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FURTHER DATA ON THE PROCESSING OF CANBRA OIL AND ITS UTILIZATION IN THE MANUFACTURE OF SOME SHORTENINGS AND MARGARINES

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INTRODUCTION

In view of the anticipated change-over of the Canadian rapeseed crop to zero-erucic acid varieties, it is imperative to review and interpret the scattered data gathered by the edible oil refiners in recent years. Mr. Teasdale and Mr. Mertens have presented the results of extensive research carried out at the Research and Development Laboratories of Canada Packers Ltd.

As a rule edible oil refiners and the users of fully refined oils, such as the margarine and dressing manufacturers, require years of development work before they will approve the use of a new oil, either as a raw material or as an ingredient in product formulation. In the present case decisions are required within a relatively short-time to determine the extent to which Canbra oil can replace the normal rapeseed oil.

Several other refiners have granted me access to the results of their investigations of Canbra oil from the 1966 crop. That part of the data which can be regarded as complementary to the Canada Packers reports will be given in this paper. In addition, one sample of Canbra oil was included among 11 samples of regular rapeseed oil produced in test crushings performed in five mills, designed to determine the effect of processing conditions on oil quality.

All Canbra oil so far examined by the refiners was derived from Oro seed, a B. napus variety, and crushed by the all-solvent process in the plant of the Saskatchewan Wheat Pool, Saskatoon.

CHEMICAL COMPOSITION

Among the factors expected to have the greatest bearing on the refining and formulation properties of different Canbra oils are:

(i) the fatty acid composition,
(ii) the non-glyceride compounds entering the oil from different seed varieties,
(iii) seed maturity.

While all oils so far tested were derived from Oro seed, i.e. B. napus, most of the oil expected to be available in fall of 1971 will be derived from a B. campestris variety, which is lower in thioglucoside content, and whose fatty acid composition is expected to differ somewhat from other known varieties as shown in Table I:

TABLE I

FATTY ACID COMPOSITION OF VARIOUS RAPESEED OILS

	B. campestris		B. napus	
	Echo Type	Zero-Erucic	Target Type	Zero-Erucic
$C_{16:0}$	3	4	3	4
$C_{16:1}$	0.1	-	0.2	0.2
$C_{18:0}$	1	1	1	2
$C_{18:1}$	37	55	22	67
$C_{18:2}$	18	31	15	20
$C_{18:3}$	8	10	8	9
$C_{20:0}$	0.4	-	0.5	0.5
$C_{20:1}$	10	-	12	1
$C_{22:1}$	23	-	39	0.5

While it must be realized that each value represents only one result from a whole range of values found for each fatty acid in different samples of oils of even the same rapeseed variety, significant differences may also occur among various analysts. For example, in the case of one of the oils examined in six laboratories, the values recorded for oleic acid ranged from 27.2-39.1%.

Nevertheless, from a practical point of view it is possible to arrive at several generalizations:

(i) All types of rapeseed oil, including the Canbra oils, contain only about 4-6% of saturated acids, i.e. palmitic and stearic acid combined.

(ii) The linoleic acid content of the Canbra oil derived from B. campestris can be expected to be about 10% higher than that found in B. napus varieties.

(iii) The linolenic acid content is not likely to differ significantly in the new types of oil.

(iv) Ideally the eicosenoic and erucic acid content in the new Canbra oils will be close to zero, although agronomic problems may make it difficult to achieve this goal in practice for a number of years.

From a product formulation point of view it seems reasonable to conclude that the absence of long-chain fatty acids in the Canbra oils will have the main influence on their physical characteristics. Variations in oleic and linoleic acids are less likely to influence their physical properties. In fact, the higher linoleic acid content expected to occur in B. campestris Canbra oil should prove to be an asset for this oil.

B. napus seed has a considerably higher content of thioglucosides than B. campestris. This applies also to the strains containing Canbra oil. Consequently it is conceivable that oil derived from Oro seed may have a higher content of sulphur compounds and could, therefore, offer some hydrogenation difficulties. Seed preparation and processing will be more critical with Oro seed than with B. campestris varieties.

Similar reasoning can be applied to the effect of seed maturity on oil quality. Since B. napus rapeseed matures later, the prevalence of green seed and the occurrence of other handling problems adds to the hazards of Canbra oil derived from these varieties. As will be shown later, past experience does not indicate that this hazard has diminished the usefulness of Oro Canbra oil in its applications.

