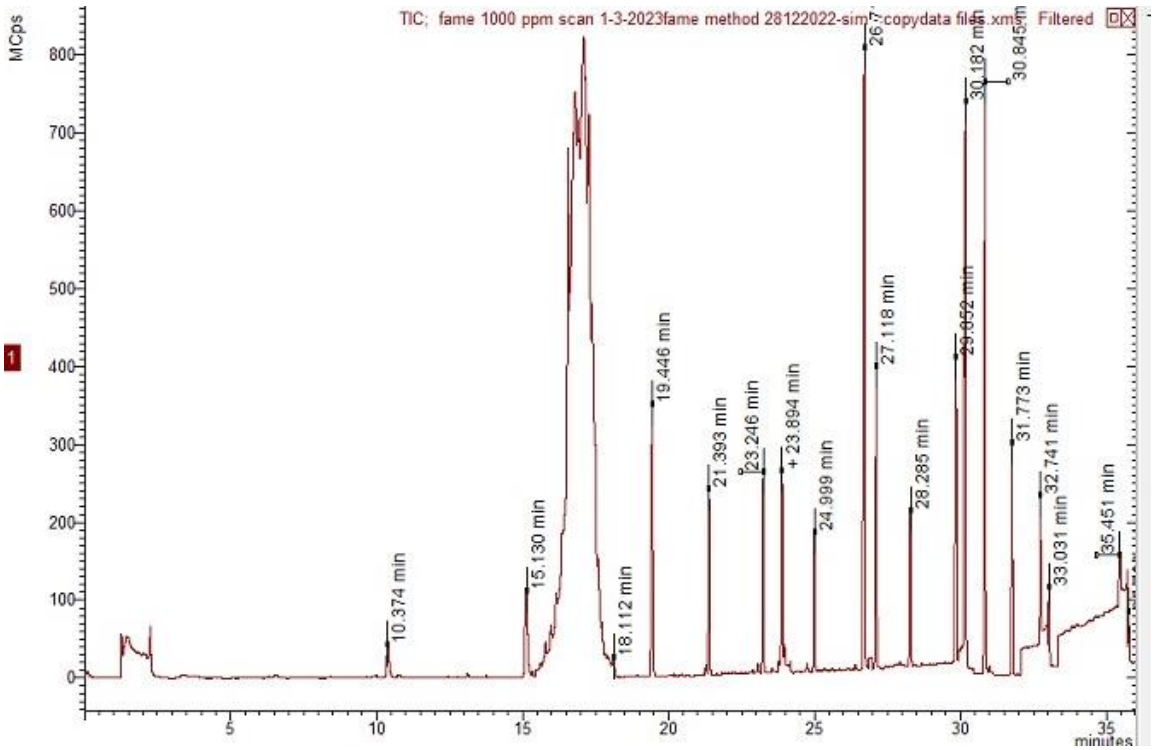

Figure 1. The elution order of the chromatogram of reference standard of FAMEs

(myristoleic, palmitoleic, oleic acid, eicosenoic and erucic) and a polyunsaturated omega-6 fatty acids (linoleic and alpha linolenic) were revealed in this study for four different types of peanut oil varieties. This research revealed that three types of fatty acid were involved the relatively amount of different concentration in four different types of peanut oil sample.

In this study, the fatty acids in four different types of peanut oils were determined by Gas Chromatography Mass Spectrometry (GCMS). Table 2 shown the characterization of the performance features for

