CANOLA MEAL PROCESSING

Canola seed is traditionally crushed and solvent extracted in order to separate the oil from the meal. The process usually includes seed cleaning, seed pre-conditioning and flaking, seed cooking, pressing the flake to mechanically remove a portion of the oil, solvent extraction of the press-cake to remove the remainder of the oil, and desolventizing and toasting of the meal. Meal quality is influenced by several variables during the process, especially temperature.

Seed Cleaning

Canola seed is graded according to strict grading standards established by the Canadian Grain Commission. These include specifications for maximum moisture content, seed damage and chlorophyll level. The seed delivered to the crushing plant contains dockage materials, which are removed by cleaning operations prior to processing.

Seed Pre-Conditioning and Flaking

Many crushing plants in colder climates preheat the seed to approximately 35°C through grain dryers in order to prevent shattering which may occur when cold seed from storage enters the flaking unit (Unger, 1990). The cleaned seed is first flaked by roller mills set for a narrow clearance to physically rupture the seed coat. The objective here is to rupture as many cell walls as possible without damaging the quality of the oil. The thickness of the flake is important, with an optimum of between 0.3 to 0.38 mm. Flakes thinner than 0.2 mm are very fragile while flakes thicker than 0.4 mm result in lower oil yield.

Seed Cooking

Flakes are cooked/conditioned by passing them through a series of steam-heated drum or stack-type cookers. Cooking serves to thermally rupture oil cells which have survived flaking, reduce oil viscosity and thereby promote coalescing of oil droplets, increase the diffusion rate of prepared oil cake, and denature hydrolytic enzymes. Cooking also adjusts the moisture of the flakes, which is important in the success of subsequent prepressing operations. At the start of cooking, the temperature is rapidly increased to 80-90°C. The rapid heating serves to inactivate the myrosinase enzyme present in canola. This enzyme can hydrolyze the small amounts of glucosinolates present in canola and will produce undesirable breakdown products which affect both oil and meal quality.

The cooking cycle usually lasts 15 to 20 minutes and the temperatures usually range between 80 and 105°C, with an optimum of about 88°C. In some countries, especially China, cooking temperatures of up to 120°C have been traditionally used when processing high glucosinolate rapeseed to volatize some of the sulphur compounds which can cause odours in the oil. However, these high temperatures can negatively affect meal protein quality.

Pressing

The cooked canola seed flakes are then pressed in a series of low pressure continuous screw presses or expellers. These units consist of a rotating screw shaft within a cylindrical barrel which consists of flat steel bars set edgewise around the periphery and spaced to allow the oil to flow between the bars while the cake is contained within the barrel. The rotating shaft presses the cake against an adjustable choke, which partially constricts the discharge of the cake from the end of the barrel. This action removes most of the oil while avoiding excessive pressure and temperature. The objective of pressing is to remove as much oil as possible, usually between 60 and 70% of the seed oil content, while maximizing the output of the expellers and solvent extractor, with the production of acceptable quality presscake.

Solvent Extraction

Since the pressing is not able to remove all of the oil from the canola seed, the presscake is solvent extracted to remove the remaining oil. The cake from the expellers, containing between 14 and 20% oil, is sometimes broken into uniform pieces prior to solvent extraction. In solvent extraction, they use a hexane specially refined for use in the vegetable oil industry. Various mechanical designs of solvent extractors have been developed for moving the cake and the miscella (solvent plus oil) in opposite directions to effect a continuous counter current extraction. Basket and continuous loop type extractors are commonly used for canola. The principles are the same – the cake is deposited in the extractor, which is then flooded with solvent or miscella. A series of pumps spray the miscella over the presscake with each stage using a successively "leaner" miscella, thereby containing a higher ratio of solvent in proportion to the oil. The solvent percolates by gravity through the cake bed, diffusing into and saturating the cake fragments. The marc (hexane saturated meal) that leaves the solvent extractor, after a fresh solvent wash, contains less than 1% oil.

