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FATTY ACID COMPOSITION AND PHYSICO-CHEMICAL CHARACTERISTICS OF COOKING OILS AND THEIR BLENDS

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ABSTRACT

In the present study blending of crude palm oil was done with sunflower oil and groundnut oil to attain ideal fatty acid ratio. CPO was blended with sunflower and groundnut in two different proportions i.e., CPO:sunflower (70:30 and 65:35) and CPO:groundnut (50:50 and 45:55). Fatty acid composition and physico-chemical characteristics of individual oils and their blends were determined. The palmitic acid was the major fatty acid (43.45%) in CPO followed by oleic and linoleic acid. Sunflower oil contained 67.76% polyunsaturated fats, 22.72% monounsaturated and 9.54% saturated fats. On the other hand in groundnut oil, oleic acid was the prominent fatty acid, which was 48.90% of total fatty acid followed by linoleic acid (48.9%), palmitic acid (7.76%) and stearic acid (2.31%). â-carotene content was 366.19 μg/g in CPO; however, no â-carotene was present in sunflower and groundnut oils. Saponification value was highest in CPO and lowest in sunflower oil. Iodine value was lowest in CPO and highest in sunflower oil. No peroxide value was detected in fresh oils. Four types of products namely cake, biscuit, *sev* and *mathi* prepared using different oil blends were found acceptable. On the basis of fatty acid composition and physico-chemical characteristics, 70:30 blend of CPO and sunflower was recommended for a vitamin A deficient population. Therefore, popularization of palm oil becomes all the more important in the context of Indian population where vitamin A deficiency is still highly prevalent.

INTRODUCTION

Vegetable oils are the main source of dietary fat in India. The country has a wide range of sources of edible oils and approximately 2/3rd of the total supply of vegetable oil is met through groundnut oil, mustard oil and rapeseed oil. Palm oil is derived from the mesocarp of the oil palm fruit (*Elaeis guineansis*). It is a native of West Africa where wild palms are still harvested and the oil is obtained by simple traditional methods in the village. Palm oil is obtained from the flesh surrounding the seed, simply by cooking, mashing and pressing. In India, palm oil is cultivated in Andhra Pradesh, West Bengal, Kerala and Karnataka states. Since palm oil is used worldwide in food, its nutritional properties are naturally of great interest to the consumers (MPOPC, 2002).

Palm oil consists mainly of glycerides (9%) and about 0.5 per cent non-glyceride materials (Choo, 1994). It is a highly viscous semi-solid fat, orange-red in colour and has 45-56 iodine value and 31.38^{0}C melting point. Palm oil also contains other minor constituents, such as free fatty acids, which determine the oil's chemical and physical characteristics. Crude palm oil contains high content of mono-unsaturated fatty acids. The uniqueness of palm oil from other vegetable oils lies in its fatty acid composition and their position in the triglyceride structure. Inspite of its higher palmitic acid content, red palm oil does not behave like animal fats that are rich in saturated fatty acids. This is because, in palm oil the middle (2nd) position of triglyceride structure is occupied mainly by unsaturated fatty acid (oleic), which are absorbed into the intestine after the fatty acid at 1 and 3 positions are split off during digestion. Thus, more of oleic acid is available to the body from palm oil. It could be blended with other vegetable oils rich in polyunsaturated fatty acids such as sunflower, groundnut, coconut etc. so that crude palm oil blend contains recommended ideal fatty acid composition which is required for the maintenance of good health. Besides, it is richest source of â-carotene, antioxidant and precursor of vitamin A and tocotrienols, all of which have antioxidant properties (Tan, 1999, MPOPC, 2002).

Sunflower seed as a source of oil was recognized in India fifteen years back. It has gained much importance now-a-days as cooking oil in India because of its high polyunsaturated fatty acid content, blend flavour and good storage stability (Semwal and Arya, 1992). It contains about 13% saturated fats, 27% monounsaturated and 60% polyunsaturated fats (Ghafoorunissa and Krishnaswamy, 2000).

