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Physico Chemical Quality and Stability of Refined and Virgin Oils

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ABSTRACT

In human nutrition, fats are physiologically important food constituents, which are most liable to oxidative degradation. The oils included in the study were refined and virgin oils of sesame, groundnut, coconut, sunflower and palm oils. The aim of the study was to determine the fatty acid composition and physico chemical parameters of the selected oils. The result showed that the refined oils had highest smoke point ranging from 145 to 229^{0}C compared to virgin oil (131 to 195^{0}C). Virgin oil had maximum iodine value attributes to the higher number of double bonds present in the oil. Virgin sesame oil had the lowest peroxide value 4.5 mEq O_2/kg and the virgin coconut oil had the highest peroxide value 8.0 mEq O_2/kg. This indicated that the traditionally processed virgin oil had peroxide value within the prescribed Codex Standard (10 meq O2/kg). Refined oils had higher content of saturated and monounsaturated fatty acids and lower polyunsaturated fatty acid contents. The fatty acid composition of the virgin oils was better than that of the refined oils. Refined palm oil and sunflower oil are more suitable for deep fat frying than refined sesame oil. Consumption of refined palm oil was found to be positively correlated with the increased level of low density lipoprotein (bad cholesterol) and incidence of Coronary Heart Diseases. Hence, the consumption of virgin sesame oil with high monounsaturated fatty acid has been recommended for improving the lipid profile concentrations followed by virgin groundnut oil.

Key words: *Physico-chemical, refined, virgin, fatty acid, colour value, saponification value*

Practical application: *Knowledge of physical and chemical properties of the virgin and refined oils is essential to select the good oil for healthy lifestyle. Therefore, the information of this work is important for selection of healthy cooking oil.*

INTRODUCTION

Lipids and triacylglycerol naturally occur in oils and fats. Their chemical composition contains saturated and unsaturated fatty acids and glycerides. Edible oils are vital constituents of our daily diet, which provide energy, essential fatty acids and serve as a carrier of fat soluble vitamins.

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Fat is an important ingredient of human diet and imparts, taste and palatability to the foods. It is a most concentrated source of energy and is essential for the absorption and mobilization of fat soluble vitamins and antioxidants. Vegetable oils are the only sources of essential fatty acids to the body and help in raising high density lipoprotein cholesterol[11].

The physical value of oil depends upon its chemical composition, and plays a vital role in the use of different oils. The chemical and physical properties of edible oils depend primarily on its composition and temperature. Pure fats and oils are generally white or yellow solids and liquids. Pure fats and oils are also odourless and tasteless[18]. However, over a period of time fats become rancid and develop an unpleasant odour and taste. There are many reasons for the current push for physico-chemical studies of some edible oils like sunflower oil, sesame oil, palm oil, coconut oil and ground nut oil, because they are important in daily cooking, salad dressing and for various other industrial uses. They are key components of the diet and also provide characteristic flavour and texture to foods[11].

Different physical and chemical parameters of edible oil are used to monitor the compositional quality of oils[14]. These physico-chemical parameters include iodine value (IV), saponification value (SV), viscosity, density and peroxide value (PV). Several researchers have studied the impact of temperature on the stability, viscosity, peroxide value and iodine value to assess the quality and functionality of the oil[13].

Generally, fats and oils are characterized by various physical and chemical parameters. These characteristics are essentially reflected by the chemical nature of various constituents like fatty acids, their chain length, degree of unsaturation / saturation and several other non-glyceride components. The identity of an unknown fat for the evaluation of its purity is generally accomplished by determining its physical and chemical characteristics.

India is experiencing an epidemic of type 2 diabetes attributed to epidemiological and nutrition transition occurring in urban and rural areas though at faster levels in urban settings. Currently, there are an estimated 62.4 million people with diabetes and 77.2 million with pre-diabetes in India. Nutrition transition is marked by a change in the food supplies and consumption, especially the shift from traditional Indian home-cooked foods to more processed foods, foods of animal origin, fat- and sugar rich foods, all of which could possibly contribute to higher rates of diabetes and obesity.

The role of the quality of dietary fat, a precursor of diverse functional molecules and metabolic health, has not been evaluated in detailed manner. The consumption of vegetable oils has increased threefold in developing countries like India. Due to import liberalization and globalization, many varieties of cooking oils are available in India.