Desolventizing and Toasting

The solvent is removed from the marc in a desolventizer-toaster. In a series of compartments or kettles within the desolventizer, the majority of the solvent is flashed from the meal by injection of live steam. The final stripping and drying of the meal is accomplished in the subsequent compartments heated to between 103 and 107°C. The total time spent in the desolventizer-toaster is approximately 20 minutes. The meal emerges free of solvent. It contains about 1% residual oil and 15 to 18% moisture. After drying to 8 to 10% moisture and cooling, the meal is often granulated to a uniform consistency and then is either pelleted or sent directly as a mash to storage.

Effects of Processing on Meal Quality

The quality of the meal can be both enhanced and diminished by altering the processing conditions in the crushing plant. Minimum processing temperatures are needed in order to deactivate myrosinase enzyme, which if not destroyed will break down glucosinolates into their toxic metabolites (aglucones) in the animal's digestive tract. The canola crushing process can also cause thermal degradation of 30 to 70% of glucosinolates in the meal (Daun and Adolphe, 1997). However, if temperatures are too high for too long a period, then the protein quality of the meal can decrease. In Canada, most crushers have very similar processing conditions and canola meal quality does not vary widely between and within crushers. In some countries, however, there can be considerable variation in temperatures used during canola processing. In these cases, it is important for canola meal users to routinely measure the protein quality of the meal or audit and approve suppliers.

As well, some of the byproducts of canola processing are sometimes added back into the canola meal. In the case of added gums and soapstocks, these oil rich components will increase the energy content of the meal. In the case of added screenings and foreign material, the meal quality may decrease. A good ingredient quality control program will pick up these differences in processing practices.

Temperature

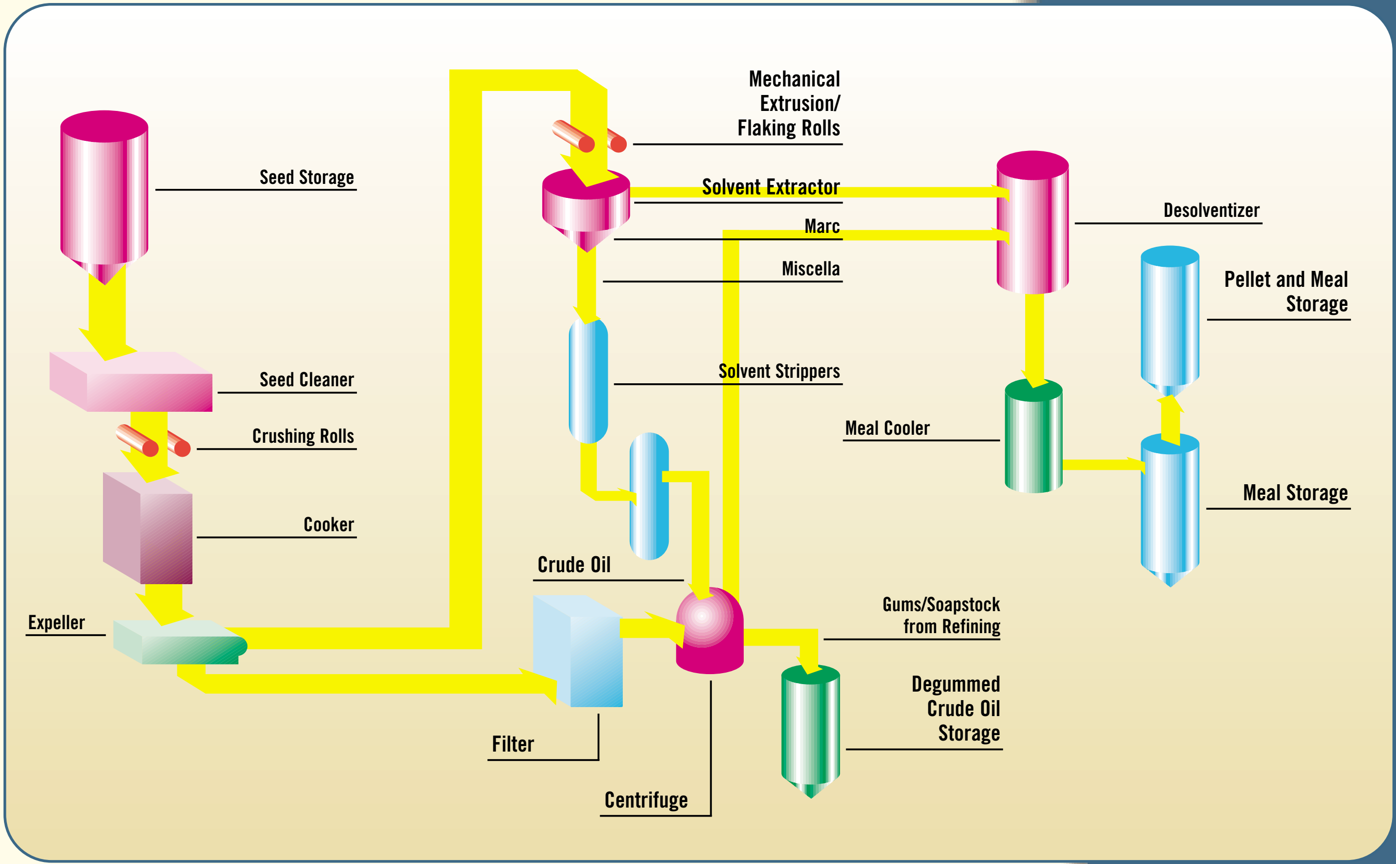
Deactivation of myrosinase enzyme is best accomplished during the canola seed cooking stage. The early research of Youngs and Wetter, (1969) regarding steps to minimize glucosinolate hydrolysis by myrosinase has become the operating practice for processors around the world. Moisture content of the seed during processing should be between 6 and 10%. Above 10% moisture, glucosinolate hydrolysis will proceed rapidly, and below 6% moisture the myrosinase enzyme is only slowly inactivated by heat. As well, during seed cooking, the temperature must be raised to 80 to 90°C as rapidly as possible. Myrosinase catalyzed hydrolysis of glucosinolates will proceed with increasing temperature until the enzyme is deactivated so that a slow rate of heating favours glucosinolate hydrolysis.