Groundnut oil is one of the widely used vegetable oils and highly acceptable as cooking oil. These two oils i.e. sunflower and groundnut oils are preferred over soybean oil because they contain practically no linolenic acid which is prone to auto oxidation.

Blending of different cooking oils is one of the emerging issues now-a-days as people are becoming more health conscious. Since no single refined oil alone has ideal fatty acid composition, so blending of palm oil with sunflower and groundnut oil was proposed in the present study so that ideal fatty acid composition of oils could be attained. In the present study, an attempt was made to blend sunflower and groundnut oil in different proportions.

MATERIAL AND METHODS

Procurement of oil

Crude palm oil was obtained from National Research Centre for Oil Palm, Kerala, India. Sunflower and groundnut oils were procured in a single lot from the local market of Hisar, Haryana.

Blending of oils

Based on the fatty acid composition, oils were blended in different proportions to attain the nearby ideal fatty acid ratio i.e. 1:2:1::SFA:MUFA:PUFA. Two best suited blends of each CPO : sunflower oil and CPO : groundnut oil were selected which are given below:

CPO : Sunflower oil (70:30)
CPO : Sunflower oil (65:35)
CPO : Groundnut oil (50:50)
CPO : Groundnut oil (45:55)

Chemical analysis

Fatty acid composition of different oils and their blends

Fatty acid composition was determined using gas liquid chromatography method of Metcalfe *et al,* (1966). The peaks were identified by retention time or position on the recorder chart using a standard reference mixture. The fatty acid methyl esters eluted in the order - palmitic (16:0), stearic (18:0), oleic (18:1), linoleic (19:2), arachidic (20:0), eicosenoic (20:1), behenic (22:0) and lignoceric (24:0) acids when the above mentioned column was used. Percentage of each component was calculated from the ratio of each peak area (integrator count) to column to sum of areas (integrator count) under all peaks and reported as percentage by weight.

Physico-chemical characteristics of oils

All the individual oils and their blends were analysed for various physico-chemical properties. Saponification value and Iodine value of individual oils was determined employing the method of Chopra and Kanwar (1980). Peroxide value and fat acidity were determined by the method of AOAC (1995). *â*-carotene in sample was separated by column chromatography and estimated colorimetrically (AOAC, 1995).

Development of products

Various types of products like cake, biscuit, *sev*, and *mathi* were prepared using CPO, sunflower oil and groundnut oil and their blends in different proportions. Their organoleptic characteristics in respect of colour, appearance, aroma, texture, taste and overall acceptability were judged by a panel of judges using 9-point Hedonic Rating Scale (ISI, 1971) Based on this method, 10 judges comprising scientists of Department of Foods and Nutrition were involved as they were familiar with the importance and methodology of sensory evaluation and moreover, they were accustomed to use vegetable

oils in their diets. The judges were considered semi-trained by the provision of this information. The sensory evaluation was done in the department itself and one product at a time was served in triplicate to judges.

Experimental design and statistical analysis

The data for physico-chemical characteristics of oils were analyzed in three replications, while the data for sensory evaluation were analyzed in ten replications. Statistical analysis was performed using complete randomized design (CRD) for analysis of variance (Panse and Sukhatme, 1961).

RESULTS AND DISSUCTION

Fatty acid composition of individuals oil

The fatty acid composition of palm, sunflower and groundnut oil has been presented in Table 1. The dominated fatty acid in crude palm oil was palmitic acid i.e. 43.45% followed by oleic acid (40.98%) and linoleic acid (14.67% of total fatty acids). Stearic acid was 0.88 %of total fatty acids. Similar fatty acid composition of palm oil reported was by various workers (Manorama, 1994; Rukmini, 1994)

