than did the open-pollinated or confectionery seed having a compressibility of about 24% as compared to 13% for the confectionery seed. Regression analysis with a simple log expression showed that compressibility correlated negatively (r^2 = 0.69) with hull thickness. Although the varietal characteristics that influence dehulling appear complex, our data suggest that the adherence of the hull to the kernel, the width of the hull, and thickness of the lignified layer of the hull could affect the dehulling process.

Complete separation of hull and kernel is neither practical nor advisable if the seed is to be prepressed and solvent-extracted. The presence of some hull improves extraction. The increased wax content in the hull of the hybrid seed, along with possibly more of the hull fragments being held to the kernel by fibrous material, probably accounts for the increased wax content of the oil from newly introduced hybrids.

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Fatty Acids of Canola *Brassica campestris* var Candle Seed and Oils at Various Stages of Refining

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ABSTRACT

Fatty acids of oil of a current variety of canola *Brassica campestris* var Candle, at 3 stages of commercial production and refining, were compared with authentic seed oils, and with the oil of *B. napus* var Tower. The proportion of *cis*-9, *cis*-12, *trans*-15 and *trans*-9, *cis*-12, *cis*-15-octadecatrienoates relative to the all-*cis* isomer was lower than that previously observed in processed oils. The minor C_{14}, C_{15}, C_{17} fatty acids previously documented for Tower were also found in the same proportions in the Candle oil. The proportion of 22:1ω7 isomer (1.1% of a total 1.2% 22:1) was intermediate to that of a high erucic variety (0.9% out of 23% 22:1) and the very low 22:1 Tower (2.3% out of 0.1% 22:1). Thus the proportion of ω7 isomers is governed by total 22:1 present.

The exceptionally rapid development of new varieties of canola (the registered name for low glucosinolate, low erucic acid varieties of *Brassica campestris* and *Brassica napus*) means that, in the near future, established varieties such as the *B. campestris* var Candle (of turnip or Polish rape origin) will be replaced by higher yielding varieties (1). Numerous feeding trials have been conducted with meal from this variety (2), many based on comparisons (3) with the *B. napus* var Tower (of Argentine rape origin). Crude fat is about 4% of candle meal and the oil content of the whole seed sometimes used in feed studies is about 41% (4,5). The fatty acid composition of the oil is therefore of interest to animal nutritionists. The oil has also been readily accepted for salad use or margarine stock (6), and canola oil now amounts to over 45% of production of deodorized vegetable oils in Canada (1). However the effects of refining on fatty acids have not, to our knowledge, been published for candle oil.

For the benefit of future researchers who are interested in making comparisons between Tower and Candle seed, oils, or meal, we report (Table I) a study of Candle oil fatty acids, including minor fatty acids such as we reported for Tower oil (7).

EXPERIMENTAL

Candle seed was obtained from Agriculture Canada in Saskatoon and from CSP Foods in Nipawin, Saskatchewan. Commercial oils from the CSP Foods were supplied in crude, degummed and refined form. The seeds were crushed and extracted by refluxing twice with hexane to yield an oil for comparison with the commercial oils. Fatty acid analysis of methyl esters of oils followed procedures outlined earlier (7), including combined gas liquid chromatography, $AgNO_3$ thin layer chromatography, and oxidative fission for determination of proportions of monoethylenic isomers.

RESULTS AND DISCUSSION

The effect of refining on the fatty acid composition of the Candle oil was negligible (Table I). The two mono-*trans* geometric isomers (8) of the dominant *cis*-9, *cis*-12, *cis*-15-octadecatrienoic acid (18:3ω3) were apparent in the gas liquid chromatograms of the crude commercial oil, as well as in the degummed and refined oils. The levels were considerably below those found (ca. 0.5%) in retail soybean oils (8). The *cis*-9, *cis*-12, *trans*-15 isomer was also found in the laboratory-extracted oil, but at a low level in one lot of seed and at levels similar to those of the processed oils in the other lots of seed (Table I). As percentages of the *cis*-9, *cis*-12, *cis*-15 isomer, these isomers were very much less (ca. 1%) than the 25% of 18:3ω3 originally observed (8). This reduction probably reflects the modification of seed and oil processing, especially milder deodorizer conditions, possible with recent canola varieties (9).

A variety of shorter-chain (C_{14}, C_{15} and C_{17}) minor fatty acids were found in the Candle oil, in proportions similar to those previously found in the Tower oil (7). Clearly, these are not qualitatively or quantitatively different in *B. campestris* and *B. napus* varieties of canola.

