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THE USE OF CANBRA OIL IN MARGARINE AND SHORTENING

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INTRODUCTION

The development of canbra oil began in the late 1950's in Western Canada. In 1961, Stefansson, Hougen and Downey reported that zero-erucic acid strains of both Brassica campestris and Brassica napus had been produced(1). By 1963, agronomically acceptable strains had been selected(2). The first commercial quantities of canbra oil, extracted from a napus variety of seed, were made available in 1965 through the combined efforts of the Saskatchewan Wheat Pool and the Canada Department of Agriculture. It is reported that canbra oil from more than 8,000 acres of seed was processed for the Canadian domestic market in 1967-1968(2). The acreages for 1969 and 1970 were lower, but substantial increases are expected for 1971.

Some of the data in this paper concerning the evaluation of canbra oil in margarine and shortening are derived from laboratory-scale tests of a few pounds of oil, and some are based on plant-scale tests involving several thousands of pounds.

CANBRA OIL IN MARGARINE

All of our work to date concerning the use of canbra oil (CBO) in margarine has been done on a laboratory-pilot plant scale with batches of about 5-7 pounds.

The oil used in our first margarine tests was supplied in 1964 by the Prairie Regional Laboratory of the National Research Council.

This oil, which had a free fatty acid (FFA) content of 0.2%, was alkali refined, bleached, and hydrogenated. Hydrogenation conditions were:

$176^{o}C \pm 5^{o}C$,
5 psig H_2 gas pressure,
0.2% Ni catalyst (0.05% Ni).

The oil was hydrogenated until the linolenic acid content had been reduced to less than 1%. Table I gives the fatty acid composition (by GLC) before and after hydrogenation.

TABLE I

FATTY ACID COMPOSITION OF CBO

	P	E	R	C	E	N	T		
	C_{14}	C_{16}	$C_{16}^{=}$	C_{18}	$C_{18}^{=}$	$C_{18}^{2=}$	$C_{18}^{3=}$	C_{20}	$C_{20}^{=}$
Before Hydrog	Tr	3.7	0.1	2.3	63.0	20.2	8.0	0.7	2.0
After Hydrog	Tr	3.7	0.1	3.0	78.0	12.1	0.4	0.7	2.0

The hydrogenated oil had *SFI's* (as determined by AOCS dilatometric method Cd 10-57) of:

1.5 at 10.0°C
1.0 at 21.1°C
Nil at 33.3°C.

This lightly hydrogenated canbra oil was compared against lightly hydrogenated rapeseed oil (RSO) in 50:50 blends with hydrogenated soybean oil (SBO) having an IV of 68. The SFI's at 10.0, 21.1 and 33.3°C of the two margarine oil blends were:

50:50 CBO : SBO 27.0/17.0/4.0
50:50 RSO : SBO 27.0/15.5/3.5

The two oil blends were combined with the usual emulsifiers and milk phase, consisting of skim milk and salt, and then votated into margarine using a laboratory emulsorator(3). The votated margarines were evaluated for hardness, spreadability, and oiling. Both margarines were satisfactory and essentially equal to each other.

In a second series of tests, a different sample of canbra oil was used. It also was refined, bleached, and hydrogenated. Two different hydrogenated ingredient oils were prepared. In addition, two hardnesses of hydrogenated soybean oil were prepared as controls. The SFI's of the four hydrogenated oils are given in Table II.

TABLE II

SFI'S OF HYDROGENATED CBO AND SBO

	10.0°C	21.1°C	33.3°C
Soft Hydro CBO	13.5	3.0	0
Hard Hydro CBO	56.5	40.0	19.5
Soft Hydro SBO	11.5	3.0	1.0
Hard Hydro SBO	57.5	41.5	18.5

Four margarine oil blends were prepared from these oils as shown in Table III.

TABLE III

MARGARINE OILS FROM HYDROGENATED CBO AND SBO

	M1	M2	M3	M4
Soft Hydro SBO %	56	-	60	-
Hard Hydro SBO %	44	-	-	40
Soft Hydro CBO %	-	60	-	60
Hard Hydro CBO %	-	40	40	-
SFI at 10.0°C	29.5	29.5	27.0	30.0
21.1°C	17.0	16.0	15.0	16.5
33.3°C	4.0	4.5	4.0	3.0

These four margarine oils were blended with the usual emulsifiers and milk phase, and then votated into margarines.

Samples of the four margarines were evaluated in the usual way for hardness at 45°F, 70°F and 80°F (7.2°C, 21.1°C, and 26.7°C), and for oiling at 80°F.

All were found to be satisfactory.

