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IMPROVING THE FRYING QUALITY OF VEGETABLE OILS (SUNFLOWER AND COTTON SEED) BY BLENDING WITH CANOLA OIL

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ABSTRACT

The aim of this study was to preparation of high stable frying by blending either sunflower or cottonseed oil with canola oil. Samples of sunflower, cottonseed and canola oils and their blends (canola oil at various levels of 25% or 50% with sunflower and cottonseed oils) were intermittent frying at 180°C $\pm$ 5 °C for 5 hr/day and the frying process was repeated for 5 consecutive days. Some physical (refractive index, smoke point, color and viscosity) and chemical properties (acid value, peroxide value, iodine value, thiobarbituric acid value, polar content, polymer content and oxidized fatty acid level) were determined in all samples. Fatty acid composition were determined. The results indicated that the addition of canola oil to vegetable oils (sunflower or cottonseed) was carried out to improve oils frying properties.
Keywords: Blending, canola oil, deep-fat frying

INTRODUCTION

Oils and fats intended for commercial frying applications must be stabilized to prevent deterioration caused by oxidation, polymerization and hydrolysis during high temperature use (Warner and Knowlton. 1997 and Nasirullah and Rangaswamy., 2005). Modifying the fatty acid composition of the oil, the most common method to stabilize frying oils, can be done by several methods. For example, blending polyunsaturated oils with more saturated or monounsaturated oils is an option to adjust fatty acid levels to optimal levels, such as combining higholeic sunflower oil with corn oil or hydrogenated soybean oil with soybean oil (Frankel and Huang, 1994; Moulton *et al.*, 1975; Cowan *et al.*, 1973 and Nasirullah., 2001). Chemically altering the fatty acid ratios by hydrogenation increases saturated fatty acids and decreases polyunsaturated fatty acid to produce more stable oil (Frankel *et al.*, 1985).

A recent approach has been to genetically modify fatty acid composition of oil seed to produce oils with greater frying stability, usually by decreasing linoleic acid and linolenic acid and increasing oleic acid (Warner *et al.*, 1994). During the past 10 years various oils were developed with fatty acid compositions modified by plant breeding, including low linolenic soybean, high-oleic sunflower, low linolenic canola and high oleic canola (Subramanian *et al.*, 2000). All this modified oils have improved frying stability compared to unmodified oils. Cottonseed oil, with its high level of linoleic acid (52%), is considered to be the industry standard for producing food with desirable fried–food flavor. This flavor may be partly derived from the formation of 2, 4 -decadienal during the thermal oxidation of linoleic acid. On the other hand, foods such as potato chips that are frayed in high linoleate containing oils are not oxidatively stable (Engelsen, 1997). Xu *et al.*, (1999) documented the sensory analysis of potato chips produce from high-oleic oils reported only on the development of rancid flavor. Although this flavor is important in the sensory analysis of stability, the characteristic flavors imported to foods that are fresh or slightly oxidized, but not rancid, are probably of greeter interest.

Canola is growing extensively in Australia and due in part to its low saturated content and high monounsaturated fatty acids content, has nutritional properties superior to those of most traditional frying oils (Carr, 1991 and Eskin *et al.* 1996).

The objective of this study was carried out to prepare a suitable blend from cottonseed or sunflower oils with canola oil to improve its properties and stability during frying process and study the effect of blending formula on the physical, chemical and fatty acids profile.

MATERIALS AND METHODS

Materials:

1. Canola Seeds (Pactol 339 M variety) was obtained from Agriculture, Research Center, Giza, Oil Crops Department.
2. Refined sunflower and cottonseed oils were obtained from Cairo Oil and Soap Company, EL-Aiyat Factory, Giza, Egypt.
3. The potatoes were obtained from the local market in Giza Egypt.

Methods

1. Extraction of canola oil: The seeds were ground and packed in cheese cloth, pressed by using hydraulic laboratory (Carver) press. The produced oil was filtered using Whatman filter paper No. I and kept in brown glass bottle.
2. Preparation of oil blends: system I: sunflower oil System 2: cottonseed oil, system 3: canola oil, system4: sunflower oil 75% canola oil 25%, system 5: sunflower oil 50 % canola oil 50%, system 6: cottonseed oil 75% + canola oil 25% system 7: cottonseed oil 50% + canola oil 50%.
3. Preparation of potatoes: the potatoes were washed, peeled and sliced to chips 2mm thick using a manual chips slicer.
4. Frying process: canola, sunflower, cottonseed oils and other systems were used for frying potato chips as follows: two Kg of oil was placed in an aluminum frying container with 35 cm. diameters and 20cm high, oil was heated at 180 °C± 5°C for 5 hr/day for 5 days. After frying of potato chips and at the end of each day, samples of oils were withdrawn and stored in brown bottles at 20 °C until analysis.
5. Quality assurance testes: Color, refractive index , viscosity, smoke point, acidity, peroxide value , thiobarbituric acid (TBA) value , iodine value and oxidized fatty acid content were determined according to the methods described by A.O.A.C.(2000), polar and non polar components of oil were measured by column chromatography according to the method described by Waltking and Wessels (1981), polymer content was analyzed

