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THE UTILIZATION OF RAPESEED OIL AS SALAD OIL

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Canadian rapeseed oil (RSO) is predominantly of the Brassica campestris variety with an erucic acid level of around 25-30%. This oil can be classed as a natural salad oil, since its cold test meets the AOCS requirements(1). The fatty acid composition (by GLC) of several samples is given in Table I.

TABLE I

CANADIAN RAPESEED OIL

FATTY ACIDS BY GLC								
16	16:1	18	18:1	18:2	18:3	20	20:1	22:1
2.9	0.2	1.3	25.4	16.5	7.7	0.4	12.1	33.5
4.4	0.1	1.6	33.9	20.0	7.6	0.1	9.1	23.2
2.9	-	1.2	33.6	17.8	9.4	-	11.8	23.3
2.7	-	1.5	27.2	17.6	8.5	-	12.0	30.5

Characteristic features of this oil are the low level of saturated acids, the linolenic acid content of about 7-9% and, of course, the presence of erucic acid. Aside from nutritional aspects, the major problems in the use of this oil as salad oil are its tendency towards flavour reversion and its generally poor oxidative stability, both caused mainly by the relatively high level of linolenic acid (18:3). Because of this characteristic, it can be grouped together with soybean oil (SBO), both showing noticeably poorer flavour stabilities than oils containing no or only traces of linolenic acid (cottonseed, corn, sunflowerseed oils).

The testwork at Canada Packers Ltd. was therefore generally an evaluation of the flavour stability (shelf life) of RSO. In most cases, SBO was also tested for comparison. The samples included:

1. different shipments from the same location,
2. shipments from different locations,

3. shipments from different crop years,
4. samples stored after different extraction procedures,
5. samples stored in different containers,
6. samples stored with different additives.

I. LIQUID RAPESEED OIL

The test procedure for lab samples was to bleach a plant alkali refined oil (2% activated clay, 105°C, 15 min.) and then to deodorize it at 252°C for 2½-3 hrs. After cooling in the deodorizer, the vacuum was broken with nitrogen and 0.01% monoglyceride citrate (MGC) was added.

It was known to us from previous tests that saturation of the oil with nitrogen, flushing of containers with nitrogen, the addition of MGC to the oil, and the use of amber instead of flint glass bottles were steps to improve the flavour stability of a salad oil. In all our tests, the largest number of deodorized samples were therefore stored under these "standard conditions", usually on laboratory shelves at room temperature. The samples were evaluated organoleptically by an expert panel, grading from 1 = very poor to 7 = very good. The endpoint was the development of a strong and objectionable, reverted oil flavour (score 2.5).

Results showed larger variations in the flavour stability of RSO samples than had been experienced previously with SBO samples, not only from one crop year to the next or from one extraction plant to another, but also from one shipment to another from the same extraction plant. Different seed varieties did not show noticeable differences in the oil stability. In a limited number of tests from the same seed lot, an expeller oil was better than a solvent-extracted oil.

Some oil samples had, under these standard storage conditions, a flavour stability of only 1-2 months, whereas the best results were in the range of 7-8 months. Generally, good quality oil could be stored in amber bottles for 3-4 months.

Drastic reductions in stability were observed if the oil was stored in flint-glass bottles or in contact with air, to a lesser extent if no MGC was added. The use of phenolic antioxidants (BHA, BHT) sometimes gave slight improvements but generally the results were inconsistent.

II. HYDROGENATED RAPESEED OIL

The difficulties observed while attempting to make a flavour-stable rapeseed salad oil by storing liquid, non-hydrogenated oil under the best possible conditions revealed the definite limitations of this approach. The next method tried was therefore partial hydrogenation, followed by winterization.

An investigation of different hydrogenation conditions showed that medium-selective conditions gave the best salad oil yields (160°-175°C, 5-10 psi, 0.05% Ni). These conditions combine a good rate of linolenic acid reduction with a low rate of solid glyceride and trans-acid formation.

Hydrogenation was generally continued to linolenic acid levels of 0.5-1.5%. The samples were then winterized at 8-9°C for 2-3 days and filtered at this temperature. No commercial production of hydrogenated, winterized RSO was attempted, mainly because of the necessity of a slow winterization and the formation of very small crystals, causing difficult filtration. Some test results are listed in Table II.

TABLE II

HYDROGENATED RAPESEED OIL SAMPLES

IV	18:3	SFI 10°	Salad Oil Yield %
90	1.5	0.8	87
86	0.5	6.1	75
90	2.5	-	87
87	2.2	5.9	78
84	1.0	9.3	53
82	0.8	12.9	-

Salad oil yields for hydrogenated RSO samples at 0.5-1.5 linolenic acid were found to be about 10% better than for comparable SBO samples. The flavour stability of hydrogenated RSO samples was noticeably better than for non-hydrogenated oil, usually in the order of 5-7 months under the standard storage conditions. Table III lists results with different oils in flint and amber glass.

