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The Effect of Rapeseed Oil Added to Control Grain Dust on the Quality of Wheat[1]

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ABSTRACT

The effect of spraying edible rapeseed oil on controlling dust in barley, oat, rye and wheat has been investigated. Both the amount of rapeseed oil deposited and initial dust level govern the dust reduction level whereas the type of grain is immaterial. Regardless of the initial dust concentration, about 80% dust could be reduced with only 0.05% rapeseed oil addition. When the initial dust level exceeded 750 mg/m^3, dust reduction could reach 90%. Although some dust adhered to the wheat kernels after rapeseed oil application, except for slight deteriorations in flour ash and color, other flour analytical properties, physical dough properties, and milling and baking qualities were unaffected.

INTRODUCTION

Handling or processing grain creates dust. Aside from causing respiratory discomfort, dust particles of less than 5 μm in size are also considered a potential health hazard (1). In addition, grain dust explosions which have occurred in both grain elevators and flour mills are perhaps the most serious dust problem in the grain industry (2,3).

Controlling grain dust is very difficult because the dust becomes airborne whenever grain is moved or transferred. Furthermore, grain handling operations such as loading and unloading at a grain elevator are not usually confined to a small space. Effective grain dust control thus becomes extremely costly. Capital costs to install grain dust collection equipment have been estimated at between $250,000 and $1,000,000, depending on the size of the grain elevator. The annual operating costs are an additional one-fifth of the capital investment (4). Even after the grain dust is successfully collected (0.05-1.0% of the weight of the grain handled), unless it can find an end use such as becoming a feed or feed ingredient on the spot, it can create a solid waste disposal problem (4). There is an urgent need for new and improved dust control methods applicable to the grain industry.

Several methods have been used to control grain dust. Applying a continuous water mist via a series of fog nozzles in dusty areas has been suggested (5). Spraying extremely low levels of a hydrocarbon-base oil and soybean oil to wheat, corn and soybeans has resulted in surprisingly large reduction in grain dust levels (6,7). The aim of this study was to investigate the effectiveness of grain dust control by spraying the grain with an edible rapeseed oil and to study the effect of applying rapeseed oil on milling and baking qualities of Canadian Western red spring (CWRS) wheat.

MATERIALS AND METHODS

A grain dust measurement device was built according to Cocke et al. (6). A needle valve controlled the flow of air to exactly 1.5 L/min (measured by a Fisher Laboratory Flow Meter). Both the needle valve and the flow meter were installed between the cylinder containing the dirty grain and a vacuum pump. The vacuum pump was further connected to a Laboratory timer to control the dust sampling time. Grain sample size, sampling time and the procedure of measuring dust levels were the same as described by Cocke et al. (6) except that the dust collector contained a 47 mm, 5 μm Millipore membrane filter. Rapeseed oil was added to the samples by spraying directly into the rotating cylinder using a nitrogen-powdered atomizer.

Four dirty grains (barley, oats, rye and wheat) were used to study the effectiveness of grain dust control with rapeseed oil. The samples were obtained from rail car shipments and were subdivided and partially cleaned to provide subsamples with different dust levels. The rapeseed oil was slightly hydrogenated and was supplied by Canada Packers Limited Research Centre, Toronto. The fatty acid composition of the rapeseed oil was as follows: 16:0, 5%; 18:0, 3.4%; 18:1, 79.4%; 18:2, 8.9%; 18:3, 0%; 20:0, 0.6%; 20:1, 1.7%; 22:0, 0.3%; 22:1, 0.7%. For milling and baking studies, the wheat used was a composite sample of No. 1 CWRS type from the 1978 crop. The ash and protein (N × 5.7) contents were 1.51 and 13.4%, respectively (13.5% moisture basis). The wheat was mixed with 10% of a dust and chaff mixture obtained from the screen room of a local flour mill, to make dirty wheat.

Eight wheat samples were treated with various levels of rapeseed oil with or without 10% dust and chaff (Table I). After cleaning with a Carter Dockage Tester, they were tempered to 16.5% moisture fr 18 hr and then milled in the modified Allis-Chalmers Laboratory mill (8). The amount of wheat milled was 3 kg based on 14% moisture to the first

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break rolls.

