International Research Symposium
Rajarata University of Sri Lanka

IRSyRUSl 2015

Determination of Fatty Acids Composition of Some Cooking Oils in Sri Lanka

Edirisinghe E.M.R.K.B. [1]*, and .Herath H.M.S.N[2]
Department of Physical Sciences, Faculty of Applied Sciences, Rajarata University of Sri Lanka, Mihintale
[1,2]

ABSTRACT

The fatty acid composition is an important factor for determination of nutritional value of edible oils. Therefore the newest trend in food processing industry is notifying the composition of edible oils and other food commodities for the content of each individual fatty acid. The main objective of this study was to determine the fatty acid composition of commonly available cooking oils in local market in Sri Lanka. Cooking oil samples includingSoyabean oil, Sunflower oil, Corn oil, Coconut oil, Extra virgin olive oil and Madhucalongifolia oil (Mee oil) were analyzed for fatty acid composition by capillary gas chromatography. Among the evaluated oils, the higher contents of saturated fatty acids (SFA) were found in coconut oil (nearly 88% - 91%) with predominant presence of Lauric acid (C12:0) and Myristic acid (C14:0). The result shows that the extra virgin olive oil contain the highest percentage of monounsaturated fatty acid (MUSFA): Oleic acid (C18:1) (77.01%) and sunflower oil contain the highest percentage of polyunsaturated fatty acid (PUSFA) Linoleic acid (C 18:2) (61.80%). Total unsaturated fatty acids were high in soyabean oil, sunflower oil, corn oil and olive oil (83.71%, 88.31%, 85.00% and 85.38%). The fatty acid composition of extra virgin olive oil and Madhucalongifolia oil contains all the types of saturated and unsaturated fatty acids. Linolenic and Linoleic acids were essential fatty acids identified in this study.Some coconut samples obtained from Anuradhapura and Ambanpolamarkets were differ from standard values and their SFA% were low and MUSFA% were high, indicating possible mixing with some other oil sources.

KEYWORDS: *Cooking Oils, Fatty Acid, Gas Chromatography, Lauric Acid, Linoleic Acid, Myristic Acid, Oleic Acid.*

[1] *Corresponding author: Edirisinghe E.M.R.K.B: ranjith_e@hotmail.com

1. Introduction

Cooking oils are biological mixtures of plant origin consisting of ester mixtures derived from glycerol with chain of fatty acids. Fatty acids are merely carboxylic acids with long hydrocarbon chains. The hydrocarbon chain length may vary from 10-30 carbons. Mainly fatty acids can be classified in classes as saturated (SFA), monounsaturated (MUFA) and polyunsaturated (PUFA) fatty acids. Essential fatty acids (EFA) are also fatty acids that must be consumed since the body cannot synthesize.

Cooking oils are used in food preparation such as frying and baking. So it also termed edible oil. They are typically liquid at room temperature. Different types of cooking oils available and some examples are olive oil, palm oil, soybean oil, corn oil, sunflower oil, peanut oil and other vegetable oils.Some oils are flavourful and others have very little taste. They also have different purposes and characteristics. Heating an oil changes its characteristics. Oils that are healthy at room temperature can become unhealthy when heated above certain temperatures. When choosing cooking oil, it is important to match the oil's heat tolerance with their cooking method. Most foods cook well between 325ºF and 375ºF, developing a good flavour and golden colour. Foods cooked in this temperature range absorb between 8% and 25% oil. Higher temperatures mean thinner crusts and less oil absorption. Lower temperatures mean less flavour development, a pale colour, and more oil absorption. All oils are sensitive to light, oxygen and heat. If oil is rancid, it will smell and taste bad and will lost most of its nutrients. It is best to keep cooking oils in a dry, cool place. They are keeping in the refrigerator but allow them to reach room temperature before using them.