TABLE III

FLAVOUR STABILITY OF SALAD OILS

	STABILITY IN MONTHS	
	Flint Glass	Amber Glass
Liquid soybean oil	2-3	3-6
Hydrogenated soybean oil	2-4	4-8
Liquid rapeseed oil	1-6	2-8
Hydrogenated rapeseed oil	2-6	3-10

III. LIQUID CANBRA OIL

The following tests with canbra oil (CBO) - zero-erucic acid rapeseed oil - should be of special interest at the present time.

Canbra oil samples with linolenic acid levels of 8-10% have been tested; some fatty acid analyses (by GLC) are listed in Table IV.

TABLE IV

FATTY ACID ANALYSES OF CANBRA OIL

IV	16	16:1	18	18:1	18:2	18:3	20	20:1	22:1
-	3.6	0.5	2.0	62.7	20.3	8.9	0.5	1.5	-
116.8	3.6	0.2	2.0	61.6	21.2	9.6	0.2	1.6	-
111.2	3.7	0.1	2.3	62.9	20.4	7.9	0.7	2.0	-
112.4	3.9	0.3	1.8	60.6	19.4	8.8	0.7	1.8	2.7

Levels of saturated acids and of linolenic acid are usually slightly higher in CBO than in RSO. The last sample shows a slight contaminatio with RSO.

When non-hydrogenated CBO was stored under standard conditions, its stability was equal to that of regular RSO.

IV. HYDROGENATED CANBRA OIL

When CBO with an IV of 111-117 was hydrogenated under medium selective conditions (175°C, 5 psi, 0.05% Ni), it reached a linolenic acid level of 1% at an IV of 93-96, and of 0.5 at an IV of 92-93. The oil can then be used directly as a cooking, baking or frying oil(3), or, after winterization, as a salad oil(2).

Winterization was done as described previously (8-9°C, for 2-3 days). Compared to SBO and RSO samples hydrogenated to the same degree, the yields of salad oil were substantially better. Lab test results with hydrogenated oil samples are listed in Tables 5, 6 and 7.

TABLE V

SALAD OIL YIELDS

(at 0.5-1.0% linolenic acid)

	SFI 10°	Yield %
Hydrogenated canbra oil	2.5- 3.5	90-95
Hydrogenated rapeseed oil	6.5-10.5	70-75
Hydrogenated soybean oil	8-10	60-70

TABLE VI

COMPARISON OF CANBRA AND RAPESEED OIL

LIQUID OIL IV	HYDRO OIL			S A L A D O I L				
	IV	18:3	SFI 10°	Yield %	IV	18:3	Trans %	Cold Test Hrs.
Canbra 111.2	92	0.7	2.1	95	93.4	0.8	13.3	12
Rapeseed 106	86	0.5	6.1	75	87	0.8	15.0	6

TABLE VII

HYDROGENATION TESTS WITH CANBRA OIL

IV	FATTY ACID ANALYSIS BY GLC				Trans %	Salad Oil Yield %
	18	18:1	18:2	18:3		
111.2				7.9		
93.8				0.9		96.8
89.5				0.3		89.4
	2.6	71.3	18.4	3.9	6.4	99
	2.3	71.7	16.8	2.7	8.6	97
	2.2	73.6	16.9	1.9	12.2	96
	3.7	75.0	15.5	1.0	-	95
	3.7	77.4	12.7	0.2	23.8	85
94.1	(lab test)			1.0	13.8	95
90.2	(plant test)			1.0	24.4	85

Hydrogenated, winterized CBO samples had a substantially better flavour stability than non-hydrogenated CBO samples under identical storage conditions. They showed equal and sometimes slightly better flavour and oxidative stabilities than hydrogenated RSO samples at comparable levels of linolenic acid. Examples from different tests are given in Table 8 (storage at room temp.).

TABLE VIII

FLAVOUR STABILITIES OF SALAD OIL SAMPLES

	18:3	SHELF LIFE IN WEEKS	
		Flint Glass	Amber Glass
Liquid CBO	7.9	4	7.5
Hydro CBO	0.9	12	20+
Hydro CBO	0.3	12	18
Liquid RSO	7.7	4	8
Hydro RSO	1.6	7	11
Hydro RSO	0.8	11	18

A commercial lot of CBO (1965) was processed in the plant. The oil was generally equivalent to previous experimental lots, except for a slight contamination with RSO. Hydrogenation in the plant took longer than in the lab, and the plant batch had more trans-acids and a higher SFI level. It gave poorer salad oil yields than comparable lab tests (see Table VII).

