Canola—
a new oilseed from Canada

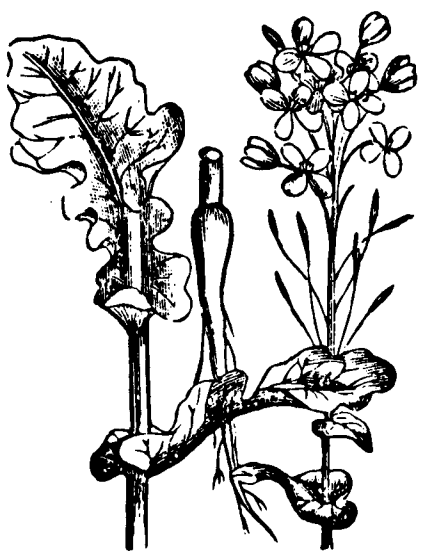
The oilseed which produces Canada's best-selling vegetable oil and which Canadians are now calling "canola" is a new version of the rapeseed traditionally cultivated in Asia and in Western Europe, which has been extensively re-engineered by plant geneticists.

Canola is the industry's new name for a rapeseed with drastically reduced levels of erucic acid, a component fatty acid possibly detrimental to health, and of glucosinolates, the goitrogens which limit the value of rapeseed meal for livestock. Canola—"double-low" rapeseed—provides Canada with a source of domestic feed protein and a vegetable oil which can compete, in price and quality, with the world's better known edible oils.

Rapeseed, a member of the Brassica family, is similar to turnip and mustard seed and is grown mostly in the form of the two species, *Brassica napus* and *Brassica campestris* (turnip rape). The crop, which thrives in the rich, moist soil of cool climates, is well-adapted to Canada's prairie provinces of Alberta, Saskatchewan and Manitoba. Rapeseed is relatively easy to grow and meets the criteria for a successful oilseed crop, having a high oil content (approximately 40%) and valuable residual protein meal.

Canada is a newcomer to the rapeseed business and has been growing the crop only since about 1942. In China, India and Japan, rapeseed has several thousand years' tradition and 60% of the total world production is still consumed in those nations. Today, Canada and China vie for the position of the world's largest producer of rapeseed, with Canada being the largest exporter and supplying about 1/4 of the total consumed worldwide.

A small acreage of rapeseed on the Canadian prairies initially provided lubricating oil for the marine industry during World War II and production grew in response to a need for a profitable alternative crop to wheat. During an agricultural recession in 1968-71, when the glut of wheat supplies was at its peak and many Canadian farmers were suffering with cereal marketing problems, rapeseed proved to be the salvation crop. Today, canola-rapeseed ranks second only to "King Wheat" as a cash crop. Allan Earl, executive director of the Canola Council of Canada, claims that canola "relieves a dangerous monocrop agriculture which has existed at times in Canada." Members of the food industry see the crop as an important part of a Canadian food policy to reduce the country's dependence on imports of vegetable oil and meal.



Brassica napus

Rapeseed oil was first extracted for edible use in 1956, when production leaped to 136,000 MT from 35,000 MT the previous year. A decade later, rapeseed was the fourth largest of Canada's field crops, following wheat, oats and barley. Between 1968 and 1971, the industry saw a five-fold increase in acreage and production and, as each harvest disappeared in markets at home and abroad, the potential of rapeseed became apparent to Canadian producers.

During the 1960s, nutritionists published the results of several experiments which suggested that large amounts of erucic acid, which forms up to 40% of the fatty acids in rapeseed oil, could cause heart damage in laboratory rats. Erucic acid has been shown to parallel the process of lipidosis—that is, transitory lipid accumulation in the heart. Additional findings included growth retardation, increased cholesterol concentration in the adrenals, and reproductive disturbances, which in turn led to speculation that erucic acid in rapeseed oil might constitute a human health hazard. Around the same time, the appreciable levels of sulfur-containing glucosinolates in rapeseed were identified as the main impediment to the effective use of rapeseed meal in livestock feed. Glucosinolates are common in the Brassica family and produce the sharp taste so desirable in mustard and horseradish. According to Jim Daun, oilseed researcher at the Canadian Grain Commission, glucosinolates "are considered an antinutritional factor, different from, but with the same negative role as trypsin inhibitors in soybeans, chlorogenic acid in sunflower seed, gossypol in cottonseed and possible aflatoxins in peanut meal."