Sunflower oil contained 67.76%polyunsaturated fats, 22.72 %monounsaturated and 9.54 % saturated fats. On the other hand in groundnut oil, oleic acid was the prominent fatty acid which was 48.90 % of total fatty acid followed by linoleic acid palmitic acid and stearic acid .Palmitic acid was the predominant saturated fatty acid (43.45%) in palm oil followed by oleic and linoleic acid. The sunflower oil sample contained 67.76% of linoleic acid, which is higher than palm oil and groundnut oil. The linoleic acid content of groundnut oil was about 39% less than that of sunflower oil. Huang et al. (1981) also reported higher value of linoleic acid (70.6 %) in sunflower oil samples. On the other hand, linolenic acid which is more prone to autooxidation, was found absent in CPO, groundnut and sunflower oil. The sunflower oil contained more polyunsaturated fatty acids whereas the groundnut oil contained more monounsaturated fatty acid and palm oil was slightly richer in saturated fatty acids. Parvathi and Geervani (1976) reported that groundnut oil contained 51.86 and 31.71 % of oleic and linoleic acid, respectively.

Fatty acid composition of oil blends

Results of fatty acid composition of blends of crude palm oil with sunflower and groundnut oils are given in Fig. 1. Blend of CPO and sunflower (70:30) oil had 30.85 % palmitic, 2.54 % stearic, 33.97 % oleic and 32.10 % linoleic acid. Almost similar fatty acid profile was observed in case of 65:35 blend of crude palm and sunflower oil. Blend of crude palm and groundnut oil in 50:50 proportion contained 24.18 % saturated fats, 48.22 % monounsaturated and 27.60 % polyunsaturated fatty acid of total fatty acids. Whereas 45:55 blend of crude palm and groundnut oil contained 23.12 % saturated fats, 46.98 % monounsaturated and 29.07 % polyunsaturated fatty acid of total fatty acids.

TABLE 1: Fatty acid composition of different cooking oils and their blends

	CPO	Sunflower oil	Groundnut oil
Fatty acid composition			
Palmitic C:16	43.45	6.87	7.76
Stearic C-18	0.8865	2.67	2.31
Oleic 18:1	40.98	22.72	48.90
Linoleic 18:2	14.67	48.90	40.91
Linolenic 18:3	-	-	-
Categorical summary			
% Polyunsaturates	14.67	48.90	40.91
% Monosaturates	40.98	22.72	48.90
% Saturates	44.34	9.54	10.07

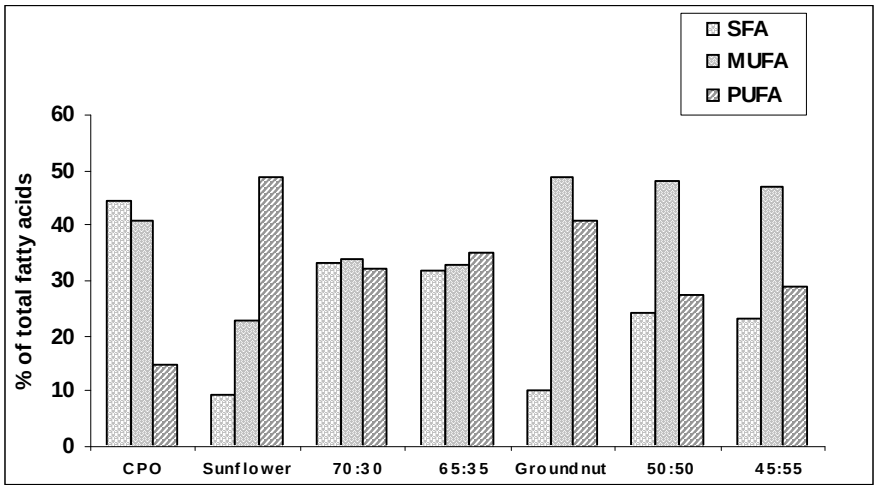

Fig. 1. Fatty acid composition of different cooking oils and their blends

Fatty acid ratio of blends

Crude palm oil was blended with sunflower oil in 65:35 and 70:30 proportions whose SFA:MUFA:PUFA ratio was 1:1.09:1.03 and 1:1.09:1.12, respectively whereas Crude palm oil was blended with groundnut oil in 50:50 and 45:55 proportions and the SFA:MUFA:PUFA ratio was 1:2:1.16 and 1:2.04:1.30, respectively (Table 2).

