

PREPARATION OF DIFFERENT OIL BLENDS FOR FRYING

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ABSTRACT: *Due to inadequate production of edible oils in Egypt, importation is necessary to meet the demand. Cottonseed oil (CSO), Soybean oil (SBO), Sunflower oil (SFO), and palm olein (PO) are consumed in the refined form and used for some culinary practices including deep-frying and cooking. Blending of oils has many distinctive economic and technological advantages. It avoids the problems of high price, availability and stability.*

The main purpose of this study was to evaluate the quality of four vegetable oils: CSO, SBO, SFO and PO and their blends. The quality attributes including moisture content, refractive index, free fatty acid, peroxide number, anisidine, totox number and induction period measured by rancimat.

The fatty acid profile obtained for investigated oils and their blends showed that (PO) was characterized by lowest content of unsaturated fatty acids compared to CSO, SBO and SFO. The most prominent saturated fatty acid in oils and their blends was palmitic acid where as the corresponding unsaturated fatty acid was oleic acid. However, Blend 2F (50% PO + 35% CSO + 15% SBO) had the highest total saturated fatty acids followed by blend 1F (50% PO + 35% CSO + 15% SFO).

Rancimat results for PO (24 hr) at 110°C was much higher than CSO (11.3 hr) indicating that the stability of PO is about two times the stability of CSO. Using 50% PO increasing the induction period from 11 hrs to 17 hrs (blend 1F), from 11 hrs to 19 hrs (blend 2F), from 11 hrs to 16 hrs (blend 3F), from 11 hrs to 17 hrs (blend 4F).

Prolonged heating up to 60 hr. at 180°C induced regular increments till the end of heating in refractive index, while the acid number were almost tripled the initial values. Peroxide numbers reached their maximum after 40 hrs heating.

The results of acid number and peroxide number revealed that all blends (except blend 4F) could be considered good frying media for potato chips. As such, upon using blend 2F as frying oil, the product was given the highest scores for sensory properties. These advantages will be considered by health-conscious consumers.

Key Words: *Deep-frying, Unsaturated fatty acids, Stability, Physicochemical properties, potato chips.*

INTRODUCTION

With only a limited number of oils and fats available on a commercial scale, it is not surprising that these some times inadequate to meet the physical, nutritional and chemical properties required for use in food products. The technological solutions are blending distillation, fractionation, hydrogenation and inter-estrification with chemical catalyts or with specific lipases and enzymatic enhancement (Gunstone 2002).

However, blending process could be used to improve vegetable oils quality either for salad or frying purposes in this respect blends of palm olein with other vegetable oils can made to improve oxidation stability (Berger 1986 a). The author stated that French regulations dos not permit the description of frying fat to be used for a product containing more than 2 % linolenic acid (Berger 1986 b).

Mostafa *et al* (1994) found that olein could be considered more stable due to its low content of polyunsaturated fatty acids as well as the presence of tocopherols and tocotrinols. Flavor of potato chips fried at different prolonged periods with different Cottonseed oil (CSO 70%) and palm olein (PO 30%) blends received the highest scores. However, the clear liquid blend with higher content of saturated fatty acids was the blend of 80% SFO + 20% PO (Abdel Rahman, 1994).

Meltzer *et al.*, 1981 reported that cyclic and/or oxidized monomers are considered responsible for toxic effects and their formation seams to be proportional to the degree of unsaturation of the fat as well as to the time of exposure to high temperature.

Studies conducted by Combe *et al.* (1981) on non volatile substances with the canalization of the hypatic duct have shown that oxidized monomers are well absorbed (from 25% to 93%) while the absorption of cyclic monomers is very high (from 91% to 96%) but polymers are very poorly absorption.

Landers and rothman (1981). showed that the rate of oxidation of oil during deep frying was roughly proportional to the degree of unsaturation of fatty acid presents thus linolenic acid was much more susceptible than oleic, this explained in part why oils such as soybean and canola which tend to be high in linolenic acids were not considered to be as satisfactory for deep fat frying as oils such as corn which was lower in linolenic acid.

Pokorny *et al.* (1982). reported that the acidity of the oil extracted from fried foods was much higher than that of frying oil for the same length of time. Similer trend was observed for peroxide and benzedine values while the iodine value of the extracted oil was much lower indicated the possibility of an interaction between the oxidation products formed in the frying oil and the surface of the fried foods.

Izaki *et al.* (1984). found that the carbonyl value, acid value and the content of polar materials of heated oil increased markedly during the frying period. The maximum value of carbonyl value and polar materials were

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obtained after 87.5 hrs of heating period while the acid value and viscosity continued to increase with the prolongation of the heating time.

The demand for cottonseed oil has persisted because the oil composition is well suited for frying because of its light golden color, bland, slightly nutty taste and stability, for these reasons cottonseed oil often is the standard against which other oils are compared for odor and flavor Robertson *et al.* (1978); Warner (1988) and King and Marry (1989).

