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Studies on the Fatty Acid Composition of Edible Oil

K. Chowdhury, L. A. Banu, S. Khan and A. Latif

IFST, BCSIR, Dhaka-1205, Bangladesh

Abstract

Fatty acid analysis of the five types of locally consumed edible oils (n = 22) was carried out using a Gas Chromatograph (G.C) equipped with a Flame Ionization Detector (FID) and stainless steel packed column. The results showed that sunflower oil contained the highest percentage of long chain mono and polyunsaturated fatty acids (91.49 ± 1.91 %) compared to soybean oil (81.14 ± 1.49 %), mustard oil (86.80 ± 3.07 %), palm oil (53.30 ± 0.36 %) and coconut oil (7.12 ± 0.51 %). Two varieties of mustard oil, low erucic (= 5 %, n=3) and high erucic acid (>14 %, n=2) and two varieties of sunflower oil, high linoleic-low oleic (61-66 % & 22-27 %, n=2) and low linoleic- high oleic (29-38 % and 53-63 %, n = 3) were found. Sunflower oil with the highest percentage of mono and polyunsaturated fatty acids especially the high linoleic-low oleic variety appeared to be superior and most suitable edible oil for mass consumption.

Key words: Fatty acid, Gas chomatograph, Sunflower oil, Soybean oil, Mustard oil, Palm oil, Coconut oil.

Introduction

Edible oil is an essential nutrient and an important source of energy providing 9 kcal/g. For oil to be utilized as a source of energy it must be well digested and absorbed into the body (Tannenbaum, 1979). Oils in the diet are available to the body as fatty acids, which are excellent sources of dietary calorie intake. Fatty acids (FAs) are classified as saturated (SFA), monounsaturated (MUFA) and poly-unsaturated (PUFA) fatty acids. The total energy intake from oils for a normal healthy adult is approximately 30 energy percent and that in the western diets is about 40 energy percent. High fat diets enhance the incidence of coronary heart disease (Romon *et al.* 1995 and Simon *et al.* 1995). Risk factors for coronary heart disease (CHD) such as elevated levels of serum total cholesterol, low density lipoprotein cholesterol (LDL-C), serum triglycerides (TG) and reduced levels of high density lipoprotein cholesterol (HDL-C) are modulated by the fat content in the diet. A high intake of saturated fatty acids and cholesterol in the diet

may lead to hypercholesterolaemia, largely through an increase in LDL-C. On the contrary, polyunsaturated fatty acids have a hypocholesterolaemic effect in human (Sundram, K. 2003). Deficiency of essential fatty acids (EFA) such as linoleic (18:2), linolenic (18:3) and arachidonic acid (20:4), growth is retarded and dermal symptoms appear. Patients with chronic intestinal disorders causing malabsorption, nutritional losses through diarrhoea or catabolic illness would be expected to have EFA deficiency (Kaul *et al.* 1986, Okeef, 1996 and Siguel *et. al.*1996).

The aim of this study was to find out a suitable variety of locally available edible oil rich in essential fatty acids for general mass to combat malnutrition.

Materials and Methods

Edible oil samples of five different varieties: sunflower oil (5 samples), soybean oil (3 samples), palm oil (3 samples), mustard oil (5 samples) and coconut oil (6 samples) were collected from local market during the period between July 2002 to June 2003.

Preparation of fatty acid methyl ester (FAME)

Relative concentration of fatty acid (FA) from oil samples were measured as their corresponding methyl esters according to the method described in IUPAC (1979) with a minor modification. 5-7 drops (~50 µl each) of oil was taken in 15 ml test tube and 3 ml of 0.5 M sodium methoxide (prepared by mixing metallic sodium in methanol) was added and digested by stirring in a boiling water bath for about 15 minutes. It was allowed to cool to room temperature and 1 ml of petroleum ether (b.p 40-60^{O} C) was added followed by 10 ml deionized water, mixed gently and allowed to settle for some time. The distinct upper layer of methyl ester in petroleum ether was separated carefully in a capped vial and used for analysis. 200 mg of different fatty acid standards in their respective methyl ester form were dissolved separately in 10 ml petroleum ether (b.p 40-60^{O} C) in a series of screw capped test tubes. Aliquots of 1µL FAME was injected and peaks were recorded for their respective retention time and areas by the data processor unit of the GC.

