# Modern Processing of Rapeseed

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**The various processing steps for rapeseed into finished oil and meal products have been reviewed. Particular attention has been given to recent developments, such as the inclusion of an extruder step in oil extraction, an aqueous enzymatic process to separate flakes into oil, flour and molasses, the TOP total degumming process, and the new Centri-Ad process to eliminate small quantities of impurities (dissolved or emulsified) from large volumes of liquid by a continuous adsorption-centrifugation technique.**

**KEY WORDS: Centri-Ad process, centrifugation, continuous adsorption, enzymatic process, oil extrusion, oilseed processing, rapeseed, TOP degumming.**

Rapeseed is an oilseed with worldwide importance. It is currently ranked third, after soybean and palm oils (Table 1). Rapeseed originates from India or China and has been grown in Europe for hundreds of years. The real expansion came when so-called double low (canola) varieties became available through plant breeding some 10 years ago. Rapeseed became a cinderella crop in Canada in the 1970's, and today canola oil accounts for nearly 60% of Canada's domestic production of deodorized oils. The use of rapeseed meal also has increased substantially. In recent years, there has been a growing interest in growing rapeseed in the U.S. One reason for this is that in 1985 the USDA granted GRAS (generally recognized as safe) status to low-erucic acid rapeseed (canola) oil, allowing the oil to be marketed in the U.S. Another reason is that rapeseed has the potential to be a good "cash crop" in many states. Some growers predict a potential acreage of 5 million acres, mainly in the Eastern and Southeastern states.

Rapeseed contains about 40–45% oil, 20–25% protein and 25% carbohydrate. Canola contains only minor quantities of erucic acid and glucosinolates in the oil and in the meal, respectively. Both are considered anti-nutritional for humans and for animals. To obtain oil and protein products of high quality the starting seed material has to be well-ripened, clean and stored properly. The important steps in processing rapeseed are shown in Figure 1.

**TABLE 1**

**World Production of Major Vegetable Oils (in million tons)**

| Oil | 1965 | 1975 | 1985 | 1990 |
|---|---|---|---|---|
| Soybean | 4.0 | 8.0 | 13.9 | 16.0 |
| Palm | 1.4 | 2.9 | 6.9 | 11.2 |
| Rapeseed | 1.5 | 2.4 | 6.0 | 8.2 |
| Sunflower | 3.1 | 3.9 | 6.5 | 8.1 |
| Cotton | 2.7 | 2.9 | 3.8 | 3.7 |
| Groundnut | 2.8 | 2.7 | 3.1 | 3.3 |

| | |
|---|---|
| PRETREATMENT | Dehulling<br>Crushing<br>Cooking |
| MANUFACTURE OF OIL | Pressing<br>Solvent extraction<br>Degumming |
| OIL REFINING | Neutralization<br>Bleaching<br>Deodorization |
| MODIFICATION OF OIL | Hydrogenation<br>Interesterification |

**FIG. 1. Processing steps for rapeseed.**

## PRETREATMENT OF RAPESEED

As for most other oilseeds, pretreatment includes crushing, cooking and, in rare cases, dehulling. Dehulling of rapeseed aims at the removal of the major part of the fiber and pigments, which otherwise would lower the feeding value of the meal. On the other hand, the hulls facilitate percolation by increasing the porosity of the material during extraction. Dehulling (*i.e.*, removal of 15% of material) would theoretically increase the throughput in the extraction equipment 15%. If the dark hulls are removed before extraction, the oil obtained will have a lighter color and will require less bleaching. Different techniques are available for dry dehulling of rapeseed—pneumatic impact, splitting between rollers, or cleavage by deformation (Fig. 2). This third technique has given the best results and caused the least loss of oil.