Augustin and Berry (1983) mentioned that the absorbance at 233 nm which measure the degree of primary oxidation of Palm oil showed a trend of increasing diene content with progress in frying time. The increase in absorbance at 268 nm was not commensurate with the anisidine value, the relative rates of formation of ketonic and aldehydic oxidative products coupled with the possibility of volatilization of their products might further contribute to the observed difference between the anisidine value and absorbance at 268 nm.

Deffense (1985) stated that palm oil fatty acid composition include 50% saturated and 50% unsaturated fatty acids, therefore it could readily be fractionated, i.e. partially crystallized and separated into a high melting fraction or stearin and a low melting fraction or olein.

Pazola *et al.* (1983) reported that the indices recommended for the quality assessment of abused frying fats:

- 1) The concentration of petroleum ether insoluble oxidized fatty acids is above 0.7% (or 1.0%).
- 2) The smoke point is lower than 170°C.
- 3) Both odor and flavor are not acceptable.

This study was hence undertaken to:-

- 1- Prepare different blends of indigenous seed oils i.e. cottonseed oil, sunflower oil and soybean oil using palm olein in order to improve the quality aspects towards oxidative stability as cooking and frying oils.
- 2- Study the effect of blending different oils of salad and/or frying on their physical and chemical properties fatty acid profile, unsaponifiable matter percentage and stability using rancimat method.
- 3- Study the effect of blending of different fried oil blends on their physical and chemical properties during heating process at 180°C for 60 hrs and/or frying potato chips at 180°C.
- 4- Evaluate the palatability and flavor performance of frying oil blends during intermittent frying of potato chips.

MATERIALS AND METHODS

Materials:

Oils Palm olein oil, cottonseed oil, sunflower oil and soybean oil were obtained from Extracted Oils and Derivatives Company, 35 Suez Canal St.,

Moharam Bek, Alexandria. All oils samples were stored at Freezer (at 0°C) in dark glass bottles for further analysis.

Frying oils blends:

Four blends of frying oils were prepared.

	Palm Olein	Cottonseed	Sunflower	Soybean
Blend (1F)	50 %	35 %	15 %	-
Blend (2F)	50 %	35 %	-	15 %
Blend (3F)	50 %	25 %	25 %	-
Blend (4F)	50 %	-	-	50 %

Physical Characteristics of oils:

Refractive index was measured using Abbè refractometer (Carl Zeiss JENA, GDR) at 25°C according to the Method of AOAC (2000).

Color Determination A lovibond tintometer was applied to measure the color using 5.25 inch cell according to the method of the A.O.A.C. (1990)

Chemical Characteristics of oils:

Determination of moisture: An appropriate amount of the oil Sample was accurately weighed (Ca.10g) and dried in the oven at 105°C until constant weight was reached as described in the A.O.A.C. (2000).

Acid value (AV), Peroxide value (PV), Saponification Number and Iodine Number (Wijs Method) were determined according to A.O.A.C. (2003). p-Anisidine value (p-AV) was determined as per AOCS (1998).

Totox number: were calculated as follow formula:

$$\text{Totox number} = 2 (\text{peroxide number}) + \text{Anisidine number}$$

Identification of Fatty acid by GC: Methyl esters of fatty acids were obtained according to AOAC (1990). In Extracted Oils and Derivatives Company, 35 Suez Canal St., Moharam Bek, Alexandria, the fatty acid methyl esters were determined by gas chromatography (PERKIN ELMER) models 8400 equipped with flame ionization under the following conditions: Column temperature: 180°C isothermal. Detector flame ionization (FID), Carrier gas Nitrogen, foil gases air 0.5 ml/min and detector temperature 270°C, sensitivity $10^2 \times 16$ and chart speed 2.5 mm/min. The peaks were identified by comparison with pure methyl ester standards through their retention time under identical conditions.

Rancimat method: A 679 Rancimat (Metrohm, Herisan, Switzerland) was used and the experiment was undertaken as described by (Laubli and Bruttel, 1986).

The frying process of potato: The oil was heated to 180°C \pm 5°C potato tubers were peeled, washed and cut into 5.0 x 0.7 x 0.7 cm pieces potato

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slices Bars were soaked in water before fried. The potato slices (200 gm) were strained of water prior to frying the experiment was repeated for 5 subsequent days. Every day potato was fried for five subsequent times for every batch there was a rest period of half an hour. After, the oil turning cool, a sample had been taken for determining refractive index, acid number and peroxide.

Heating oil treatment: Heating temperature Oil had been subjected to C \pm 5 for five subsequent days in an oven dryer aerated by a fan, oil samples were taken after 10, 20, 30, 40, 50 and 60 hours for determining refractive index, acid and peroxide number.