Dietary fat includes all the lipids in plant and animal tissues that are eaten as food. The most common fats (solid) or oils (liquid) are glycerolipids, which are essentially composed of triacylglycerol (TG). The TG is accompanied by minor amounts of phospholipid, monoacylglycerol, diacylglycerol and sterols/sterol esters(Jonson and Saikia, 2009). Fatty acids constitute the main components of these lipid entities and are required in human nutrition as a source of energy, and for metabolic and structural activities. One gram of fat gives 9kcal of energy as compared to carbohydrates and proteins, which provide only 5kcal of energy per gram(Wikramanayake, 1996). The most common dietary fatty acids have been subdivided into three broad classes according to the degree of unsaturation. Saturated fatty acids (SFAs) have no double bonds, monounsaturated fatty acids (MUFAs) have one double bond and polyunsaturated fatty acids (PUFAs) have two or more double bonds (Chand, 1991). In general, these fatty acids have an even number of carbon atoms and have unbranched structures. The double bonds of naturally occurring unsaturated fatty acids are very often of the cis orientation (Badr, et al. 2014). More than one hundred cis-MUFAs occur in nature, but most are very rare compounds. At room temperature MUSFA stays in the liquid form. It runs cloudy when kept in refrigerator obtain it by consuming plant sources like canola oil, peanut oil, olive oil and rice bran oil. Olive oil has highest monounsaturated fat. Oleic acid (OA) is the most common MUFA and it is present in considerable quantities in both animal and plant sources (FAO, 2010)

Natural Polyunsaturated fatty acids (PUFAs) with methylene interrupted double bonds and all of cis configuration can be divided into 12 families, ranging from double bonds located at the n-1 position to the n-12 position (Gunstone, 1999). At room temperatures as well at cold temperatures it stays in liquid state. It has a lower melting point comparison with MUSFAs and SFAs. Primary sources of PUSFAs are vegetable oils like Conola oil, Sunflower oil, Nuts and seeds. The most important families, in terms of extent of occurrence and human health and nutrition, are the n-6 and n-3 families. Linoleic acid (LA) is the parent fatty acid of the n-6 family. It has 18 carbon atoms and two double bonds and the first double bond is 6 carbon atoms from the methyl end of the fatty acid chain, and hence the n-6 name(Kostik, et al. 2005). Alpha linolenic acid (ALA) is the most common fatty acid of the n-3 family.It also has 18 carbon atoms, but three double bonds. In contrast to LA, the first double bond in ALA is 3 carbon atoms from the methyl end of the fatty acid chain, and hence the n-3 name. Similarly to LA, ALA can also be desaturated and elongated to form a series of n-3 PUFA. LA and ALA are considered essential because the human body cannot produce them, so they must be supplied in the diet. LA and ALA occur in almost all dietary fats and attain major proportions in most vegetable oils.

Fats are essential in the diet for the absorption and mobilization of fat soluble vitamins such as vitamin A,vitamin E and fat-soluble antioxidants(Dauqan,et al. 2011). These vitamins are not utilized by the body if fat is not available in the diet. Thus fat works as a vehicle to carry the fat-soluble vitamins, nutrients and antioxidants in the body. Fats and oils are integral lubricants of food in two ways; through use as release agents as part of the cooking process and as a lubricant during mastication (chewing). The nutritional

quality of dietary fats is determined by the nature of fatty acids, their chain lengths, degree of unsaturation, and orientation of double bonds(Mudambi,2006).

Cooking oils are plant or animal lipids used in food preparation such as frying and baking. Cooking oils are sometimes added during the preparation of processed foods. All the cooking oils supply energy irrespective of their source. Cooking oils are typically a liquid at room temperature. Types of cooking oils include: olive oil, palm oil, soybean oil corn oil, sunflower oil, peanut oil, rice bran oil and other vegetable oils, as well as animal-based oils like butter and lard. A number of cooking oils are available in the market. The choice depends on the food preparation in which the fat is to be used, the family needs, the food budget and regional preference. A large amount of oil is marketed as unrefined or crude oil. Criteria for selection of oil presence of the natural characteristics aroma, natural colour, clarity, freedom from contamination by other oils and free from solid particles, flat or rancid odour.

