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DEVELOPMENT AND APPLICATION OF RAPESEED OIL IN FRYING

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We all know that frying is the process by which foods are cooked using a fat or an oil as a heat exchange medium to prepare palatable foods with a popular and distinctive flavour. Four main methods of frying have been described.

1. Shallow Frying Using a minimum amount of fat or oil to barely cover the bottom of the pan. This is used for such items as bacon, pancakes and thinly sliced meat.

2. Sauté Frying When meat or vegetables are cooked in very little fat and shaken frequently to prevent sticking.

3. Semi-Deep Frying When sufficient oil or fat is used to approximately half submerge the food. Used for foods such as thicker chops, fish cakes, etc.

4. Deep Fat Frying This term is used for the method in which the food is fully immersed in the fat and thereby cooked more rapidly than in the previous methods.

All these methods may be used in the home but deep fat frying is the most popular industrial method.

Both fats and oils are used for frying and each has advantages and disadvantages. Fats, which are higher in melting point produce foods having a drier or "less oily" appearance than oils which produce a moist appearance. There are other differences in mouth qualities of the food and in resistance toward oxidation and off-flavour development. Oils are becoming more popular with the housewife because of ease of handling and measuring and because of the theory that unsaturated fats are better for health. For the retail trade a frying oil should, we believe, have the following qualities.

a) As bland an initial flavour and odour as possible.

b) Good colour stability and flavour stability during repeated frying operations.

c) High smoke point.

d) A cold test of 5 hours or more.

The following two tables will show typical analyses of non-hydrogenated rapeseed and soybean oils, and of the same oils after partial hydrogenation and winterizing. These examples are typical of plant production.

Table I shows that soybean oil is superior in regard to yield of winterized oil. The cold test is better as is the A.O.M. test which is a measure of oxidative stability.

As I said before, the method favoured by industry is deep-fat frying in which the food product is completely immersed in the fat or oil.

The types of oil or fat used by industrial fryers are usually very specifically prescribed by them. They may demand a single oil component or a blend of oils. They usually specify melting point and oxidative stability. The specifications are also governed by economic factors. One of the over-riding concerns, however, is for oxidative stability, both for the fat in storage and for the product on the shelf. Because of this, hydrogenated fats are generally used. The degree of hydrogenation permitted is related to the customer's assessment of the mouth qualities he wants in his product. Addition of antioxidants only assists to improve the initial stability before the product is used, since normal antioxidants are volatilized by the steam generated from the food during the frying operation.

Hydrogenated rapeseed oil has been sold as a frying fat for several years by our Company. In order to evaluate its frying properties, we performed frying tests in our Research Laboratories using:

a) 100% rapeseed oil, hydrogenated to an iodine value of 76.0.

b) 100% soybean oil, hydrogenated to the same level.

c) An equal blend of these two fats.

These oils and the blends were analysed before use for the following criteria:

1) Colour
2) Free Fatty Acid (F.F.A.)
3) Peroxide Value (P.V.)

TABLE I

ANALYSIS OF HYDROGENATED AND NON-HYDROGENATED SOYBEAN AND RAPESEED OILS

	I.V.	% Yield as Liquid Fraction	Cold Test (Hours)	A.O.M. (Hours)	Colour	% F.F.A. (as Oleic)	Smoke Point °C
SOYBEAN OIL							
Non-hydrogenated	134.7	100	10	8	2.0 R	0.021	218
Hydrogenated and Winterized	109.0	90	10	20	0.8 R	0.014	220
RAPESEED OIL							
Non-hydrogenated	103.9	100	6	6	1.5 R	0.028	218
Hydrogenated and Winterized	89.8	75	6	15	0.9 R	0.014	218

4) A.O.M. (Oxidative Stability)
5) Smoke Point
6) Iodine Value (I.V.)
7) Solid Fat Index (S.F.I.)
8) Fatty Acid Composition
9) % of Trans-Isomers
10) Tocopherol, mg/Kgm

Analyses 1-6 were performed according to the official A.O.C.S. methods. The Solid Fat Index was tested according to the modified method of Teasdale (J. A.O.C.S. 33, 78 (1956)).

