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SOME VEGETABLE OILS, BUTTER FAT AND THEIR BLENDS: PH7YSICO-CHEMICA PROPERTIES AND EFFECT OF DEEP FRYING THEREON.

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ABSTRACT

Three different oils, namely palm oil (P.O.), corn oil (C.O.) and sunflower oil (S.O.) along with butter fat "ghee" (B.F.) were investigated to explore their heat stability during deep frying of French fries. Moreover, five blends of the aforementioned oils and B.F. were formulated as follows: Blend 1 (1 PO + 2 CO + 3 SO + 4 BF), Blend 2 (4 PO + 3 CO + 2 SO + 1 BF); Blend 3 (2 PO + 1 CO + 3 SO + 4 BF); Blend 4 (3 PO + 4 CO + 1 SO + 2 BF) and blend 5 (1 PO + 2 CO + 4 SO + 3 BF). Oils, BF and their blends were continuously heated at 180°C for 8 hours. Samples of each oil and blend were with drawn at 2, 4, 6 and 8 hours of deep frying and analyzed. Data indicated that refractive index, viscosity, peroxide value, free fatty acids were found to significantly increase as the time of frying was proceeded. In contrast iodine value, was found to decline as frying time was prolonged.

Oils and blends exhibited different patterns of solid fat content (SFC) and fatty acid composition and to some extent different colour as measured by Lovibond Tintometer. Meanwhile, sensory evaluation of the five oil blends under study did not reveal any significant variation. In the light of data presented here, it can be concluded that the blends under investigation can be applied in deep frying process up to 8 hours without significant deterioration in their qualities.

INTRODUCTION

Frying means the cooking of food in hot, liquid medium at temperatures between 140 and 200°C. Meanwhile, a number of nations have published their own standards for frying fat and oils. These national regulations include criteria like acid value, polymer concentration, oxidized fatty acids or polar materials, as well as physical characteristics like viscosity, colour and foam. The history of deep-frying fats and oils is not yet finished as demonstrated the new developments of quick tests and the idea of optimum frying. Fried foods are very popular all around the world and comprises a wide variety of different products. The chemical composition of oils and fats determines their functions since these lipids become part of the fried products, Factors like the melting point and the solid fat content may contribute a lot to the palatability and appearance of fried foods. The visible changes taking place in a fat or oil during frying include color darkening, increased viscosity and foaming increments and smoke point reduction (Gere, 1983).

Fried food quality and, hence, its sensory, properties are affected by a number of parameters including the type of oil and its chemistry or quality. Once frying operation starts, the quality of that oil begins to change, but the

bottom line is that sensory properties of the food are directly affected by the changes in oil quality (Stier, 2000).

Individual descriptions and analyses of the effects of frying processes can be found in articles on potato chips/crips (Mottur, 1989), flavour volatiles (Chang *et al.*, 1978), polymers (Walking *et al.*, 1975; Christopoulou and Perkins, 1989), oil quality control techniques (Fritch, 1981, Paradis and Nawar, 1981), and oil oxidation products (Frankel, *et al.*, 1984, Nawar, 1985). Other properties start low and end up with high values, an example is viscosity (Rock and Roth, 1966). In addition, the initially low colour or ultraviolet absorption spectrum dramatically increases, although the quantitative amount of chemicals causing the increase in colour is very small (Paradis and Nawar, 1981).

On the other hand, composition of a frying fat or oil has a significant effect on the flavour of fried food (Pokorny, 1989; El-Sayed, 2003). The food fried in modified oils contained of 42% to 63% oleic acid and 23% to 37% linoleic acid produced fried food with the best flavour stability (Nawar, 1982).

The main objective of the present study was to follow up the changes occurred due to frying process in some oils and oil blends, commonly used in Egypt. Measurement of such changes can help in terms of elucidating the most oil blends suitable for frying.

MATERIALS AND METHODS

Materials:

Representative samples (35 kg each) of three different oils were kindly secured from Extracted Oils and Derivative Company, Alexandria, Egypt. The oils are palm oil (P.O.), corn oil (C.O.) and sunflower oil (S.O.). Fresh Butter ghee (B.F.) was purchased from a farmer in Tanta City, Egypt.