RESULTS AND DISCUSSION

Physical Characteristics of frying oils and their blends:

Physical Characteristics of fresh palm olein (PO), cottonseed oil (CSO), sunflower oil (SFO), soybean oil (SBO) and their frying blends are represented in Table (1). Moisture content of fresh frying oils and their blends ranged "between" 0.012 % to 0.186 %, soybean oil had the lowest content of moisture 0.012 %, whereas palm olein oil had the highest moisture content 0.186 %. While blend (4F) contains the lowest percentage of moisture content 0.030 % compared with other frying blends, since moisture content of Blend (3F), blend (2F) and blend (1F) were 0.051%, 0.139% and 0.047% respectively. The results in Table (1) also show the color of fresh PO, CSO, SFO and SBO was 2.9, 5.9, 1.5, 2.6 red color (at 35 yellow) respectively. Blend (1F) had higher red color 3.9, followed by blend 2F 3.8, blend 3F (2.4) and blend 4F (2.3) red color. Results in the same Table (1) showed that refractive index of fresh oils and their blends ranged "between" 1.4543 to 1.4686.

Table (1): Physical Characteristics of Frying oils and their blends.

Type of Oil	Moisture (%)	Color (Red)	Refractive Index
Palm Olein	0.186	2.9	1.4543
Cottonseed	0.073	5.9	1.4653
Sunflower	0.070	1.5	1.4676
Soybean	0.012	2.6	1.4686
*Blend (1F)	0.047	3.9	1.4616
*Blend (2F)	0.139	3.8	1.4626
*Blend (3F)	0.051	2.4	1.4633
*Blend (4F)	0.030	2.3	1.4613

Results in Table (2) show the chemical characteristic of fresh oils and their blends. Acid number ranged "between" 0.07 to 0.170 %, SBO had the lowest acid number 0.070% followed by PO (0.147%) and CSO (0.167%) while SFO had a highest acid number 0.17% compared with other fresh frying oils. Blend (1F), blend (2F), blend (3F) and blend (4F) of frying oil had the acid number 0.153, 0.147, 0.163 and 0.147% respectively.

Table (2): Chemical Characteristics of Frying oils and their blends.

Type of Oil	Acid number	Peroxide number Meq oxygen/kg	Iodine number	Saponification number	Anisidine	Totox	Unsaponifiable Matter (%)
Palm Olein	0.147	2.283	55.903	195.947	6.20	10.760	0.553
Cottonseed	0.167	0.600	108.863	188.993	3.21	4.410	0.156
Sunflower	0.170	1.050	129.453	187.66	1.89	3.990	0.297
Soybean	0.070	0.823	130.907	190.583	1.83	3.476	0.022
*Blend (1F)	0.153	1.891	86.713	194.913	0.53	4.312	0.347
*Blend (2F)	0.147	2.175	78.487	193.617	0.62	4.970	0.300
*Blend (3F)	0.163	1.994	92.962	194.937	0.85	4.838	0.312
*Blend (4F)	0.147	2.238	92.850	192.687	2.20	6.676	0.258

The peroxide number ranged "between" 0.60 to 2.283 meq/kg of fresh frying oils. It could be noticed from the results that CSO had the lowest quality and the lowest peroxide number (0.6 meq/kg) followed by SBO (0.823 meq/kg), SFO (1.05 meq/kg), and PO (2.283 meq/kg).

Iodine number of fresh frying oils were 55.903, 108.863, 129.453 and 130.907 for PO, CSO, SFO and SBO respectively. this is mainly due to the type of oils related to semi-drying which had iodine number ranging between 90-130 contain a high percent of unsaturated fatty acid (except PO related to non-drying oils) and blending PO with other oils resulted change in iodine number according to the blend percentage.

Saponification number of fresh frying oils ranged "between" 187.66 to (195.947), PO oil had the highest saponification number (195.947) followed by SBO (190.583), CSO (188.993) and SFO (187.66), while blend 4F frying oil had the lowest saponification number compared with other frying oil blends.

The anisidine number determines the level of aldehydes principally 2-alkanols, their present in the oil indicate the formation of secondary oxidative compounds the data in table (2) reveal that the PO showed higher anisidine number (6.2) in comparison to CSO, SFO and SBO which were 3.21, 1.89 and 1.83 blend (1F) frying oil had the lowest anisidine number compared with blend (2F), blend (3F) and blend (4F) frying oils.

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Results in the same table show that totox number of PO had the highest totox number compared with CSO, SFO and SBO which were 4.41, 3.99 and 3.476 respectively.

Unsaponifiable matter ranged between 0.022 to 0.553. PO contained a higher percentage of unsaponifiable matter and frying oils blends changing according to the blend percentage.