The most commonly used cooking oils are sunflower (64%) and palmolein oil (23%), whereas the traditional oils such as groundnut (peanut) (13%) and gingelly (sesame) (18%) are less often used. Sunflower oil provides higher linoleic acid (LA) (about 66%) polyunsaturated fatty acids (PUFAs), PUFA/saturated fatty acids (SFAs) ratio and total LA/alpha-linolenic acid (ALA) ratio, whereas traditional oils like groundnut oil provide optimal levels of monounsaturated fatty acids (MUFAs 49%), LA (30%) and lower PUFA/SFA (1.5) and LA/ALA ratio[6]. Epidemiological studies have shown that LA intake and high LA/ALA ratio are associated with both insulin and leptin resistance and the related metabolic disorders.

The aim of this research was to study the correlation between important physico chemical parameters of selected virgin and refined vegetable edible oils (fatty acid profile, viscosity, colour value, smoke point, free fatty acid, saponification value, iodine value and peroxide value).

MATERIALS AND METHODS

The survey on the consumption pattern of cooking oils in Madurai city was conducted with the pretested questionnaire. Information on the types of oil used for cooking, preference of brand, price of oil, reason for the preference, buying behaviour and mode of storage after purchase from market was documented. Based on the survey, the most preferred brand of cooking oil by the consumers was selected for the study. The selected oils were the traditionally processed vegetable oils (virgin oil) such as sesame oil, groundnut oil, sunflower oil and palm oils and refined oil such as sesame oil (Idayam), groundnut oil (Manthra), coconut oil (M.P.R), sunflower oil (Gold winner) and palm oil (Roobini brand). The virgin oils were purchased from the Sathasivam cold pressed oil mill, Madurai and the refined oils were purchased from the local market, Madurai. Physico chemical properties of selected oils were analysed at the Department of Food Science and Nutrition, Home Science College and Research Institute, Madurai.

Physico-chemical analysis

The physical parameters like smoke point and chemical parameters like iodine value, saponification value, free fatty acids and peroxide values were determined according to AOCS standard[1]. Colour flex meter (model: Hunter Lab, Model: $45^{o}/0^{o}$) was used for the measurement of colour value of selected oils.

Fatty acid analysis

The fatty acid composition of the selected oils was analyzed as per the procedure given by AOAC[3] using Gas Chromatography (Perkin Elmer® Clarus®, 580).

Five different commercially refined vegetable oils and five different virgin oils were analyzed and reported in relative area percentage. The fatty acid methyl esters (FAME) were used as standard. A solution of oil (0.1 g) in hexane (10 ml) was mixed with methanolic potassium hydroxide (0.2 ml, 2N) by shaking vigorously for 30 seconds and allowed to stand overnight.

The hexane layer was suitable for injection into the Gas Chromatograph. The fatty acid methyl esters were identified using Gas Chromatograph equipped with dual flame ionization detector. The fractions of fatty acid methyl esters were conducted using column (Elite-1). The initial oven temperature was 120°C, hydrogen gas was used as a carrier 40ml/min, and the temperature of injector and detector were 250°C and 260°C, respectively. The fatty acid methyl esters were identified by comparison of their retention times with known fatty acid standard mixture. The fatty acid composition was expressed as percentage of total fatty acids.

Statistical analysis

The virgin oil and refined oil combinations were evaluated for statistical inference - with two Factorial Completely Randomized Design (FCRD) which were used for the selected oils as per the method described by Gomez and Gomez[8] with triplicate number of samples.

RESULTS AND DISCUSSION

Preference of oil for cooking

Preference of oil for the cooking purpose was found to differ according to the consumer acceptance. Preferences of various types of oil by different groups like households and hotels were recorded and presented in Table 1. Among the households, the refined sunflower oil (88 %) was the one which was most preferred by the consumers followed by sesame oil (58 %) because of its taste, aroma and health benefits followed by palm oil (38 %), groundnut oil (24 %) and coconut oil (12 %) From the survey it was noticed that most of the households showed preference for refined sunflower oil which was used for the preparation of deep fat fried foods viz., *poori*, *bhajji*, *muruku*, *vadai*, *athirasam* etc., whereas sesame oil was used for seasoning, dosa and idli podi. In hotels, refined sunflower oil (80 %) was the most preferable oil followed by palm oil (56 %) for the preparation of deep fat fried products because of its cheaper price than the other cooking oils.