Blends:

The aforementioned three vegetable oils along with butter ghee were blended at different ratios to formulate 5 blends shown in Table (1).

Table (1): Blending ratios of some vegetable oils and butter fat (ghee) (W/W).

Oil Blends				
(1)	(2)	(3)	(4)	(5)
1 P.O.	4 P.O.	2 P.O.	3 P.O.	1 P.O
2 C.O.	3 C.O.	1 C.O.	4 C.O.	2 C.O.
3 S.O.	2 S.O.	3 S.O.	1 S.O.	4 S.O.
4 B.F.	1 B.F.	4 B.F	2 B.F.	3 B.F.

Methods:

Frying process:

Potato French fries were deeply fried in each of the three vegetable oils under study as well as butter ghee, individually. Meanwhile, the fingers were fried in each of the oil blends mentioned previously in Table (1). A

constant weight of 5 kg of each oil or blend was used in frying process at 180°C for 10 minutes. For each batch of potato fingers Frying was carried out continuously for 8 hours without a replenishment of oil amount that absorbed by potato fingers. Oils blend was heated without agitation in aluminum frying pan at 180 + 5°C at ordinary atmospheric pressure. The oil temperature was controlled during heating by immersing a thermometer into the heated oil.

Analytical Methods:

Physical characteristics were determined for unheated and heated (at 180°C for 8 hrs.) oils and blends. Also, after every 2 hours of heating, a representative sample was with drawn, cooled and subjected to the same tests.

Physical methods:

Refractive index (RI):

Abbe refractometer was used to determine the refractive index (RI) according to International Union of Pure and Applied Chemistry "IUPAC" (1979). The constant temperature range (25-40°C) was achieved by holding the refractometer and the samples at such range during measurement using thermostatically controlled water bath supported with circulation pump to maintain the temperature within the prescribed range + 0.5°C. The refractometer was able to measure the refractive index to + 0.0001 within the range of 1.3000-1.7000

Viscosity :

Viscosity was measured using Brokfiled viscometer (at 40°C). The method described by A.O.C.S (1964) was followed where viscosity was measured in centipoise/s. Measurements include unheated and heated.

Colour :

The colour of oil was estimated using a Lovibond Tintometer (model E) using a (5-25) cell following the procedure described by Youssef *et al.*(1989).

Chemical methods:

Fatty acid composition:

Fatty acid composition was determined by conversion of the triglycerides to fatty acids methyl ester (FAME) using boron trifluoride (BF_3) methanol reagent according to International Organization for Standardisation (ISO) method (1978), the resultant FAMEs were analysed by GLC under the following conditions:

Gas chromatography: Perkin-Elmer 4800 fitted with a flame ionisation detector.

Column and packing materials: Nukol fused silica capillary column, 15 m X 0.53 mm i.d. 0.5 Um

Column temperature: 220°C.

Injector and detector temperature: 300°C Helium as carrier gas at a flow rat: 13 ml/min.

Solid fat content (SFC):

The solid fat content (SFC) was determined by Pulsed Nuclear Magnetic Resonance (NMR) using the computerized Bruker Minispec PC 120, West Germany. Sample of three grams of fat was melted at 80°C, stabilized and tempered according to Waddingten (1983).

Free fatty acids (FFA):

Percentage of free fatty acids was determined by alkaline titration according to IUPAC (1979), in which oleic acid represents the predominant and fatty acid for all fresh oils and oils blends free fatty acids = acid value x 0.503.

Iodine value (IV):

The Wig's method (AOCS, 1983 official method) was used to determine the iodine value.

Peroxide value :

Peroxide value was determined following the method of the A.O.A.C. (1980) using potassium iodate thiosalfate solution 0.1 N. Peroxide value was measured as meq/kg of oil or oil blend.

Sensory evaluation:

Five oil blends (fresh) were organoleptically evaluated by 13 well-trained panelists. They were asked to evaluate-each of colour, consistency and oiling out, using the following hedonic scale: 1-2 (Very poor), 3-4 (Fair); 5-6 (Good); 7-8 (Very good) and 9-10 (Excellent), (Kramer and Twigg, 1963).