Flour analysis, rheological and baking (Remix method) tests were the same as described by Holas and Tipples (9). All data are on 14% moisture basis.

Neutral lipids were extracted from the whole wheat and from the flour, bran and shorts fractions with hexane using a Goldfisch extraction unit (16 hr). The samples were not dried or ground prior to extraction. The fatty acid composition of the neutral lipid fraction was determined by gas chromatography of the methyl esters on a 3-m glass column (3 mm id) packed with 10% SP 2330 on AW/DMCS Supelcoport. Methyl esters were prepared with methanolic HCl (10). The amount of rapeseed oil in any of the fractions from rapeseed oil treated grain was estimated by comparing the content of 18:1 fatty acids with that of rapeseed oil and with that of the neutral lipid from the untreated grain.

RESULTS AND DISCUSSION

Effect of Rapeseed Oil on Grain Dust Reduction

The effect of spraying rapeseed oil on grain dust reduction is shown in Figure 1(A). The grain dust reduction was calculated as:

$$\% \text{ Dust reduction} = \frac{\text{Initial dust level (mg/m}^3\text{) - final dust level (mg/m}^3\text{)} \times 100\%}{\text{Initial dust level (mg/m}^3\text{)}}$$

In general, regardless of the type of grain or initial dust level, percentage dust reduction increased with the amount of rapeseed oil applied. The most significant increase occurred between 0.03 and 0.05% of rapeseed oil where dust reduction level changed from 60 to 80%. Further increases in rapeseed oil application caused only minor improvements in dust reduction efficiency.

Figure 1(B) shows the effect of initial dust level on grain dust reduction for the same samples shown in Figure 1(A). For all grains tested, dust reduction changed steadily from 70 to 90% when initial dust level was increased from 100 to 750 mg/m^3. There was no significant change in dust reduction efficiency when initial dust level was further increased up to 2,530 mg/m^3.

It appears that both the amount of rapeseed oil deposited and initial dust level govern the percentage dust reduction. Cocke et al. (6) reported that for dust in wheat, the dust reduction level exceeded 92% at additive levels of 0.07% and above. These studies were carried out, however, at initial dust levels of 1,285 mg/m^3 and higher. For lower initial dust levels (less than 330 mg/m^3) in wheat, corn or soybean, applying additive from 0.04 to 0.36% caused only 59 to 89% dust reduction. Therefore, although a hydrocarbon-base oil was used as additive, their results were essentially the same as this study with rapeseed oil as additive.

Milling Quality

Eight wheat samples were milled in the modified Allis-Chalmers Laboratory mill. The results are given in Table I. Introducing rapeseed oil up to 0.19% with or without 10% dust and chaff had little or no effect on the yields of bran, shorts or straight-grade flour. It should be noted that some dust adhered to the wheat when both rapeseed oil and dust were added as was evidenced from the slight sample weight gain after cleaning with a Carter Dockage Tester before milling (Table I). The dust adherence to wheat kernels can also be observed directly by comparing the scanning electron microscopic pictures of Figures 2(A) and 2(B).

Examination of wheat surface neutral lipids (Table II) showed that almost all of the added rapeseed oil could be found on the surface of clean wheat, but only between 1/4 and 1/3 of the added oil was found on the surface of wheat containing 10% dust and chaff. In the ground products, only ca. 2/3 of the added oil could be accounted for in the clean wheat, indicating that some of the oil was removed by processing, possibly during tempering. About 1/2 of the added oil was found in the flour. The major effect of the addition of rapeseed oil on the fatty acid composition was a minor change in the 18:1 and 18:2 contents of the lipids.