All oils are sensitive to heat, light, and exposure to oxygen, Thus cooking oils undergo certain undesirable changes during cooking and storage, which result in rancidity. Rancidity implies development of undesirable odour and flavour in fats and oils rancid oil has an unpleasant aroma and acrid taste, and its nutrient value is greatly diminished. To delay the development of rancid oil, a blanket of an inert gas, usually nitrogen, is applied to the vapour space in the storage container immediately after production. This is referred to as tank blanketing. Vitamin E oil is a natural antioxidant that can also be added to cooking oils to prevent rancidity.
The objectives of this study were to determine the fatty acid profile of commonly available cooking oils in local market and to evaluate the authenticity of different oil varieties using fatty acid profiles.

2. Materials and methods

Samples of seven different varieties of oils as: Coconut oil (8 samples), Corn oil (2 samples), Soyabean oil (1 sample), Sunflower oil (1 sample), Vegetable oil (1 sample), Extra virgin olive oil (1 sample) and Madhucalongifolia oil (Mee oil) (1 sample) were collected from the local markets in Anuradhapura area of Sri Lanka.

Fatty acid (FA) composition of the lipids was determined as their corresponding methyl esters. They were prepared by base hydrolysis followed by tran's esterification. Weighted about 50 mg of duplicate oil samples into screw cap tubes. 1.0 mLof the internal standard solution was added to one of the duplicate tubes. 1.0 mLof 0.5 moldm-3methanolic sodium hydroxide was added and the cap was tightening firmly. The tubes were placed in the boiling water bath for until the oil had dissolved about 5 mins. The solution was cooled and 1.5 mL of boron trifluoride reagent and 0.5 mL of 0.1% hydroquinone solution were added. The cap was tightening firmly and again it placed in the boiling water bath for 5 mins. The solution was cooled and 5.0 mLof saturated sodium chloride and 2.5 mL of normal heptane were added in it. Then it was shaken vigorously for 30 s and it was kept until separate the phases. The organic phase was transferred in to an injection vial and it was kept at -18 0C.

Fatty acid methyl esters (FAME) were separated by capillary column Gas chromatography using Agilent GC (Agilent 7890B, AOC-20I, Japan) with a DB-WAX capillary column (length 30 m, 0.25 mm ID, 0.25 μm film thickness). Helium was used as the carrier gas at a rate of 50 ml/min. The split ratio was maintained at 1:50.The temperature program used in the oven was from 150°C to 225 over 40 min periods. The injection and the detector ports were operated at 240°C and 250°C respectively. The separated compounds were detected using a hydrogen flame ionization detector.

The obtained peaks were identified and quantitatively determined by comparing retention times of methyl esters in a standard mixture from Larodane fine Chemicals AB, Sweden.

3. Results and discussion

A total of 15 samples of cooking oils were collected from local market and were analyzed based on their composition of fatty acids using gas chromatographic method. The content of following saturated and unsaturated fatty acids was identified in the samples : Caproic acid (C 6:0), Caprylic acid (C 8:0), Capric acid (C 10:0), Lauric acid (C 12:0), Myristic acid (C 14:0), Palmitic acid (C 16:0), Palmitoleic acid (C 16:1), Stearic acid (C 18:0), Oleic acid(C 18:1), Vaccenic acid(C 18:1), Linoleic acid(C 18:2), Linolenic acid(C 18:3), γ-Linolenic acid(C 18:3), Arachidic acid(C 20:0), Eicosenoic acid(C 20:1) and Behenic acid (C 22:0). The fatty acid compositions of tested oils are shown in Table 1.