Statistical analysis:

Data were subjected to analysis of variance (ANOVA) and multiple correlation analysis as out lined by Snedicor (1958). Further multiple comparison of means for each constituent or property was conducted by Duncan's multiple-range test.

RESULTS AND DISCUSSION

Refractive index:

Data given in Table (2) indicate that refractive indices of the four lipids under study varied from 1.4517 (Butter fat) to 1.4650 (corn oil). These values are in accordance with Codex Standards (1993).

Moreover, data presented here cope with the degree of unsaturation of the three oils and butter fat under study, since the more unsaturated fatty acids, the higher the refractive index of the oil. On the other hand, refractive indices were found to increase as the frying time was elongated. This was true for all lipids as well as their blends formulated in the present study. Such an increase in refractive index, elucidate formation of high molecular compounds via polymerization that can take place as a result of frying (Chang *et al.*, 1978).

Table (2): Refractive index of oils, butter fat and their blends, as affected by heating (180°C, 8 hrs)..

Frying time (hrs)	Frying time at (180°C) (hrs)				
	O	2	4	6	8
Oils:					
P.O.	1.4552	1.4573	1.4592	1.4592	1.4592
C.O.	1.4650	1.4690	1.4695	1.4698	1.4699
S.O.	1.4642	1.4692	1.4701	1.4701	1.4705
B.F.	1.4517	1.4567	1.4568	1.4570	1.4571
*Blends:					
(1)	1.4583	1.4588	1.4595	1.4595	1.4595
(2)	1.4578	1.4584	1.4597	1.4597	1.4608
(3)	1.4572	1.4589	1.4594	1.4594	1.4698
(4)	1.4602	1.4608	1.4676	1.4680	1.4723
(5)	1.4593	1.4695	1.4698	1.4698	1.4702

*** Blends were formulated as shown in Table (1).**

Viscosity :

The oils and butter fat under study varied in terms of their viscosities (Table 3). Butter fat (ghee) had the lowest viscosity (43.0 centipoise) while palm oils possessed the highest viscosity (81.6 centipoise). It is well known that viscosity of oils and fats can be applied as a good indicator of oil or fat ability to form lubricant films. There is a reverse relationship between unsaturation degree and the viscosity of oil or fat (Foda, 1998).

It was quite clear that viscosity of oils and blends increased as the frying time was elongated. Such an effect was much pronounced for blends than oils. Data in this respect are in accordance with numerous research papers and studies (Kun, 1988; EL-Shami *et al.*, 1992; Foda, 1998).

Table (3): Viscosity of fresh oils, butter fat and their blends as affected by deep frying at 180°C, 8 hrs.

Frying time (hr)	0	2	4	6	8
Oils					
P.O.	81.6	87.8	89.60	91.01	92.50
C.O.	68.4	73.5	80.60	86.90	99.01
S.O.	66.4	73.4	88.30	92.10	100.3
B.G.	43.0	55.1	60.45	67.20	80.70
*Blends					
(1)	64.00	80.40	100.4	124.0	140.0
(2)	63.40	86.60	102.4	157.2	205.2
(3)	70.40	11.4	142.2	168.0	210.0
(4)	66.40	80.40	103.2	166.0	244.4
(5)	66.40	84.40	100.0	121.0	141.6

*** Blends were formulated shown in Table (1).**

Colour :

Table (4) gives the Commission International de L'Eclairage C.I.E. chromaticity co-ordinates (X, Y and Z). It was obvious that X value (Red) increased as the frying time was proceeded, for all oils and blends investigated in the present study. It is worth to mention that butter fat exhibited Z (Blue) value at zero time.

Blend 1 exhibited Z value at zero time, while Blends 2 and 3 possessed Z value after 2 hours of frying. On the other hand, Blends 4 and 5 did not explore the blue colour before 6 hours of frying.

Data presented here with respect to colour, confirm data published by many authors revealing that colour of oils and their blends undergo darkening as the frying process is prolonged (Perkins,1960; Fritsch, 1981; Peers and Swoboda, 1982; Min and Schweizer, 1983; Foda, 1998; Youssef *et al.*, 1989 and Clark and Serbia, 1991).