Fatty acids composition of frying oils and their blends

Fatty acid composition of fresh frying oils PO, CSO, SFO, SBO and their frying blends are presented in Table (3). Blend (1F): (50% PO + 35% CSO + 15% SFO), blend (2F) (50% PO + 35% CSO + 15% SBO), blend (3F): (50% PO + 25% CSO + 25% SFO) and blend (4F): (50% PO + 50% SBO) are shown in table 3. The most prominent fatty acids in the blends of fresh frying oils were oleic acid (56.1%, 20.05%, 18.68%, and 25.5%), linoleic acid (13%, 62.1%, 74.98%, and 58.5%) and palmitic acid (29.4%, 15.35%, 4.37%, and 6.2%) for PO, CSO, SFO and SBO, respectively. PO had the highest amount of palmitic acid (29.4%) but contained the lowest amount of stearic acid (0.83%) and linoleic acid (13%). SFO had the highest amount of linoleic acid (74.98%) of all fresh oils followed by CSO (62.1%), SBO (58.5%) and PO (13%). The total saturated fatty acids in PO were very high (30.84%) compared to the other fresh frying oils (17.33%, 5.93%, 9.3% for CSO, SFO and SBO, respectively). The most prominent fatty acids in the frying oils blends were palmitic acid (32.78%, 34.17%, 27.98% and 32.68%), oleic acid (33.59%, 31.13%, 34.3%, and 32.48%), and linoleic acid (32.13%, 31.68%, 35.78%, 32.42%), for blend 1F, blend 2F and blend 3F and blend 4F, respectively. Blend 2F had the highest amount of total saturated fatty acids (37.17%) compared with other frying oils blends, blend 1F (33.38%) blend 3F (28.35%) and blend 4F (33.16%). The unsaturated fatty acids in blend 3F were the highest content 71.62% compared with other blend oils (66.82%, 66.59% and 62.81%) for blend 4F, blend 1F and blend 2F, respectively.

Table (3): Fatty acids Composition of Frying oils and their blends.

Type of Oil	% Fatty acids									Total Saturated : Total Unsaturated
	Saturated					Unsaturated				
	C12:0	C14:0	C16:0	C18:0	Total	C18:1	C18:2	C18:3	Total	
Palm Olein	0.17	0.44	29.4	0.83	30.84	56.1	13.00	0.00	69.10	1.00 : 2.240
Cottonseed	0.00	0.19	15.35	1.79	17.33	20.05	62.1	0.49	82.64	1.00 : 4.768
Sunflower	0.00	0.00	4.37	1.56	5.93	18.68	74.98	0.38	94.04	1.00 : 15.85
Soybean	0.00	0.00	6.20	3.10	9.30	25.5	58.5	6.56	90.56	1.00 : 9.737
*Blend (1F)	0.00	0.6	32.78	0.00	33.38	33.59	32.13	0.87	66.59	1.00 : 1.994
*Blend (2F)	0.00	0.00	34.17	3.00	37.17	31.13	31.68	0.00	62.81	1.00 : 1.689
*Blend (3F)	0.00	0.37	27.98	0.00	28.35	34.3	35.78	1.54	71.62	1.00 : 2.526
*Blend (4F)	0.00	0.48	32.68	0.00	33.16	32.48	32.42	1.92	66.82	1.00 : 2.015

The stability of frying oils and their blends

Induction period as determined by the rancimat method represents an effective alternate to assess the oxidative stability of oils as an easy, quick and safe method (Rauen - Migueletal, 1990).

Results of the stability of frying oils namely palm olein, cottonseed, sunflower and SBO and their frying blends as indicated by induction period using rancimat method are presented in table (4).

Table (4): The stability of frying oils and their blends.

Oil/Blend	Induction period at 110^o C in	Relative stability (%)
Palm olein (Po)	24	100
Cottonseed (CSO)	11	45.8
Sunflower (SF)	11	45.8
Soybean (SB)	10.9	45.42
B1F Po/CSO/SF (50/35/15)	17.3	72.1
B2F Po/CSO/SB (50/35/15)	17.24	71.83
B3F Po/CSO/SF (50/25/25)	17.3	72.1
B4F Po/SB (50/50)	17.1	71.25

It is obvious from the obtained data in table (4) that the induction period using rancimat method of palm olein at 110^o C was much higher than that of CSO, as the induction periods at 110^o C were 24 and 11.3 hrs for palm olein and CSO respectively. These findings are coinciding with that found by mostafa (1996). However, induction period of palm olein was found to be the highest one among tested oils such as SFO and SBO (11 hrs and 10 hrs) respectively. This means that the stability of investigated palm olein is about more than twice the stability of other oils. The increase in the induction period of palm olein is due to its high content of both tocopherols and tocotrinols. These natural antioxidants gave palm olein and its blends special and unique advantage of being stable and nutritious furthermore, the high level of tocotrinols and tocopherols in PO encourage the trend of decreasing level of the industrial antioxidants which have some nutritional problems (Mostafa *et al.*, 1993).

The same results revealed also that the oil stability of the blends showed a remarkable increase as a result of using 50% palm olein as the induction period at 110^o C increased from 11 hrs in CSO and SFO to 17 hrs (Blend 1), from 11 hrs to 19 hrs (Blend 2), from 11 hrs to 16 hrs (Blend 3) and from 11 hrs to 17 hrs (Blend 4).

Consequently, blending CSO, SFO and SBO with palm olein improved their oxidative stability. These results are in good agreement with those obtained by Allam (1994), Mostafa *et al.*, 1994 and Wetherit *et al* (1994), Who

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found that fresh palm olein had a much longer induction period (40 hours) than that of other fresh oils olive oil, SFO, SBO (8.2 – 14.8 hours) inducing its oxidative stability.