EXAMINATION OF COMMERCIAL SAMPLE OF CANBRA OIL BY FIVE EDIBLE OIL REFINERS (RAPESEED UTILIZATION ASSISTANCE PROGRAM)

Five edible oil refiners cooperated in most of the tests reported below, where one sample of Canbra oil was included in the examination of the refining properties of eleven samples of rapeseed oil produced under controlled conditions in five crushing plants. The Canbra oil was extracted by the all-solvent process from seed grown in 1968. The properties of the Canbra oil are compared with four other oils. One group was derived from B. napus seed and the other from B. campestris seed. Both were extracted by the prepress-solvent process. The results may be regarded as reasonably representative for all the experiments of this test series. It should also be kept in mind that the Oro seed, which was grown in central Saskatchewan had probably not matured quite as well as the regular Brassica napus seed grown in southern Manitoba.

Table II represents an attempt to summarize the results, which must be interpreted with the greatest of caution. Apart from differences due to seed quality and crushing conditions, it was clearly established that the methodology used by the analysts in the different laboratories frequently revealed such divergencies of results, which could not be related to oil quality. Either the test conditions or the analytical techniques are in need of improvement and standardization

Nevertheless, the comparison of the ranking of the oil characteristics by different laboratories showed a considerable degree of agreement. This in turn should add to the validity of the following comments concerning Table II:

(i) Despite differences in maturity, and all seed samples had been graded C.W. No. 1, the refined and bleached color was satisfactory.

(ii) When measuring the green color of the crude oils, all except one refiner, graded the oils as lighter (L) than Standard A. One refiner regarded both B. napus oils as darker (D) than Standard A.

(iii) The Chromo Loss of the Canbra oil is somewhat higher than the values found for the other samples. However, it should be noted that Canbra oil and the B. campestris oil were not degummed, while the regular B. napus oil has been degummed. The additional loss for the Canbra oil in this case should be regarded as about 0.5%.— Commercial tests on other Canbra oil samples carried out under plant conditions have apparently not shown this difference.

(iv) Analysts differed considerably in their estimates of the chlorophyll content, however, there is no doubt about the higher levels present in B. napus oils. There is no indication that the chlorophyll content found in these samples affected the requirements for bleaching earth or influenced the rate of hydrogenation.

TABLE II

COMPARISON OF REFINING PROPERTIES OF ORO CANBRA OIL WITH OTHER COMMERCIAL RAPESEED OILS

Property Examined	B. napus		B. campestris
	Canbra Oil	Regular RSO (Probably Target)	Echo Type RSO
FFA (%)	0.45	0.33	0.40
Refined & Bleached) Color, 5¼")	1.1R	0.9R	1.0R
Green Color	L	L	L
Chromo Loss) Ca-9f-57) (%)	1.93	0.92	1.40
Chlorophyll, ppm	11	10	3
Rate of Hydrogenation	Very Slow	Fast	Intermediate
Sulphur Content, ppm	32	3	16
Acetone Insoluble (%)	1.1	-	0.5
Phosphorus ppm	285	50	140
Oxidative Stability) AOM, hrs)	18	21	17
Schaal Oven) 115°F, Days before) being unacceptable)	9	9	8

(v) The most significant differences found by all investigators concerned the rates of hydrogenation. Each Company employed that method which in their experience gave them the most meaningful results when applied to plant-scale operations. While absolute values are not reported in Table II, it can be stated that based on drop in iodine value per minute, most participants gave a similar ranking to the oils reported here. All oils were compared against a standard control sample of refined and bleached soybean oil.

Thus, the regular rapeseed oil extracted from a B. napus seed was hydrogenated to the same iodine value in about the same time as the soybean oil. On the other hand, the Canbra oil reacted very slowly, while the B. campestris oil showed a fairly good rate of hydrogenation.

For example, one refiner reported the following drop in iodine value per minute:

B. napus, Canbra oil	: 0.19
B. napus, reg. RSO	: 2.23
B. campestris, reg. RSO	: 1.73
SBO	: 3.30

It should be noted that the initial iodine value of soybean oil is higher than that of rapeseed oil and that consequently a larger drop is required to reach the same endpoint.

