EFFECTS OF OILSEED PRESS CONDITIONS ON YIELD AND COMPOSITION OF CANOLA OIL AND MEAL

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INTRODUCTION

Environmental concerns over the use of volatile solvents as commercial extractants has placed greater emphasis on the efficient operation of the expeller in the prepress plus solvent system of oil extraction. In previous studies, a laboratory-scale continuous screw press was used to determine the effects of seed pretreatments and operating parameters of the press on oil extractability from canola (Vadke and Sosulski, 1988). Oil output was enhanced by seed flaking, low seed moisture, high feed temperature, slow shaft speed and narrow choke opening. Except for shaft speed, each of these treatments resulted in higher press temperatures which might have specific effects on quality of crude oil or presscake. The objective of the present study was to determine the effects of flaking and processing temperatures on the quality of canola oil and presscake from high and low grade canola seed.

MATERIALS AND METHODS

Seed source

Two lots of the canola genotype of rapeseed, Brassica napus L. cv. Westar, were obtained from commercial farms near Saskatoon, SK. One lot had matured normally and was graded No.1 Canola. The second was harvested under moist weather conditions and a small proportion of immature seeds resulted in over 6% of 'distinctly green' seeds in the sample and a lower seed grade (Table 1). The No.1 grade of commercial canola must contain less than 2.0% of green seeds. In the present samples, the No.2 canola seed contained less oil than the sound sample with a correspondingly higher protein content.

Table 1. Chemical composition of No.1 and No.2 Canola seed, % dry basis, mean of four replicates

Canola grade	Green seed %	Crude oil %	Crude protein (1) %	Crude fiber %	Total ash %
No.1	1.0	48.4	23.0	7.5	4.3
No.2	6.1	46.5	24.8	6.7	4.0

(1) N x 6.25

Processing conditions

Initially the No.1 Canola was pressed at progressively lower moisture contents, from 10.0% to 4.0%, at room temperature, 20°C. Then the samples of No.1 Canola were pressed at the optimum moisture, 5.0%, but at progressively higher seed temperatures from 20°C to 100°C as whole seed and as flakes (0.3 mm thickness). The No.2 Canola seed was pressed at variations of the above conditions which gave press barrel temperatures of 85°, 95°, 105°, 115° and 125°C.

The oil was expelled on a Simon-Rosedowns Mini-40 screw press set at 120 rpm and choke opening of 0.42 mm for No.1 Canola and between 0.61 mm and 0.42mm for No.2 Canola. The barrel temperature and pressure were monitored near the discharge end of the barrel (Vadke and Sosulski 1988). The expelled oils were centrifuged at 5,000 x g for 25 min to remove fines before analysis.

Chlorophyll concentrations were determined spectrophotometrically at 660 nm using chlorophyll a as standard (Levadoux et al. 1987). Carotenoids were quantitated using net absorbance values of 446 nm and 600 nm (DeRitter and Purcell 1981). Analyses for tocopherols and sterols were by gas-liquid chromatography (GLC) (Slover et al. 1983). Free fatty acids were measured by the cupric acetate procedure of Lowry and Tinsley (1976) and peroxide value spectrophotometrically at 230 nm (Swoboda and Lea 1958).

Phosphorus analysis was based on the Totani et al. (1982) procedure. Total sulphur compounds in the oil were converted to hydrogen sulphide by nascent hydrogen released from glacial acetic acid using magnesium catalysis.

Glucosinolates in the fat-free meals were determined by the GLC procedure of Sosulski and Dabrowski (1984). 'Non-available' lysine was measured as the difference between total lysine and lysine bound by 1-fluoro-2,4-dinitrobenzene (Sosulski et al. 1987).

RESULTS AND DISCUSSION

Seed pretreatments

Maximum seed flow rate (throughput) and oil yield were obtained at 5.0% seed moisture level (Table 2). At this moisture level, chlorophyll and sulphur(S) contents of the crude oil, and residual oil in the presscake, were also the lowest in the experiment, and so 5.0% moisture was adopted for the remainder of the investigation.

Table 2. Effects of seed conditioning and flaking on press performance, oil and meal quality of No.1 Canola, average of two runs

Seed Moist %	Seed Temp °C	Pressure MPa	Press Temp. °C	Seed flow kg/hr	Oil yield kg/hr	Chlorophyll ppm	Oil S ppm	Presscake Oil %	Presscake Glu(1) µM/g
				SEED					
4	20	4.7	112	10.0	3.7	8	1	15	27
5	20	4.5	103	12.1	4.4	7	2	16	25
6	20	2.5	94	10.4	3.3	8	4	22	25
8	20	1.5	86	8.6	1.9	11	8	31	23
10	20	1.2	82	8.2	1.4	12	19	35	20
				SEED					
5	20	4.7	112	10.0	3.7	8	<1	15	29
5	40	5.0	115	11.5	4.4	9	<1	14	29
5	60	5.5	116	12.3	4.7	9	<1	13	28
5	80	7.0	119	13.2	5.1	17	<1	12	28
5	100	11.0	130	15.1	6.1	18	<1	10	27
				FLAKES					
5	20	5.7	94	13.9	3.6	3	<1	28	26
5	40	7.5	96	14.6	4.6	5	<1	22	29
5	60	7.6	106	15.6	5.1	5	<1	21	27
5	80	10.5	125	16.0	6.3	16	<1	12	27
5	100	18.0	140	16.6	6.8	18	<1	9	24

(1) Glucosinolates in micromoles/g of fat-free meal.