according to the method of Peled *et al.*, (1975) and oxidative stability by Rancimat method at 100 °C ± 2°C were determined according to the methods of Evange, *et al.*, (1997).

6. Analysis of fatty acids: The fatty acids of the oil were converted into methyl esters using diazomethane and identified by gas liquid chromatography according to the methods of Leth *et al.*, (1998). The compositions of fatty acids were achieved by gas liquid chromatography analysis using a Pye unicam model PV 4550 capillary gas chromatography fitted with flame ionization detector, the column (1.5m × 4 mm) packed with diatomate C (100- 120 mesh) and coated with 10%polyethlene glycol adipate (PEGA). The column over temperature was programmed at 8°C /min. from 70° to 190°Cthen isothermally at this temperature for 20 min. Nitrogen flow rate was 30 ml/min. detector, injection temperatures, hydrogen and air-flow rates were 300°C, 250°C, 33 ml/min, 330 ml/min, respectively. The presented fatty acids were identified according to an authentic sample of fatty acids chromatographer internal standard.
7. Statistical analysis: Statistical analysis involved used of the statistical analysis systems (SAS, 1985) software package. Analysis of variance performed by ANOVA procedures. Significant differences between means were determined by Duncan's multiple range testes.

RESULTS AND DISCUSSION

Characteristics of fresh oils (sunflower, cottonseed and canola):

The refractive index at 25°C, viscosity "centipoises", color, acid value, peroxide value, TBA value, iodine number, polar content, polymer content, oxidative stability by Rancimat at 100°C in hours and unsaponifiable matter were determined for the investigated sunflower, cottonseed and canola oils. The obtained results are shown in Table (1) which showed that the refractive index (at 25°C) of sunflower, cottonseed and canola oil was 1.4725, 1.4726 and 1.4653 respectively. Also .it could be noticed that the viscosity (centipoises) was 83.5, 82.30, and 78.0 for oils, respectively, while color was 2.5, 3.5, and 3.00 for oils (sunflower, cottonseed and canola) respectively.

Acid value (mg KOH/g oil) was 0.21, 0.29 and 0.25 of sunflower, cottonseed and canola oils respectively, while peroxide value was 0.80, 0.85 and 0.70 (meq. /Kg oil) for oils (sunflower, cottonseed and canola) respectively, iodine value of investigated oils was 131.50, 110.50, and 132.0 (g I 2/100g oil).this is mainly due to the type of oils relate to semidrying oils which have iodine value ranging between 90-130. TBA value at 532 nm of oils (sunflower, cottonseed and canola) was 0.01, 0.07 and 0.05 respectively. Also, it could be noticed that the polar and polymer content for oils not detected. Also, form the same results in Table (1) it could be noticed that the oxidative stability of oils at 100°C using Rancimat method the induction period was 7.0, 6.3 and 11.5 hr for the formations oils, respectively. Higher oxidative stability of canola oil compared to sunflower and cottonseed oils could be due to its higher content of monounsaturated fatty acids.

From results in Table (1) the unsaponifiable matter content of oils were 1.30, 1.50, and 1.60 respectively. The results are in accordance with the Egyptian standard organization (1993) for oils, indicating the authenticity of these oils and its suitability for consumption.

Gas liquid chromatography technique was employed to study the composition of oils fatty acids. Data of the relative percentage of the identified fatty acids of oils (sunflower. Cottonseed and canola) are shown in Table (1).

From the tabulated data in Table (1), it could be noticed that linoleic acid (18: 2) was the major unsaturated fatty acid in sunflower and cottonseed oils, since it amounted to 73.20 %, 52.3 % and 14.5 % in oils, respectively. Meanwhile oleic acid was the major unsaturated fatty acid in canola oil as it reached 61.50 % respectively.

These results are with in the limits of Codex Alimentarius (1981) for these oils, respectively.

Table (1): Characteristics of fresh oils (Sunflower, Cottonseed and Canola).