The relative stability of oils and their blends (R. S.) was calculated and also are presented in Table (4). Hence, it could be noticed that the blends (1) and (3) had the highest relative stability among the investigated oils and blends followed by blend (2), CSO, SFO and SBO since their corresponding values were 71.83, 45.8, 45.8 and 45.42 % respectively.

Effect of heating time at 180°C for 60 hours on some physical and chemical properties of frying oils and their blends.

Palm olein is usually used as frying media; it is of primary importance to study the effect of blending PO with CSO, SFO and SBO on their quality aspects during successive heating at 180°C up to 60 hours.

Results of effect of heating at 180°C for 60 hours on the physical and chemical characteristics of PO, CSO, SFO, SBO and their frying blends: blend (1F): (50% PO + 35% CSO + 15% SFO), blend (2F) (50% PO + 35% CSO + 15% SBO), blend (3F): (50% PO + 25% CSO + 25% SFO) and blend (4F): (50% PO + 50% SBO) are presented in figure (1, 2 and 3).

Change in refractive index

Results in and figure (1) show that the refractive index of fresh PO, CSO, SFO, SBO and their blends ranged from 1.454 to 1.467 at the beginning of the experiment. Refractive index was gradually increased versus heating time being ranged from 1.464 to 1.484 for palm olein and SFO after 60 hours. However, it could be noticed that SFO had the highest refractive index increase whereas palm olein had the lowest increase in refractive index followed by cottonseed and soybean. These results show that the decreasing rate in refractive index of palm olein compared with other investigated oils could be attributed to the high content of natural antioxidants to in palm olein and these antioxidants underwent remarkable decrements during heating of sunflower, soybean and CSO compared to palm olein. The same observation was reported by Du – Plessis *et al* (1981) and Mostafa (1996) upon evaluation CSO and peanut oil for deep frying. On the other hand, blending CSO, SFO and/or palm olein (blends 1, 2, 3 and 4F) led to a decrease in the refractive index of blended oils compared to cottonseed, sunflower and soybean accompanied with only slight and gradual increase in their values during heating process (Blend 4F had the lowest value whereas Blend 3F had the highest).

Therefore, blending of palm olein with other vegetable oils: cottonseed, sunflower and/or soybean kept their characteristics from being deteriorated during heating as refractive index of oil was concerned. These results are in agreement with those reported by Khalil *et al* (1993), Allam (1994), Mostafa (1996) and Khatab (2007).

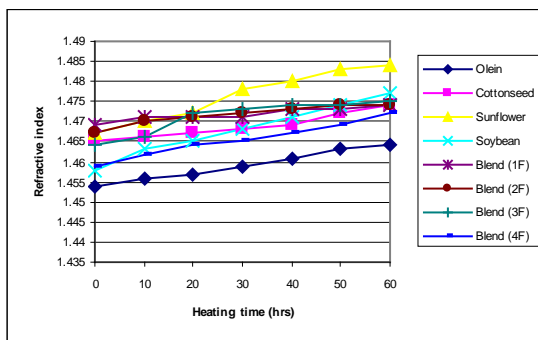


Figure (1): Effect of heating time (hrs) on refractive index of fresh frying oils and their blends.

However, the increase of refractive index of frying oils and their blends by increasing the subsequent heating up to 60 hours at 180°C could be attributed to polymer formation and thermal degradation of the oils during heating process. These observations are coincided with those obtained by Mostafa (1994), Abdel Rahman (1994), Mostafa (1996) and Khatab (2007).

Effect of heating time at 180°C for 60 hours on some chemical properties of frying oils and their blends including acid number and peroxide number are shown in figure (2), (3). However, the developments of such parameters in oils are considered to be highly importance to be used in evaluating the quality of heating oils.

Furthermore, it could be noticed that the rate of increment in acid number of oils and their blends was sharply during the first 20 hour of heating since the acid number of fresh oils: palm olein, cottonseed, sunflower and soybean were 0.14, 0.16, 0.17 and 0.07 respectively. Which increased sharply during the first 20 hours of heating to 1.42, 2.03, 2.29 and 2.99 and increased gradually during the last 40 hours of heating to 4.12, 4.56, 5.10 and 5.23 respectively. The same trend in the rate of increment in acid number of oil blends was observed. Since the acid number of fresh oil blends (1F), (2F), (3F) and (4F) were 0.15, 0.14, 0.13 and 0.11 respectively. Which increased during the first 20 hours of heating to 1.73, 1.89, 1.82, 2.26 and increased after that during the last 40 hours of heating to 4.40, 4.49, 4.42 and 4.73 respectively. The changes in acid number of oils and their blends could be attributed to the formation of peroxides and hydroperoxides after 20 hours heating, thereafter, they broke down to carbonyl compounds some of which contained COOH group causing the increase in acid number (Figure 2). Generally, these results proved high stability of palm olein compared to the other investigated oils. As expected in figure (2) blending cottonseed, sunflower and/or SBOs with palm olein. Improved the acid number value since, after 60 hours of heating. However, blend 3F (50% PO + 25% CSO + 25% SFO) and blend 1F (50% PO + 35% CSO + 15% SFO) are considered the best ones to be used as frying oil.