Although the Canadian government did not advise the reduction of erucic acid and glucosinolate levels in rapeseed until 1970, a small plant-breeding program had been initiated in the mid '60s by two Canadian plant breeders, Drs. Baldur Stefansson and Keith Downey, who had anticipated the problem and set out to eliminate, through genetic breeding, these two naturally occurring components.

Gas liquid chromatography gave the

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two scientists an effective tool with which to measure the levels of individual fatty acids in single seeds whereas the development of the "half-seed" technique at the Prairie Regional Laboratories allowed the splitting of a seed in order to analyze one half and use the other half to grow a new plant. Within two years, Stefansson and Downey had isolated the first low-erucic, genetically controlled seed. The first low-erucic-acid rapeseed (LEAR) variety was released in 1969. The name Canbra was chosen to distinguish the LEAR types, but Canbra came into disuse as a generic term when it was chosen as a corporate title by a processing company.

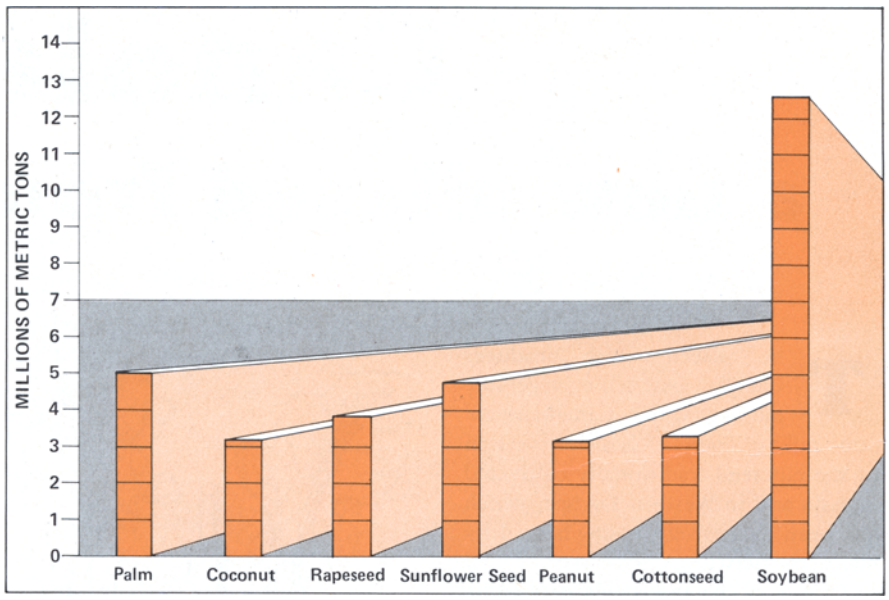
The early LEAR varieties had several agronomic disadvantages and the farming community was reluctant to switch from a familiar crop to one which was, at first, less productive. Processors of LEAR varieties were dissatisfied with erratic oil yields and variable protein levels of the new seed, and exporters could not guarantee 40% oil content in their oilseed shipments. Nevertheless, the "erucic acid scare," which, by the mid 1970s, had already caused rapeseed production in Europe to drop alarmingly, encouraged Canada's industry to work together to avoid losing a profitable cash crop. As Jack Giles of the Canola Council comments, "the threat of annihilation on the marketplace provided an impetus that no other oilseed industry had had forced upon it."

By 1967, rapid analytical procedures for measuring glucosinolate content in small samples of rapeseed had led to a breeding program for low glucosinolate seed.

The first "double-low" rapeseed—that is, rapeseed containing less than 5% erucic acid (the government of Canada's "zero effect" level) and not more than 3 milligrams of glucosinolate per gram of dry meal—was released for commercial production in 1974. The name "canola" (implying "Canadian low-acid" seed or "Canadian oil") was officially recognized in 1980.

The Rapeseed Association of Canada, established as a nonprofit corporation in August 1967, and officially recognized as the Canola Council of Canada in 1980, contributed substantially to the marketing of the "Cinderella" crop. The council is a noncommercial, "umbrella" organization representing the interests of the canola industry, and coordinates efforts between federal and provincial governments, researchers, growers, processors and marketing agencies. Along with the crushing industry, traders and processors, the organization gave strong support to the new crop and, by 1974, the old high-erucic-acid varieties of rapeseed in Canada essentially had been replaced by low-erucic varieties. Double-low began to predominate by 1976 and, by 1980, approximately 80% of the rapeseed crop was canola and contained, on average, less than 3% erucic acid. In that year, Canadians consumed over 400 million pounds of canola oil—almost half the total vegetable oil used in Canada.