Similar observations have been made by Grundy (1998) who reported that an ideal saturated, monounsaturated and polyunsaturated fatty acid ratio was 1:2:1 and it is in close agreement with the present investigation.

Physico-chemical characteristics of oils

Physico-chemical characteristics such as saponification value, iodine value, peroxide value, *â*-carotene and fat acidity of individual oils i.e. crude palm, sunflower and groundnut oil and their blends are given in Table 3.

Saponification value

Saponification value is a measure of the average molecular weight. Crude palm oil had the highest (202.46mg) saponification value and sunflower oil had the lowest (192.65). The saponification value of all the seven types of oils i.e. crude palm, sunflower, groundnut oil and their four blends varied considerably. This might be due to the difference in molecular weight of

TABLE 2: Fatty acid ratio of blends of different cooking oils with crude palm oil

Oil blends	Ratio		
	SFA	MUFA	PUFA
CPO : Sunflower oil			
70 : 30 (Type Ia)	1.00	1.09	1.03
65 : 35 (Type Ib)	1.00	1.09	1.12
CPO : Groundnut oil			
50 : 50 (Type IIa)	1.00	2.00	1.16
45 : 55 (Type IIb)	1.00	2.04	1.30

SFA = Saturated fatty acid
MUFA = Monounsaturated fatty acid
PUFA = Polyunsaturated fatty acid
CPO = Crude palm oil

TABLE 3: Physico-chemical characteristics of crude palm oil, sunflower oil, groundnut oil and their blends

Type of oil	Saponification value (mg)	Iodine value(%)	Peroxide (value(meq/kg)	â-carotene(μg/100 g)	Fat acidity mg KOH/100 g)
Crude palm oil (control)	202.46 ± 0.76	51.34 ± 0.10	ND	36619.24 ± 14.0	0.12 ± 0.04
Sunflower oil (control)	192.65 ± 0.23	135.47 ± 0.43	ND	-	0.25 ± 0.00
CPO : Sunflower oil			ND		
70 : 30 (Type Ia)	196.78 ± 0.40	78.43 ± 0.13	ND	24178.16 ± 8.0	0.21 ± 0.01
65 : 35 (Type Ib)	197.45 ± 0.16	82.38 ± 0.07	ND	22298.17 ± 5.0	0.20 ± 0.03
CD (P<0.05)	1.40	0.72	ND	20.36	0.12
Groundnut oil (control)	193.45 ± 0.43	99.16 ± 0.15	ND	-	0.28 ± 0.00
CPO : Groundnut oil			ND		
50 : 50 (Type IIa)	195.45 ± 0.21	75.67 ± 0.02	ND	18927.11 ± 35.0	0.20 ± 0.02
45 : 55 (Type IIb)	197.89 ± 0.59	78.90 ± 0.04	ND	15667.18 ± 23.0	0.22 ± 0.04
CD (P<0.05)	1.88	0.30	ND	24.80	0.14
Overall CD (P<0.05)	1.36	0.51	ND	24.48	0.13

Values are mean ± SE of three independent determinations
ND = Not detected CPO = Crude palm oil

the oils. A range of 190.1 to 201.7 mg saponification value was reported by Maclellan (1983).

Iodine value

The iodine value represents the degree of unsaturation. The higher the iodine value is, the greater is the unsaturation of specific oil or fat (Lawson, 1995).Iodine value was maximum (135.47%) in sunflower oil and minimum (51.34%) in crude palm oil. Similaraly higher iodine value (119.5%) was also reported in sunflower oil by Parvathi and Geervani (1976). When crude palm oil, sunflower oil and their blends i.e. Type Ia (70:30) and Ib (65:35) were compared together, significant (P<0.05) differences were noticed.

