Quality Evaluation of Canola Frying Fats

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Introduction

Canola oil, from low erucic acid, low glucosinolate rapeseed, is now our major source of edible oil in Canada. It is processed into salad and cooking oils, margarines, and shortenings for baking and frying. However, little information has been reported on the use and performance of canola frying fats as compared to other more commonly used fats and oils. A study by Dobbs (1975) identified off odours in heated rapeseed oil which may have limited its acceptance as a frying oil. However, since that time many improvements have been made in the chemical composition of the oil, and also in processing techniques. Thus the quality of canola fats and oils for frying is much improved, but there are few studies which have assessed the quality. Thus, one aim of this study was (1) to gain information on the performance of canola frying fats and oils. Another objective was (2) to evaluate newer methods for the determination of frying fat quality. Concern has been expressed regarding the nutritional quality of heated fats and oils; Germany has set limits on the amounts of degradation products allowed in frying fats. In Canada as yet there are no regulations concerning the quality of used frying fats, but it was considered useful to have a rapid method for monitoring fat quality.

Experimental

The project was set up to simulate commercial frying using a small commercial electric deep-fryer such as is used in a small restaurant. Two separate frying studies were carried out using frozen French fry potatoes in institutional pack. In the first study, two solid hydrogenated canola frying fats (I.V.=78; 76) from different processors were compared to a solid hydrogenated soy fat (I.V.=83). In the second study, a liquid or pourable canola frying

fat (I.V.=94) was compared with a liquid soy fat (I.V.=97). In the first study frying was done for 5 consecutive days with each fat; in the second study frying time was increased to 10 days for each fat. In other aspects the conditions of the two studies were similar. Each day, a lot of frozen potatoes was fried every 15 min throughout a 7½ hour day. Samples of both the frying fat and the cooked French fries were taken periodically and were stored at -20°C for later analysis. The fryer was topped up twice daily with freshly melted fat, and was turned off overnight.

The frying fats and the fats extracted from the cooked French fries were analysed for thiobarbituric acid (TBA) value, iodine value (I.V.), peroxide value, hydroperoxide value, fatty acid composition, colour, viscosity, smoke point, free fatty acids and contents of polar components.

Results and Discussion

Frying Fat Quality. The results of all tests were correlated with hours of frying time (Table 1), as reported by Stevenson et al. (1983). In brief, the highest correlations with hours of frying time were observed with the free fatty acid values, and with the contents of polar components as determined by a modified column chromatographic method of Billek et al. (1978). The free fatty acid values for the solid frying fats ranged from 0.02% initially to 1.2% at the end of 5 days of frying. The two canola fats gave similar values, slightly lower than the values for the soy fat. Fatty acid values for the fats extracted from the cooked French fries were very similar to the values for the actual frying fats.

The content of polar components in frying fats has been reported to be a more useful indicator of deterioration as it gives an estimate of the total amount of breakdown products in the fat. An actual value of 30% polar components was determined to be the practical end point of use of a commercial frying fat (Billek, 1979).

Analytical Methods. Methods for determining polar components were evaluated using a Food oil Sensor (Northern Instruments Corp.), column chromatography and thin-layer chromatography. The Food oil Sensor, a small portable instrument (Graziano, 1978) gives an estimation of the polarity of a fat by measuring its dielectric constant relative to a fresh fat sample. However, initial testing of the instrumentgave inconsistent results and the method was abandoned.

Table 1: Correlation (r) of hours of frying time with physical and chemical changes in frying fats.[a]

	Physical			Chemical					
Fat	Colour	Smoke point	Viscosity[b]	Peroxide value	TBA value	Hydroperoxide value	Iodine number	Free fatty acids	Polar components
Solid Fats									
Canola I	-	-0.80	0.76	0.34	0.54	-	0.50	0.99	0.95
Canola II	-	-0.78	0.80	0.77	0.26	-	0.28	0.99	0.97
Soy	-	-0.70	0.93	0.69	-0.31	-	0.38	0.99	0.96
Liquid Fats									
Canola I	0.96	-0.90	0.92	0.86	0.89	0.67	-0.36	0.99	0.96
Soy	0.97	-0.92	0.95	0.88	0.05	0.34	-0.19	0.98	0.96

[a] From Stevenson et al. (1983).

[b] 12 rpm at 60°C for solid fats and at 21°C for liquid fats.

A column chromatographic method (Billek et al., 1978) was evaluated for reproducibility and was subsequently modified to improve its efficiency. The original 25 g silica gel column was reduced to a 6.25 g column packed in a smaller diameter water-jacketed glass column. A 250 mg sample of the used fat was chromatographed first with 50 ml of mixed solvent (petroleum ether:ether 87:13 v/v) to elute the non-polar or triglyceride fraction and then with 50 ml of diethyl ether to elute the polar fraction (Fig. 1). The contents of triglyceride and polar lipid in each fraction were determined gravimetrically. The resolution between the two fractions was slightly improved over the large column, and considerable savings in column packing, solvents and time to run each column were realized.