Flour Quality Data

The analytical data for flours are presented in Table III. Except for flour color and ash, other flour properties were essentially unaffected by the addition of rapeseed oil and/or dust and chaff. Introducing either rapeseed oil (sample nos. 2-4) or dust (sample no. 8) increased flour color by 0.3-0.5 KJ units (i.e., flour color became poorer) whereas flour ash was not changed. Adding both rapeseed oil and dust (sample nos. 5-7) caused further deterioration in flour color and a slight increase in flour ash. The deterioration

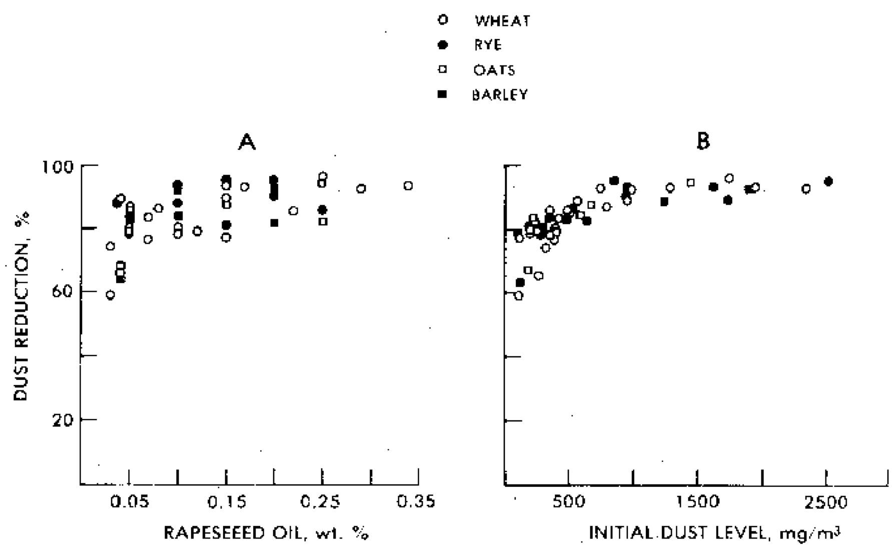

FIG. 1. Effect of rapeseed oil on grain dust reduction: (A) effect of rapeseed oil level; (B) effect of initial dust level.

TABLE I

Wheat Samples and Milling Results

Sample code	Wheat (kg)	Rapeseed oil added (%)[a]	Dust and chaff added (%)[a]	Sample wt after cleaning (kg)	Milling yield[b]		
					Bran (%)	Shorts (%)	Straight grade flour (%)
1	3.10	0	0	3.09	21.1	3.8	75.1
2	3.10	0.07	0	3.10	21.6	3.6	75.1
3	3.10	0.14	0	3.10	21.3	3.7	75.0
4	3.10	0.19	0	3.10	21.5	3.6	74.9
5	3.10	0.07	10	3.12	21.3	3.7	75.0
6	3.10	0.14	10	3.12	21.4	3.7	74.9
7	3.10	0.19	10	3.11	21.3	3.6	75.1
8	3.10	0	10	3.11	21.2	3.7	75.1

[a]Based on 3.10 kg wheat.

[b]The amount of wheat milled was 3 kg based on 14% moisture to the first break rolls. The yield results are also calculated on 14% moisture basis.