The Gas Liquid Chromatography analysis for Fatty Acid composition used a 10-foot stainless steel column 1/16" I.D. and 3% E.G.S.P.-Z (Ethylene Succinate Phenyl Polymer) Stationary phase (at 100/120 mesh). All samples were run as methyl esters using a temperature program (125°C - 200°C) at the rate of 6°C/minute. (Table II)

The method for trans-isomer determination was A.O.C.S. 14d-61. The tocopherol level was determined by the method of Emmerie and Engel.

All these analyses will be examined later.

The frying tests were performed using automatic deep-fat fryers which were filled with 6,810 gm of fat. The fat was electrically heated to 185°C and kept continuously at this temperature for six hours.

Every 9 minutes, 227 grams of washed potatoes, cut into chips, were fried.

At the end of the frying period the excess of hot fat was allowed to drain back into the fryer from the chips for a one minute period during which time the basket was shaken.

Every 5 fryings, a sample of oil was taken from each fryer and fresh oil added to the fryer to bring the level back to the original. In this way the ratio of oil to potatoes was kept at approximately 30:1.

During the 6 hour period about 3,400 gms of oil were added to each fryer.

Also during this time period, the batches of chips were sampled by a team of panelists with uniformly good results - no variations in flavour or texture were noted.

TABLE II

F.A. COMPOSITION (% AS METHYL ESTERS) BY G.L.C.

	C10:0	C12:0	C14:0	C16:0	C16:1	C18:0	C18:1	C18:2	C18:3	C20:0	C20:1	C20:2	C22:0	C22:1	C22:2
SOYBEAN OIL															
Non-hydrogenated	Trace	0.2	0.1	8.8	0.3	2.3	28.8	50.4	8.6	0.5	-	-	-	-	-
Hydrogenated and Winterized	Trace	0.2	0.1	8.8	Trace	5.0	46.1	35.6	3.8	0.4	-	-	-	-	-
RAPESEED OIL															
Non-hydrogenated	-	-	Trace	3.2	0.5	1.3	25.3	16.8	8.5	0.8	12.0	0.8	0.2	29.8	0.7
Hydrogenated and Winterized	-	-	Trace	3.4	0.7	2.0	36.8	11.8	0.7	0.7	11.9	1.0	Trace	31.0	Trace

Keepability tests on the fried chips were not done due to insufficient material. The oil samples which were taken every 5 fryings were analysed in the same manner as the unused oils. Table III shows the results on the hydrogenated rapeseed oil samples.

The oil colour increased to a level of 2.1 Red, from an original 0.8 Red, after 10 fryings and remained at that level for the remainder of the test.

The F.F.A. remained quite constant after the initial increase to 0.04%. This is expected since the free fatty acids produced by hydrolysis are distilled off by the steam generated. Peroxides formed during frying are destroyed again, thus maintaining a low peroxide value. There are only minor or inconclusive variations in the Solid Fat Index and Iodine Values.

The fatty acid composition shows some variations. Octadecenoic acids increase from the original 40% to 45% after 20 fryings, however, they return to their original level at the end of the test.

At the same time there is a progressive change in the level of docosenoic acids from an original level of 31.7% to 25.4% after 20 fryings.

Table IV shows that changes also occur in hydrogenated soybean oil. Fatty acid analysis shows a slight decrease in the level of octadecenoic acids from 74.9 to 71.7%.

The blend of rapeseed and soybean oil shows similar changes in regard to colour, F.F.A., P.V., I.V. and S.F.I. It was observed that blending the oils produces a eutectic as evidenced by the S.F.I. results. The decrease in docosenoic acids in the blend occurs at the same time as an increase in the octadecenoic acids and the stearic acid values.

CONCLUSIONS

We concluded from these results that all three samples performed well during the specific frying tests described and that no serious breakdown occurred in any of the oils. The only common change occurred in the reduction of the tocopherol content.