Characteristics	Sunflower oil	Cottonseed oil	Canola oil
Refractive index (25 °C)	1.4725	1.4726	1.4653
Viscosity (centipoises)	83.5	82.30	78.00
Color (red) (yellow at 35)	2.5	3.50	3.00
Acid value (% as oleic acid)	0.21	0.29	0.25
Peroxide value (meq. /kg oil)	0.80	0.85	0.70
Induction period (hr)	7.0	6.30	11.50
TBA value at 532 nm	0.01	0.07	0.05
Iodine number (Hanus)	131.50	110.50	132.00
Polar content %	0.00	0.00	0.00
Polymer content %	0.00	0.00	0.00
Fatty acid compositions:			
C12: 0	0.9	1.20	2.20
C14: 0	0.85	0.80	2.50
C16: 0	1.70	25.50	5.30
C18: 0	3.50	2.00	3.00
C18: 1	20.0	18.0	61.50
C18: 2	73.20	52.30	14.50
C18: 3	0.40	0.11	11.20

Changes in some physical properties of oils and their blends during deep-fat frying:

1- Refractive index:

Table (2) shows the changes in refractive index of fried sunflower, cottonseed and canola oils and their blends at various periods. The values of refractive index of fried sunflower, cottonseed and canola oils were gradually increased with prolonging the frying period. Mixing sunflower or cottonseed oils with canola oil at various levels (25% and 50 %) caused gradual decrease in the refractive index values compared with values of the fried sunflower and cottonseed oils. The higher level of oleic acid in canola oil exhibited the highest decrease in the blends oils refractive index phenomenon.

Table (2): Changes in some physical properties of oils (sunflower, cottonseed and canola) and their blends during deep-fat frying.

Frying time (day)	Systems of frying						
	1	2	3	4	5	6	7
Refractive index (25°C)							
0	1.4725	1.4726	1.4653	1.4720	1.4710	1.4723	1.4720
1	1.4726	1.4727	1.4655	1.4720	1.4710	1.4723	1.4720
2	1.4729	1.4728	1.4656	1.4721	1.4711	1.4724	1.4721
3	1.4730	1.4730	1.4657	1.4722	1.4711	1.4725	1.4721
4	1.4735	1.4732	1.4660	1.4723	1.4712	1.4725	1.4722
5	1.4739	1.4736	1.4662	1.4724	1.4713	1.4725	1.4723
LSD	0.0002	0.0002	0.0001	0.0003	0.0003	0.0003	0.0003
Smoke point (°C)							
0	235	230.50	225	232	230	229	228
1	230	225	221	229	229	228	227
2	229	221	219	227	228	226	226
3	225	216	215	225	225	224	225
4	220	212	211	220	223	222	223
5	215	209	209	218	219	218	220
LSD	0.80	0.80	0.75	0.75	0.75	0.75	0.75
Color (red) (yellow at 35)							
0	2.5	3.5	3.00	2.8	2.70	2.40	2.50
1	5.00	5.5	5.30	3.0	2.90	2.90	2.70
2	10.10	11.0	10.50	4.20	3.10	2.410	3.00
3	12.90	13.0	12.80	5.60	4.60	5.30	4.20
4	14.50	15.20	14.70	7.30	5.90	7.60	5.80
5	17.20	18.10	18.00	9.50	6.70	9.60	6.90
LSD	0.50	0.55	0.55	0.55	0.55	0.55	0.55
Viscosity (centipoises)							
0	83.50	82.30	78.0	82.10	80.50	81	80.30
1	92.30	92.0	88	84.50	81.30	83.20	81.20
2	100.00	100.20	95	86.30	83.00	84.90	82.90
3	104.20	105.30	100	88.10	84.30	86.30	83.50
4	110.50	109.40	105.40	92	86.50	88.11	84.90
5	113.20	112.50	109.50	94.30	88.30	90.15	86.30
LSD	2.00	2.00	2.00	2.00	2.00	2.00	2.00

LSD demonstrates to least significant difference test.

2- Smoke point:

Table (2) shows the changes in smoke point of fried oils and their blends at various periods. The values of smoke point of fried sunflower and cottonseed oils were gradually decrease compared with canola oil. It is worth noting that the smoke points of fried sunflower, cottonseed oils mixed with canola oil at various levels (25% and 50%) were generally higher than sunflower or cottonseed oils alone.

3- Color:

In the present study, the values of yellow glass slides were fixed at 35 and variable values were recorded for the red glass slides. During the frying, the values of red glasses for oils without blending were gradually increased (table2). Mixing sunflower or cottonseed oils with canola oil at various levels (25% and 50%) and fried under the aforementioned conditions, did not cause an obvious darkening in oil color.