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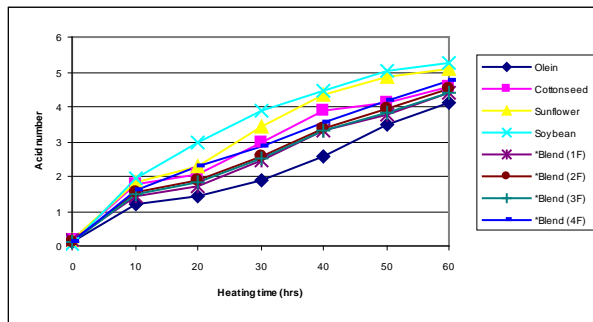


Figure (2): Effect of heating time (hrs) on acid number of fresh frying oils and their blends.

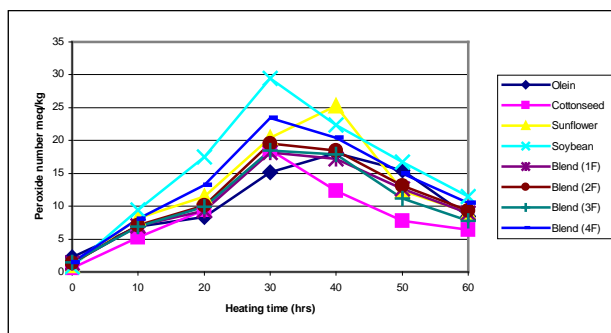


Figure (3): Effect of heating time (hrs) on peroxide number of fresh frying oils and their blends.

The increase in acid number due to successive heating or frying of oil was also observed by El-sharkawy (1979), Allam (1994) and Mostafa *et al* (1994). Meanwhile, Galal *et al* (1992) and Khatab (2007) indicated that these was a gradual increase in acid number from 0.3 for fresh SFO to 1.9 after 48 hours accompanied by a gradual decrease in smoke point during frying. In addition, Mostafa (1987) found that heating of peanut oil caused an increase in acid number due to the formation of both acidic compounds and free fatty acids. Also, oxidized fatty acids formed as a result of heating and increased markedly with increasing heating time. This phenomenon was noticed during heating of oil blends Khatab (2007).

It is evident from Figure (3) that heating the fresh oils and their blends up to 180°C increased their peroxide number. It could be observed also that the peroxide number gradually increased after being heated for 30 hrs and

followed by a sharp decrease after 60 heating hours. These results indicate that peroxides are formed during the first 30 hours of heating and after that they usually decompose or polymerize.

The same observation was reported by Allam (1994) and Mostafa (1996). However, Lesizkiewicz and Kasperk (1988) attributed the drop in peroxide number not due to decomposition of peroxides, but to the decrease in the rate of oxidation and/or acceleration of polymerization reaction. Generally, results obtained, indicate that oxidation had occurred to a greater extent in soybean, sunflower, cottonseed more than in palm olein. This could be explained by the difference in the composition of investigated oils in respect to polyunsaturated fatty acids and natural antioxidant. Therefore, as expecting, blending cottonseed sunflower and/or soybean with palm olein improved their oxidative stability during heating process at 180°C up to 60 hrs, since the rate of increase in peroxide number of blended oils was lower than that of frying oils. However, blend (3F): (50% PO + 25% CSO + 25% SFO) and blend (1F): (50% PO + 35% CSO + 15% SFO) were considered the best ones to be used as frying oil.

Effect of frying time (day) on some physical and chemical properties of frying oils and their blends

Physico-chemical properties of frying oil blends

The Physico-chemical properties of frying oil blends incorporated in potato frying process for subsequent 5 days are presented in figure (4, 5 and 6).

These results reveal that the refractive index values increased with increasing the frying time of all blends. Increments percentages were almost always the same in all blends. Acid number also increased with increasing frying time. Results in figure (5) show the changes in acid number for fresh frying oils palm olein, cottonseed, sunflower, SBO and their blends after 5 days of frying. The amount of free fatty acid in oils can be used to indicate the extent of its deterioration due to hydrolysis of triglycerides and/or cleavage and oxidation of fatty acid double bond. Although the initial acid number of the fresh frying oils was different (0.14, 0.16, 0.17 and 0.07) for palm olein, cottonseed, sunflower and soybean oil, respectively. After one day frying SBO had the highest acid number 1.61 compared with fresh frying oil palm olein 0.85, CSO 1.06 and sunflower 0.99. PO had the lowest acid number 1.59 after three days of frying followed by 2.43, 2.63 and 2.95 for CSO, SFO and SBO, respectively. Changes in acid number over 5 days frying period from the initial values for fresh oils palm olein; 0.14 - 2.39 was lesser followed by CSO; 0.16 - 2.7 and SFO; 0.17 - 2.92, however higher changes were found in SBO; 0.07 - 4.17.