While reaction kinetics plays an important function in hydrogenation, it seems evident that the differences in hydrogenation rates found in this test series can be related to the sulphur content of the oil. Again, different analysts failed to agree on absolute values, but when ranking the sulphur content against rate of hydrogenation, a good correlation was found. Needless to mention that there was no sulphur present in the soybean oil. Furthermore, it should be noted that the sulphur content was determined in the crude oil, so that it must be concluded that only an insufficient amount is removed upon alkali refining and bleaching.

These results reconfirm the importance of taking all possible precautions to avoid the hydrolysis of the thioglucosides prior to and during the crushing process.

(vi) With regard to oxidative stability (AOM) and the stability as measured by the Schaal Oven test, the results included in Table II show no significant differences. While these conclusions are probably correct, the wide differences actually reported by various participating laboratories are more a reflection of methodological difficulties than an indication of real differences in oil quality.

PLANT-SCALE EXAMINATION OF CANBRA OIL FROM THE 1966 CROP

Several Canadian edible oil refiners purchased tank car quantities of Canbra oil derived from Oro seed of the 1966 crop for evaluation under plant-scale conditions. Canada Packers has reported on the value of Canbra oil especially in salad oil applications, but also in certain margarine and a few shortening formulations.

In view of the dearth of commercial data on the assessment of Canbra oil I am grateful that several other Canadian refiners have given me permission to examine their own results. I shall try to report the most significant findings without infringing on any aspects of commercial confidentiality.

While most results represent only very few plant runs, and at times only a single run, the fact that they were all arrived at on the basis of plant-scale operations should give them a fair degree of validity.

1a) PRODUCTION OF HIGH-RATIO SHORTENING

This test was designed to determine whether in a customary formulation made up of 50% soybean oil and 50% regular rapeseed oil, the zero-erucic oil could replace the regular rapeseed oil. The Canbra oil required 110 minutes of hydrogenation to reach the required end point versus 100 minutes for the soybean oil. Approximately the same amount of monoglyceride was added to either formulation.

Baking test results:

	50/50, CBO:SBO	50/50, RSO/SBO
Height :	3 3/8"	3 3/8"
Pound Cake Batter :	0.736	0.707
Pound Cake Volume :	1480 cc	1525 cc
Icing Test :	0.760	0.729

The refining properties of this tank car of Canbra oil compared with a regular rapeseed oil were as follows:

	CBO	RSO
FFA %	0.35	0.55
Neutral oil loss (lab) %	1.12	0.97
Neutral oil loss (plant) %	2.57	2.5
Bleached color (2% earth)	1.4R, 15Y	0.9R, 11Y

CONCLUSION: Canbra oil could successfully replace regular rapeseed oil in this high-ratio baking shortening.

1b) HIGH-RATIO SHORTENING

In another test a blend containing 40% of Canbra oil and 60% of soybean oil was produced, and also compared with a control containing regular rapeseed oil. A type of white cake and a yellow pound cake were baked giving the following results:

	SBO-RSO	SBO-CBO
White Cake	1,300 cc	1,290 cc
Yellow Pound Cake	1,255 cc	1,250 cc

Texture	:	Similar to Control
Visual Color	:	Better than Control
Body	:	Equal to Control
Streaks	:	None

CONCLUSION: Canbra oil is equal in performance to regular rapeseed oil.

2) ALL-PURPOSE SHORTENING

This series of tests compared three formulations, one based primarily on soybean oil, another one on regular rapeseed oil and finally one based on Canbra oil. The rapeseed oil and Canbra oil formulations contained about 50% of these oils.

HYDROGENATION DATA

	CBO	RSO	SBO
Time (Mins.)	150	330	140
Catalyst (Lbs.)	100	100	100

The Canbra oil compared well with soybean oil and was superior to the regular rapeseed oil.

When these oils were used in the formulation of all-purpose shortenings, the following analyses were reported:

ALL-PURPOSE SHORTENING ANALYSIS

	Approx. 50% CBO	Approx. 50% RSO	Mainly SBO
SFI (°C) 10.0	35	35	34
21.1	22	19	21
26.7	19	15	18
33.3	13	10	12
40.0	5	4	5
AOM (hrs.)	100+	100+	100+
Smoke Point, °F	460	420	420
I.V.	70.1	71.8	71.5
Penetration	166	159	179

CONCLUSION: The Canbra oil shortening meets all specifications. Detailed performance test results were as follows:

On the left the best result is shown, and the poorest on the right:

Baking Tests	Best		Poorest
Shortening Character	CBO	SBO	RSO
Total Score	CBO	SBO	RSO
Cake Volume	SBO	RSO	CBO
Heating Tests			
Highest Smoke Point	CBO	RSO	SBO
Smoke Point Stability	CBO	RSO	SBO
Color Stability	RSO	CBO	SBO
Odor Stability	RSO	SBO	CBO
Frying Tests			
Doughnuts	CBO	SBO	RSO

CONCLUSIONS:

(i) The baking laboratory results appear to indicate that the Canbra oil-blend is the best of the three experimental shortenings.