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## MANUFACTURE OF RAPESEED OIL

Rapeseed is processed for oil recovery by flaking the seeds to fracture the seed coats (if not removed) and to rupture the oil cells. The flakes are cooked to rupture any remaining intact cells, which enhances coalescence of oil droplets by increasing fluidity, and to inactivate enzymes, particularly myrosinase, the enzyme that hydrolyzes glucosinolates. The flakes are cooked at 77–100°C, depending on seed variety, for 15–20 min. In most cases, the flaked and cooked seed is screw-pressed to reduce the oil content from 42% to 16–20%; this operation also compresses the tiny flakes into large cake fragments. This cake is solvent-extracted with hexane to remove most of the remaining oil. Flaked cooked seed also can be directly solvent-ex-

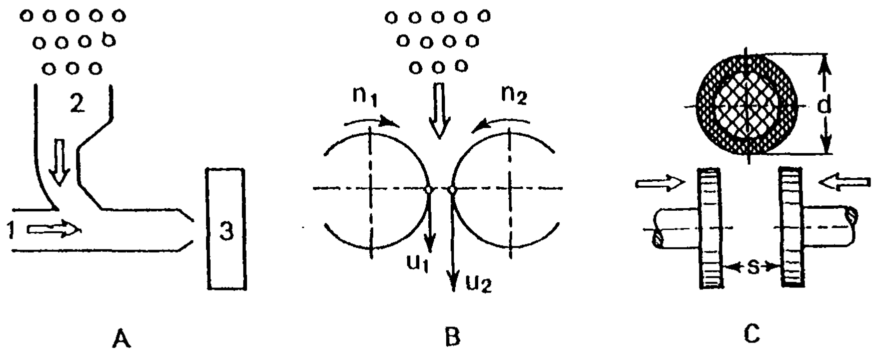


FIG. 2. Techniques of rapeseed dehulling. A, Pneumatic impact; B, splitting between rollers; and C, cleavage by deformation.

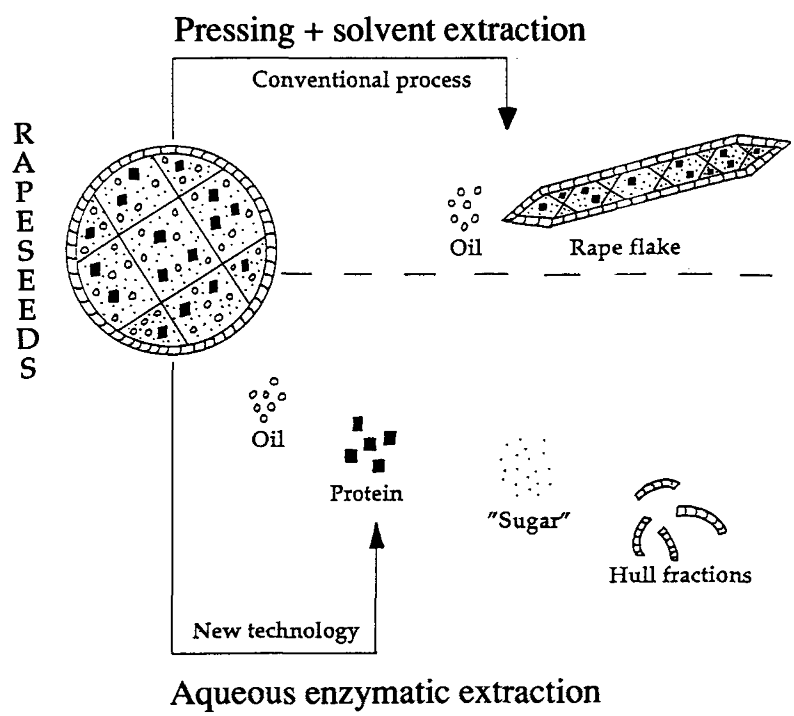


FIG. 3. Conventional and enzymatic extraction of rapeseed oil.

tracted by omitting the prepress step, but this is not common practice. The oil-extracted seed meal is finally processed in a desolventizer-toaster with steam sparging at 100–130°C for 30 min to remove hexane and to improve the nutritional quality of the meal by removing volatile glucosinolates. Protein denaturation can occur during both the initial cooking stage and the desolventizer-toaster stage.