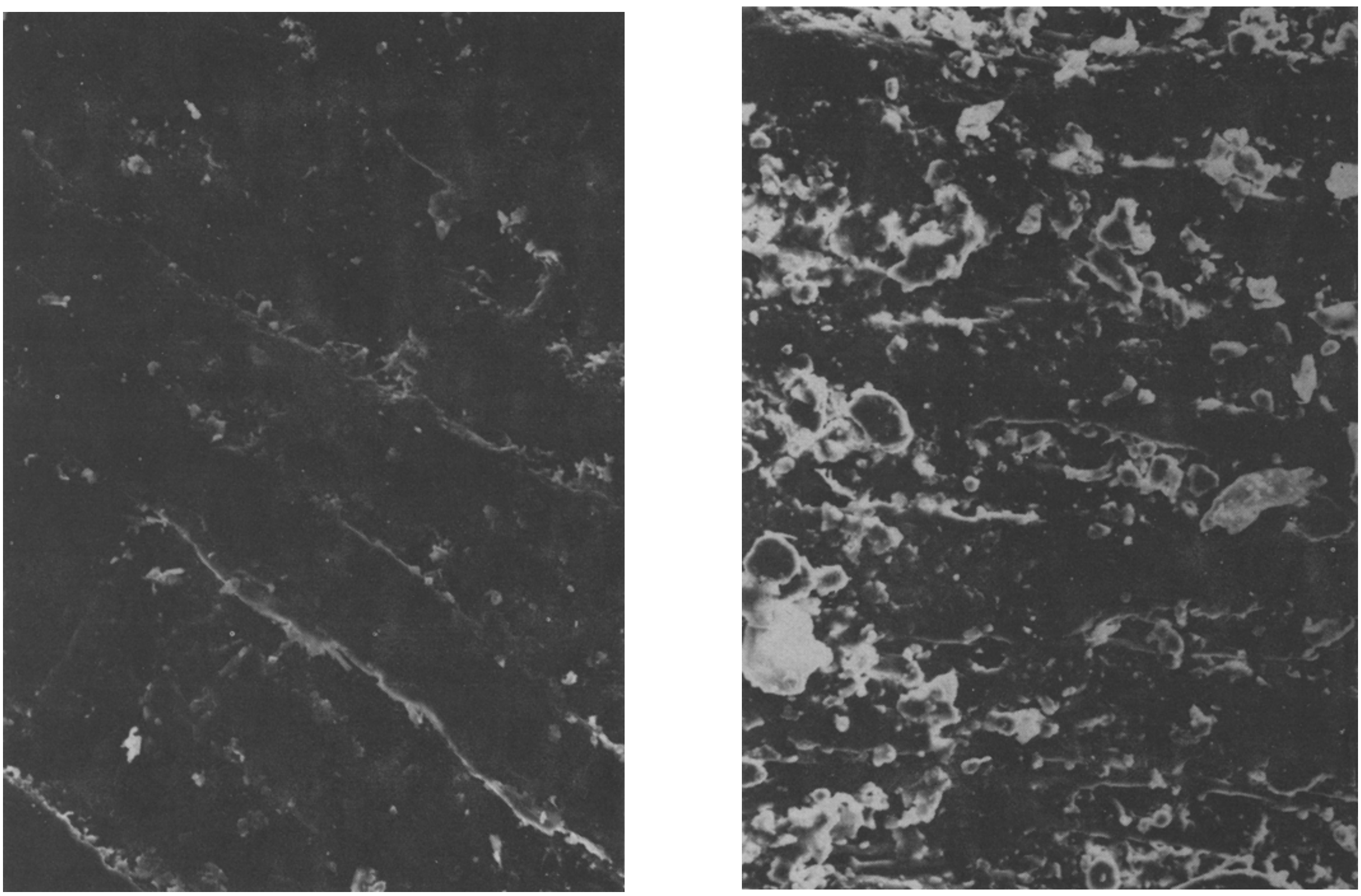

FIG. 2. Adherence of dust to wheat kernels (magnification 750 X): (A) clean wheat; (B) wheat after adding rapeseed oil and dust and cleaning with a Carter Dockage Tester.

in flour color seemed in proportion to the level of rapeseed oil applied (sample nos. 2-4 and sample nos. 5-7).

Physical Dough Properties and Baking Quality

Tables IV and V give the physical dough properties and baking quality of various samples. It is interesting to note that although flour color and flour ash became poorer resulting from addition of rapeseed oil and dust, flour rheological properties were essentially unaffected. Bread loaf volume, appearance, crumb structure, crumb color and baking absorption were also unaffected. The lack of effect on milling and baking quality is in agreement with Lai et al. (7) who worked with soybean oil. Probably this is because the amount of rapeseed oil and dust trapped in flour was not enough to cause any changes.

ACKNOWLEDGMENT

The authors acknowledge the assistance of H.C. Black in setting up the equipment and thank A.W. MacGregor for taking the SEM pictures.