Among two different groups, only eleven per cent of the consumers showed preference for coconut oil for cooking purpose. The mean value showed that refined sunflower oil (83.5%) was the most preferred oil among the selected oils followed by sesame oil (50.0 %), palm oil (47.0 %) and groundnut oil (22 %). Statistical analysis of the data revealed that the differences in usage of cooking oil were highly significant.

Brand name of the oils

Specific brand preferences of the consumers towards a product represent the quality and acceptability of the products by them. The table 2 summarizes the consumer preference data regarding the preference for different brands of cooking oils. Among the various brands, Gold Winner was the most preferred refined sunflower oil by all segments of consumers. With regard to refined palm oil (Roobini) and refined groundnut oil (Manthra) had higher preferences due to the lesser price. 'Idhayam' sesame oil had higher price than all the other brands and it was preferred by most of the people due to the taste and quality.

Buying behaviour and mode of storage of cooking oils

The buying behaviour and mode of storage of cooking oils were surveyed and the data is given in Table 3. Higher preference (51.5%) was given for the purchase of low cost oil (Rs. 50 - 60). On the whole 21, 11, 8 and 8 per cent of the consumers preferred oils with the cost in the range of Rs.61–70; 71 – 80, 81 – 100 and 101 – 120 per litre respectively. Low cost was cited as the only reason for the preference of certain brands of oil by the hoteliers (72 %) whereas higher preference was given by households (84 %) for the taste and quality of the oils. With respect to buying behaviour, the oils were purchased daily by the commercial centre's i.e., hotels 76 per cent and 81 per cent of the households it was once in a month. Majority (31 %) of the consumers stored the oils in stainless steel containers, followed by tin/can (16 %) and glass bottles (11 %). In hotels, since the purchase was based on the daily needs, no specific mode of storage was practiced.

Smoke point

The smoke point of an oil or fat is the temperature at which, under defined conditions, enough volatile compounds emerge when a bluish smoke becomes clearly visible from the oil. At this temperature, volatile compounds, such as free fatty acids, and short-chain degradation products of oxidation are formed. These volatile compounds degrade in air to give soot. The smoke point indicates the temperature limit up to which that cooking oil can be used.

The results showed that the RSUO oil had highest smoke point (227ºC) followed by RGO (225ºC), RPO (196ºC), RSO (170ºC) and RCO (127ºC) respectively. Fat with high smoke point is generally desirable for deep fat frying. It could be seen that RSUO and RGO samples and are more suitable for deep fat frying. Virgin oils had the lowest smoke point ranging from 131 to 195^{0}C. The VGO (195ºC) had the highest degree of smoke point followed by VSUO (173ºC), VSO (148ºC), VPO (131ºC) and VCO (108ºC). The statistical analysis revealed significant difference (P≤0.01) between the refined and virgin oils respectively.

Tautua *et al*[17]., reported higher value of smoke point for refined sunflower oil, refined groundnut oil and refined palm oil as 226, 225, and 197ºC respectively, which are similar to the present findings.

Iodine value

Iodine value is defined as the percentage of iodine absorbed by the oils or fats. The greater the iodine value, the more unsaturation and the higher the susceptibility to oxidation. This test gives an indication about the purity of the samples.

The results showed that the iodine values for virgin oils ranged from 55 to 135 and for refined oils were in the range of 41 to 127 respectively. The VSUO had the highest iodine value of 135 followed by VSO 115, VGO 106, VCO 98 and VPO 55. The RSUO had the highest iodine value of 127 followed by RSO 107, RGO 95, RCO 92 and RPO 41 which is due to the more number of double bonds present in the oil. This test gives an indication about the purity of the samples. These values were found to be within the specifications (118-141) of the Agmark and Codex Alimentarius commission[4]. The statistical analysis revealed significant difference ($P \leq 0.01$) between the refined and virgin oils.

Musa *et al*[15]., reported that the refined groundnut oil iodine value 95.20 followed by virgin groundnut oil iodine value 95.87 respectively.