TABLE I

Comparison of Weight Percentages of Fatty Acids of Oil Extracted from Canola *B. campestris* var Candle Seed with Commercial Oils at Various Stages of Refining and with Fatty Acids of Oil from Canola, *B. napus* var Tower

Fatty acids[a,b,c]	Laboratory-extracted Candle oils		Commercial Candle oils			
	Saskatoon	Nipawin	Crude	Degummed	Refined	Tower oil
14:0	0.04	0.07	0.05	0.07	0.05	0.05
15:0	0.01	0.02	0.01	0.01	0.02	0.01
16:0	3.28	4.19	4.51	4.03	3.82	3.88
17:0	0.02	0.04	0.05	0.03	0.04	0.04
18:0	1.23	1.53	1.39	1.37	1.23	1.56
20:0	0.35	0.42	0.42	0.37	0.35	0.50
22:0	0.16	0.16	0.21	0.22	0.20	0.28
24:0	0.07	0.05	0.06	0.07	0.04	0.14
Total saturated	5.16	6.48	6.70	6.17	5.75	6.46
14:1	ND	0.01	0.01	0.01	0.01	0.01
*c*15:1ω10	0.01	0.02	0.01	0.01	0.02	0.02
*t*15:1ω10	0.01	0.02	0.01	0.01	0.01	0.01
15:1ω8	0.02	0.01	Trace	Trace	Trace	Trace
16:1	0.20	0.24	0.25	0.25	0.24	0.29
17:1ω8	0.03	0.04	0.05	0.04	0.03	0.06
18:1	60.21	56.87	51.61	52.54	53.50	64.02
19:1	Trace	0.02	0.02	0.02	0.03	0.02
20:1	1.04	1.94	1.42	1.37	1.37	1.24
22:1	0.43	1.77	1.16	1.22	1.00	0.08
24:1	0.16	0.19	0.21	0.22	0.25	0.09
Total monoethylenic	62.11	54.75	55.69	55.69	56.46	65.80
16:2ω6	0.03	0.03	0.03	0.03	0.02	0.09
16:2ω4	0.01	0.01	Trace	Trace	Trace	Trace
16:3ω3	0.11	0.14	0.13	0.13	0.15	0.08
18:2ω6	19.93	22.08	24.47	23.94	23.52	18.79
18:3ω3	12.58	10.07	13.58	13.64	13.82	8.59
20:2ω6	0.08	0.10	0.14	0.11	0.11	0.05
20:3ω3	0.01	0.03	ND	ND	ND	0.01
Isom.18:3ω3						
*c*9,*c*12,*t*15	0.02	0.04	0.18	0.25	0.15	ND
*t*9,*c*12,*c*15	Trace	Trace	0.15	0.09	0.02	ND
Total polyethylenic	32.77	32.50	38.68	38.19	37.70	27.61
Calc. iodine value	121	116	125	125	125	112

[a]Not including traces of 12:0, Iso 16:0, iso and anteiso 15:0 and 17:0, and other 15:1 isomers.

[b]*c* = *cis*, *t* = *trans*, ND = not determined.

[c]14:1 Isomer is mostly ω9 (7), for isomer details of other chain lengths see Table II.

TABLE II

Weight Percentage Proportions of Monoethylenic Isomers in a Sample of Canola, *B. campestris* var. Candle oil[a]

Isomer	Chain length			
	16:1 (0.25)	18:1 (53.5)	20:1 (1.4)	22:1 (1.2)
ω9	15	94.3	96.2	98.9
ω7	81	5.7	3.8	1.1
ω5	4	–	–	–

[a]Figures in parentheses give fatty acid total weight % in oil.

The proportions of monoethylenic isomers of the degummed candle oil are shown in Table II. The 22:1ω7 isomer proportions of 1.1% of total 22:1 for *B. campestris* var Candle, with about 1.2% 22:1, are intermediate to the proportions (0.9%) for the high-erucic variety Target (23% 22:1) and the very low (0.1%) 22:1 variety Tower with 2.3% ω7 in total 22:1, both being *B. napus* varieties. This agrees with the earlier proposal (7) that the 22:1 isomer ω7 to ω9 proportions probably relate to total 22:1. The suppression of the ω9 fatty acid elongation does not suppress the ω7 fatty acid elongation to the same extent. The objective of reducing total 22:1 by plant breeding (10) has been attained and 22:1 fatty acids are now found in negligible quantities in canola oil. It is therefore likely that the monoethylenic isomer proportions will not change in newer canola varieties now being licensed.

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