TABLE II

Effect of Added Rapeseed Oil on the Fatty Acid Composition of the Neutral Lipids of Wheat and Milled Wheat Fractions

Sample	RSO added (%)	Dust and chaff added (%)	Lipid content (%)	RSO in lipid (%)	Added oil (%)	Fatty acid composition (% total fatty acids)						
						16:0	18:0	18:1	18:2	18:3	20	22
Wheat	0	0	0.13	0	—	17.3	1.0	19.3	54.6	4.9	0.7	0.6
	0.07	0	0.16	42.4	97	13.5	1.7	39.4	40.3	3.5	0.8	0.8
	0.14	0	0.27	61.2	118	12.0	2.0	44.2	37.2	3.4	0.7	0.7
	0.19	0	0.27	69.0	98	9.3	2.5	52.2	30.6	2.7	0.6	0.8
	0	10	0.13	0	–	16.9	0.8	19.6	56.3	5.3	0.6	0.4
	0.07	10	0.15	12.5	27	15.6	0.9	25.0	51.2	5.0	0.7	0.6
	0.14	10	0.16	17.4	20	15.6	1.5	26.9	49.1	4.2	0.6	0.6
	0.19	10	0.18	30.3	29	14.6	1.7	32.8	44.2	3.6	0.8	0.5
Flour	0	0	0.88	0	—	19.1	1.2	16.3	59.5	2.7	0.7	0.4
	0.07	0	1.02	1.7	19	17.9	1.1	17.1	59.3	2.7	0.7	0.8
	0.14	0	0.92	4.2	21	17.5	1.1	18.7	58.6	2.5	0.8	0.6
	0.19	0	0.87	6.2	21	17.7	1.2	20.0	57.0	2.3	0	0.7
	0	10	0.97	0	—	18.7	1.1	15.8	60.5	2.6	0.7	0.4
	0.07	10	0.88	0.7	7	19.1	1.1	16.5	59.0	2.8	0.7	0.4
	0.14	10	0.91	0.2	1	17.8	0.8	16.2	60.1	3.2	0.7	0.9
	0.19	10	0.88	3.9	14	18.7	1.5	18.5	56.0	2.6	1.5	1.4
Bran	0	0	4.16	0	—	16.4	0.9	20.6	55.8	4.2	1.0	0.6
	0.07	0	4.18	3.3	41	16.9	0.9	22.5	53.6	4.0	1.2	0.5
	0.14	0	4.11	5.4	33	16.8	1.0	25.7	53.2	3.9	1.2	0.6
	0.19	0	4.61	8.8	45	16.0	1.0	21.7	51.4	4.2	1.2	0.6
	0	10	4.05	0	–	16.2	0.9	20.5	56.4	4.5	0.9	0.3
	0.07	10	4.00	2.0	24	16.5	0.9	21.8	44.4	4.2	1.0	0.6
	0.14	10	4.03	3.0	18	16.4	0.9	20.6	55.8	4.2	1.0	0.5
	0.19	10	3.88	2.1	9	16.2	0.9	20.5	56.4	4.5	1.0	0.7
Shorts	0	0	4.90	0	–	16.8	1.0	20.8	56.0	3.9	1.0	0.3
	0.07	0	4.80	1.7	4	15.4	1.1	21.8	55.6	3.8	1.0	0.5
	0.14	0	5.00	3.6	5	16.9	1.0	22.9	54.0	3.5	1.0	0.6
	0.19	0	4.91	5.6	5	17.1	1.1	24.1	52.4	3.5	1.2	0.5
	0	10	5.00	0	—	16.6	0.9	20.8	56.5	3.9	1.0	0.4
	0.07	10	4.89	1.2	3	18.2	1.0	21.5	54.8	3.6	1.0	0.5
	0.14	10	4.90	0.9	1	16.8	1.0	21.3	56.0	9.0	1.0	0.8
	0.19	10	5.00	1.2	1	17.1	0.9	21.5	56.5	3.9	1.0	0.5

TABLE III

Analytical Data for Flours

Sample code[a]	Ash (%)	Color (KJ units)	Protein (%)	Wet gluten (ppm)	Yellow pigment (ppm)	Starch damage (Farrand units)	Gassing power (mm)
1	0.46	0.3	12.6	37.3	2.40	26	335
2	0.46	0.6	12.7	37.9	2.41	27	345
3	0.46	0.8	12.6	37.4	2.35	26	340
4	0.46	0.8	12.6	37.4	2.38	28	335
5	0.48	1.3	12.6	38.0	2.41	26	360
6	0.47	1.3	12.6	37.1	2.39	26	340
7	0.47	1.6	12.6	36.7	2.45	27	340
8	0.46	0.7	12.6	36.7	2.41	28	350

[a]Refer to Table I for the meaning of the sample code.

