



Photo courtesy the Canola Council of Canada

*Burcon NutraScience Corporation, a Canadian research & development company, has developed and patented an innovative extraction technology that uses inexpensive rapeseed meal to yield a high quality, cost-effective plant-based protein that rivals animal sources in nutrition and functionality.*

*Dr Don Murray, Burcon director and vice president of biosciences, provides the details*

**R**APESEED is now the world's number two-oilseed crop, ranking behind soybeans and ahead of cottonseed, peanuts and sunflower seeds. The reason for this position is simple – oil from the “double low” or “canola” variety of rapeseed has the best fatty acid composition of all the

vegetable oils. Over the years, this has gained it considerable public praise from international nutrition experts as one of the healthiest oils for use in food manufacturing and consumption by health-conscious consumers.

However, the good news doesn't stop there,

because it appears Mother Nature has been just as kind to rapeseed protein as she has been to rapeseed oil. In fact, given the evidence of rapeseed protein's impressive nutritional and functional qualities, this oilseed may turn out to not only be an excellent source of high-quality plant protein but also a successful competitor to such leading animal-based proteins as egg white, casein and whey in the food ingredients world. Research at Burcon has found that rapeseed has the potential to be the highest-quality plant protein in the world. The successful exploitation of this potential could open a whole new world in protein utilisation.

### Rapeseed: a brief history

Rapeseed, a world oilseed staple, made a major advance in 1974. That was the year that Dr. Baldur Stefansson, a plant breeder at the University of Manitoba in Canada, bred the first "double low" variety, which reduced the levels of the negative nutritional factors erucic acid and glucosinolates naturally present in rapeseed.

This *Brassica napus* variety, tower, was the first to meet the specific quality requirements used to identify a greatly improved crop known in its native Canada, and Australia, Japan and the US as canola. While these canola-quality, or "double low," varieties of rapeseed have been exported around the world to form the majority of global rapeseed production, this oilseed is still best known in Asia and Europe simply as rapeseed or oilseed rape.

From those humble beginnings more than two decades ago, rapeseed has now spread to become an important agricultural source of edible oil and animal feed in many countries. In fact, the global production of rapeseed and canola has expanded to the point where it now ranks second, with 45 million metric tonnes produced, or 15 percent of world oilseed production of 286.2 million tonnes.

Soybean is the dominant oilseed, with more than 160 million tonnes produced annually (USDA estimates for 2000). Soy protein is by far the largest and most significant segment of the plant protein ingredient market, with greater than 72 percent of the US market for plant protein ingredients.

Each rapeseed plant produces yellow flowers which, in turn, produce pods similar in shape to pea pods but about one-fifth the size. Within the pods are tiny round seeds that are crushed to obtain oil. The seeds contain approximately 40 percent oil, and once the oil is removed, the remainder, approximately 60 percent of the seed, is processed into

protein meal for use as livestock feed.

Nutritional researchers have long recognised the huge protein potential of rapeseed meal. Unfortunately, until recently, the protein was unfit for human consumption due to the presence of large amounts of fibre and anti-nutritional factors such as glucosinolates, phytic acid etc. As such, it has been sold only as animal feed.

Now, however, after many years of research, Burcon NutraScience has developed and patented an environmentally friendly process for extracting the protein from any variety of rapeseed meal – and other oilseed meals – without harming the protein quality. As we have found, the result is a protein isolate that has impressively high protein content as well as new, unique

functionalities that together herald a significant advance for rapeseed as a world food crop.

### An environmentally friendly process

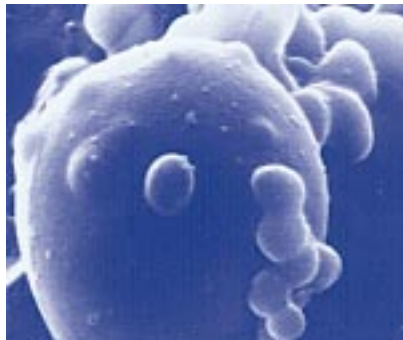
Current processing technology used to extract major food proteins (e.g., soy, and gelatin) from different sources almost exclusively uses extremes of acid and base. These chemicals reduce the nutritional value and functional properties of the treated protein, and also pose significant environmental challenges for cleanup and disposal.