Oil samples from the plant run were lab winterized and tested after deodorization (2½ hrs at 252°C, for AOM stability (97.8°; peroxide value of 70 me/kg) and Schaal oven stability at 46° (organoleptic test). CBO was compared with SBO, the results are given in Table IX.

TABLE IX

TESTS WITH CANBRA AND SOYBEAN OILS

	IV	18:3	SFI 10°	Salad Oil Yield	Cold Test Hrs	OIL STABILITY		
						AOM Hrs	Schaal Days	Amber Glass Weeks
Canbra	112.2	8.8	-	-	-	25	10	16
	102.1	4.3	0.6	97	3	30	18	17
	98.7	3.2	0.9	95	5	35	18	17
	98.5	2.9	1.1	85	7	50	21	22+
	90.2	1.0	2.1	81	4	55	22	22+
Soybean	134.6	9.1	-	-	-	10	6	15
	117.9	5.4	0.8	95	6	20	14	10
	110.4	3.5	2.7	80	4	25	14	14
	105.3	2.6	5.9	64	4	25	14	14

At linolenic acid levels of above 5% the salad oil yields were equal; CBO gave better yields by 10-15% at linolenic acid levels of 1-1.5%, and by more than 15% at levels below 1%. In all stability tests the CBO samples were superior to the corresponding SBO samples.

V. OTHER TESTS

Two other methods should be mentioned which look promising for increasing the use of canbra oil as salad oil,

1. the hydrogenation with very selective catalysts, for example of the copper-chromite type,

2. the blending of slightly hydrogenated oil, without winterization, with oils of good cold tests.

The superior selectivity of copper catalysts leads to the ideal combination of low linolenic acid levels at low SFI values. The improved flavour stability at low linolenic acid levels will, however, only become a noticeable advantage, if the traces of copper are completely removed after hydrogenation. The following hydrogenation tests were done with Ni-catalyst (0.2%) at 175°C and 10 psi, and with copper catalyst (0.5-0.7%) at 205°C and 60 psi All samples were winterized very slowly. Table X shows the test results; note especially the following:

- lower levels of trans-acids,
- lower SFI values, and
- higher salad oil yields for the copper catalyst samples.

TABLE X

HYDROGENATION TESTS WITH NICKEL AND COPPER CATALYSTS

Oil	Catalyst	IV	18:3	Trans	SFI 10°	SALAD OIL	
						Yield %	Cold Test Hrs
Soybean	Ni	110.7	2.7	11.5	2.1	93	5
	Cu	116.6	2.6	6.1	0.5	97	5
	Ni	91.0	0.7	29.7	13.9	71	2
	Cu	113.1	0.8	10.5	0.3	95	5
Rapeseed	Ni	95.5	2.2	23.9	1.5	97	2
	Cu	100.0	2.6	6.7	0.4	99	4
	Ni	88.9	0.7	33.5	11.8	80	1
	Cu	92.6	0.8	11.9	0.5	98	2
Canbra	Ni	96.7	3.0	17.2	0.9	96	5
	Cu	104.2	3.1	4.9	0.1	99	5
	Ni	96.2	1.2	21.3	0.7	91	5
	Cu	97.9	0.9	11.1	1.2	98	6

The blending of oils which have a poor cold test with other good salad oils has been reported previously(5). In the presence of 0.1% crystal inhibitor (Claricol) these blends have often shown surprisingly good cold tests, obviously caused by mutual solubility conditions. Such a blending procedure will increase a given salad oil output without additional winterization. Tests with hydrogenated RSO samples having linolenic acid levels of 3% and of less than 0.5% in blends with sunflowerseed oil are listed in Table XI.

TABLE XI

BLENDING TESTS WITH HYDROGENATED RAPESEED OIL

		FATTY ACIDS BY GLC					RATIO OF OILS				
	IV	16	18	18:1	18:2	18:3	%				
Sunflower	132	7.0	4.8	24.8	63.4	-	100	80	60	90	80
Hydro RSO	98.6	3.1	1.5	28.4	14.6	3.3		20	40		
Hydro RSO	89.8	2.8	2.0	32.9	12.1	<0.5				10	20
	COLD TEST HRS:						24+	17	7	10	2

It becomes obvious that very selective hydrogenation of canbra oil and the application of this blending technique offer interesting possibilities for its use. Some tests were also made in our laboratory to use a DSC-instrument to determine the cold-test of an oil blend and thereby to predict how much of a hydrogenated oil can be added to another oil of good cold test. These tests have so far been without success.

In flavour stability tests, another fairly well known fact was confirmed, namely that in a blend of oils one does not obtain a mathematical average, but the oil with the poorest flavour stability generally determines the stability of the whole blend.

In closing may I say that in all our testwork with canbra oil in its application as salad oil - either liquid or hydrogenated, either by itself or in blends with other oils - it has given satisfactory and often very good results both in the area of salad oil yield and oil stability.

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