Rapeseed Preparation for Solvent Extraction

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ABSTRACT

This paper discusses procedures and outlines the flow of rapeseed from field to extraction unit. The important areas of handling, grading, and cleaning are identified with the most satisfactory solutions to the problems described. Rapeseed contains nutritional depressant factors, i.e. glucosinolates and erucic acid. Their presence necessitates careful selection and processing requirements to meet the high quality demand of vegetable oil processors and the feed manufacturers. The specific attention required to consistently meet these requirements will also be presented and discussed.

INTRODUCTION

Canadian rapeseed presently represents the largest indigenous oilseed crop for domestic consumption. It is ca. 20% of world production, which makes Canada the largest exporter of rapeseed in the oilseed trade (1).

From an initial 100 acres of crop which served as the preliminary field trial of rapeseed in Canada in 1942, it now occupies two to four million acres each year (2). The large variation in acreage is in response to the demand for other Canadian agricultural products in the world market. It has provided a cash crop to the farmer in times of depressed cereal sales. Canadian rapeseed averaged, in 1974, (calculated on an 8½% moisture content) 40.8% oil and 35.6% protein. (Protein was calculated on an oil-free basis) (3). In 1975 when new varities low in erucic acid and thioglucosides were introduced and increased oil and protein content, the crop of rapeseed averaged on the same basis, 41.3% oil content and 36.9% protein (4). These two numbers show a marked improvement indicative of improvements continuing to take place with new variety development (Table I).

Utilizing two to four million acres with average field production and average analytical results, Canadian rapeseed represents 0.3 to 0.6 million tons of oil for domestic and export markets.

For those not familiar with rapeseed, it is a small round seed similar in size to mustard, turnip, or radish seed. Weed contamination and tramp material of small pieces of earth and stones can be present in the harvested field sample, presenting preparation problems for processing.

Similarly, nonuniformity in field performance, germination, early frost, poor storage conditions, etc. contribute to seed quality variation which must be carefully attended to, otherwise product quality and extraction results seriously effect plant crushing margins.

In the policy of CPS Foods Ltd., we attempt to be prepared for as many of the problems mentioned through the practice of the grower submitting field harvested samples to our Grain Procurement Department prior to actual delivery of the seed. This allows the elevator agent and the laboratory to assess potential problem seed becoming available for purchase. Deliveries are scheduled and allowances made for the variations observed. This tends to average out the seed presented for extraction in as uniform a condition as is practical. Rapeseed programmed for delivery at our elevators is unloaded with a continuous sample taken by a belt-type sampler. The sample is pneumatically delivered to the agent's office for confirmation of seed requested, dockage contamination, moisture and other degrading factors assessed at the time, to establish the grade and hence the market price for the seed. The rapeseed is binned on the basis of grade and variety. The following steps are followed in cleaning the rapeseed drawn from the storage bin prior to delivery to the extraction plant.

From the elevator receiving bin, the rapeseed is processed to an indent grain cleaner equipped with an aspirator and scalper. The aspirator and scalper handle dust, fines, and large refuse material which are normally part of harvested seed. The indent cleaner, a rotating drum that selects seed on the basis of the length principle makes distinction of small seeds vs. longer length seeds. The size of indents range from #16/64 to #19/64 for the first cut and followed through with a #12 or #13. These larger seeds are for example, wild oats, large wheat and barley kernels, sections of broken seed pods, knuckles, etc. From this machine the seed is taken to another holding bin prior to being processed to a sieve machine which uses width separation for the removal of fine seeds and slightly over or under-sized seeds of irregular configuration to that of rapeseed, i.e. buckwheat, lamb's quarters, cracked and broken seeds. This unit also uses aspiration for the handling of additional dust and fine materials. As seed exits this machine, it is continuously sampled for laboratory confirmation as to suitable preparation for crushing. In times of early crop damage, this confirmation would identify adequate blending of seed of good quality with that of seed of marginal quality; namely, color, free fatty acid, and moisture content. This year, moisture content is a critical factor; the new crop is of excellent quality and is being delivered with a very low moisture content in the seed. This condition necessitates the addition of moisture to the seed put up in mill bins for processing. The moisture is being added by means of sprays fixed above conveying belts to mill bins for some residence time ro provide for absorption. Further additional moisture is added through injecting blanket steam in the initial cooking stages.