Fatty acid composition:

Table (5) gives the fatty acid composition of the three fresh oils and butter fat along with their five unheated blends formulated in the present study. As it can be noticed, palm oil exhibited the highest palmitic acid (38.41%), while butter fat (ghee) possessed the highest stearic acid (16.04%). On the other hand, palm oil was found to contain the highest oleic acid (43.98%) followed by butter fat (33.33%) then corn oil (31.15%) while sunflower oil was tailed behind in this respect (25.1%). The point of interest is that sunflower oil possessed 50.4% of linoleic acid (Table 5).

Data presented here are in accordance with the fatty acid composition published by many authors (Alexander, 1978; Telingai Asap and Augustin, 1986 and Yoon *et al.*, 1987). The five blends as it is suspected varied in terms of their fatty acid composition. In general, palmitic acid comprised a portion ranged between 21.93% (Blend 4) to 30.9% (Blend 1). On the other hand, (Blend 5) exhibited the highest oleic acid content (32.27%) on contrary to (Blend 1) which possessed the lowest oleic acid content (27.36%). Meanwhile, linoleic acid comprised 37.52% of fatty acid present in (Blend 4) being the highest, while (Blend 1) contained the lowest content of linoleic acid (26.27%).

Solid fat content (SFC):

solid fat contents of fresh oils, butter fat and their unheated blends formulated in the present study are given in Table (6). It was abvious that palm oil possessed higher solid fat content than butter fat "ghee" at all temperatures examined. Notwith- standing, blends 1, 4 and 5 explored better melting behaviour than blends 2 and 3 did. Decrease in SFC is known to be attributed to decline in the proportion of higher melting triacylglycerols (i.e. fatty acid composition) in the blends. Data in this regard are in accordance with data published by Agoub *et al.* (1999). In other words, to formulate oil blends suitable for frying process, it is advisable in the light of data presented here to blend 1 P.O. + 2 C.O. + 3 S.O. (Blend 1) followed by blending 3 P.O. + 4 C.O. + 1 S.O. + 2 B.F. (Blend 4) and finally in descending order to formulate a blend consisting of 1 P.O. + 2 C.O. + 4 S.O. + 3 B.F. (Blend 5).

Table (4) Colour of oils and butter fat and their blends as affected by deep frying at 180oC for different periods.

Frying time	Oils												*Blends														
	P.O.			C.O.			S.O.			B.F.			1			2			3			4			5		
	blue	red	yellow	blue	red	yellow	blue	red	yellow	blue	red	yellow	blue	red	yellow	blue	red	yellow	blue	red	yellow	blue	red	yellow	blue	red	yellow
0		3.6	20		2.1	20		0.4	20	0.2	1	20	0.2	1.1	20		2.1	20		1.7	20		1.3	20		2.3	20
2		4	20		2.4	20		3.6	20	0.2	3.1	20	0.1	4	20	0.1	3.6	20	0.7	4.5	20		4	20		5	20
4		5	20		3.1	20		5.1	20	0.2	5.1	20	0.1	4.1	20		4.2	20	0.1	4.9	20		4.1	20		5.3	20
6		6.9	20		6.7	20		6.9	20		9.8	20	0.3	6.7	20	0.2	6.5	20	0.3	6.9	20	5.1	10.3	20	1.7	10	20
8		9	20		11.1	20		11.1	20		12	20	0.3	9.3	20	3	11	20	3.1	10	20	6.3	13.4	20	5.1	14	20

* Blends were formulated as shown in Table (1).

Table (5): Fatty acid composition of fresh oils, butter fat and their unheated blends.