Excessive heating during processing can result in reduced animal digestibility of some amino acids, particularly lysine. Processors must exercise strict process control to ensure amino acid damage is minimized by not overheating the meal in the desolventizer-toaster. Examination of meal quality at various processing stages in several Canadian crushing plants (Newkirk and Classen, 2000), revealed that canola meal is a uniform and high-quality product until it enters the desolventizer-toaster phase. During this stage crude protein and lysine digestibility and lysine content were significantly reduced and the apparent metabolizable energy was numerically lower. This research by Newkirk suggests that the commonly used temperatures in the desolventizer-toaster stage of 105°C cause some protein damage. They found that processing with a maximum temperature of 95°C in the desolventizer-toaster significantly increases lysine digestibility – to similar levels found in soybean meal. Also, traditional toasting causes the meal to become much darker in colour. This is a quality concern for some feed manufacturers, which prefer using light coloured ingredients due to feed customer preferences.

Additives

Crude canola oil contains a portion of phospholipid material which is removed during oil processing. This material is commonly referred to as "gums" and in Canada is added back to the meal in the desolventizer-toaster at a level of 1 to 2%. Also, in crushing plants with associated oil refining, the acidulated soapstocks may be added to the meal at a level of 1 to 2%. These additions serve to reduce the dustiness of the meal and, more importantly, increase its metabolizable energy value. In some countries the gums and soapstocks are used for other purposes and not added to the meal. This is the main reason that Canadian canola meal has higher levels of oil than meal from many other countries.

Figure 1 Schematic of prepress solvent extraction process



References

Daun, J.K. and D. Adolphe. 1997.
A revision to the canola definition. GCIRC Bulletin. July, 1997. Pages 134-141.

Newkirk, R.W. and H.L. Classen. 2000.
The effects of standard oil extraction and processing on the nutritional value of canola meal for broiler chickens. Poult. Sci. 79 (Suppl. 1):10.

Unger, E.H. 1990.
Commercial processing of canola and rapeseed: crushing and oil extraction. Canola and Rapeseed: Production, Chemistry, Nutrition, and Processing Technology. F. Shahidi (ed.). New York, N.Y.: Van Nostrand Reinhold. 1990. Ch. 14: 235-249.

Youngs, C.G. and L.R. Wetter. 1969.
Processing of rapeseed for high quality meal. Rapeseed Meal for Livestock and Poultry. Rapeseed Association of Canada. Publ. No. 3: 2-3.