Table VI shows that at the end of the frying tests a reduction of 39%, 45% and 35% was registered respectively for soybean, rapeseed and the blend. It is conceivable that these values might relate to the keepability of the fried product. Actual

TABLE III

HYDROGENATED RAPESEED OIL SAMPLES TAKEN FROM THE FRYER AT DIFFERENT STAGES

	Original	After 5 Fryings	After 10 Fryings	After 15 Fryings	After 20 Fryings	After 25 Fryings	After 30 Fryings	After 35 Fryings	After 40 Fryings
Colour	0.8 R	1.6 R	2.1 R	2.1 R	1.9 R	2.1 R	2.2 R	2.2 R	2.2 R
F.F.A. % (as oleic)	0.024	0.040	0.040	0.036	0.038	0.036	0.040	0.040	0.038
P.V.m.e.	0.1	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0
I.V.	76.1	76.8	77.1	77.2	75.9	75.9	75.4	76.0	75.9
A.O.M.	225 Hrs. +	-	-	-	-	-	-	-	-
Smoke Pt.	232.0°C	-	-	-	-	-	-	-	-
SFI @ 10.0°C	46.0	45.9	46.8	46.4	45.9	46.1	46.5	46.3	46.3
21.1	28.5	28.3	28.5	28.5	28.5	28.3	28.3	28.6	28.3
26.7	21.0	21.1	21.4	21.2	21.3	21.1	21.0	21.4	21.1
33.3	8.3	8.1	8.3	8.3	8.2	8.3	8.3	8.3	8.2
37.8	2.8	2.7	2.8	2.8	2.8	2.7	2.6	2.8	2.6
40.0	0.6	0.4	0.6	0.8	0.6	0.5	0.7	0.6	0.6
C16:0	2.7	2.7	2.3	2.8	3.9	2.9	2.9	2.5	2.8
C16:1	T	T	T	T	0.2	T	T	T	T
C18:0	6.0	6.1	7.1	6.6	7.4	6.5	7.0	6.0	6.9
C18:1	40.0	40.5	43.2	43.0	45.0	41.2	41.2	41.7	40.1
C18:2	6.6	6.1	6.4	6.6	6.2	6.0	6.1	5.6	6.4
C20:0	1.5	1.5	1.1	1.6	1.2	1.4	1.4	1.2	1.6
C20:1	11.0	11.3	10.5	10.5	10.3	10.7	10.5	9.7	12.1
C22:0	0.4	0.4	0.4	0.3	0.4	1.0	1.4	1.4	0.9
C22:1	31.7	31.4	28.9	28.9	25.4	30.3	29.5	31.9	29.1
Trans-Isomers %	56.6	55.1	57.9	52.3	55.3	54.7	58.1	58.1	54.9

TABLE IV

HYDROGENATED SOYBEAN OIL SAMPLES TAKEN FROM THE FRYER AT DIFFERENT STAGES

	Original	After 5 Fryings	After 10 Fryings	After 15 Fryings	After 20 Fryings	After 25 Fryings	After 30 Fryings	After 35 Fryings	After 40 Fryings
Colour	1.3 R	2.2 R	2.6 R	2.6 R	2.2 R	2.4 R	2.4 R	2.4 R	2.5 R
F.F.A. % (as oleic)	0.021	0.046	0.072	0.042	0.042	0.042	0.044	0.044	0.040
P.V.m.e.	Nil	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0
A.O.M.	225 Hrs. +	-	-	-	-	-	-	-	-
Smoke Pt.	235.0°C	-	-	-	-	-	-	-	-
I.V.	75.5	75.9	75.0	74.5	74.1	74.5	75.1	75.3	72.2
SFI @ 10.0°C	46.1	46.0	46.2	45.6	46.1	46.3	45.8	46.1	46.0
21.1	29.1	29.0	29.0	28.7	28.8	28.8	28.6	29.0	28.9
26.7	21.3	21.2	21.2	21.2	21.1	21.2	21.4	21.4	21.3
33.3	7.1	7.0	6.9	7.0	6.9	7.4	7.1	7.4	7.1
37.8	1.2	1.0	1.0	1.0	1.0	1.1	1.0	1.1	1.1
40.0	0.2	0.4	0.3	0.3	0.4	0.5	0.3	0.6	0.4
C16:0	10.0	10.0	10.0	9.9	10.3	10.2	10.1	10.0	11.2
C18:0	8.6	8.1	9.1	9.5	9.7	10.3	9.1	9.6	10.8
C18:1	74.9	75.4	74.5	74.4	73.7	72.5	74.3	73.1	71.7
C18:2	6.5	6.5	6.4	6.2	6.3	7.1	6.6	7.3	6.2
C18:3	T	T	T	T	T	T	T	T	T
C20:0	T	T	T	T	T	T	T	T	T
C20:1	T	T	T	T	T	T	T	T	T
Trans-Isomers %	55.0	54.9	53.8	51.0	51.6	55.7	57.1	56.2	54.6