Fatty Acids	C12:0	C14:0	C16:0	C17:0	C18:0	C18:1	C18:2	C18:3	C20:0	C10:0	C15:0
Oils											
P.O.	0.47	1.64	38.41	0.95	4.41	43.98	9.41	-	0.32	0.13	0.28
C.O.	0.15	0.46	21.02	6.08	7.78	31.15	32.16	-	1.20	-	-
S.O.	-	0.36	13.28	5.43	5.43	25.10	50.40	-	-	-	-
B.F.	1.80	3.7	29.6	2.77	16.04	33.33	1.80	-	4.69	-	-
*Blends											
(1)	0.94	5.44	30.90	0.60	5.61	27.36	26.27	-	0.72	0.86	1.20
(2)	0.37	2.07	28.41	0.61	3.79	31.40	31.05	-	1.30	0.51	0.49
(3)	0.94	5.35	25.72	1.25	5.59	29.69	28.23	-	1.11	1.04	1.04
(4)	0.68	3.29	21.93	0.49	5.36	28.75	37.52	-	0.86	0.61	0.86
(5)	0.67	2.69	26.20	0.77	4.10	32.27	31.74	-	0.74	0.64	0.36

*** Blends were formulated as shown in Table (1).**

Table (6) : Solid fat content (SFC) of fresh oils, butter fat and their unheated blends.

Sample Temp.	Oils				*Blends				
	P.O	C.O	S.O	B.F	1	2	3	4	5
5	52.16	-	-	50.05	15.83	17.85	17.91	12.61	14.38
10	50.46	-	-	45.69	14.92	16.12	17.76	10.89	14.01
15	44.91	-	-	34.45	13.88	15.52	17.82	10.52	13.94
20	32.71	-	-	23.69	10.12	12.15	13.41	8.21	9.81
25	21.61	-	-	14.65	5.29	6.68	6.9	4.35	4.06
30	12.4	-	-	8.15	1.09	3.42	2.98	1.56	2.01
35	6.71	-	-	2.56	-	0.56	0.22	-	-
40	2.01	-	-	0.42	-	-	-	-	-
45	0.12	-	-		-	-	-	-	-

*** Blends were formulated as shown in Table (1).**

Free fatty acids:

Table (7) gives the free fatty acids (FFA) of oils and butter fat and their blends under study. It was obvious that FFA contents of unheated oils and their blends were almost comparable ranging between 0.08 and 0.45%. In contrast, heating of oils and their blends resulted in significant increases in FFA contents. It was clear that palm oil and corn oil exhibited higher heat stability than sunflower oil and butter fat. The point of interest is that deterioration of all oil blends was less than that occurred in the oils from which these blends were formulated. Data presented here indicate that the oils under study underwent severe hydrolytic rancidity after two hours of heating at 180°C. But, oil blends under study did not undergo severe hydrolytic rancidity even after 8 hours of heating at 180°C.

The increase of FFA as a result of heating may be due to formation of some polar compounds (such as fatty acids) as a result of oil degradation (Yates and Cald-well, 1993). Moreover, it was reported that FFA are formed during frying process by both oxidation and hydrolysis (Stevenson *et al.*,

1984). Meanwhile, steam which is generated during frying process leads to slight elevation in FFA content (Berger, 1988).

Iodine value (IV):

Data given in Table (8) reveal that the iodine value was found to decrease as the time of frying at 180°C was prolonged. This was true for both oils and their blends. The differences in iodine value of the oils and blends used in frying here are considered as an indicator of the increased rate of oxidation during fryings as reported by Augustin and Berry (1983).

Data presented here concerning the decline in iodine value as a result of heating are in agreement with numerous published studies (Simon Aziz, 1982; Augustin and Berry, 1983; Youssef *et al.*, 1989).

Peroxide Value (P.V.)

Data presented in Table (9) reveal that the peroxide value of all oils increased as a result of heating applied in the frying process at 180°C. This was also true for all oil blends tested in the present study with an exception of 4 hours frying period at which values were found to decline.

Such as a decline can be attributed to destruction of peroxides by heating. Data in this regard are in accordance with data published by Foda (1998).

Sensory evaluation of oil blends:

Data presented in Table (10) show that the fresh five oil blends under investigation exhibited almost comparable acceptabilities as judged by panelists. The sensorical characteristics which were examined included colour, consistency and oiling out. Consequently, the five blends under study are suitable in general to be used in deep frying process. On the other hand, our previous work (El-Sayed, 2003) on the same oil blends indicated that despite some diversity in quality of French fries fried in different blends, data revealed that potato French fries were significantly deteriorated by frying in all reheated oils and their blends. It was obvious that as reheating time was proceeded, the quality of French fries was dramatically declined.