Increasing seed temperature before expelling resulted in marked increases in pressure in the barrel near the outlet but the associated increase in temperature in the barrel was small (Table 2). Increasing seed temperature and pressure in the barrel gave progressive increases in seed flow rate and oil yield up to the highest temperature used in the study. Similar results were obtained when pretreated canola flakes were fed into the expeller except that even higher pressures, temperatures, flow rates and oil yields were obtained. Residual oil levels in the presscake were reduced to 9-10% for the 100°C pretreated seeds or flakes, which represented a substantial improvement over normal commercial practice. While sulphur levels in the oil were controlled very effectively by the low moisture in the seeds, the chlorophyll contents increased substantially for seeds heated to 80°C-100°C. Therefore, the following experiment on No.2 Canola seed, with high initial green seed count was conducted to assess, more completely, the effects on oil quality.

It was of interest to determine if the high temperature used in pretreatments, or generated at the barrel outlet, had an adverse effect on protein quality of the meal. The total lysine content of the presscake was 5.57± 0.11 g lysine/16 g meal nitrogen, fat-free basis for all treatments in Table 2. The 'available' lysine in the presscake samples ranged from 92.7% to 95.7%, with no variation due to seed pretreatments or expeller conditions.

Thus, it appeared that meal quality was not adversely affected by the pressures and temperatures achieved in these studies. In seeds or flakes processed at 5.0% moisture, there did not appear to be a significant degree of breakdown in total glucosinolates in the presscake as a result of the treatments (Table 2).

Temperature in barrel

Increasing the temperature at the barrel outlet from 85°C to 125°C during oil extraction of the No.2 Canola sample increased oil yield from 70 to 87% and reduced the residual oil in the presscake to only 8% (Table 3). At the 125°C level, it would not be economical or necessary to extract the remaining oil in the presscake with solvent, which would reduce processing costs dramatically.

Table 3. Effect of temperature in the barrel of the expeller on rate of oil extraction from No.2 Canola seed and quality on crude oil, average of two runs

Seed Temp. °C	Press Temp. °C	Oil yield %	Meal Oil %	FFA %	P ppm	Chlor-ophyll ppm	Caro-tenes ppm	Toco-phe(1) mg %	Ste-rols mg%
20	85	70	18	.08	13	6	126	57	689
20	95	77	14	.09	16	10	138	58	696
80	105	81	12	.12	22	47	178	52	621
100	115	85	10	.12	42	47	203	47	685
100	125	87	8	.15	64	68	216	64	741

(1) Tocopherols in mg per 100 g.

As oil extraction rate was increased, the composition of free fatty acids, phosphorus, chlorophyll, carotenoids, tocopherols and sterols in the crude oil increased, especially chlorophyll (Table 3). Therefore, the crude oil from a 125°C run was processed by degumming alone or degumming, alkali refining and bleaching (DRB) (Table 4).

Degumming decreased free fatty acid and phosphorus levels whereas the DRB oil was devoid of free fatty acids and very low in phosphorus and chlorophyll contents. Carotenoid and tocopherol levels were almost halved but total sterols was only slightly reduced by the refining processes. The crude oil was relatively stable and degumming reduced the peroxide value even further.

Table 4. Effect of refining on the quality of press oil extracted from No. 2 Canola at a barrel temperature of 125°C, average of two determinations

Refining	FFA %	P ppm	Chlorophyll ppm	Carotenes ppm	Tocopherols (1) mg %	Sterols mg %	PV (2) mEq
Crude	.23	59	67	214	59	773	1.4
Degummed	.13	19	60	212	52	631	0.7
DRB(3)	.00	4	11	138	31	621	0.8

(1) Tocopherols in mg per 100 g.
(2) Peroxide Value in milliequivalents active oxygen per kilogram of oil.
(3) Degummed, alkali refined and bleached oil.

CONCLUSIONS

By appropriate seed conditioning and press adjustment, up to 87% of the seed oil was extracted from canola on a simple laboratory screw press, leaving only 8% of residual oil in the presscake. The protein quality of the presscake was not adversely affected by the pressures and temperatures achieved on the press but oil contamination was high. Refining was effective in removing most oil contaminants including the high chlorophyll level in No.2 Canola seed.

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