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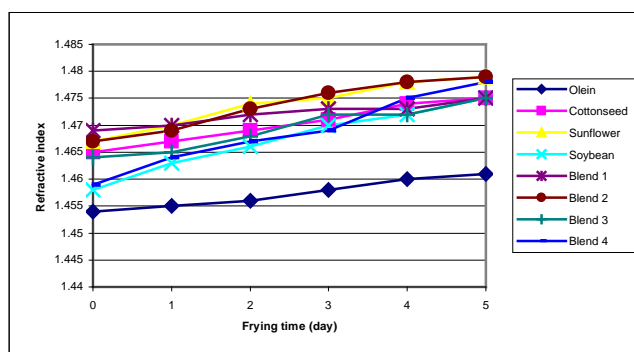


Figure (4): Effect of Frying time (day) on refractive index of fresh frying oils and their blends.

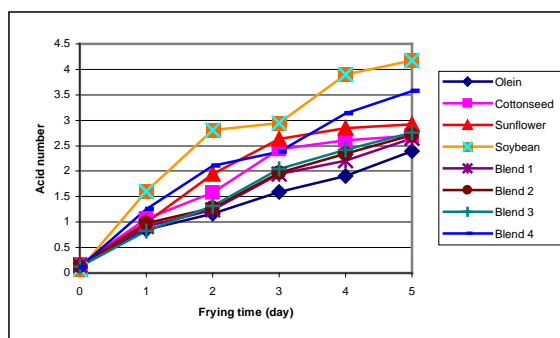


Figure (5): Effect of Frying time (day) on acid number of fresh frying oils and their blends.

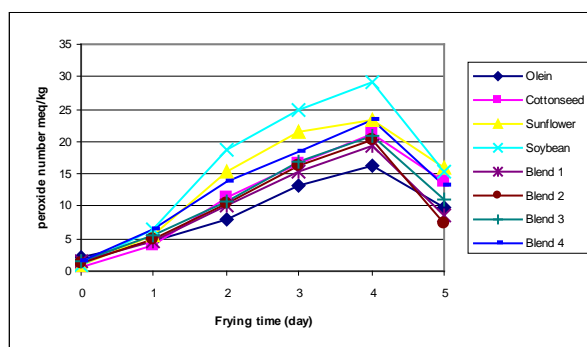


Figure (6): Effect of Frying time (day) on peroxide number of fresh frying oils and their blends.

Acid number in frying oil blends were as follows: 0.11, 0.13, 0.14 and 0.15 for blend 4 frying, blend 3F, blend 2F and blend 1F, respectively. There was an increasing trend in acid number in all oils with increasing frying time from day 0 to day 5. There was an initial sharp increase in the acid number for blend 4F from 0 day to one day frying while blend 3F, blend 2F and blend 1F showed a gradual increase throughout the frying time from day 0 to fifth day of frying the increase in the acid number content could be caused by the increase in rate of hydrolysis when water is introduced into the frying system by the potato crisps. Changes in acid number over the 5 days period from the initial values for blend 4F; 0.11 – 3.57 was the larger followed by blend 3F; 0.13 – 2.76 and blend 2F 0.14 – 2.71 but lesser changes was found in blend 1F; 0.15 – 2.65. The initial acid number was around 0.14 for blend 2 and 3 but it reached 0.16 for blend 1 and 0.153 for blend 4, however percent increment after 5 days of potato frying process was obvious for blend 4 followed by blend 1, blend 2 and blend 3. however all the blends could be considered good frying oils since the acid number did not reach 2 according to Mankel (1970) who stated that oils should be considered spoiled when the acid values were more than 2. Olieman (1983) also considered the frying fat could be rejected when its acid number exceeded 2.5.

Peroxide number is a measure of the amount of peroxides formed in oils through autoxidation and oxidation processes. Results in Figure (6) show the changes in peroxide number for fresh frying oils and their blends from day 0 to day 5. There was an initial sharp increase in the peroxide number for SBO from day 0 to day 1 while PO, CSO and sunflower showed a gradual increase throughout the frying time (day) peroxide number in day 2 frying of palm olein, cottonseed, sunflower and SBO were 8.13, 11.41, 15.33, and 18.71 meq oxygen/kg, respectively. PO had the lowest change content of peroxides after day 3 (13.09 meq/kg) followed by CSO (16.64 meq/kg), SFO 21.43 meq/kg, and SBO 21.43 meq/kg. Rapid increase in peroxide number in SBO and SFO showed the oils to be very unstable to oxidative degradation. This was largely due to the highest percentage of linoleic acid in the two oils. The lower peroxide number of palm olein in day 4 compared with other oils mainly due to the higher total unsaturated fatty acid content of palm olein compared with other fresh frying oils.