TABLE IV

Physical Dough Properties

Sample code[a]	Farinogram		Extensogram (135 min)			
	Absorption (%)	Peak development time (min)	Length (cm)	Height at 5 cm (BU)	Maximum height (BU)	Area (cm^2)
1	63.3	5.50	20.5	285	440	125
2	63.8	5.00	20.5	285	450	130
3	64.0	5.25	20.5	290	430	130
4	64.3	5.25	21.0	280	435	130
5	63.4	5.25	20.5	290	445	130
6	63.5	5.25	20.5	290	440	125
7	63.7	5.25	20.5	300	455	130
8	63.9	5.50	20.5	295	460	130

[a]Refer to Table I for the meaning of the sample code.

TABLE V

Baking Quality

Sample code[a]	Loaf volume (cm^3)	Appearance	Crumb structure[b]	Crumb color[c]	Baking absorption (%)
1	825	8.0	6.8-o	6.2 dy	62.0
2	820	7.8	7.0-o	6.5 dy	63.0
3	820	8.0	6.8-o	6.5 dy	63.0
4	815	7.8	6.8-o	6.2 dy	63.0
5	820	7.8	6.8-o	6.2 dy	62.0
6	830	7.8	6.8-o	6.5 dy	63.0
7	835	7.8	6.8-o	6.2 dy	63.0
8	820	8.0	6.8-o	6.2 dy	63.0

[a]Refer to Table I for the meaning of the sample code.

[b]o = Open.

[c]d = Dull, y = yellow.

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The Relationship between Rapeseed Chlorophyll, Rapeseed Oil Chlorophyll and Percentage Green Seeds[1]

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ABSTRACT

Oils with high levels of chlorophyll have become a major problem in the Canadian crushing industry. It was not possible to compare visually the color of samples of rapeseed oil from various crushing plants in Western Canada with the nickel sulfate standard used as a trade standard. Comparison was easy using samples of oil prepared from seed in the laboratory. The difficulty in comparison was probably caused by conversion of green-colored chlorophyll to russet-colored pheophytin in the crushing process. An "apparent chlorophyll" standard with a maximum of 20 ppm (measured by AOCS Cc 13d 55) is recommended. The "percentage green seed" count used in the Canadian grading system was found to correlate poorly ($r^2 < 0.5$) with the chlorophyll level in the seed or oil. A maximal chlorophyll level of 12 ppm was found to be allowable in the top grade of seed. It is recommended that a rapid, accurate and inexpensive procedure for chlorophyll measurement be developed to supplement the grading system.

[1]Contribution No. 478 from the Grain Research Laboratory, Canadian Grain Commission, 1404 - 303 Main St., Winnipeg, Manitoba, Canada R3C 3G9.

INTRODUCTION

In the Canadian grain grading system, grain samples are assigned grades according to the number and type of damaged seeds and the amount and kind of admixture found on visual inspection. In the case of rapeseed or canola, damage factors include immature seeds, heated seeds, and frosted and otherwise weathered seeds. Despite the relatively stringent restrictions on the number of damaged seeds allowed in the top grades (Table I), about 90% of the rapeseed inspected annually arrives at shipping points as No. 1 Canada Rapeseed.

Canola is a trademark of the Canola Council of Canada and refers to seed and products from varieties of *B. napus* and *B. campestris* which are low in erucic acid and glucosinolates. Although about 75% of Canada's rapeseed production has been converted to canola, there is no effort to segregate canola from rapeseed in export channels. Since canola crushers use about two thirds of the seed produced and the carryover of rapeseed from previous years is large, canola does not regularly appear in Canadian export cargoes. This study uses samples of both canola and rapeseed.