In contrast, Burcon's extraction process is a much simpler one that employs only rapeseed meal, table salt and tap water. Although the process appears simple, the related chemistry interactions are complex. While many of the technical procedures are proprietary and patented, we can provide a brief overview.

The processing procedures must cause the protein molecules to self-associate to form microscopically large protein spheres, called *micelles*. Once a concentrated protein solution has been prepared by physical methods, the micelles are induced to form through a reduction of the ionic strength of their surrounding environment.

Micelle formation is a rapid process and the micelles settle to the bottom of a dilution vessel. The collected wet micelles are viscous and sticky, somewhat like wheat dough in texture, and may be used in this liquid state for suitable applications or, more preferably for long-term stability, spray-dried to form a free-flowing, light, tan-coloured protein isolate powder of less than 300 microns particle size.

The resulting powder has been branded Puratein and contains at least 90 percent protein, with a significant



An electron microscope shot of rapeseed protein molecules self-associating into larger protein micelles.

reduction of the anti-nutritional factors normally associated with rapeseed meal. Puratein also has “neutral” sensory properties in terms of colour, flavour and aroma, and does not adversely affect the characteristic food product to which it is added. Its physical attributes include a bland flavour, off-white to light-tan colour, and no odour. In the dried form, it requires no refrigeration, an important consideration in hot, humid climates.

Analysis of Puratein (dry basis)	
Component	Typical content
Protein (N x 6.25)	107.00 %*
Fat	0.15%
Ash	0.69%
Carbohydrates (six sugars)	0.13%
Phenolic compounds	0.27%
Phytates	0.20%
Glucosinolates (nine forms)	<0.05 umol/g

\*Mathematically impossible but true according to the standard industry formula for calculating protein.

From an environmental point-of-view, Burcon’s extraction process uses no harsh chemicals (only salt) and emits no noxious odours or wastes. All inputs and by-products are biodegradable and environmentally friendly. This patented process can be used on either GMO or non-GMO oilseeds and can also be used to extract protein from other oilseeds like flaxseed.

It is important to note that the Burcon process is only now being tested at large-scale commercial levels in 10,000-litre batches. With that caveat, however, extensive testing has shown that the Puratein protein isolate produced at the 400-litre small-batch output level has outstanding nutritional and functional qualities.

**High-quality nutritional values**

One of the accepted methods used to express nutritional values is by determining the protein efficiency ratio (PER) of a specific protein by feeding it to animals. The PER compares the total weight gain of a growing animal to the weight of protein consumed over the growing period. Values are generally within a range of 0.5 at the low end to 4.9 at the high end. The protein values for various proteins are as follows:

Plant proteins	PER	Animal proteins	PER
Rapeseed	3.29	Egg white	3.71
Soy	1.60	Minced beef	3.36
Pea flour	1.56	Casein (cow’s milk protein)	3.13
Wheat flour	0.95		

Source: Journal of Agricultural Food & Chemistry, 1996, 44, (6-29).

According to the PER assay, rapeseed is the first plant protein to be classified at the levels usually accorded to animal-based proteins.

Another measurement of nutritional value is to use industry standard protein formulae. Applying the metric used most often within the protein industry, rapeseed protein isolate tests out at 107 percent protein content, a mathematical impossibility but true nonetheless. The reason for this anomaly is that protein percentages are calculated by multiplying the actual nitrogen content (“N”) of the isolate by a standard conversion factor, called the “Kjeldahl conversion factor.” The global standard industry factor is Nx6.25 and the average nitrogen content in Burcon’s Puratein samples is 17.1857 percent, hence the 107 percent value.