Microwave inactivation of myrosinase has been shown to be effective in whole and in flaked seeds on a pilot-plant scale. Inactivation of the enzyme depends on initial seed moisture (the ideal is 10%). A drawback is that the sulphur content increased somewhat in the oil, mainly due to the long exposure time necessary. A number of rapeseed processors have added an extruder in their process after the prepress and before solvent extraction. This extruder is an additional piece of equipment, but the benefits are enough to justify the expense. The latest development is a combination of both the prepress and extruder into one unit, which has the advantage that no extra horse power is required.

*Meal processing.* Rapeseed meal is used in animal feeds

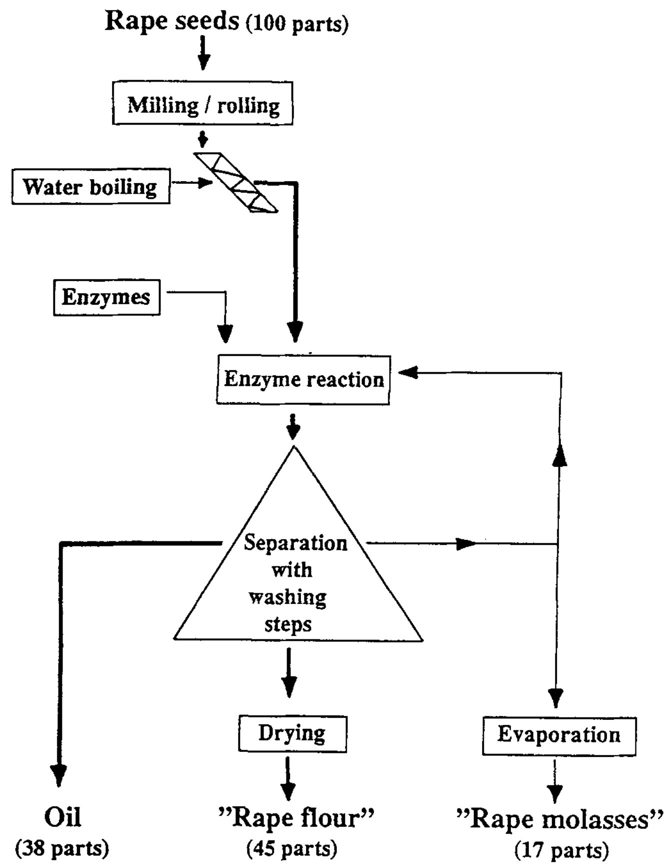


FIG. 4. Enzymatic extraction of rapeseed, process principle.