World production of fats and oils



SOURCE: Counselor and attache reports, official statistics, FAS Washington estimates, May 1981

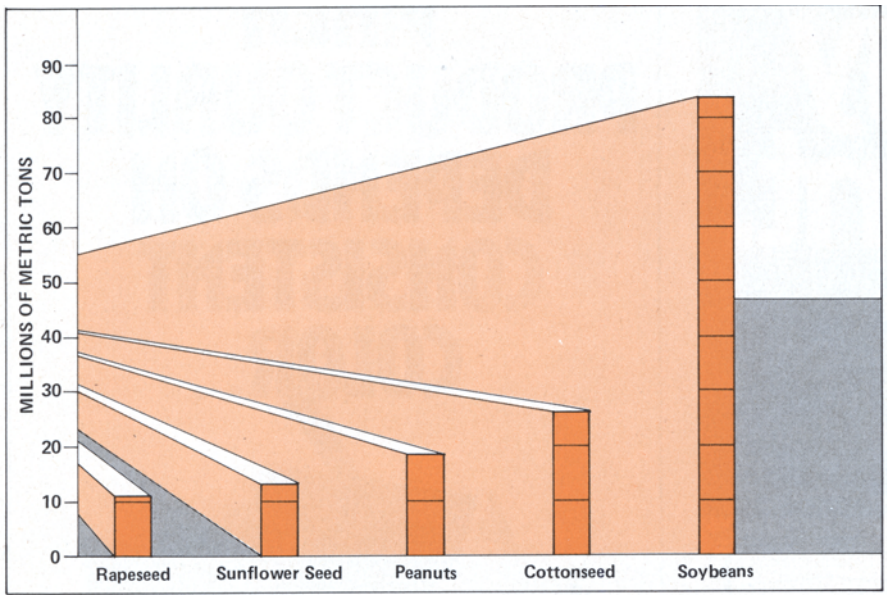
Although "canola's best customers are Canadians," as Dr. Earl remarks, producers are now voicing fears that canola has captured the biggest share it will ever have of the Canadian market where the sales of other oils—such as corn at 7% and soybean at 24%—will tend to remain static. Of necessity, Canada, as the world's first or second largest producer of rapeseed, must export the majority of its production.

With regard to world markets, the Canola Council hopes that its product will be incorporated into the general increase in demand for protein from oilseeds and that oilseed-importing nations will spread their purchases of seed, oil and meal over a variety of sources to reduce dependence on one or two nations. Says Jack Giles: "In Canada, meal and oil substitution between canola and soybean is becoming a casual thing and we would hope foreign buyers will soon look at canola with this transferability in mind."

At present, China, like Canada, produces about 25% and India about 20% of the world supply of rapeseed. Until 1938, China was the world's principal producer, supplying 2-1/2 million tons of the world's output of about 4 million. China remains the world's largest consumer of rapeseed. The crop has been cultivated for 4,000 years in India and, in Japan, rapeseed has long been the most popular cooking oil. Canadian rapeseed and canola made up 34% of Japan's edible vegetable oil supply in 1979 and the 1980/81 purchases are estimated to reach 1 million tons of seed. India was Canada's largest customer for rapeseed oil and canola oil in 1980, with purchases of over 117,000 tons.

Although India, Japan and other buyers are now stipulating canola for their imports, it is not necessarily the *oil* which has been the real attraction, but the better quality meal. Erucic acid reduction programs are virtually completed in Western Europe and in several other areas besides Canada, but Asian producers have shown little interest. H. Dodds Hughes, reporting

World production of oilseeds



SOURCE: Counselor and attache reports, official statistics, FAS Washington estimates, May 1981

on the potential of the Chinese market at the Canola Council's 14th Annual Convention in Vancouver in March, pointed out that erucic acid was no concern to the Chinese, who have used rapeseed oil for centuries, and that their present interest in canola has been aroused by the improved meal quality. Japan's Etswya Shinohara, of C. Itoh and Company Ltd., who spoke at Vancouver, confirmed that the Japanese interest in canola stemmed from the low glucosinolate content and that, since Japan once grew very pungent rapeseed, erucic acid has never bothered them. In Japan, as in China, where rapeseed meal has traditionally been used as a fertilizer, low glucosinolate meal signifies a new source of feed protein.