It is well known that in fat blends which have a high degree of homogeneity of triglyceride composition, recrystallization is likely to occur under some conditions of storage, with the resultant formation of "grains" or "lumps".

Since the canbra oil used in this test contained a high percentage (93.4%) of C_{18} fatty acids, a fact which could result in a high degree of triglyceride homogeneity, samples of the four margarines were tested to compare their resistance to "graining". The test procedure consisted of "temperature-cycling" between 45°F (for 7 days) and 80°F (for 1 day).

The three margarines containing canbra oil, M2, M3, and M4, showed some "lumps" and "grains" after 3-5 weeks of temperature-cycling, and after 7 weeks, the graining had made all three completely unacceptable. The all-SBO margarine showed some very slight indication of recrystallization after 14 weeks.

As a result of these findings, another series of margarines was prepared to determine if the "graining" could be repeated, and if so, whether it could be prevented by the addition of palm oil (PO), which is high in C_{16} - fatty acids, or by the addition of RS oil (49.5% non-C_{18} fatty acids). The SFI's and the FA composition of the oils used in this test series are given in Table IV.

TABLE IV

SFI'S AND FA COMPOSITION OF CBO, RSO, AND PO

	Soft Hydro CBO	Hard Hydro CBO	Hard Hydro RSO	PO
SFI at 10.0°C	15.8	57.7	56.7	23.9
21.1°C	4.9	41.4	41.5	13.3
33.3°C	0.4	18.8	17.5	7.8
FA Compos. % C_{16}	-	5.1	3.3	43.5
C_{18}	-	17.7	9.9	5.3
$C_{18=}$	-	71.5	36.8	38.6
$C_{18}2=$	-	2.0	3.2	9.9
C_{20}	-	1.0	3.1	0.3
$C_{20=}$	-	1.3	10.6	0.2
C_{22}	-	0.3	5.6	0
$C_{22=}$	-	0.9	27.3	0
Trans % of Unsats	-	69.0	54.3	-

Five margarine oils were prepared from these oils as shown in Table V.

TABLE V

MARGARINE OILS FROM CBO, RSO AND PO

	M5	M6	M7	M8	M9
Soft Hydro CBO %	60	60	65	58	50
Hard Hydro CBO %	30	10	35	32	30
Hard Hydro RSO %	10	30	-	-	-
PO	-	-	-	10	20
SFI at 10.0°C	29.6	28.1	29.7	29.8	29.5
21.1°C	16.1	15.0	15.8	15.7	15.2
33.3°C	3.9	2.8	4.2	4.5	4.1

These five margarine oils were votated into margarines as described previously. Samples of the votated margarines were then evaluated for hardness, oiling, and for development of "graininess". For the "graining" tests, three different test conditions were chosen:

(a) storage at 45°F,
(b) storage at 45°F for 2-3 days followed by 1 day at 80°F,
(c) storage at 45°F for 1 week followed by 1 day at 80°F, the same as in the first test series.

The five margarines were essentially equal to each other in hardness as judged by penetrations. None showed any oiling.

In the graining tests the following results were obtained to date (data for 8 weeks' storage):

(A) 45°F STORAGE

M5 showed some coarseness but no large grains after 4 weeks. No large grains had formed even after 8 weeks.

M6 had developed slight lumpiness after 4 weeks. There was no further noticeable change during the next 4 weeks.

M7 has remained free of any signs of grains for 8 weeks, so far.

M8 and M9 developed some grains after 1 weeks, and had large grains after 2 weeks. These were still present after 8 weeks.

(B) STORAGE AT 45°F FOR 2-3 DAYS FOLLOWED BY 1 DAY AT 80°F

M5 developed some coarseness after 4 weeks; slight lumps could be noticed after about 6-7 weeks.

M6 remained very smooth up to 3 weeks. From about 5 weeks on it became slightly lumpy and oiled heavily at 80°F.

M7 showed no definite signs of graininess even after 8 weeks. It started to oil heavily after about 5 weeks.

M8 started to oil heavily after 3 weeks but noticeable grains appeared only after 5 weeks. These disappeared again after 7-8 weeks.

M9 was slightly lumpy after 1 week and had large lumps after 3 weeks. No oiling was observed.

(C) STORAGE AT 45°F FOR 1 WEEK FOLLOWED BY 1 DAY AT 80°F

M5 was again slightly coarse after 4 weeks but had no lumps even after 8 weeks. There was no oil separation.

M6 showed no lumps and no oiling.

M7 had no noticeable grains after 8 weeks but oiled heavily after 4 weeks.

M8 was equal to M7.