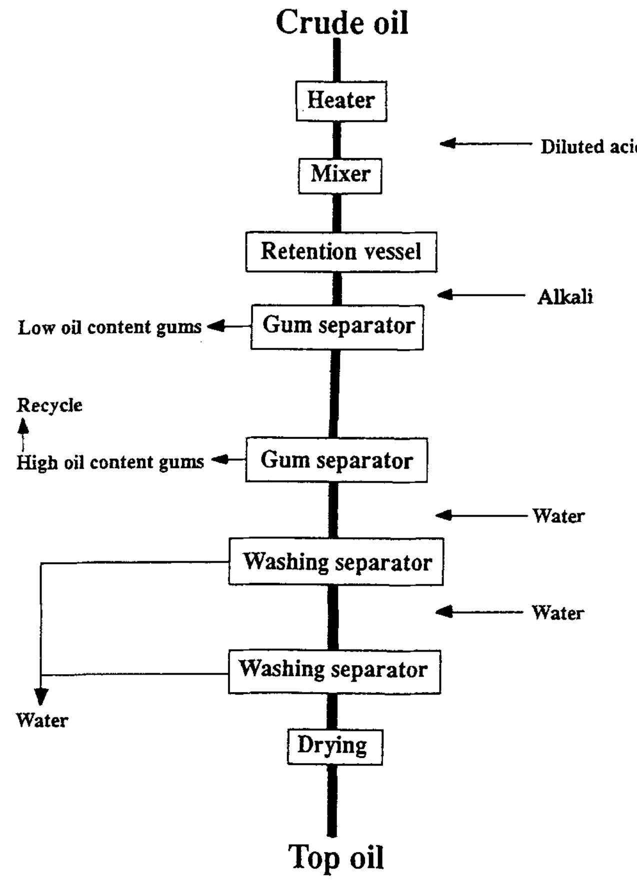


FIG. 5. Flow diagram for total degumming process (TOP).

as a source of high-quality protein in lieu of soybean meal, but in some feeding situations its use is restricted to less than full replacement of soybean meal, due to the presence of anti-nutritional components. In order to get a rapeseed meal with a higher protein quality, new methods have been developed in Scandinavia (Öpex, ExPro). The main change is a more careful heat treatment. Effective desolventizing, to minimize residual hexane in the meal, has been obtained if the seed moisture is <5%. The meal should be extracted under conditions that minimize the hexane temperature.

The production of protein concentrates and isolates for food use from rapeseed has been investigated for the last 20 years in Canada and in Sweden. But no commercial production has been started. An aqueous enzymatic process for extraction of rapeseed oil has been developed by Novo Industri A/S (Bagsvaerd, Denmark). A comparison of this new process with the traditional one is shown in Figure 3. The process principle is shown in Figure 4. The pretreatment includes a milling operation and a heat treatment to inactivate myrosinase and other enzymes. Multiactivity complexes with hydrolytic enzymes are then used to degrade the primary cell walls and release the oil. The products are separated and dried. The quality of the oil is high. The meal, *i.e.*, the combination of the fractions "rape flour" and "molasses", has been fed to animals in Denmark. The true digestibility was 77.2, the biological value 92.7 and the NPU was 71.5.

*Oil processing.* Rapeseed oils are traditionally refined by chemical neutralization processes. A new development is the total degumming process (TOP). Figure 5 represents a flow sheet of the process steps involved. For a number of years the vegetable oil industry has paid a lot of attention to physical refining, *i.e.*, the removal of fatty acids by distillation. Physical refining only led to acceptable results when starting oils of good quality were available. Insufficient removal of undesirable components during pretreatment (degumming) of the oil had to be compensated for by an increased use of bleaching earth.

In TOP, phosphatide/metal complexes are decomposed by a strong acid into insoluble metal salts and phosphatides in their acid form. The latter are converted into hydratable compounds by partial neutralization and can then be removed from the oil. It is essential that the acid is dispersed finely in the oil. After a certain contact time, alkali is added and mixed into the acid-in-oil emulsion in such a way that soap formation is prevented; this is especially important for yield reasons. The oil is then degummed in a first centrifuge, yielding a gum phase with minimal oil content and oil still containing residual gums. This oil is then passed to a second centrifugal separator, yielding gum-free oil and an oil-rich gum phase, which is recycled.

Centri-Ad, a new method for continuous adsorption of impurities, has been developed by Alfa-Laval (Fig. 6). Centri-Ad utilizes low-density particles and centrifugal