Nevertheless, although approximately 80% of the Canadian rapeseed crop is canola, the domestic crushing industry consumes most of the canola seed, leaving a canola/LEAR mixture for export. The result is that export buyers end up with a seed which is always low in erucic but often higher in glucosinolates than the specified levels for canola.

As for selling to the Asian nations, a competitive price is perhaps the major marketing factor. The Japanese will buy canola/rapeseed—and in great quantities—when the price is right. They are accustomed to "hedging" their sources to avoid becoming dependent on one alone, and will accept canola as a reasonable equal to soybean. Nevertheless, Shinohara reminded industry members that to rely too heavily on the Japanese market is unhealthy. He urged Canadians to create a wider basis of demand and to cut down transportation costs for canola, both of which would result in a more competitive price for their oilseed. Japanese consensus is that 50,000-60,000 tons of canola/rapeseed were lost to soy last season because of a price disadvantage.

John Smythe, president of the Canola Council, agreed that, with Canada's dependence on Japan and India for their rapeseed exports, there are a lot of eggs in one basket and this limited customer base "puts the industry in an intolerable position." The Canola Council, he urged, must follow the example of the American Soybean Association which, by campaigning so enthusiastically for soybeans, has created a widespread demand and is now able to provide a much more economical product. Having attained such heights in genetic breeding, canola producers must match these achievements, not only in quality, but in price and availability, Smythe said.

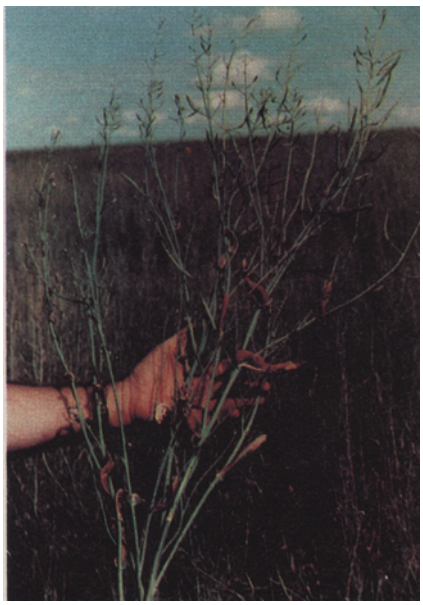
Most Americans know very little about canola or rapeseed, since virtually no rapeseed is grown in the U.S. In recent years, American farmers have grown some canola crops in North Dakota, Minnesota, Montana, Utah and Alaska, which are directly exported through Pacific ports or through Canada, but the U.S. preoccupation is primarily with high-erucic oil for industrial purposes. Rapeseed was never given GRAS (generally recognized as safe) status by the U.S. Food and Drug Administration for food products and regulations would have to be changed before canola could become a marketable product in the U.S. Rapeseed remains an unfamiliar commodity in the eyes of the American food industry, where it is not approved for general use in salad oils, cooking oils, margarines or shortenings, and only to a small extent as a stabilizer in some peanut butters.

David Riggs, agricultural marketing specialist at the USDA Foreign Agricultural Service, comments that at the time the GRAS list was drawn up by the FDA, rapeseed was a minor crop in Canada and the erucic acid issue made it unlikely that an application for GRAS listing would be accepted. Since then, the Canadian seed has been significantly restructured, but as yet no official petition has been made to have either LEAR or canola on the GRAS list. Riggs believes that the committee at the Ministry of Health and Welfare in Ottawa (composed of producers and members from government, academia and industry) has been reluctant to approach the FDA until it is sure that the research and literature will support a successful petition.

Many Canadians believe the issue is a political one. A few years ago, the government in Alberta threatened to forbid additional exports of its natural gas to the U.S. unless GRAS status for canola was granted by the FDA. Canadian opinion, however, is divided regarding the American market. The Alberta government, for one, considers that the proximity of the United States, and especially of the Pacific Northwest, close to the Albertan refineries, makes it an obvious area for Canadian market expansion and they would be happy to see the Americans divide some of their purchases to include canola seed. Some industry members don't agree. K.D. Sarsons, chief executive officer of CSP Foods, believes that the canola industry would do well to concentrate on existing markets, rather than attempt to push the product on an uninformed American public.