Saponification value

Saponification value is defined as the number of milligrams of potassium hydroxide required to saponify 1g of fat under the conditions specified. It is a measure of the average molecular weight (or chain length) of all the fatty acids present. The long chain fatty acids found in fats have a low saponification value because they have a relatively fewer number of carboxylic functional groups per unit mass of the fat as compared to short chain fatty acids. If more moles of base are required to saponify N grams of fat then there are more moles of the fat and the chain lengths are relatively small.

The results indicated that the saponification value of VPO was highest at 195 followed by VCO 189, VSUO 184, VGO 181 and VSO 180. The RPO had highest saponification value (186) followed by RCO 177, RSUO 174, RSO 172 and RGO 170. The higher the saponification numbers of the oil, the more soluble the soap that can be made from it. The lower value of saponification value in the oil suggest that the mean molecular weight of fatty acids is lower than that of other vegetable oil or that the number of ester bonds is less when compared to that of other vegetable oils.

Free fatty acid

The level of free fatty acids (FFA) depends on time, temperature and moisture content because the oils and fats are exposed to various environments such as storage, processing, heating or frying. Since FFA is less stable than neutral oil, they are more prone to oxidation and to turning rancid. Thus, FFA is a key feature linked with the quality and commercial value of oils and fats. The release of free fatty acids is responsible for the development of undesirable rancid flavour (hydrolytic rancidity). Free fatty acid is more susceptible to oxidation than the glycerol esters of these fatty acids. Therefore, any increase in the acidity of the oil must be absolutely avoided. Free fatty acids (FFA) are produced by the hydrolysis of oils and fats.

The results of the study showed that the limiting value for FFA were found in the refined oil ranging from 0.2 to 1.25 per cent and the virgin oil ranging from 1.70 to 2.47, which was threefold higher than the refined oils. Refining process helps to remove the free fatty acids and hence the lesser values for FFA are seen in refined oil samples. The results indicated that the free fatty acid of virgin oils ranged from 1.70 to 2.47 per cent. The values obtained in the study were found to be within the specifications of Agmark and Codex Alimentarius commission standard[4] for free fatty acid of vegetable oil up to 3.0 per cent level and hence it can be arrived at that virgin oil had the safe level of free fatty acid. The statistical analysis revealed significant difference ($P \leq 0.01$) between the refined and virgin oils respectively.

Kucuk and Caner[12] showed that the free fatty acid value in refined sunflower oil ranged from 0.05 to 0.06 per cent which are similar to the present findings.

Peroxide value

The peroxide value is defined as the amount of peroxide oxygen per 1 kilogram of fat or oil. Traditionally this was expressed in units of milliequivalents, which has been commonly abbreviated as mequiv or even as meq. The peroxide value is defined as the weight of active oxygen contained in one gram of oil of fat. The degree of oxidation of oil also gives an indication of the level of deterioration of oils and fats.

In the study, results indicated that the peroxide value of the refined oil ranged from 2.2 to 6.90 mEq O_2 /kg and the virgin oil ranged from 4.5 to 8.7 mEq O_2 /kg respectively. The result showed that the slight decrease in the peroxide value was observed due to the adsorption reaction of peroxide products with the bleaching agent during the refining process. The VSO had the lowest peroxide value 4.5mEq O_2 /kg and the VCO had the highest peroxide value 8.0 mEq O_2 /kg respectively. This indicated that the traditionally processed virgin oil had a higher peroxide value since they were within the Codex Standard which requires that good quality oil should have a maximum peroxide value of 10 mEq O2/kg.

Colour value

For consumers, color is an important sensory attribute in oil. The L* scale ranges from 0 black to 100 white, the *a** scale extends from *a** negative value (green hue) to a positive value (red hue), and the b scale ranging from negative blue to positive yellow. The L* a* and b* values for refined and virgin oil are summarized in Table 5..