Crude palm oil, groundnut oil and their two blends had 51.3, 99.1, 75.6 and 78.9% iodine value, which varied significantly. Overall, crude palm oil had the lowest iodine value while it was maximum in sunflower oil. Iodine value of all seven types of oils i.e. crude palm, sunflower, groundnut oil and their blends differed significantly among themselves. Higher the degree of unsaturation, higher was the iodine value of the oil.

The value obtained for saponification value and iodine value were within the range of minimum and maximum limits specified under PFA act i.e. 180-196mg and 135-146% respectively (Vibhakar *et al*. 1981).

Peroxide value

Peroxides are major initial reaction products of lipid oxidation that measure for primary oxidation (Warner, 1996). Peroxide value of all the oils is given in Table 3. No peroxide value was detected in fresh oils i.e. crude palm, sunflower, groundnut oil and their four blends. Similarly, Parvathi and Geervani (1976) reported that fresh sunflower and groundnut oil contained no peroxide value.

â-carotene

Palm oil is a richest source of carotenoids. It owes its deep red colour due to the presence of carotenoids. The main component of its carotene is â-carotene which is a precursor of vitamin A. Maximum â-carotene was observed in crude palm oil and no â-carotene was observed in sunflower and groundnut oil. The amount of â-carotene was 36619.1 μg/100 g in CPO followed by 24178.1 μg/100 g in 70:30 blend and 22298.2 μg/100 g in 65:35 blend of CPO and sunflower oil.

Similar trend was also found in CPO and groundnut oil blends. As sunflower and groundnut oil did not contained â-carotene, so

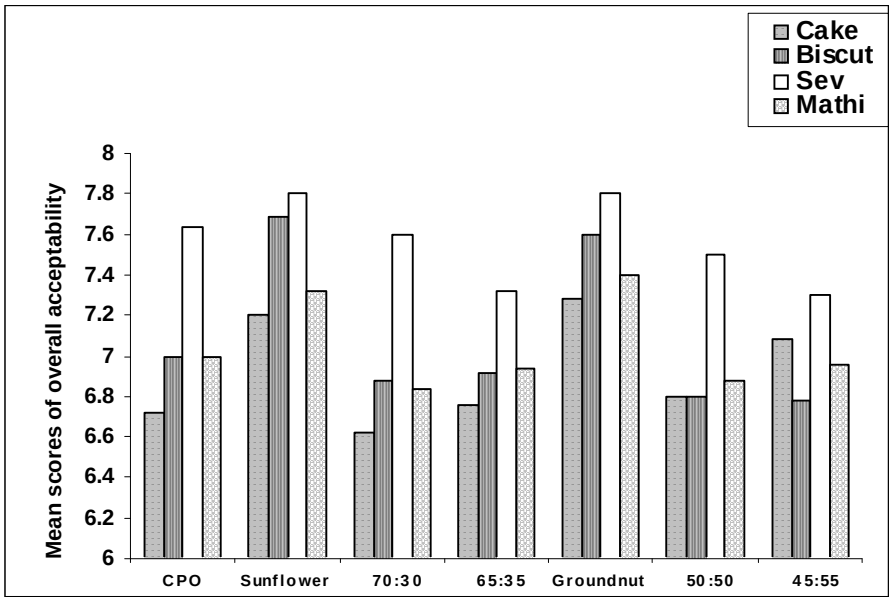

Fig. 2. Mean scores of overall acceptability of different products

amount of *â*-carotene in the blends of oil depended upon the proportion of CPO used in respective blend. Higher the amount of CPO, more was the amount of â-carotene in the blend.

Fat acidity

Maximum fat acidity was found in sunflower oil i.e. 0.25 mg KOH/100g and minimum in crude palm oil (0.12 mg KOH/100 g). A significant difference in fat acidity was observed in all four types of oil.

The fat acidity in groundnut oil, Type. IIa (CPO:groundnut::50:50) and Type IIb (CPO:groundnut::45:55) oil blends was 0.28, 0.20 and 0.22 mg KOH/100 g, respectively, which varied considerably among themselves. In all the seven types of oils, groundnut oil had the maximum fat acidity followed by sunflower oil and minimum in crude palm oil, differences observed were non-significant.