(ii) The Canbra oil blend hardened in ¼-½ the time required for the two other blends.

(iii) The hardened Canbra oil blend showed a flatter SFI curve than the other two blends. This flatness of the curve produced in the final shortenings a desirable increase in plastic range.

(iv) Canbra oil can successfully replace regular rapeseed oil and soybean oil in these shortening formulations.

3) FRYING FATS

Plant-scale batches of frying fat composed of 40% Canbra oil plus 60% soybean oil, hydrogenated to an iodine value of 70 have been produced and tested. The product has a Wiley melting point of 103°F. Its AOM stability ranges close to 200 hrs. Aging tests have shown that it retains an acceptable flavor after 3 months of storage, i.e. it is as satisfactory as a similar Soybean oil:Rapeseed oil blend. It has been claimed that the potential utilization of Canbra oil in frying shortenings exceeds that of regular rapeseed oil.

4) CANBRA OIL IN MARGARINE FORMULATIONS

Mr. Teasdale has referred to difficulties encountered in some cases with the development of graininess and oiling-out when producing margarines containing very high levels of Canbra oil.

The following three tests illustrate the use of Canbra oil and of regular rapeseed oil as a partial replacement of soybean oil in the manufacture of an established margarine formulation. While originally soybean oil had been used as the major ingredient for this margarine, an alternate formulation had been developed and adopted in commercial practice, where 40% of the oil used in this product was rapeseed oil. Now it was to be determined whether Canbra oil could replace this regular rapeseed oil fraction.

Refining and hydrogenation conditions for Canbra oil and soybean oil were similar, so that there was no significant cost difference in handling these two oils.

The following SFI values were reported for the three margarine base stock blends:

SFI (°C)	40% CBO	40% RSO	Mainly SBO
10.0	35.1	34.9	31.3
21.1	18.7	17.0	16.4
26.7	13.2	11.5	12.1
33.3	5.3	4.6	5.1
37.8	0.4	0.3	0.3

All formulations met the Company's specifications.

As to oxidative and flavor stability the following tests were made:

(i) The oil was extracted from the three margarine samples after two months of storage in a cold room and the AOM stability determined:

- 40% CBO : 110 hrs.
- 40% RSO : 110 hrs.
- Mainly SBO : 110 hrs.

(ii) A taste panel evaluated all three margarines over a period of 12 weeks and arrived at the following scores:

Time	CBO	RSO	SBO
Fresh	7.5	7.4	7.5
3 Weeks	7.3	7.3	7.5
5 Weeks	7.4	7.4	7.4
7 Weeks	6.6	6.6	6.6
9 Weeks	7.2	7.0	6.8
11 Weeks	6.8	6.6	6.9
12 Weeks	6.5	6.3	6.9

After 7 weeks the panelists characterized all three margarines as slightly stale, and made the same comment after 12 weeks, except that the regular RSO margarine was described as stale.

CONCLUSION: These results show that Canbra oil can replace regular rapeseed oil in these blends.

SUMMARY

- Canbra oil derived from Oro rapeseed (B. napus) has been examined for its refining characteristics and for its utilization in the manufacture of various shortenings and margarine.

- It can be concluded that Canbra oil will perform well on refining and hydrogenation, provided that care is exercized to prevent sulphur compounds from entering the oil upon extraction.

- When replacing regular rapeseed oil with Canbra oil in the manufacture of all-purpose shortenings, high-ratio shortenings, frying shortenings and margarine of the types illustrated in this report, Canbra oil proved to be either equal to or superior to regular rapeseed oil.

- It is gratifying that even limited commercial testing of Canbra oil has shown such encouraging results. However, it is obvious that a great deal more work is required on the handling of the seed, the extraction of the oil and the utilization of the new oil in the whole spectrum of edible oil products before its full potential can be realized.