The table showed that the virgin oil colour values were found to range from 33.94 to 56.58 color (as indicated by their lower L* values) compared to the colour value of refined oil which ranged from 71.11 to 86.67. The lightness (L*) of the virgin oil T_1, T_3, T_5, T_7 and T_9 had the mean value of 56.58, 35.92, 39.78, 40.53 and 33.94 respectively. The lightness (L*) of the Refined oil T_2, T_4, T_6, T_8 and T_{10} had the mean value of 86.67, 83.59, 79.45, 71.11 and 82.39 respectively. In general the colour value of virgin oils were found to be closest to the darkness values and refined oil values were found to be closest to the lightness values.

Fatty acid profile

The fatty acid profile provides information on oil nutritional quality. The World Health Organization (WHO) recommends the *n*-6/*n*-3 fatty acid ratio in the diet to be between 5:1 and 10:1[2].

Results indicated that the saturated fatty acid, Lauric acid (47.7%), Myristic acid (19.9%) and Palmitic acid (8.3%) was found to be high in T_1 followed by T_2 Lauric acid (51.02%), Myristic acid (18.94%) and Palmitic acid (8.62%) respectively. The presence of lauric acid (46.458%) was found in coconut oil. This result is in line with Gregorio[10] and Gopala *et al*[9]., who reported that coconut oil was a major source of lauric acid. High dietary intakes of saturated fatty acids is a risk factor for development of obesity, cardiovascular disease[7].

The results indicated that the T_3 fatty acid, oleic (41.5%), linoleic (40.9%) and palmitic acid (9.7%) was found to be high in T_4 followed by T_4 oleic (40.51%), linoleic (36.12%) and palmitic acid (22.48%) the fatty acid profile had some slight changes was found in the refined oils respectively. Nesma *et al*[16]., and Abdulkarim *et al*[2]., observed similar results when they studied the fatty acid composition in virgin sesame oil and refines sesame oil respectively.

The virgin groundnut oil fatty acid, oleic (54.1%), linoleic (36.2%) and palmitic acid (7.5%) was found to be high in T_5 followed by T_6 oleic (44.72%), linoleic (28.43%) and palmitic acid (12.5%) respectively. The virgin sunflower oil fatty acid, oleic (24.0%), linoleic (63.2%) and palmitic acid (8.2%) was found to be high in virgin sunflower oil followed by refined sunflower oil oleic (45.39%), linoleic (46.02%) and palmitic acid (6.52%) respectively.

The virgin palm oil fatty acid, oleic (40.84%), linoleic (18.54%) and palmitic acid (42.70%) was found to be high in T_9 followed by T_{10} oleic (47.34%), linoleic (41.90%) and palmitic acid (11.52%) respectively. Edem *et al*[5]., reported that the virgin palm oil contains 41.02 per cent saturated, 40 per cent monounsaturated and 18.21 per cent polyunsaturated fatty acids followed by refined palm oil had 12.54 per cent saturated, 48.69 per cent monounsaturated and 40.02% polyunsaturated fatty acidsit is clearly showed the refined oil had some changes of fatty acid profile compared to that of the virgin oils.

The total saturated fatty acid was found to be maximum (95.9%) in T_2, while minimum values noted in T_5 (3.84%). The percentage of mono unsaturated fatty acid was found to be maximum (54.1%) in T_5 and minimum (3.84%) in T_2. The percentage of poly unsaturated fatty acid was found maximum (63.4%) in T_7 and minimum (1.28%) in T_2.

Table 1: Preference of various types of oil used for cooking

S. No.	TYPES OF OILS	HOUSEHOLD (n=500)	HOTELS (n=500)	MEAN VALUE (%)
1.	Refined sunflower oil	88 (375)	80 (360)	83.5
2.	Groundnut oil	24 (120)	20 (100)	22.0
3.	Sesame oil	58 (400)	20 (100)	50.0
4.	Coconut oil	12 (60)	10(50)	11.0
5.	Palm oil	38 (190)	56 (280)	47.0
6.	Others (cotton seed oil)	-	5 (25)	2.50