4- Viscosity:

Changes in the viscosity of sunflower, cottonseed and canola oils and their blends during frying at 180°± 5 ° for 5 hr/day for 5 consecutive days are shown in Table (2). The viscosity of unblended oils was gradually increased during the frying process. Blending sunflower or cottonseed oils with canola oil at various levels (25 % and 50 %) induced the least change on blended oil viscosity after frying.

Changes in some chemical properties of oils and their blends during deep-fat frying:

1- Acid value:

Data in Table (3) indicated that acid value of unblended oils increased during frying and was strongly correlated with prolonging the frying period. Mixing of various levels of canola oil caused a depression in the acid value during the frying process. These results indicate that the blending with canola oil (high oleic acid) decreased the oil hydrolytic rancidity.

2- Peroxide value :

The changes in peroxide values during frying are presented in Table (3). The results showed that peroxide value of unblended oils increased during frying. Oils (sunflower or cottonseed) blended with of canola oil at various levels (25% and 50%) resulted in lower peroxide value than those of the unblended oils.

3- Iodine value:

Changes in iodine value during 5 days in all systems are given in Table (3). Iodine value is a measure of overall unsaturation and is widely used to characterize oils and fats. Larger change in iodine value of the unblended oils (sunflower and cottonseed) compared to the other systems indicated that the rate of oxidation of unsaturated fatty acids was reduced .

4- Thiobarbituric acid (TBA):

The changes in TBA values during frying are presented in Table (3) .TBA values of unblended oils (sunflower or cotton seed) unblended increased progressively with the frying time. Blending with canola oils at various levels (25% and 50%) caused a depression in the TBA value during the frying process.

The TBA value has been widely used as an objective measure of secondary oxidation products of oils. It related to the level of malonaldehyde formed during oxidation of lipids.

Table (3): Changes in some chemical properties of oils (Sunflower, Cottonseed and Canola) and their blends during deep-fat frying.

Frying time (day)	Systems of frying						
	1	2	3	4	5	6	7
Acid value (mg KOH/g oil)							
0	0.21	0.30	0.25	0.24	0.22	0.27	0.26
1	0.59	0.60	0.63	0.50	0.40	0.53	0.45
2	0.99	1.20	0.95	0.81	0.61	0.80	0.64
3	1.90	1.97	1.95	0.93	0.81	0.91	0.83
4	2.50	2.60	2.66	1.12	0.95	1.10	0.93
5	3.40	3.50	3.45	1.30	1.00	1.25	1.03
LSD	0.03	0.03	0.03	0.03	0.03	0.03	0.03
Peroxide value (meq. /kg oil)							
0	0.80	0.85	0.70	0.77	0.75	0.78	0.76
1	3.50	3.90	3.81	0.99	0.95	1.00	0.97
2	12.60	13.10	12.30	2.40	1.50	2.10	1.45
3	7.17	17.30	16.40	3.90	2.20	3.30	2.30
4	24.50	25.10	23.30	2.20	4.80	6.70	4.76
5	39.30	40.10	38.10	10.10	9.50	10.29	9.90
LSD	0.05	0.05	0.05	0.05	0.05	0.05	0.05
Iodine value (g I_2/100 g lipids)							
0	131.50	110.50	132	131	130	122	121
1	129.0	109.50	129	130	129	119	118
2	124	105.	125	128	128	117	117
3	121	101	122	126	127	116	116
4	117	95	118	124	123	114	115
5	110	90	112	120	121	111	113
LSD	1.5	1.5	1.5	1.5	1.5	1.5	1.5
Thiobarbituric acid (absorbance at 532 nm)							
0	0.01	0.07	0.05	0.04	0.03	0.03	0.03
1	0.24	0.30	0.29	0.05	0.04	0.06	0.05
2	0.83	0.87	0.84	0.19	0.09	0.20	0.11
3	1.60	1.72	1.71	0.23	0.12	0.25	0.14
4	1.85	1.90	1.86	0.31	0.19	0.32	0.18
5	2.50	2.9	2.75	0.46	0.27	0.47	0.25
LSD	0.05	0.05	0.05	0.05	0.05	0.05	0.05

LSD demonstrates to least significant difference test.

5- Polar content:

The changes in polar content (%) are presented in Table (4). The results showed that the polar component increased gradually during frying in oils (sunflower and cotton seed) compared with their blends (canola oil with sunflower and cottonseed oils). It also showed that monounsaturated oils had lower content of polar content than polyunsaturated oils (sunflower and cotton seed).