Rapeseed is presented to the preparation plant clean, i.e. normally 1 to 2% of inseparable seeds, and ideally at ca. 8½% moisture content. A trend with processing plants in Western Canada is the practice of preheating rapeseed as it begins the preparation for extraction process. Rapeseed heaters come as rotating horizontal steam tube heater, stationary steam tube heaters, or hollow-flight, steam-jacketed conveying screws. The temperature rise across the heater is usually designed for 18 C. This step has assisted oil

TABLE I

Average Oil, Protein, and Nitrogen (N) Content of Canadian Rapeseed and Rapeseed Meals by 5-Year Intervals and for the Last Four Crops

	% Oil at moisture		% Protein[a] at moisture		
Year	8.5	0	8.5	0	% N
1956-60	38.9	42.5	38.6	42.1	6.7
1961-65	39.4	43.1	38.2	41.8	6.7
1966-70	40.7	44.5	36.6	40.0	6.4
1971	39.6	43.3	36.2	39.6	6.3
1972	39.5	43.1	34.5	37.7	6.0
1973	39.0	42.6	35.5	38.8	6.2
1974	40.8	44.6	35.6	38.9	6.2
1975	41.3		36.9		

[a]Calculated on an oil-free basis.

plant operations by providing seed that has been heat conditioned prior to flaking. It was our experience that in subzero weather the frozen seed processed through the flaker resulted in manufacturing large quantities of fine material. These fines are seed and seed coat fragments which occur from fracture vs. rolling of a thin flake; the fines from fracture create additional problems in extraction and drainage. For rapeseed on direct solvent extraction it is our practice to attain flake thicknesses by the flaking rolls between 0.2 mm and 0.22 mm thickness; for prepress solvent extraction that flake thickness would measure between 0.22 mm and 0.25 mm thickness. With small seeds such as rapeseed, constant attention to service roller mills is required to maintain this flaking standard and to ensure that whole seeds do not slip by the roll ends. Out experience with roller mills indicates that the standard alloy of a 56 to 58 Rockwell hardness provides the best service. Standard alloy rolls have ca. 1% nickel and 0.25% chromium content. The rolls are smooth surface rolls operating with zero slip to a maximum of 5% slip. Poor flaking results in poor extraction.

Following the flaker, the material passes by conveyor to the stacked cooker. The seed enters at ca. 30 C to this cooker and, under the cooking functions of time, temperature, and moisture, is cooked and made ready for prepressing and solvent extraction; for direct solvent extraction, it is crisped in an open-screw conveyor, then rerolled through a standard roller mill to a maximum of 0.3 mm and presented to the solvent extraction plant.

Rapeseed is cooked for ca. 30 min in normally four-high or five-high, stacked cookers, with a material bed depth of ca. 30 cm. The average residence time in each kettle is ca. 5 to 7 min. If the flaked material contains ca. 8 to 10% moisture, there is normally no requirement to add any additional moisture to the cooking process. Should the moisture content of the flaked material be lower than 8%, there will be a requirement for the addition of moisture to effect adequate cooking functions, i.e. weaken oil cells, agglomerate the fines, and condition the protein material for percolation and drainage at the extractor. The process of cooking rapeseed is complicated by the breakdown of thioglucosides by the rapeseed enzyme myrosinase. As has been demonstrated, the activity of this enzyme is greatest between the temperature of 40 and 70 C. The object in rapeseed cooking is to rapidly achieve the temperature levels at which the enzyme is inactivated namely, that above 70 C (5). This enzyme, through hydrolysis, acts on the thioglucosides in the rapeseed producing the products isothiocyanates, oxazolidinethiones, and nitriles. The addition of excess amounts of water increases the opportunity for the formation of these products. When the seed is crushed and the enzyme brought into contact with the thioglucosides, the moisture content of the seed should be between 6 and 10%. Above 10% moisture hydrolysis will proceed rapidly, and below 6% moisture the enzyme is only slowly inactivated by heat. The temperature rise in the cooker should be sufficient at the second kettle level to accomplish the inactivation of the enzyme. When processing dry seed, moisture either in the form of water or steam should be added in small increments and controlled in order not to provide the environment for hydrolysis and hence the breakdown of the thioglucosides.

The cooker kettles are vented either through atmospheric vents or through the use of exhaust fans. A normal procedure is to have the vents in the top kettles closed to allow a rapid rise in cooking temperatures and to vent the lower kettles of the cooker to achieve a reduction in moisture content of the cooked material to ca. 5 to 6% for prepressing and for direct solvent extraction, realizing a final outlet temperature of the cooked material at 105 C maximum. On mechanical pressing, oil is pressed to between 14 and 18% residual oil in the cake. On direct solvent, the material discharges from the cooker into an open-vented screw conveyor which is designed to promote the flashing of a portion of the moisture contained in the hot, cooked material. This action produces crisp porous granules essential for subsequent extraction. This material then is fed to reroll which reforms the cooked and crisped material to rupture weakened oil cells, to eliminate larger particles formed during cooking, and to uniformly size the material for extraction. These steps are very important in achieving optimum preparation for extraction and filtration necessary in rapeseed process preparation.

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