Table 2: Preference of various types of branded oils used for cooking

Name of oil	Brand name of edible oil	Household (%)	Hotels (%)	Mean value (%)
Sunflower oil	Gold winner	60	80	70
	Fortune	8.0	10	9
	Sunland	12	-	6
	Gajapathi	3.0	7	5
	Saffola	6.0	-	3
	Others	12	14	13
Groundnut oil	Mantra	40	10	25
	VVS	16	-	8
	Others	10	20	15
Sesame oil	Idhayam	55	11	33
	Anjali	20	-	10
	Sastha	8	-	4
	VVV Anandha	6	-	3
	VVS	2	5	3.5
	others	10	5	7.5
Coconut oil	M.P.R	30	-	15
	VVD	5	-	2.5
	Others	3	13	8
Palm oil	Roobini	16	-	8
	Others	6	6	6
Cotton seed oil	TRV	-	-	-
	Others	-	5	2.5

Table 3: Buying behaviour and mode of storage of cooking oils (n=500)

S. NO.	PARTICULARS	Households (%)	Hotels (%)	Mean value (%)
1.	**Price of oils (Rs.)**			
	50 - 60	41	62	51.5
	61 – 70	23	19	21
	71 – 80	12	10	11
	81 - 100	10	7	8.5
	101-120	16	-	8.0
2.	**Reasons for buying the oils**			
	Low cost / cheap & best	49	72	64.7
	Taste and quality	84	23	34
	For health aspects	10	-	6.7
	No reasons	-	-	-
3.	**Usage level**			
	Daily	50	50	100
	Weekly	-	-	-
	Monthly	-	-	-
4.	**Buying period**			
	Daily	11	76	58.7
	Weekly	8	7	11.3
	Monthly	81	3	30
5.	**Mode of storage**			
	Tin / can	16	10	16
	Stainless steel	31	10	27.3
	Pet jar / plastic box	11	-	6.7

Table 4: Physico-chemical properties of refined and virgin oil

Sample	Smoke point (°C)		Iodine value		Saponification value		Free fatty acid (%)		Peroxide value (mEq O_2/kg)	
Codex standard	Virgin	Refined	Virgin	Refined	Virgin	Refined	Virgin	Refined	Virgin	Refined
	>170		**118-141**		**188 -194**		**3.0 (max)**		**up to 10 mEq O_2/kg**	
Sunflower oil	173±3.00	227±5.00	135±0.25	127±0.10	184±1.00	174±0.20	1.70±0.30	0.50±0.10	4.9±0.40	3.2±0.20
Sesame oil	148±2.00	170±6.00	115±0.32	107±0.11	180±1.20	170±0.43	1.90±0.20	0.20±0.13	4.5±0.52	2.2±0.29
Groundnut oil	195±2.00	225±3.00	106±0.43	95.0±0.13	181±3.50	172±0.10	1.90±0.10	0.80±0.25	7.7±0.20	4.0±0.08
Coconut oil	108±3.00	127±1.00	98.0±0.41	92.0±0.12	189±9.20	177.5±6.5	2.05±1.50	1.25±4.50	8.00±0.49	6.90±0.17
Palm oil	131±2.00	196±4.00	55.0±0.1	41.0±0.9	193±0.15	186±0.39	2.47±0.15	1.00±0.12	7.48±0.02	6.14±0.06
SED	0.1095	0.1461	0.1491	0.1300	0.1135	32.3188	0.0135	0.0245	0.0735	0.1035
CD (0.05)	0.2441*	0.3254*	0.3322*	0.2896*	0.2530*	72.0111*	0.0301*	0.0546*	0.1637*	0.2307*
CD (0.01)	0.3472*	0.4629*	0.4725*	0.4119*	0.3598*	102.432*	0.0428*	0.0776*	0.2328*	0.3282*

*significant

Table 5: Colour value of refined and virgin oils

Treatments	Lightness (L*)	Chromaticity coordinates	
		a*	b*
T_1	56.58±1.08	11.11±0.85	10.48±2.00
T_2	82.67±2.00	6.32±0.56	25.51±3.80
T_3	35.92±3.10	9.18±1.04	7.89±1.95
T_4	83.59±1.50	5.28±0.43	19.86±1.58
T_5	39.78±1.70	14.47±0.90	6.69±0.40
T_6	79.45±2.21	6.16±0.45	14.13±1.80
T_7	40.53±2.54	16.2±0.78	7.72±0.50
T_8	71.11±1.98	7.39±0.93	12.23±1.20
T_9	33.94±3.05	19.12±1.34	6.24±2.55
T_{10}	82.39±3.56	10.38±0.90	12.68±2.38
SED	0.0726	0.0339	0.0217
CD (0.05)	0.1515**	0.0708**	0.0452**
CD (0.01)	0.2067**	0.0965**	0.0616**