Using the small column method, the contents of polar components were determined for each of the solid and liquid fats at the beginning and end of frying (Table 2). In the first study of solid frying fats, the contents of polar components reached only 12-13% after 5 days of frying. Although no formal sensory evaluation was done on the French fries, comments from operators indicated that the fries were still of good quality. In the second study, using the liquid frying fats, the total frying time was extended to 10 days to reach a higher level of deterioration in the fats. However, chemical tests still revealed only 15% of polar components in either fat.

Table 2: Contents of polar components in frying fats at the beginning and end of each frying study (%).

	Days of frying		
Fat Source	0	5	10
Solid hydrogenated			
Canola I	4.31	13.10	
Canola II	4.51	13.42	
Soy	2.51	12.70	
Liquid hydrogenated			
Canola	3.41		15.12
Soy	4.84		15.33

In this study formal sensory evaluation panels were conducted on days 1, 2, 4, 6, 8 and 10 of frying. The testing was done in the Food Science Department in individual booths, using staff and

students as members of the panel. On each day of testing, a sample of French fries was compared to a control sample of the same potatoes cooked in fresh frying fat. There was no significant decrease observed in the quality of the French fries cooked in either canola or soy fat after 10 days of frying, which would indicate that a content of 15% polar components does not cause noticeable deterioration in the quality of the fat. It would be interesting in future experiments to continue frying over an extended period and to correlate the content of polar components with a decrease in sensory quality of the fat. However, results did show that liquid frying fats stand up well under extended periods of frying and that canola fat performed as well as soy fat.

Although the modified column chromatographic method could be used for monitoring frying fat quality, it was felt to be somewhat tedious for routine analysis. A thin-layer chromatographic technique using the Iatroscan Analyzer was investigated as a possible method for routine analysis of polar components in frying fats. This instrument, manufactored by Iatron Laboratories of Japan and described in detail by Ackman (1981), uses a flame ionization detector to quantitatively estimate the material after thin layer chromatographic separation on glass chromarods coated with silica gel. Although the Iatroscan system has been used for analysis of blood lipids and fish lipids, it has not reportedly been used for analysis of food lipids. Representative standards for a triglyceride and a polar fraction were obtained by column chromatography of a used frying fat. These were individually spotted, developed and scanned on the chromarods and were used to establish standard curves relating the amount of material spotted to the detector response. The detector response was linear over a range of sample size from 1-30 μg. The response was also slightly greater for the triglyceride standard than for the same amount of polar lipid standard.

Although it was possible to obtain good resolution of mixtures of the above standards (Fig.2), the precision and accuracy of the analysis were not sufficiently high to recommend this method at the present time. A recent paper (Crane et al., 1983) discusses some of the factors which affect the reproducibility of results with the Iatroscan instrument.

Summary and Conclusions

A number of chemical and physical tests were done to evaluate the quality of canola fats during extended deep frying. Quantitative thin-layer chromatography using the Iatroscan Analyser was not as accurate as a modified column chromatography method for determining total polar components. The free fatty acid values and the

contents of polar components, as determined by column chromatography, gave high correlations with hours of frying. The results showed that the canola frying fats were of good quality throughout 5-10 days of frying.

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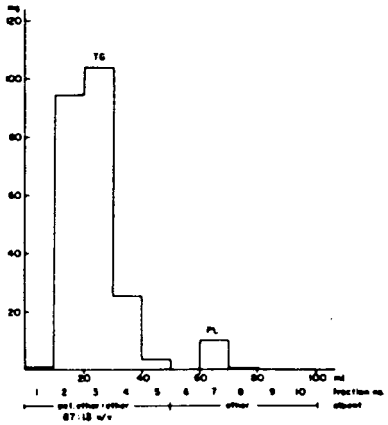

FIGURE 1: COLUMN CHROMATOGRAPHY OF 250 MG OF USED FRYING FAT ON 6.25 G SILICA GEL.

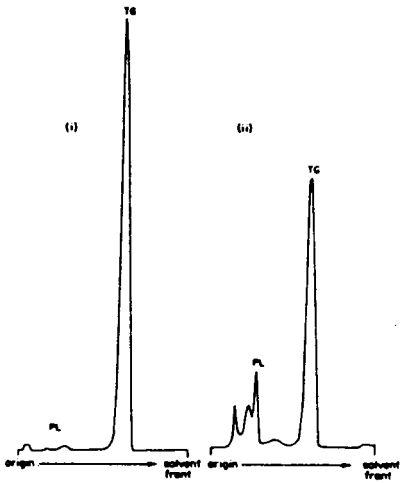

FIGURE 2: TYPICAL CHROMATOGRAMS OF LIPID MIXTURES CONTAINING (I) 4.79% POLAR COMPONENTS AND (II) 34.43% POLAR COMPONENTS, DEVELOPED AND SCANNED ON CHROMARODS.