TABLE V

BLEND: 50 PARTS HYDROGENATED SOYBEAN OIL, 50 PARTS HYDROGENATED RAPESEED OIL SAMPLES TAKEN FROM THE FRYER AT DIFFERENT STAGES

	Original	After 5 Fryings	After 10 Fryings	After 15 Fryings	After 20 Fryings	After 25 Fryings	After 30 Fryings	After 35 Fryings	After 40 Fryings
Colour	1.0 R	1.8 R	2.3 R	1.9 R	2.6 R	2.3 R	2.6 R	2.7 R	2.3 R
F.F.A. % (as oleic)	0.021	0.040	0.044	0.042	0.038	0.046	0.038	0.046	0.046
P.V.m.e.	T	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0
A.O.M.	225 Hrs. +	-	-	-	-	-	-	-	-
Smoke Point	235.0°C	-	-	-	-	-	-	-	-
I.V.	76.1	75.9	76.7	75.1	75.2	74.2	74.6	75.1	74.5
SFI @ 10.0°C	40.5	40.4	40.7	40.7	40.2	40.8	40.5	40.3	40.3
21.1	22.1	21.8	22.2	22.0	22.0	21.9	21.8	22.0	21.6
26.7	14.6	14.3	14.7	14.5	14.5	14.6	14.5	14.7	14.3
33.3	3.8	3.7	3.6	3.8	3.8	3.8	3.6	3.9	3.7
37.8	0.4	0.6	0.4	0.5	0.5	0.5	0.3	0.8	0.5
40.0	0.2	0.3	0.4	0.2	0.4	0.4	0.3	0.4	0.4
C16:0	6.6	6.6	6.6	6.1	6.6	6.6	7.0	6.8	6.7
C18:0	7.4	8.4	7.9	8.3	8.1	9.0	8.6	9.1	9.0
C18:1	58.6	61.4	65.1	60.3	63.5	58.7	56.8	58.5	58.0
C18:2	6.2	6.2	5.9	6.3	5.6	6.3	7.1	7.1	6.3
C20:0	0.6	0.4	T	0.5	0.5	0.5	1.5	0.7	0.8
C20:1	5.4	5.1	3.3	4.4	3.6	4.7	4.9	4.6	5.0
C22:0	T	T	T	1.5	0.8	1.3	0.6	0.7	0.5
C22:1	15.2	11.9	11.2	12.6	11.4	12.9	13.5	12.5	13.8
Trans-Isomers %	55.5	54.4	55.5	55.2	52.5	56.1	56.9	54.0	55.6

performance in the trade over the past several years has demonstrated an increasing acceptance of rapeseed oil as a frying medium. No complaints traceable to deficiencies in the oil as a frying medium or with regard to the shelf life of fried products have been observed.

TABLE VI

TOCOPHEROL CONTENT (Mg/Kg) AT VARIOUS FRYING STAGES

Number of Fryings	Hydrogenated Soybean Oil	Hydrogenated Rapeseed Oil	50/50 Blend
Original	1048	704	876
10	832	557	669
20	783	519	636
30	721	431	617
40	641	390	573

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