The results showed that Soyabean oil had ten fatty acids. They were Palmitic acid (16:0), Stearic acid (C 18:0), Oleic acid (C 18:1n-9), Vaccenic acid (C 18:1n-11), Linoleic acid (C 18:2), Linolenic acid (C 18:3), γ-Linolenic acid (C 18:3), Arachidic acid (C 20:0), Eicosenoic acid (C 20:1n-11) and Behenic acid (C 22:0). Most prominent fatty acids were Linoleic (C 18:2), Oleic (C 18:1n-9), Palmitic (16:0), Linolenic (C 18:3), Stearic(C 18:0) and Vacceenic (C 18:1n-11) acids (51.90%, 23.79%, 10.78%, 6.20%, 4.17% and 1.35%). Soyabean oil and Sunflower oil had similar fatty acid patterns with two dominant fatty acids (FAs). They were Linoleic (C 18:2) and Oleic (18:1n-9) acids (Table no 01). Corn oil had seven fatty acids with three prominent FAs. They were Linoleic acid (C 18:2), Oleic acid (C 18:1n-9) and Palmitic acid (C 16:0) (50.96%, 31.73% and10.61%). So Linoleic acid (C 18:2) was the most prominent fatty acids in Soyabean, Sunflower and Corn oils (51.90%, 61.56% and 50.96%). Vegetable cooking oil had eleven fatty acids. Oleic (C 18:1n-9), Plmaitic (C 16:0), and Linolenic (C 18:3) were the most prominent FAs (42.82%, 33.64% and 15.95%). Olive oil had nine fatty acids. Prominent fatty acid was Oleic acid (C 18:1) (77.01%).Madhucalongifolia oil was the special type of oil, extract from “Madhucalongifolia seeds” and normally used for frying. It contained nine fatty acids and most prominent fatty acids were Oleic (C 18:1) (46.84%), Palmitic (C 16:0) (20.55%), Stearic (C 18:0) (20.20%) and Linoleic (C 18:2) (10.31%). Therefore Oleic (C 18:1n-9) was the most prominent fatty acid in Vegetable oil, Extra virgin olive oil and Maducalongifolia oil (42.82%, 77.02% and 46.85%). Olive oil contained highest percentage of oleic acid in this study.

Table 1: Fatty acid composition of different cooking oil varieties

Name of the fatty acid	Amount of Fatty acids (%)														
								Coconut oil							
	soya bean oil	Sunflower oil	Corn oil	Corn oil made in lab	Vegetable cooking oil	Extra virgin Olive oil	*Madhucalongifolia* oil	Refined coconut	Pure white coconut	Coconut oil- Home made	King coconut - Home made	Market sample-1Mihintale	Market sample2-Abagaswawe	Market sample3-Anuradhapura	Market sample4-Ambanpola
Caproic acid (C 6:0)	-	-	-	-	-	-	-	-	0.37	0.62	0.67	0.54	0.62	-	0.06
Caprylic acid(C 8:0)	-	-	-	-	-	-	0.08	-	6.41	8.16	7.81	6.99	7.92	0.07	0.92
Capric acid (C 10:0)	-	-	-	-	-	-	0.06	6.03	5.26	5.87	5.59	5.00	5.50	0.47	0.65
Lauric acid (C 12:0)	-	-	-	-	0.26	-	0.47	49.47	45.96	47.33	44.59	43.41	45.41	0.46	5.68
Myristic acid (C 14:0)	-	-	-	-	0.92	-	-	20.69	20.04	18.59	19.17	19.98	19.66	1.11	3.33
Palmitic acid(C 16:0)	10.78	6.49	10.61	15.99	33.64	10.58	20.55	9.90	9.38	8.40	10.10	9.93	8.93	39.40	35.28
Palmitoleic acid(C 16:1)	-	-	-	-	0.21	0.81	-	-	-	-	-	-	-	0.19	0.17
Stearic acid (C 18:0)	4.17	3.93	2.16	2.64	3.89	3.62	20.20	2.98	2.89	2.48	2.94	2.75	2.87	4.00	3.91
Oleic acid (C 18:1)	23.79	25.71	31.73	29.61	42.82	77.01	46.84	8.01	7.16	6.73	7.49	7.93	6.76	42.12	38.45
Vaccenic acid (C 18:1)	1.35	0.68	0.79	0.53	0.93	2.09	-	-	-	-	-	0.11	-	0.81	0.72
Linoleic acid (C 18:2)	51.90	61.56	50.96	48.44	15.95	4.45	10.31	2.74	2.45	1.82	1.64	2.92	2.07	10.42	9.40
Linolenic acid (C 18:3)	6.20	0.23	1.52	1.28	0.70	0.74	0.42	-	-	-	-	-	-	-	0.18
γ-Linolenic acid (C 18:3)	0.29	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Arachidic acid (C 20:0)	0.45	0.28	0.45	0.86	0.37	0.42	0.55	-	0.09	-	-	0.09	0.08	0.36	0.34
Eicosenoic acid (C 20:1)	0.18	0.14	-	0.34	0.16	0.27	-	-	-	-	-	-	-	0.13	0.13
Behenic acid (C 22:0)	0.45	0.78	-	0.31	-	-	-	-	-	-	-	-	-	-	-
Total Identified FAs	99.55	99.80	98.22	100.00	99.85	100.00	99.51	99.82	100.00	100.00	100.00	99.65	99.82	99.74	99.20
Total SFAs	15.84	11.49	13.22	19.79	39.08	14.62	41.92	89.07	90.39	91.45	90.87	88.69	90.99	45.87	50.18
Total MUSFAs	25.32	26.52	32.53	30.48	44.12	80.19	46.84	8.01	7.16	6.73	7.49	8.04	6.76	43.26	39.47
Total PUSFAs	58.39	61.80	52.48	49.73	16.65	5.19	10.74	2.74	2.45	1.82	1.64	2.92	2.07	10.60	9.56
Total UFAs	83.71	88.32	85.00	80.21	60.77	85.38	57.58	10.75	9.61	8.55	9.13	10.96	8.83	53.87	49.02