Chromatography

Analysis of FAME was carried out on Gas Chromatograph (GC) Model-14B, Shimadzu, Japan loaded with software Class GC-10 (version-2.00). The GC was equipped with Flame Ionization Detector (FID) and stainless steel column, dimension 10 X 1/8, packed with 5 % DEGS-PS. The column was conditioned at 180^{O} C about 2 hours for attaining thermal stability before use. The operating condition was programmed at oven temperature 150^{O}C (hold time 5min) with increasing rate 8^{O} C/min to190^{O} C (hold time 0 min), 2^{O} C/min to 200^{O} C (hold time 10min), injection temperature 250^{O} C and

detector temperature 250^{O} C. Nitrogen was used as a carrier gas with flow rate of 20 ml/min.

Results and Discussion

A total of 22 edible oil samples collected from the local markets were analyzed using gas chromatograph for their fatty acid (FA) compositions of them, five samples were of sunflower oil, three of soybean oil, five of mustard oil, three of palm oil and six of coconut oil. Their respective fatty acid (FA) percent composition are shown in Table-I and the mean of total saturated fatty acid (SFA), monounsaturated fatty acid (MUFA) and polyunsaturated fatty acid (PUFA) percent are shown in Table II. Table III shows the varieties of mustard oil and sunflower oil.

Table I. Fatty acid composition of different types of edible oil

Fatty acids %	Sunflower oil (n=5) Mean ± SD	Soybean oil (n=3) Mean ± SD	Mustard oil (n=5) Mean ± SD	Palm oil (n=3) Mean ± SD	Coconut oil (n=6) Mean ± SD
Caprylic ($C_{8:0}$)	--	--	--	--	6.21 ± 0.34
Capric ($C_{10:0}$)	--	--	--	--	6.15 ± 0.21
Lauric ($C_{12:0}$)	--	--	--	--	51.02 ± 0.71
Myristic ($C_{14:0}$)	--	--	--	1.23 ± 0.28	18.94 ± 0.63
Palmitic ($C_{16:0}$)	6.52 ± 1.75	14.04 ± 0.62	4.51 ± 3.83	41.78 ± 1.27	8.62 ± 0.50
Stearic ($C_{18:0}$)	1.98 ± 1.44	4.07 ± 0.29	2.78 ± 0.59	3.39± 0.65	1.94 ± 0.17
Oleic ($C_{18:1}$)	45.39 ± 18.77	23.27 ± 2.43	38.21 ± 21.88	41.90 ± 1.20	5.84 ± 0.50
Linoleic ($C_{18:2}$)	46.02 ± 16.75	52.18 ± 2.64	25.31 ± 5.74	11.03 ± .02	1.28 ± 0.18
Linolenic ($C_{18:3}$)	0.12 ± 0.09	5.63 ± 3.48	11.30 ± 6.09	--	--
Arachidic ($C_{20:0}$)	--	--	10.86 ± 3.29	--	--
Erucic ($C_{22:1}$)	--	--	11.35 ± 13.83	--	--

Table II. Percentage of saturated (SFA), monounsaturated (MUFA), polyunsaturated (PUFA) and total unsaturated (MUFA+ PUFA) fatty acid of each types of oil

Fatty acids %	Sunflower Oil (n=5) Mean ± SD	Soybean Oil (n=3) Mean ± SD	Mustard Oil (n=5) Mean ± SD	Palm Oil (n=3) Mean ± SD	Coconut Oil (n=6) Mean ± SD
SFA	8.51 ± 1.91	18.26 ± 0.67	15.94 ± 2.58	46.34 ± 0.40	92.92 ± 0.56
MUFA	45.5 ± 16.89	23.28 ± 1.99	49.57 ± 8.56	41.46 ± 0.56	5.84 ± 0.46
PUFA	46.10 ± 14.92	57.86 ± 1.20	36.62 ± 6.42	11.84 ± 0.92	1.28 ± 0.17
MUFA + PUFA	91.49 ± 1.91	81.14 ± 1.49	86.18 ± 3.07	53.30 ± 0.36	7.12 ± 0.51

Table III. Varieties of sunflower and mustard oil

	Sunflower oil variety(n=5)		Mustard oil variety(n=5)	
	i. High linoleic- low oleic		i. High erucic acid	
Sample No.	Linoleic acid (%)	Oleic acid (%)	Sample No.	Erucic acid (%)
S-1	61.24	27.76	S-1	14.73
S-2	66.55	22.78	S-5	34.12
	ii. Low linoleic-high oleic		ii. Low erucic acid	
	Linoleic acid (%)	Oleic acid (%)		Erucic acid (%)
S-3	29.45	63.55	S-2	4.76
S-4	34.08	59.04	S-3	2.25
S-5	38.80	53.83	S-4	0.91