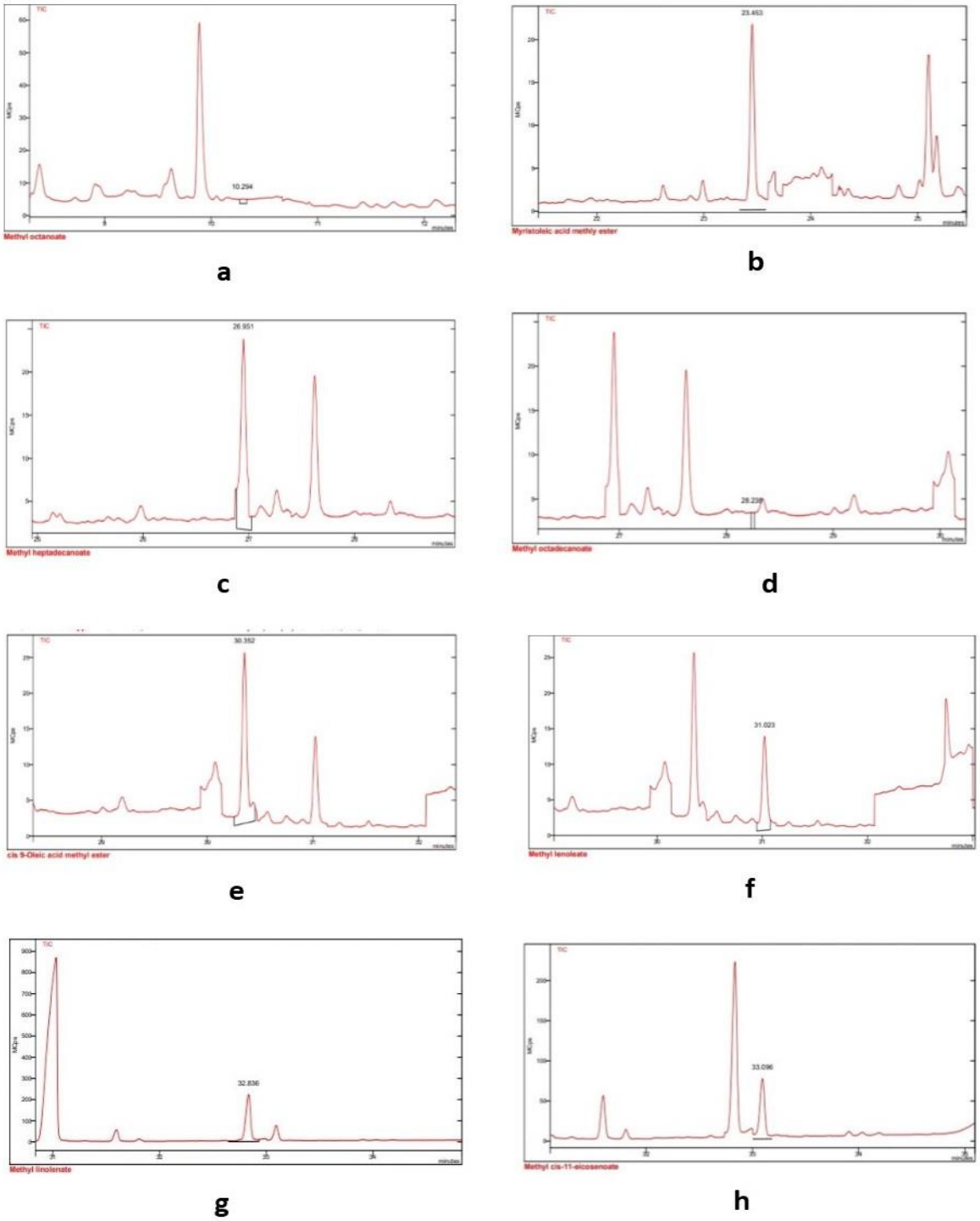

Figure 2. Ion chromatograms of fatty acid in Pin Pyant 6 M Peanut Variety
(a) Methyl Octanoate (b) Myristoleic acid methyl ester, (c) Methyl heptadecanoate, (d) Methyl octadecenoate, (e) cis 9-Oleic acid methyl ester (f) Methyl lenoleate, (g) Methyl linoleate, (h) Methyl cis-11-eicosenoate

retention times and limit of retention times. The results were shown in the Table 3. The total fatty acid in Pin Pyant 6 Month was 10787.75 ppm, Pin Pyant 4 Month was 10173.83 ppm, Sinpadethar-11 was 9818.96 ppm and Spain-121 was 8173.713 ppm. Therefore, Pin Pyant 6 Month peanut oil can be considered as the best fatty acids source for the edible oil. The ranges of fatty acid in different peanut oils were 0.333 to 0.112 ppm for Pin Pyant 6 Month, 0.445 to 0.456 ppm for Pin Pyant 4 Month, 0.889 to 0.789 ppm for Sinpadethar-11 and 0.879 to 0.897 ppm for Spain-121. The most abundant fatty acids in peanut oil were lauric acid, behenic acid, capric acid, caprylic acid and eicosenoic acid. Regarding the fatty acid