In this study eight coconut oil samples were analyzed. Most of coconut oil samples include refined coconut oil, pure white coconut oil, coconut oil made in home, king coconut oil and coconut oil samples were taken from Mihintale and Abagaswawe were rich in Lauric acid (C 12:0) (49.47%), 45.96%, 47.33%, 44.59%, 43.41% and 45.41%) and Myristic acid (C 14:0) (20.69%, 20.04%, 18.59%, 19.167%, 19.98% and 19.66%). Some coconut samples obtained from Anuradhapura and Ambanpola markets were differ from standard values. They were rich in Oleic acid (C 18:1) (42.12% and 38.45%) and Palmitic acid (C 16:0) (39.40% and 35.29%). And also they contained lot of fatty acid varieties than other coconut oil samples. They had all fatty acids, identified in this study except Behenic acid.

According to the results of this study, three major fatty acids were identified. Those were saturated fatty acids (SFAs), monounsaturated fatty acids (MUFAs) and polyunsaturated fatty acids (PUFAs). Saturated FAs were Caproic (C 6:0), Caprylic (C 8:0), Capric (C 10:0), Lauric (C 12:0), Myristic (C 14:0), Palmitic (C 16:0), Stearic (C 18:0), Arachidic (C 20:0) and Behenic (C 22:0) acid. Most prominent SFAs were Lauric (C 12:0), Myristic (C 14:0) and Stearic (C 18:0). Monounsaturated fatty acids were Palmitoleic (16:1), oleic (C 18:1n-9), Vacceenic (C 18:1n-11) and Vicosenoic (C 20:1) acids. Most prominent MUSFAs were Oleic (C 18:1n-9). Polyunsaturated FAs were Linoleic (C 18:2), Linolenic (C18:3) and γ-Linolenic (C18:3). Linoleic and Linolenic acid were prominent. Figure no: 01 illustrate the total SFAs and USFAs% present in these oil varieties. According to the graph SFAs were high in most of coconut oil samples and their MUSFAs% and PUSFAs% were very low. Extra virgin olive oil had highest % of MUSFAs. Sunflower oil had highest % of PUSFAs. Some coconut samples obtained from Anuradhapura and Ambanpola markets were differ from standard values and their SFA% were low and MUSFA% were high, indicating possible mixing with some other oil sources.