T_1 : Virgin coconut oil; T_5 : Virgin groundnut oil; T_9 : Virgin Palm oil
T_2 : Refined coconut oil; T_6 : Refined groundnut oil; T_{10} : Refined palm oil
T_3 : Virgin sesame oil; T_7 : Virgin sunflower oil
T_4 : Refined sesame oil; T_8 : Refined sunflower oil

Table 6: Fatty acid profile of the virgin and refined oils

Fatty acid	T_1 (VCO)	T_2 (RCO)	T_3 (VSO)	T_4 (RSO)	T_5 (VGO)	T_6 (RGO)	T_7 (VSUO)	T_8 (RSUO)	T_9 (VPO)	T_{10} (RPO)
Caproic acid (**C6:0**)	0.52	ND	ND	ND	ND	ND	ND	ND	ND	ND
Caproic acid (**C8:0**)	7.6	6.21	ND	ND	ND	ND	ND	ND	ND	ND
Capric acid (**C10:0**)	5.5	6.15	ND	ND	ND	ND	ND	ND	ND	ND
Lauric acid (**C12:0**)	47.7	51.02	ND	ND	ND	ND	0.02	ND	0.22	ND
Myristic Acid (**C14:0**)	19.9	18.94	ND	ND	0.04	4.18	0.09	ND	1.44	1.23
Pentadecanoic acid (**C15:0**)	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Palmitic acid (**C16:0**)	8.3	8.62	9.7	22.48	7.5	12.5	8.2	6.52	42.70	47.34
Stearic acid (**C18:0**)	2.7	1.94	6.5	5.0	2.1	4.50	3.8	1.98	5.59	3.39
Arachidic acid (**C20:0**)	ND	ND	0.63	2.42	1.01	2.65	0.21	ND	0.16	ND
Behenic acid (**C22:0**)	ND	ND	0.14	1.06	ND	ND	ND	ND	ND	ND
Palmitoleic acid **C16:1 (n-7)**	ND	ND	0.11	2.90	0.07	4.03	0.12	ND	ND	ND
Oleic Acid **C18:1 (n-9)**	6.2	5.84	41.5	41.51	54.1	44.72	24.0	45.39	40.84	41.90
Linoleic acid **C18:2 (n-6)**	1.6	1.28	40.9	35.12	36.2	28.43	63.2	46.02	18.54	11.03
g-Linoleic acid **C18:3 (n-3)**	ND	ND	0.21	1.54	ND	ND	0.16	0.12	0.45	ND
Eicosenoic acid (**C20:1(n-9)**)	ND	ND	0.32	2.23	ND	ND	0.18	ND	**0.06**	ND
SFA%	**91.4**	**95.9**	**16.9**	**22.48**	**10.7**	**24.52**	**12.4**	**8.51**	42.70	**47.34**
MUFA%	**6.2**	**3.84**	**42.0**	**40.98**	**54.1**	**44.72**	**24.3**	**45.5**	**40.91**	**41.46**
PUFA%	**2.6**	**1.28**	**41.2**	**35.12**	**36.2**	**28.43**	**63.4**	**46.10**	**18.13**	**11.84**

T_1 : Virgin coconut oil; T_5 : Virgin groundnut oil; T_9 : Virgin Palm oil
T_2 : Refined coconut oil; T_6 : Refined groundnut oil; T_{10} : Refined palm oil
T_3 : Virgin sesame oil; T_7 : Virgin sunflower oil
T_4 : Refined sesame oil; T_8 : Refined sunflower oil

CONCLUSIONS

In general, the results of this study indicated that traditionally processed vegetable oils (Coconut, sesame, groundnut, sunflower and palm) meet the recommended Codex standards for the physico chemical properties though most of them were found to be at the margins of the specification requirements. The refined oils were found to have some changes in the fatty acid composition than the virgin oils. This work has also revealed that virgin groundnut oil has higher thermal stability than the other virgin oils. The fatty acid profile plays a key role to the physical and chemical properties therefore this is useful knowledge base for further advanced research.

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