Table (7): Free fatty acids of oils , butter fat and their blends as affected by deep frying at (180oC) for different periods.

Frying time (hrs)	Free fatty acids % of oils and oils blends				
	0	2	4	6	8
Oils :					
P.O.	0.17^{ABc}	0.69^{ABb}	0.89^{Ab}	1.30^{Ba}	1.70^{Ba}
C.O	0.17^{ABd}	0.52^{Bc}	1.12^{Cb}	1.30^{Bb}	1.91^{Ba}
S.O.	0.08^{Bd}	0.90^{Ac}	1.89^{Bc}	2.09^{Ab}	3.20^{Aa}
B.F.	0.45^{Ac}	1.90^{Bc}	2.50^{Ab}	2.95^{Aa}	3.10^{Aa}
*Blends :					
(1)	0.21^{Ab}	0.30^{Ba}	0.22^{Ab}	0.20^{Ab}	0.24^{Db}
(2)	0.16^{Ab}	0.22^{Cab}	0.18^{Aa}	0.17^{Ac}	0.20^{Dabc}
(3)	0.24^{Ac}	0.39^{Bb}	0.22^{Ac}	0.18^{Ad}	0.67^{Aa}
(4)	0.22^{Ab}	0.54^{Aa}	0.17^{Bc}	0.18^{Abc}	0.45^{Ba}
(5)	0.19^{Ac}	0.41^{Aa}	0.20^{ABc}	0.17^{Ac}	0.30^{Cb}

Values in a column not sharing the same capital letter are significantly different at P < 0.01
Values in a row not sharing the same small letter are significantly different at P < 0.01.
***Blends were formulated as shown in Table (1).**

Table (8): Iodine value of oils, butter fat and their blends as affected by deep frying at 180°C for 8 hrs.

Frying time at 180°C	0	2	4	6	8
Oils.					
P.O.	64.74	62.01	60.30	59.10	59.30
C.O.	124.76	120.1	155.0	112.5	109.7
S.O.	129.23	123.5	116.5	105.5	95.6
B.F.	31.25	30.0	28.35	28.30	25.5
*Blends:					
(1)	84.11^{Da}	81.46^{Db}	72.13^{Dc}	68.01^{Dd}	51.30^{Ee}
(2)	88.41^{Ba}	84.89^{Bb}	74.63^{Cc}	69.13^{Cd}	60.55^{De}
(3)	76.68^{Ea}	74.53^{Eb}	70.35^{Ec}	68.30^{Dd}	61.20^{Ce}
(4)	95.19^{Aa}	92.09^{Ab}	90.03^{Ac}	90.00^{Ac}	76.50^{Ad}
(5)	87.30^{Ca}	82.23^{Cb}	80.11^{Bc}	77.50^{Bd}	68.30^{Be}

Values in a column not sharing the same capital letter are significantly different at P < 0.01.
Values in a row not sharing the same small letter are significantly different at P < 0.01.
*** Blends were formulated as shown in Table (1).**

Table (9): Peroxide value of oils, butter fat and their blends as affected by deep frying at 180°C for different periods.

Oils	Frying time at (180°C) (hrs)				
	0	2	4	6	8
P.O.	0.53^{Dd}	1.89^{Cc}	3.38^{Cb}	4.10^{Ba}	3.30^{Cb}
C.O	1.01^{Bcd}	3.60^{Bc}	5.35^{Bb}	8.45^{Aa}	8.30^{Ba}
S.O.	2.02^{Ae}	4.12^{Ad}	7.60^{Ac}	8.20^{Ab}	10.10^{Aa}
B.F.	0.8^{CDd}	1.54^{Cc}	2.65^{Db}	3.13^{Ca}	2.15^{Db}
*Blends :					
(1)	0.95^{Cd}	9.3^{Ba}	6.1^{BCb}	5.9^{Ac}	6.7^{Bb}
(2)	0.16^{Ae}	8.2^{Ca}	6.0^{Cb}	4.8^{Abd}	5.9^{Cc}
(3)	1.22^{Be}	10.9^{Aa}	7.1^{Ac}	5.0^{Bd}	8.5^{Ab}
(4)	1.34^{Be}	9.2^{Ba}	6.8^{Bb}	5.3^{Abc}	3.8^{Da}
(5)	1.22^{Bd}	7.1^{Da}	6.3^{BCbc}	5.0^{Bc}	6.7^{Bb}