M9 showed slight graininess after 1 week and had distinct lumps at 3 weeks. It did not oil throughout the 8 week storage.

These results do not agree with those of the earlier test series. The 100% CBO margarine (M7) appears to be the most resistant to "graining", whereas earlier, the 100% CBO margarine (M2) was poor in this respect. There are no significant differences in the SFI's of the hydrogenated canbra oils used in the two tests, or in the SFI's of the two margarine oils. Also, the FA compositions are very similar.

A final answer to the question as to whether or not hydrogenated canbra oil used by itself or in combination with other oils causes "graininess" must await further testing. This, in turn, cannot be started until more canbra oil becomes available.

CANBRA OIL IN SHORTENING

The same oil from the Prairie Regional Lab was used for the first series of shortening tests as was employed in the first margarine testing. The oil, after refining and bleaching, was again hydrogenated sufficiently to reduce the linolenic acid content to less than 1%. Rapeseed oil, hydrogenated to this same endpoint was used as a control

The SFI's of the slightly hydrogenated CBO and RSO were:

	CBO	RSO
10.0°C	2.1	7.0
26.7°C	1.8	1.6
40.0°C	0.5	0.6

Table VI gives the formulation of two pairs of shortenings in which these two oils were used.

TABLE VI

SHORTENINGS FROM HYDROGENATED CBO AND RSO

	S-1	S-2	S-3	S-4
Hydro RSO %	52	-	64	-
Hydro CBO %	-	52	-	64
Beef Tallow %	43	43	30	30
Tallow Stearine %	5	5	6	6
SFI at 10.0°C	27.0	24.0	19.0	19.0
26.7°C	19.5	18.0	15.0	15.0
40.0°C	10.0	10.0	7.0	8.0

The shortenings were votated through the laboratory emulsorator. After tempering, the hardnesses of the samples were measured at 45°F, 70°F and 80°F by means of an ASTM-cone penetrometer.

In both pairs, the hydrogenated CBO was equal to the hydrogenated RSO.

TABLE VII

PENETRATIONS OF CBO AND RSO SHORTENINGS

	S-1	S-2	S-4	S-4
45°F 70°F 80°F	80 150 175	80 150 175	100 200 220	95 180 200

The remaining data are based on tests done with commercial quantities of CBO from the 1965 and 1966 crops which were extracted by the Saskatchewan Wheat Pool. Some of the tests were done on a lab-scale but most were of plant-scale.

Table VIII shows the analysis of the 1965-crop oil.

TABLE VIII

ANALYSIS OF 1965-CROP CANBRA OIL

	C_{16}	C_{18}	$C_{18=}$	$C_{18}2=$	$C_{18}3=$	C_{20}	C_{22}	$C_{22=}$
FA Composition %	4.0	2.0	61.0	19.5	8.5	0.5	2.0	2.5
FFA %	0.4							
Neutral Oil %	98.9							

The FA composition indicates that some contamination with rapeseed oil had occurred.

Our plant reported no problems in alkali refining, bleaching, or hydrogenation; the oil behaved in exactly the same way as rapeseed oil does.

Table IX gives the FA composition, trans-isomer content, and SFI's of CBO and SBO hydrogenated to different degrees.

TABLE IX

ANALYSIS OF HYDROGENATED CBO AND SBO

	PERCENT					SFI			
	C_{18}	$C_{18=}$	$C_{18}2=$	$C_{18}3=$	Trans	10.0°C	21.1°C	26.7°C	33.3°C
Canbra[a]	1.8	60.6	19.4	8.8	-	-	-	-	-
C-2	2.4	66.6	17.9	4.3	6.9	0.6	0	0	0
C-3	4.2	66.1	17.7	2.9	16.6	1.1	0.8	0	0
C-4	4.4	70.5	13.9	1.0	24.4	2.1	1.1	0	0
Soybean[a]	4.3	24.9	52.0	9.1	-	-	-	-	-
S-2	4.2	38.2	42.0	5.4	14.2	0.8	0.7	0	0
S-3	4.5	43.9	37.9	3.5	23.0	2.7	0.9	0	0
S-4	4.5	48.4	34.1	2.6	28.9	5.9	1.4	0	0

[a] - Non-hydrogenated oils.

SFI's, linoleic acid, and trans-isomer levels are lower for the CBO samples than for the SBO samples at comparable levels of linolenic acid.

Two practical advantages result from these findings:

(i) Substantially greater yields of winterized, hydrogenated salad oil can be obtained from CBO than from SBO. Mr. Mertens will be reporting on this in detail later today.