Canola Oil — a nutritional and commercial profile

Canola is characterized by a high oil content (approximately 41% of the seed), close to that of sunflower, and by a high level of oleic acid (58%), more like that of olive oil (at 77%). The presence of an appreciable amount of linolenic acid gives it properties similar to soybean. Canola is considered to be intermediate among the vegetable oils in its level of polyunsaturated fatty acids (32%), which is lower than soybean, sunflower, corn and cotton, but higher than peanut and palm. It is, however, the lowest of the major edible oils in saturated fatty acids (5% palmitic, 2% stearic). The oil has a high nutritional rating which compares favorably with other major edible oils.



Food scientist Marion Vaisey-Genser speaks of canola oil as a "product of the designed food era. It is unique among the common vegetable oils because it has been designed to be more wholesome than its parent rapeseed oil." The accumulation of fat in the hearts of laboratory animals fed with rapeseed oils was shown to be related to the erucic acid in the oils. John Kramer, research scientist at Agriculture Canada, Ottawa, believes that "this problem is completely removed with LEAR oils since the erucic acid content is now well below the no-effect level for atherosclerosis or vascular problems." Nevertheless, necrotic lesions were still observed in male rats fed low-erucic oils. Extensive research in many laboratories in Canada, France, Germany, Holland and Norway has shown that these heart lesions also were found in male rats fed other vegetable oils, but were not a problem in other species of animals tested, Kramer says. He claims that "these results, in addition to epidemiological studies in France and India, suggest that necrosis is no problem in man."

The low level of saturated fatty acids in canola oil contributes to the reduction of saturated fats, as recommended by nutritionists. Bruce McDonald, of the University of Manitoba, explains that this low content of saturated fatty acid probably accounts for the oil's "hypocholesterolemic effect when fed as the primary source of dietary fat." He says that studies in his laboratories have shown canola oil to be slightly more effective than soybean in lowering the serum cholesterol levels of healthy young men. McDonald suggests that this may also be attributed to slightly higher levels of sterols (in canola) which have been reported to be instrumental in lowering serum cholesterol levels.

The most striking difference between canola and other vegetable oils is the fairly high level of linolenic acid (18:3) relative to the level of linoleic acid (18:2). Canola contains 10% linolenic and 22% linoleic, compared to soybean (the only other major edible oil with a fairly high level of linolenic) which has 9% linolenic and 54% linoleic. As Vaisey-Genser points out, "linolenic acid, because of its 3 double bonds, is very susceptible to oxidative changes," whereas "linoleic acid is recognized as the major essential fatty acid in the diet," and "has important functions in minimizing the risk of cardiovascular disease." Linolenic poses stability problems for both soy and canola. However, refined soy oil is often partially hydrogenated to counter the tendency toward oxidation, a practice which reduces the level of linoleic as well as that of linolenic. Canola refiners claim that,

The seeds of the canola plant vary in color from very dark to light brown and produce meal pellets which are used mainly for export, and a golden oil.

since canola oil is not customarily hydrogenated in this way, the differences between soybean and canola in the finished product are lessened. Despite its relatively high linolenic content, canola cooking/salad oil is stable enough that it does not generally require hydrogenation, and has natural "winter oil" characteristics which allow good shelf-life and excellent storage at refrigerator temperatures. Roy Carr, vice-president of operations at Canbra Foods, Alberta, believes that "this characteristic alone provides a significant advantage over soybean oil." Dr. Keith Downey has suggested that the presence of small amounts of erucic acid explain the better keeping qualities reported for canola compared to soybean.

Among the Canola Council's selling points for canola oil are its stability in heat and light, its bland, "go-anywhere" flavor and the ability to remain clear at refrigerator temperatures. Its smoke point of 238 C makes canola a competitive cooking oil, especially for heavy-duty frying, and its clarity and light texture allow it to be blended smoothly in mayonnaise and salad dressings. Canola oil, in fact, finds it greatest single use as a liquid cooking/salad oil for the Canadian market, of which 72% is canola. Use of canola in margarines remains static at about 40%; 43% of Canadian shortening is made with canola oil. In all, canola accounts for over 54% of vegetable oils used in Canada, followed by soybean at 24%.