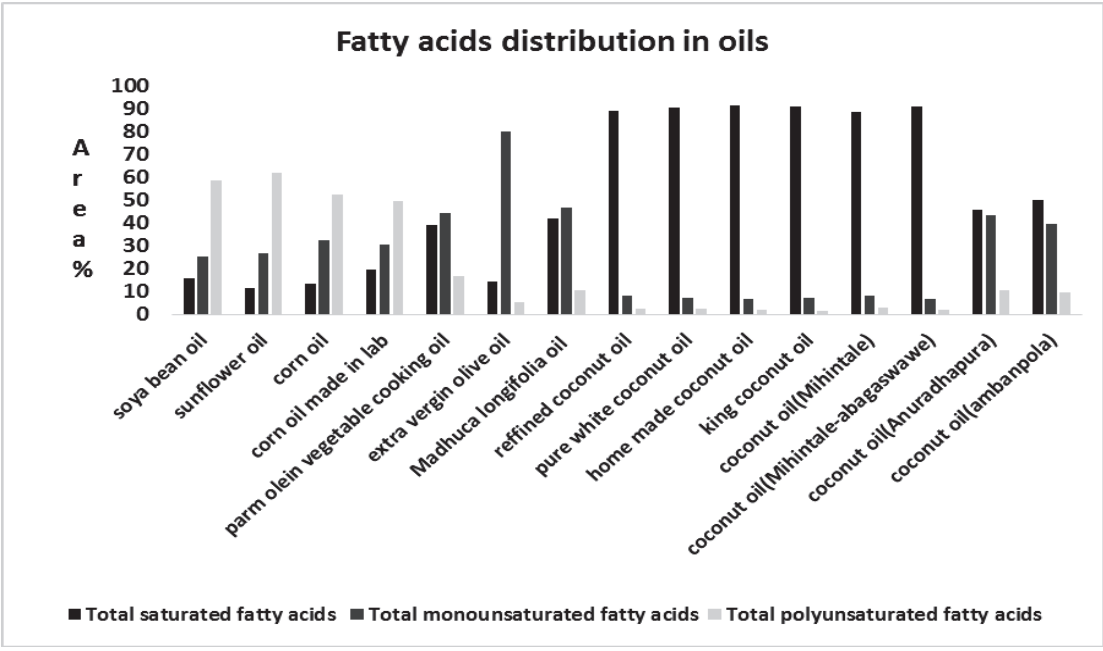

Figure 1: Fatty acid distribution in oils

Figure 2 illustrate the essential fatty acid distribution in each oil samples.Linoleic acid and Linolenic acid were identified in this study as essential fatty acids. According to this graph Linolenic acid percentage was very low comparing with linoleic acid and highest % of linoleic acid was found to Sunflower oil. Coconut oil had very low linoleic acid percentage.