It has been found in this study that sunflower, soybean and palm oils contained four to five FAs (Table I) each, whereas mustard oil and coconut oil contained seven and eight FAs respectively. Two to six different types of saturated FAs of chain length C_8 to C_{20} and two to four different types of unsaturated FAs of chain length C_{18} to C_{22} were found in all samples. Palmitic acid ($C_{16:0}$) and stearic acid ($C_{18:0}$) were common in all the saturates. Oleic acid ($C_{18:1}$) and linoleic acid ($C_{18:2}$) were common in the unsaturated FAs of all oils. Coconut oil, a nontraditional edible oil contained the highest number (six) and highest percentage (93 %) of SFA (92.92 + 0.56). Palm oil contained nearly 47 % SFA (46.34 ± 0.40) where palmitic ($C_{16:0}$) acid was predominant (41.78 ± 1.27). The major unsaturated FA of this oil was oleic acid (41.90 ± 1.20). Sunflower oil contained the lowest percentage of SFA (8.51 ± 1.91) followed by mustard oil (15.94 ± 2.56) and soybean oil (18.26 ± 0.67). Mustard oil contained two MUFAs, oleic ($C_{18:1}$) and erucic ($C_{22:1}$) acid. This oil contained the highest percentage of monounsaturated FAs (49.57 ± 8.56) followed by sunflower (45.5 ± 16.89), palm (41.46 ± 0.56) and soybean oil (23.28 ± 1.99), where oleic acid was predominant. Soybean oil was rich in PUFAs (57.86 ± 2.0) followed by sunflower (46.10 ± 14.92), mustard (36.62 ± 6.42) and palm oil (11.84 ±0.92).

Sunflower and soybean oil contained both the EFAs, linoleic ($C_{18:2}$) and linolenic ($C_{18:3}$) acid. The total percentage of essential fatty acids (linoleic and linolenic) in soybean oil is 57.81 ± 6.12 and that in sunflower oil is 46.14 ± 16.84 (Table. I). Our findings appeared identical with those of earlier published findings (Mowlah *et al.* 1990) in the context of major fatty acids of the respective oils with the exception of Mustard and Sunflower oil. In Mustard oil, we found two varieties in respect of erucic acid composition (=5 %, n=3 and 14-34 %, n=2). In

Sunflower oil also two types were found in consideration to percent composition of oleic (53-63 %, n=3 and 22-27 %, n=2) and linoleic acids (61-66 %, n=2 and 29-38 %, n=3) (Table III). This variation might be due to difference in the variety of sunflower and mustard seed.

Conclusion

In consideration of total percentage of unsaturated fatty acids (MUFA+PUFA), Sunflower oil appears superior. On the other hand in respect to total percentage of essential fatty acids (linoleic and linolenic) soybean oil is superior. But on overall consideration, sunflower oil with the highest percentage of mono and polyunsaturated fatty acids especially the high linoleic-low oleic variety appeared to be suitable for mass consumption to combat malnutrition. Proper attention should be given to identify this particular variety of sunflower seed and to promote enhanced production to make it available for general consumption.

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References

International Union of Pure and Applied Chemistry (IUPAC). (1979) Standard Methods for the Analysis of Oils, Fats & Derivatives. 6th Ed., Pergamon Press, pp 98-99.

Kaul, A. K. and. Das, M. L (1986) Oilseeds in Bangladesh. Bangladesh: BRAC Printer, Dhaka, pp 273 -28.

Mowlah, G. Sheik, N.M. and Kamal, A.S.M. (1990) A Handbook on edible Oils and Fats (with special reference to Bangladesh). 1st Ed. (The City Press), pp126, 137, 146, 158 and 159.

Okeef, S.J. (1996) Nutrition and gastrointestinal disease. Scand J Gastroenterol Suppl **220** : 52-9.

Romon, M. Nuttens , M.C .and Thaeret, N (1995) Comparison between fat intake assessed by a 3-day food record and phospholipids fatty acid composition of red blood cells : results from monitoring of cardiovascular disease - Lille study. *Metabolism* **44**(9): 1139-45.

Siguel Lerman, E.N. R.H. (1996) Prevalence of essential fatty acid deficiency in patients with chronic gastrointestinal disorders. *Metabolism* **45**(1): 12-23.

Simon, J.A. Fong,J. Bernert Jr, J.T and Browner, W.S.. (1995) Serum fatty acids and the risk of stroke **26**(5) 778-82

Sundram, K. (2003) Review Nutritional Properties of palm oil and its products. In: Oil Palm Plantation Management Course. Malaysia: MPOB 364

Tannenbaum, S.R. (1979) Nutritional and safety aspects of food Processing, Marcel Dekker, New York, pp 98.

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