(ii) It becomes possible to produce a so-called "liquid" or "pourable" shortening of superior stability from CBO.

Tables X and XI illustrate the superiority of the pourable CBO shortenings. In Table X, the data on pourability are from samples stored for six days at 44°F, 48°F and 72°F. Table XI gives some data on the stability of the same samples (with the respective non-hydrogenated oils for comparison) after they had been deodorize Citric acid at 0.01%, but no antioxidant, was added to these sample

TABLE X

POURABILITY OF SLIGHTLY HYDROGENATED CBO AND SBO

	PERCENT		CONDITION AT		
	$C_{18}2=$	$C_{18}3=$	44°F	48°F	72°F
C-3	17.7	2.9	Considerable solids, just pourable	Fairly easily pourable	Easily pourable
C-4	13.9	1.0	Too firm to be pourable	Just pourable	Easily pourable
S-3	37.9	3.5	Too firm to be pourable	Just pourable	Easily pourable
S-4	34.1	2.6	Too firm to be pourable	Still not pourable	Just pourable

TABLE XI

STABILITY OF SLIGHTLY HYDROGENATED CBO AND SBO

	AOM Hr	Schaal Days (46°C)
Canbra*	25	10
C-3	50	21
C-4	55	22
Soybean*	10	6
S-3	25	14
S-4	25	14

* - Non-hydrogenated oils.

The remaining data were derived from tests done with a commercial quantity of canbra oil from the 1966-crop. Table XII gives the analysis of the oil as received.

TABLE XII

ANALYSIS OF 1966-CROP CANBRA OIL

	C_{16}	$C_{16=}$	C_{18}	$C_{18=}$	$C_{18}2=$	$C_{18}3=$	C_{20}	$C_{20=}$
FA Composition %	4.0	0.5	2.0	62.5	20.5	9.0	0.5	1.0
FFA %	0.35							
Neutral Oil %	99.3							
Refining Loss % (Plant)	1.4							

As before, the oil responded to the plant refining and bleaching in the same way as rapeseed oil does. It was hydrogenated to differen iodine values. One of the batches was processed to a frying shortenin as follows:

Hydrogenation at 350°F (177°C),

5 psig H_2 gas pressure,
0.3% Ni-catalyst (0.075% Ni),
71 IV endpoint.

The hydrogenated oil was bleached and deodorized with no difficulty. The deodorized frying fat was compared to a standard hydrogenated SBO frying fat of the same hardness in a laboratory test in which successive lots of potatoes were fried.

TABLE XIII

ANALYSIS OF CBO AND SBO FRYING SHORTENINGS

	PERCENT				SFI				
	C_{18}	$C_{18=}$	$C_{18}2=$	Trans	10.0°C	21.1°C	26.7°C	33.3°C	40.0°C
Hydro CBO	16.0	72.0	6.0	51	39	22	18	8.5	0.5
Hydro SBO	9.5	71.5	9.0	42	40	20	14	7.0	0.5

TABLE XIV

STABILITY OF CBO AND SBO FRYING SHORTENINGS

AOM (BHA-BHT and Citric Acid Added)

HCBO	280 hr
HSBO	200 hr

Smoke Point	Fresh (^{o}F)	After Frying (^{o}F)
HCBO	450	390
HSBO	450	380

After Frying	Colour (Red)	FFA %
HCBO	3.1	0.24
HSBO	5.2	0.23

In the course of our work with canbra oil we have also done some analyses of its tocopherol content. Table XV compares levels found in CBO, RSO, and SBO.

TABLE XV

TOCOPHEROL LEVELS OF CBO, RSO AND SBO

	P E R C E N T		
	CBO	RSO	SBO
Crude	0.09	0.09	0.15
Refined	0.06	0.07	0.12
Deodorized	0.02	0.02	0.05

Tocopherol appears to be present in canbra oil at much the same levels as in rapeseed oil.

COMMENTS AND CONCLUSIONS

From the work we have done in our labs and plants, which has been summarized briefly in this paper, and recognizing that considerably more work is still required, we believe it is possible to make some comments and draw some conclusions.

1. It should be possible to refine, bleach and hydrogenate canbra oil using the same conditions as are used for rapeseed oil.
2. Canbra oil should be satisfactory for use in blended and in all-vegetable general purpose shortenings, and also as a frying shortening. We have not tested it in high-ratio shortenings.
3. Hydrogenated canbra oil appears to offer decided advantages over hydrogenated soybean oil as a liquid or pourable shortening, and also as a base for hydrogenated, winterized salad oil.
4. Further work is required to determine if canbra oil can be used satisfactorily in margarine.

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