Table 2. Characterization of the performance features of four different types of peanut oil by GC-MS method

Common Name (Fatty Acid)	Systematic Name	Retention time Limits	Retention time			
			PP 6 M	PP 4 M	Sin-11	SP-121
Caprylic	Methyl octanoate	10.170 - 10.586	10.792	10.430	10.526	10.566
Capric	Methyl Decanoate	14.822 – 15.426	14.930	14.976	14.996	15.052
Lauric	Methyl laurate	17.848 – 18.574	18.168	18.328	18.331	18.324
Tridecanoic	Methyl Tridecanoate	19.240 – 20.026	19.775	19.646	19.626	19.628
Myristic	Methyl Tetradecanoate	21.095 – 21.956	21.395	21.417	21.418	21.426
Myristoleic	Myristoleic acid ME	22.890 -23.824	23.453	23.264	23.282	23.311
Pentadecanoic	Methyl pentadecanoate	23.332 -24.284	23.851	23.718	23.790	23.804
Internal Standard	Internal Standard	23.514 – 24.474	24.906	24.134	23.856	23.802
Palmitic	Methyl palmitate	24.635 – 25.641	25.174	25.093	25.018	25.138
Palmitoleic	Methylpalmitoleic	26.175 – 27.243	26.647	26.709	26.729	26.757
Margaric	Methyl heptadecanoate	26.535 – 27.613	26.951	27.081	27.119	27.199
Stearic	Methyl octadecanoate	27.813 – 28.949	28.238	28.252	28.381	28.353
Elaidic	trans-9 Elaidic acid ME	29.392 – 30.592	30.079	29.980	29.992	30.003
Oleic	cis 9-Oleic acid ME	29.745 – 30 959	30.352	30.206	30.251	30.332
Linoleic	Methyl linoleate	30.240 – 31.474	31.031	31.010	31.049	30.795
Linolenic	Methyl linolenate	31.141 – 32.413	31.597	31.634	31.672	31.745
Arachidic	Methyl arachidate	32.079 – 33.389	32.836	32.861	32.689	32.561
Eicosenoic	Methylcis-11- eicosenoate	32.455 – 33.779	33.096	32.871	33.117	33.232
Behenic	Methyl docosenoate	34.733 – 36.151	35.524	35.517	35.453	35.437
Erucic	Methyl erucate	35.044 – 36.474	35.915	35.662	35.691	35.759

PP 6 M = Pin Pyant 6 Month, PP 4 M = Pin Pyant 4 Month, Sin-11 = Sinpadethar-11, SP-121 = Spain-121, ME = Methyl Ester.

Table 3. The typical concentration of fatty acids profile in four different types of peanut oils

Common Name (Fatty Acids)	Concentration (ppm)			
	Pin Pyant 6 Months	Pin Pyant 4 Months	Sinpadethar-11	Spain-121
Caprylic	34.792	1219.223	240.859	208.758
Capric	16.744	218.619	136.309	230.476
Lauric	ND	8620.585	9295.567	7363.782
Tridecanoic	16.004	2.296	2.061	2.459
Myristic	0.527	0.326	0.445	0.336
Myristoleic	181.941	0.619	2.603	0.905
Pentadecanoic	2.830	9.798	16.723	6.436
Internal standard	17.451	3.718	6.191	6.449
Palmitic	103.894	ND	0.399	ND
Palmitoleic	5.016	ND	0.079	0.276
Margaric	28.076	20.080	34.077	22.661
Stearic	0.183	0.388	ND	0.092
Elaidic	6.657	0.130	ND	0.037
Oleic	543.632	0.852	3.323	3.312
Linoleic	1467.062	0.558	0.547	0.234
Linolenic	205.305	1.006	3.696	1.389
Arachidic	3081.026	3.676	0.651	1.003
Eicosenoic	1365.725	19.594	ND	315.042
Behenic	3656.361	26.487	59.210	10.070
Erucic	54.519	25.875	16.220	ND
Total fatty acids	10787.75	10173.83	9818.96	8173.72

composition of peanut oil, analyzed results were in accordance with the obtained by [5, 19, 20] who showed that the major FAs are palmitic and oleic acids, followed by linoleic. Mihai, Negoiță & Belc [21] studied the fatty acid profile of oils by Gas Chromatography Mass Spectrometry (GC-MS).