6- Polymer content (%):

One of the most important changes in the fats during frying is the formation of polymer materials. The polymers are mainly responsible for the increase of physical and chemical properties in oils. The polymer content of oils and their blends during frying was determined and the results are tabulated in Table (4). The polymer content increased gradually in oils (sunflower and cottonseed) during frying. Mixing with canola oil at various levels (25% and 50%) resulted in lowering polymer content than those of the oils without mixing.

7- Oxidized fatty acids :

The results in Table (4) showed the formation of oxidized fatty acids in all treatments as a result of frying. The oxidized fatty acids of oils without blending were increased gradually during frying. Blending with canola oil at various levels (25% and 50%) had lower oxidized fatty acids than those of the oils without blending.

Table (4): **changes in some chemical properties of oils (sunflower, cottonseed and canola) and their blends during deep-fat frying.**

Frying time (day)	Systems of frying						
	1	2	3	4	5	6	7
Polar content %							
0	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1	0.71	0.63	0.60	0.45	0.32	0.50	0.30
2	5.50	5.31	4.50	1.30	1.11	1.39	1.06
3	12.20	14.20	12.50	2.20	1.95	2.45	1.85
4	25.50	24.30	22.10	5.13	3.50	5.50	3.41
5	30.20	29.50	25.41	7.50	5.20	7.81	5.11
LSD	2.00	2.00	2.00	2.00	2.00	2.00	2.00
Polymer content %							
0	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1	0.35	0.33	0.20	0.20	0.18	0.19	0.18
2	1.60	1.71	1.20	0.59	0.39	0.52	0.35
3	2.03	2.01	1.90	0.98	0.72	0.95	0.71
4	2.56	2.50	2.10	1.31	0.99	1.28	0.95
5	4.78	4.71	3.85	2.01	1.05	1.98	1.00
LSD	0.05	0.05	0.05	0.05	0.05	0.05	0.05
Oxidized fatty acids							
0	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1	0.11	0.1	0.09	0.07	0.05	0.08	0.04
2	0.35	0.29	0.25	0.15	0.11	0.16	0.10
3	0.93	0.90	0.86	0.23	0.20	0.25	0.18
4	1.30	1.27	1.20	0.56	0.25	0.60	0.24
5	2.85	2.79	2.60	0.89	0.42	0.92	0.40
LSD	0.07	0.07	0.07	0.07	0.07	0.07	0.07

LSD demonstrates to least significant difference test.

Conclusion:

In conclusion, the included data revealed that the addition of canola oil at the level of (25% and 50%) to sunflower or cottonseed oils improved frying stability of blends oil during frying with respect to oxidized fatty acids percentages, polar materials, and polymeric compounds. The results showed that blends containing 25% and 50 % canola oil with sunflower or cottonseed oils were more resistant to the formation of oxidized fatty acids, polar content and polymer content and hence are more stable against thermal oxidation during frying process.

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تحسين جودة التحمير للزيوت النباتية (عباد الشمس وبذرة القطن) عن طريق الخلط مع زيت الكانولا

أماني محمد محمد بسيونى، داليا محمود محمد مصطفى وهدي احمد عليوة
قسم بحوث الزيوت والدهون – معهد بحوث تكنولوجيا الأغذية – مركز البحوث الزراعية – جيزة – مصر

تهدف هذه الدراسة إلى تحضير زيوت على درجة عالية من الثبات اثناء عملية التحمير عن طريق الخلط مع زيت الكانولا . تم اجراء عملية التحمير لكل من زيوت عباد الشمس وبذرة القطن والكانولا كل بمفردة ثم خلط زيت الكانولا بنسب ٢٥%،٥٠% مع كل من زيت عباد الشمس وزيت بذرة القطن واجراء التحمير لشرائح البطاطس فى هذة الزيوت ومخاليطها على درجة ١٨٠°م ± ٥°م لمدة ٢٥ ساعة بمعدل ٥ ساعات يوميا لمدة خمسة ايام . تم تقدير بعض الخواص الطبيعية (معامل الانكسار، اللون، اللزوجة، نقطة التدخين) والخواص الكيماوية(رقم الحموضة، رقم البيروكسيد، الرقم اليودي، محتوي المركبات القطبية ومحتوي البليميرات والمحتوي من الاحماض الدهنية المؤكسدة) وتم دراسة تركيب الاحماض الدهنية. اشارت النتائج الى ان عملية خلط زيت الكانولا بالزيوت النباتية (عباد الشمس – بذرة القطن) يحسن من خواص الزيت اثناء عملية التحمير