Peroxide number alone is not a suitable parameter to assess the extent of fats and oils deterioration. Increase in the peroxide number during frying period indicates increased formation of peroxides due to oxidation. However, peroxides are unstable under deep-frying conditions, at the frying temperatures and as oil deterioration continues the hydroperoxides decomposes forming carbonyl and aldehydic compounds causing the peroxide value to decrease. This is the reason why the amount of peroxides in the oil cannot be used to estimate the extent of oil deterioration.

Results in Figure 6 also show the change in peroxide number of frying oils blends during frying time (day). There was an increase in peroxide

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number in all oils with increasing frying time from day 0 to day 5. Blend 1F had the lower peroxide number 4.62 meq/kg after one day frying compared to blend 2F, blend 3F and blend 4F which were 4.78, 5.38 and 6.43 meq/kg, respectively. Blend 4F had the highest peroxide number 13.72 meq/kg after 2 day frying followed by blend 3F 10.84 meq/kg, blend 2F 10.34 meq/kg and blend 1F 10.21 meq/kg. The highest peroxide number throughout the frying days found in blend 4F after 4 day frying followed by blend 3F, blend 2F and blend 1F which were 20.81, 20.34 and 19.45 meq/kg.

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تحضير مخاليط مختلفة من الزيت للتحمير

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الملخص العربي

بالنسبة إلى عدم إكتفاء الزيوت فى مصر كان من الضرورى إستيراد الزيوت لتقابل الطلب. زيت بذرة القطن (CSO) زيت فول الصويا (SBO) زيت عباد الشمس (SFO) وزيت النخيل (PO) يستهلك فى صورة مكررة ويستعمل فى شئون المطابخ وتشمل التحمير العميق والطبخ. وخط الزيوت لها كثير من المزايا الإقتصادية والتكنولوجية الواضحة حيث تتجنب إرتفاع الأسعار وعدم التواجد وثباتية الزيوت.

والغرض الأساسى من هذه الدراسة هى لتقدير جودة أربعة زيوت نباتية زيت بذرة القطن (CSO) زيت فول الصويا (SBO) زيت عباد الشمس (SFO) وزيت النخيل (PO) ومخاليطهم وعلامات الجودة تتضمن المحتوى الرطوبى ومعامل الإنكسار والأحماض الدهنية الحرة ورقم البيروكسيد ورقم الأنيزيدين ورقم التوتوكس وفترة التحضين التى تقاس بجهاز الرانسيمات .Rancimat

وشكل الأحماض الدهنية للزيوت ومخاليطها تبين أن زيت النخيل (PO) يحتوى على أقل محتوى من الأحماض الدهنية الغير مشبعة إذا قورن بواسطة زيت بذرة القطن وزيت فول الصويا وزيت عباد الشمس ومن الأحماض المشبعة الأكثر شيوعاً فى الزيوت ومخاليطها هو حامض البالميتيك فى حين أن الحمض الدهنى الغير مشبع الأكثر شيوعاً هو حامض الأوليك فى حين أن مخلوط (2F) والذى يتكون من (٥٠% زيت نخيل + ٣٥% زيت بذرة قطن + ١٥% زيت فول الصويا) يحتوى على أعلى نسبة من الأحماض المشبعة يتبعها مخلوط (1F) والذى يتكون من (٥٠% زيت نخيل + ٣٥% زيت بذرة قطن + ١٥% زيت عباد الشمس).

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ونتائج جهاز الرانسيمات Rancimat لزيت النخيل (PO) هي ٢٤ ساعة على درجة ١١٠م كانت أكثر ارتفاعاً من زيت بذرة القطن (CSO) ١١.٣ ساعة وهذا يعنى أن ثباتية زيت النخيل (PO) مرتين مثل زيت بذرة القطن (CSO) وعند استعمال ٥٠٪ من زيت النخيل يجعل فترة التحضين تزيد من ١١ ساعة إلى ١٧ ساعة (مخلوط 1F) ومن ١١ ساعة إلى ١٩ ساعة (مخلوط 2F) ومن ١١ ساعة إلى ١٦ ساعة (مخلوط 3F) ومن ١١ ساعة إلى ١٧ ساعة (مخلوط 4F).

والتسخين لمدة ٦٠ ساعة على درجة ١٨٠م تزيد بالزيادة المنتظمة حتى نهاية التسخين بالنسبة لمعامل الإنكسار فى حين رقم الحموضة يزداد إلى ثلاثة أضعاف القيمة الابتدائية فى حين أن قيم البيروكسيد تصل إلى القمة بعد ٤٠ ساعة من التسخين.

ونتائج رقم الحموضة ورقم البيروكسيد تبين أن جميع المخاليط ماعدا مخلوط (4F) ممكن أعتبارها زيوت جيدة لتحمير رقائق البطاطس. وعلى ذلك عند استعمال مخلوط (2F) كزيت تحمير فإن المنتج يعطى أعلى درجات للصفات الحسية وهذه المميزات سوف تؤخذ فى الإعتبار بواسطة المستهلك الحذر صحياً.