They studied the 40 fatty acids in four different oils of sunflower oil, palm oil, fish oil and lard oil by GC-MS. They found that the fish oil and sunflower oil contain more fatty acids than the plam oil and lard oil. However, the oleic acid, and linoleic acid were more contained in sunflower oil than other oils. In this study, the palmitic acid (103.894), oleic acid (543.632), linoleic acid (1467.062), linolenic acid (205.305), arachidic acid (3081.026), ecosenoic acid (1365.725), behenic acid (3656.361), and erucic acid (54.519) in Pin Pyant 6 Month were more contain essential fatty acids than the Pin Pyant 4 Month, Sinpadethar 11, and Spain-121. Therefore, the Pin Pyant 6 Month peanut oil can be assumed as the best peanut oil due to the presence of valuable mainly fatty acids.

Salve & Arya, [22] studied the physical, chemical and nutritional evaluation of different *Arachis hypogaea* L. seed (SB-11, JL-24, and TLG-45) samples and their oil. They found that the fatty acids in peanut oil were oleic acid (50.21%), linoleic acid (18.12%), and palmitic acid (11.12%), respectively. Moreover, they assumed that the peanut oil was considered as the superior peanut oil due to the presence of rich mineral composition, highly fatty acids composition and highly antioxidant activities. In this study, the most abundant fatty acids in peanut oil were the oleic acid and then, followed by the linoleic acid and palmitic acid. Moreover, the health benefits of peanut oil were dependent on their high content of oleic acid. According to other studies, oleic acid can help to lower the risk of heart disease and lower the cholesterol level. Moreover, oleic acid was shown to maintain good cholesterol, blood pressure, and blood sugar levels. In this study, the Pin Pyant 6 Month peanut sample contains the highest content of oleic acid (543.632 ppm), linoleic acid (1467.062 ppm), and palmitic acid (103.894 ppm), respectively. Yuenyong et al., [21] studied the fatty acid profile in 50 cold-pressed plant oils in Thailand by GC-MS and HPLC-DAD. They found that oleic acid (47.60±0.33 %) and linoleic acid (33.08±1.26 %) were present the most contained in the peanut oil samples. A similar study was done by the Mihai et al [21].

4. Conclusions

In this study, the fatty acids content in four different types of peanut oils were determined by the Gas Chromatography – Mass Chromatography (GC-MS). These results finding will be covered the peanut oil market that will be susceptible to adulterate with other vegetable oils that cause rapid oxidative rancidity due to the high content of saturated fatty acid. The mainly oleic acid (unsaturated trans fatty acid) in peanut oils was highly contained in the Pin Pyant 6 Month among the four different types peanut oil. The presence of high amounts of unsaturated fatty acids favors the suitability of the investigated peanut varieties for nutritional applications especially in lowering the congenital hypothyroidism risk and prevent the cardiovascular disease. Among the four different types of peanut oil varieties, Pin Pyant 6 Month had the predominant source of a polyunsaturated omega-6 fatty acid of linoleic acid and monounsaturated omega-9 fatty acid of oleic acid

Authors' contributions

Designed of the research, M.L. and C.M.; Executed the research, M.L.; N.K.K.W.; K.M. and C.M.; Analyses the data and interpreted the results, C.M.; N.K.K.W. and K.M.; Wrote the first draft of the manuscript, C.M.; N.K.K.W. and K.M.

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Availability of data and materials

All data will be made available on request according to the journal policy.

Conflicts of interest

The authors declare that there are no conflicts of

interest regarding the publication of this article.

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