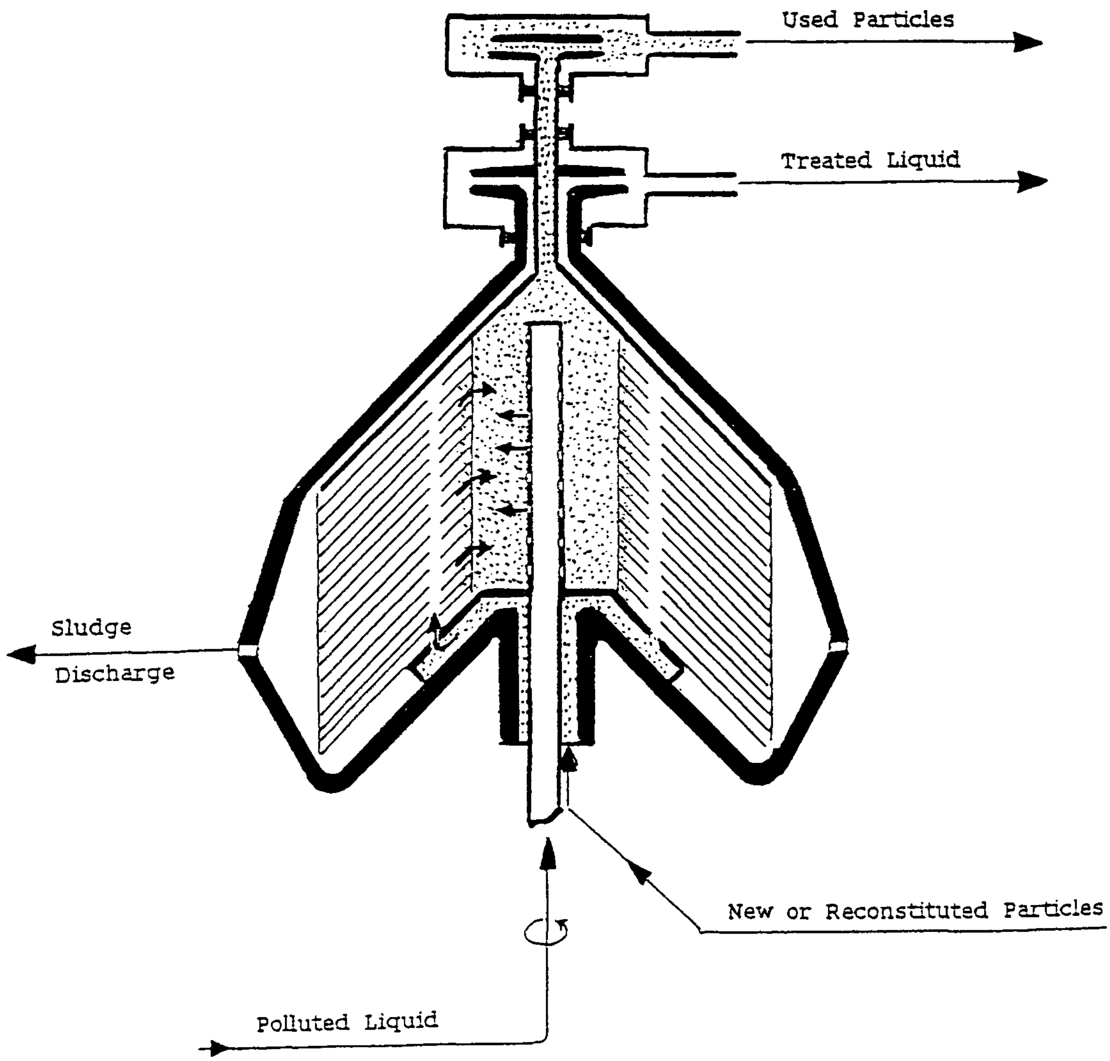


**FIG. 6. Centri-Ad, hermetic centrifugal separator.**

force. The particles form an annular bed of suspended solids that the liquid must pass through. The particles can be modified for different applications. The adsorption is counter-current, and used particles can be replaced during the operation. The main advantage is the potential to separate small amounts of substances, emulsified or dissolved, from large amounts of liquid on a continuous large scale. The centrifugal force exerts thousands of g on the particles. Potential applications for rapeseed oils are separation of sulfur or phosphorus components that would deactivate nickel catalysts and of colored components or substances affecting the flavor or odor. Rapeseed oil is hydrogenated in a traditional manner. Another interesting new idea is CIM (computer integrated manufacturing), a strategy for the integration of technology, information and organization. CIM is gradually gaining ground in the oils and fats industry and will be found in the refinery of the future.

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