The versatility of canola as an all-purpose oil appeals to the major processing companies in Canada, who look for color, flavor and resistance to off-flavors, low peroxide value and chill-test characteristics. William Wharry, of Kraft Canada, which is now heavily using canola, cites particularly the ability of canola oil, if processed properly, to age without developing undesirable flavors and to survive the 0 C chill test for up to 18 hours with no evidence of crystal formation. Bob Heywood, manager at the Vancouver edible oils division of Canada Packers, has commented that the bland taste of canola oil makes it ideal for processes that cannot tolerate any flavors carrying through to the finished product. Sensory tests, performed by Dr. Vaisey-Genser, have shown canola to be comparable to soy and corn in flavor deterioration (or rancidity) over time and in flavor changes due to light.

Canola is a natural salad oil, but it has some characteristics which tend to restrict its usage in other areas, particularly in hydrogenatd form. Margarines and shortenings, if made with pure canola oil and stored for a few months, have been reported to develop a "grainy" or "chalky" texture. This slightly unpleasant mouth-feel can be attributed to the fine crystal structure of canola oil, fostered by its homogeneous composition, which creates a gritty consistency as the crystals grow during storage. As a result, many processors in Canada use canola in blends with other oils, of varying hardness, to improve the plasticity of shortening and the smoothness of margarine.

Sulfur compounds, which cause problems with hydrogenation, have not been effectively eliminated by the reduction of glucosinolates. In a paper given at the 1981 AOCS annual meeting in New Orleans, Dr. Daun explained that processing techniques may be a primary factor in controlling the amount of sulfur in the oil, since the sulfur content of canola oil has been found to vary significantly among crushing plants. Present sulfur levels in canola—usually less than 3 ppm—allow the oil to be hydrogenated with 50-80% of the efficiency of soybean oil, a vast improvement over rapeseed. High levels of chlorophyll in some canola seeds tend to impart green color to the crude oil (this has frequently been attributed to premature harvesting before the harsh prairie winter) which must be pretreated with phosphoric acid and then bleached with acid-activated clay. Degumming procedures for the removal of phosphatides, combined with the chlorophyll and sulfur problems, have meant higher processing costs for canola than for other oils.

One of the effects of the hydrogenation process is a change in the fatty acid composition of margarines and shortenings, resulting in the formation of *trans* fatty acids. This occurs as some of the fatty acids with double bonds in the *cis*-configuration are converted to isomers with the double bond in the *trans*-configuration. Reports on the effects of *trans*-fatty acids in the human diet have, in recent years, publicized speculation as to their possibly harmful nature. Although the recent Canadian Ad Hoc Committee on the Composition of Special Margarines has recommended further research, most nutritionists maintain, like Dr. McDonald, that "there is no evidence to indicate that the present level of *trans*-fatty acids in our diets presents any health risk."

A further consequence of the committee on special margarines was the request for a general regulation requiring a minimum of 5% linoleic acid for all edible oils. Although the level of linoleic acid in canola cooking/salad oil is acceptable, the standard is harder to meet in the hydrogenated products. Some Canadian manufacturers have been mixing canola with sunflower or any other highly polyunsaturated oil in order to attain the 5% level. However, others believe that a product can be made entirely from canola with polyunsaturated fatty acid levels well above 5% and that the regulation should not prove to be a deterrent to the use of canola or LEAR oils.

In the past, rapeseed meal has been a restraining influence on sales of an oilseed which was purchased mainly for its oil content. The higher fiber of the meal reduced the metabolizable energy value for cattle and poultry, and the small size of the seed made dehulling difficult and yielded a fairly high residual oil. These problems still apply, in part, to canola which is a seed even smaller than safflower and has a fiber content of 11%, compared to 6% for soybean. Although maximal efficiency cannot be obtained with such small seeds, residual oil from canola meal is now running at 1-1.5%, which, though higher than sunflower and soybean, at 0.5% is an acceptable level. Protein content of canola meal is about 36-37%.

During recent years, domestic use of canola/rapeseed meal, which was initially treated very cautiously, has almost doubled (from 160,000 MT in 1977 to 345,000 MT in 1980), partly due to extensive promotion by the Canola Council, which has presented canola meal as an excellent source of essential amino acids and rich in available minerals. Already widely tested as a protein supplement across Canada for feeding swine, poultry and ruminants, canola meal is considered to have a protein combination competitive to soy. The principal nutritional disadvantage of canola meal is its lower protein digestibility, which, if the meal is used as a complete replacement for soybean, causes a reduction in growth rate and feed conversion efficiency with some animals. Better results have been reported with canola/soybean combinations.