Values in a column not sharing the same capital letter are significantly different at P < 0.01.
Values in a row not sharing the same small letter are significantly different at P < 0.01.
***Blends were formulated as shown in Table (1).**

Table (10): The mean scores (out of 10) of the sensory evaluation of fresh oil blends given by 13 panelists.

Character/*Blends	Blend 1	Blend 2	Blend 3	Blend 4	Blend 5	Blend mean
Colour	7.67^{a}	9.33^{a}	8.33^{a}	8.00^{a}	9.00^{a}	8.47^{a}
Consistency	8.33^{b}	9.00^{b}	8.33^{b}	7.00^{b}	9.33^{b}	8.40^{b}
Oiling out	8.00^{c}	8.67^{c}	9.33^{c}	8.33^{c}	8.67^{c}	8.60^{c}
Blends means	8.00^{d}	9.00^{d}	9.67^{d}	7.78^{d}	9.00^{d}	8.49^{d}

Values in a row not sharing the same small letter are significantly different at P<0.01 .
*** Blends were formulated as shown in Table (1).**

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بعض الزيوت النباتية ، المسلي البلدي ومخاليطهما : الصفات الفيزيوكيماوية وتأثيرات القلي العميق عليها .

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أجريت هذه الدراسة باستخدام ثلاثة زيوت مختلفة هي زيت النخيل ، زيت الذرة ، زيت عباد الشمس بالاضافة للمسلي البلدي (زبد بلدي) وذلك بهدف التعرف علي الثبات الحراري لهذه الزيوت والدهون خلال عملية التحمير العميق لأصابع البطاطس المحمرة . كذلك فقد تم خلط الزيوت سالفة الذكر بالاضافة للمسلي البلدي في خمس خلطات مختلفة علي النحو التالي :

الخلطة (١): (١ جزء نخيل + ٢ جزء ذرة + ٣ جزء زيت عباد شمس + ٤ مسلي) .
الخلطة (٢): (٤ نخيل + ٣ ذرة + ٢ عباد شمس + ١ مسلي)
الخلطة (٣): (٢ نخيل + ١ ذرة + ٣ عباد شمس + ٤ مسلي)
الخلطة (٤): (٣ نخيل + ٤ ذرة + ١ عباد شمس + ٢ مسلي)
الخلطة (٥): (١ نخيل + ٢ ذرة + ٤ عباد شمس + ٣ مسلي)

وقد تم تسخين الزيوت والمسلي وكذلك المخاليط علي ١٨٠ °م بطريقة مستمرة لمدة ٨ ساعات . وتم سحب عينه من كل زيت أو مخلوط علي فترات هي ٢، ٤، ٦، ٨ ساعات من التحمير العميق وتم تحليل هذه الزيوت والمخاليط . وقد أوضحت النتائج حدوث ارتفاع جوهري في كل من معامل الانكسار – اللزوجة – قيمة البيروكسيد كلما تقدمت عملية التحمير في الوقت في حين حدث العكس للرقم اليودي الذي انخفض بتقدم فترة التحمير .

ولقد أظهرت الزيوت والمخاليط تحت الدراسة أنماطا مختلفة لكل من الدهن الصلب وتركيب الأحماض الدهنية والي حدا ما اللون الذي تم قياسه بواسطة جهاز اللوفي بوند . وأوضحت الدراسات الحسيه علي الزيوت والمخاليط عدم وجود أي فروق جوهرية فيما بينها .

علي ضوء النتائج المتحصل عليها في هذه الدراسة فانه يمكن القول بامكانية استخدام هذه المخاليط لأكثر من ثمانية ساعات دون حدوث تدهور محسوس في جودتها .