Higher fat acidity in vegetable oils used in present study might be due to the more content of polyunsaturated fatty acids thereby, resulting in breakdown of triglycerides, increasing the free fatty acids which further increases the fat acidity. Khan *et al.* (1979) reported 6 and 7 mg acid value per g in sunflower and groundnut oil, respectively.

Sensory evaluation of products

Products prepared namely cake; biscuit, *sev* and *mathi* were found organoleptically acceptable by the panel of judges (Fig 2). The mean scores of overall acceptability of products prepared with blends of CPO, sunflower and groundnut oil were more as compared to products prepared using crude palm oil alone.

CONCLUSION

The results of the present study revealed that palmitic acid is the major fatty acid in palm oil followed by monounsaturates and polyunsaturates. Although saturated fatty acid content of CPO is more but still it does not behave like a saturated fat as palmitic acid is less hypercholesterolemic as compared to lauric and myristic acids. Palm oil can be blended

with other vegetable oil viz. sunflower and groundnut oil in different proportions to attain ideal ratio of saturated, monounsaturated and polyunsaturated fatty acid (1:2:1). Among all the blends, CPO: groundnut (50:50) oil blend has ideal fatty acid ratio. This blend can be recommended for the patients suffering from degenerative diseases. Whereas 70:30 blend of CPO and sunflower was recommended for a vitamin A deficient population. The blends have high amount of â-carotene and can be incorporated successfully in various products. These products can be recommended for supplementary feeding programme to prevent vitamin A deficiency among children.

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REFERENCES

AOAC. (1995). Official Methods of Analysis. Association of Analytical Chemists, Washington.

Choo, Y.M. (1994). *Food and Nutr. Bull* **15**, 130-137.

Chopra, R. and Kanwar, S. (1980). *Analytical Agric. Chem*, pp. 396-397.

Ghafoorunissa and Krishnaswamy, K. (2000). Diet and Heart Disease. National Institute of Nutrition, Hyderabad, pp. 23-35.

Grundy, M. (1998). *Am. J. Clin. Nutr*, **66**, 988S-989S.

Huang, A.S., *et al* (1981). *J. Am. Oil Chem. Soc*, **58**, 997-1001.

ISI (1971). Guide for sensory evaluation of foods. (IS:6723 Part-II). Indian Standards Institution, Manak Bhawan, New Delhi.

Khan, Y.A.R., *et al* (1979). *J. Food Sci. Technol*, **16**, 90-92.

Lawson, H. (1995). Physical properties in Food oil and Fats: Technology, Utilization and Nutrition. Chapman and Hall, New York, N.Y. pp. 28-38.

Maclellan, M. (1983). *J. Am. Oil Chem. Soc*, **60**, 368-373.

Manorama, R. (1994). *Indian Oil Palm J*, 21, 21-26.

Metcalfe, L.D., *et al* (1966). Food Chem, **38** 5-10.

MPOPC. (2002). Palm Oil. Malasian Palm Oil Promotion Council. Pp 1-8.

Panse,V.G.and Sukhatme,P.V.(1961): Statistical Methods for Agricultural Workers. Indian Council of Agricultural Research, New Delhi.

Parvathi, T. and Geervani, P. (1976). *J. Food Sci. Technol*, 13, 192-195.

Rukmini, C. (1994). *Food and Nutr. Bull*, pp. 2-12.

Semwal, A.D. and Arya, S.S. (1992).*J. Food. Sci. Technol*, **29**, 250-252.

Tan, B. (1987). In: Int. Palm/Palm Oil Conf. Tech. Prog. and Prospects. Kualalumpur. Malaysia: PORIM Press. pp. 370-376.

Vibhakar, S., (1981). *Indian Fd. Packer* **(1)** : 11-12.

Warner, K. (1996). Evaluation of lipid quality and stability in food lipids and health, Ed. By McDonald, R.E. and Min, D.B. Marcel Dekker, New York, NY, pp. 345-369.