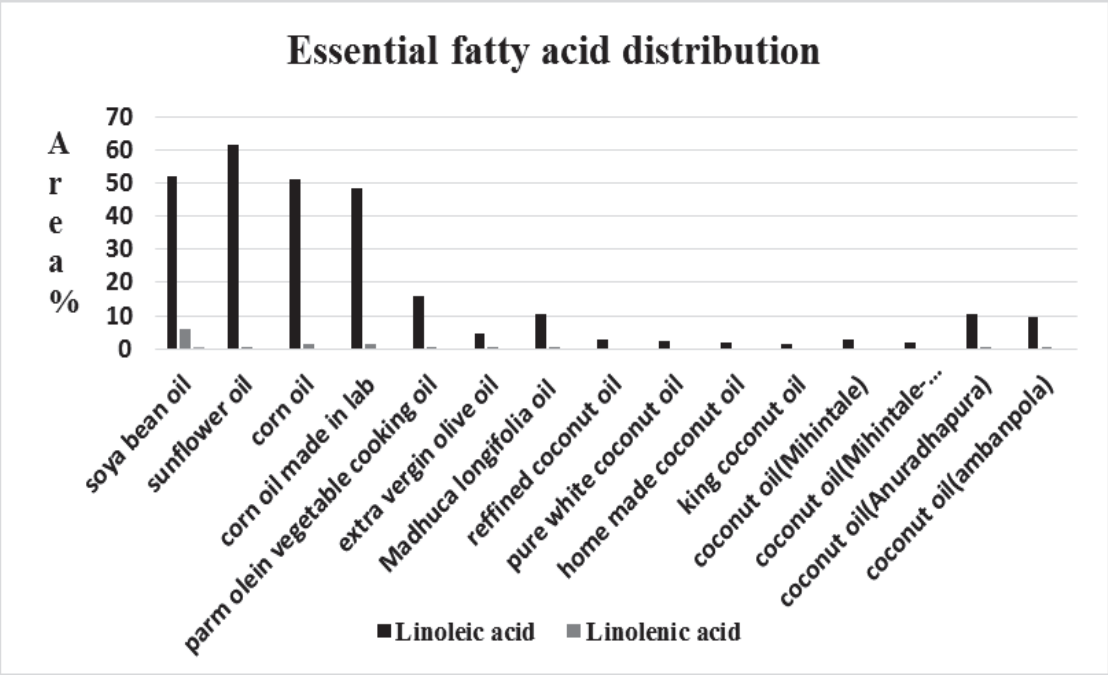

Figure 2: Variation of Essential fatty acids

4. Conclusion

Among the evaluated oils Palmitic (C 16:0), Oleic (C 18:1) and Linoleic (C 18:2) acids were the most prominent fatty acids identified in Soyabean oil, Sunflower oil, Corn oil, Vegetable oil, Extra virgin olive oil and *Madhucalongifolia* oil. Lauric (C 12:0) and Myristic (C 14:0) acids were prominent fatty acids in coconut oil. Linoleic (C 18:2), Linolenic acid (C 18:3) were essential fatty acids found in these oil varieties. The higher contents of SFAs were found in coconut oil. Extra virgin olive oil contains the highest % of MUSFAs (80.19%) and Sunflower oil contains the highest % of PUSFA linoleic acid (C 18:2) (61.80%).Coconut samples obtained from Anuradhapura and Ambanpola markets were differ from standard values and their SFA% were low and MUSFA% were high, indicating possible mixing with some other oil sources.

References

Badr, N., Arzoo, S. & Bakeet, Z.A.N. (2014). Characteristics and fatty acid composition of commonly consumed cooking oil marketed locally in Riyadh city. International journal of biosciences. 4(9), P227-234.

Chand, S. (1991). Advanced organic chemistry, Reprinted (1991), P644 - 650.

Dauqan, E.M.A., Amina, H.A.S., Abdullah. andKasim, Z.M. (2011). Fatty Acids Composition of Four Different Vegetable Oils (Red Palm Olein, Palm Olein, Corn Oil and Coconut Oil) by Gas Chromatography. 2nd International Conference on Chemistry and Chemical Engineering. 14 (1), P31-33.

FAO (2010). Fats and fatty acids in human nutrition. Food and agriculture organization of the United Nations. P9-17.

Gunstone, F.D. (1999). Vegetable oils in food technology: composition properties and uses. USA and Canada: Black well publishing. P98-203.

Jonson, S. and Saikia, N. (2009). Fatty acid profile of edible oil and fats in India. New Delhi: Center for science and environment. P3-13.

Kostik, V., Memeti1, S. and Bauer, B. (2005). Fatty acid composition of edible oils and fats. Journal of Hygienic Engineering and Design.volume?issue? P112-115.

Mudambi, S.R., Food science, 4th edition(2006), P141 – 144

Wikramanayake, T.M (1996). Food and Nutrition, 4th edition, P17