The Kjeldahl conversion factor was originally developed to characterise animal proteins, and although Nx6.25 is the worldwide standard in commerce, scientists recognise that this overstates the value of plant proteins. The recognised Kjeldahl factor for soy protein, is Nx5.71 (there is no such



**Puratein possesses a wide variety of functional properties, including foaming and whipping properties, gel-forming ability, water and fat-binding properties, and emulsification qualities. These make it usable, potentially, in cakes and pastries, processed meats, canned meats, mayonnaise and salad dressings, and as a meat-firming and binding agent.**

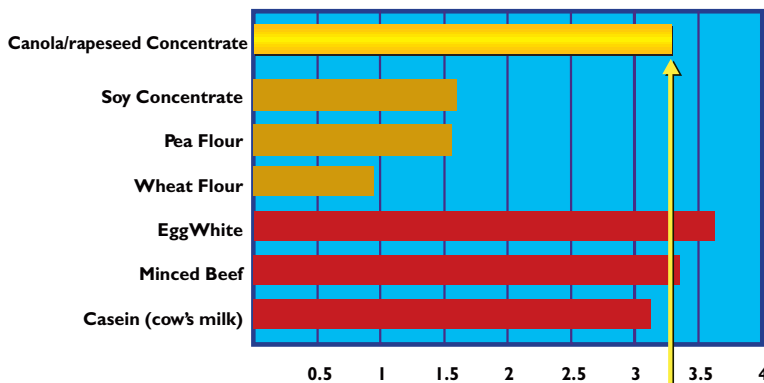
recognised factor for rapeseed) which would imply a protein content for Burcon’s protein isolate of 98.13 percent (17.1857 x 5.71).

While there is momentum for altering the protein conversion formula to make it more accurate for plant proteins, the fact remains that in global commerce the industry standard for calculating, reporting and marketing protein content is currently Nx6.25.

**Impressive functional characteristics**

In addition to the role that proteins play in human nutrition, they also bring an essential function to many foods. For example, although the nutritional value of wheat protein is low (PER 0.95), only wheat protein (gluten) will make a loaf

### Comparison of quality of protein in canola/rapeseed versus animal protein sources such as soy, egg whites and casein.



PER compares the total weight gain of a growing animal to the weight of the protein consumed over the growing period.  
Source: *Journal of Agricultural and Food Chemistry*, 1996, Vol. 44, (6-29).

1999) conducted by the Government of Canada's Department of Fisheries and Oceans using Burcon's Puratein to feed fish found that the digestibility of Puratein was 97.6 percent in rainbow trout.

In addition, an animal feeding study using rats conducted by the Department of Nutritional Sciences at the University of Toronto in June 2000 indicated that Burcon's protein isolate is a nutritious and safe protein, confirming expectations that it is a safe food ingredient. These study results, together with independent laboratory analyses of the chemical composition of Puratein now underway, are forming the basis for submissions to regulators in various countries.

of bread. Therefore, the high functionality of wheat protein makes it a staple in the North American diet. The value of wheat gluten is relatively low, at approximately US\$1.65/kg.

At the top end of the functionality scale, egg white protein will whip, coagulate, form films, etc. (i.e., it has many functional properties). These properties, along with its high PER, combine to make egg white one of the most valuable of all food proteins, valued at about US\$8.00/kg. The protein extracted from rapeseed using Burcon's patented technology is essentially native (i.e., not denatured). Because of this, Puratein has functional properties similar in scope to that of egg white.

#### Foaming, whipping and other properties

Puratein possesses a wide variety of functional properties, including foaming and whipping properties, gel-forming ability, water and fat-binding properties, and emulsification qualities. These make it usable, potentially, in cakes and pastries, processed meats, canned meats, mayonnaise and salad dressings, and as a meat-firming and binding agent.

It contains less than 0.15 percent fat content by weight, reducing rancidity problems and increasing long-term flavour stability. Overall, Puratein holds significant promise as a cost-effective solution to food manufacturers in need of structural and nutritional fortification for their products, and for those wishing to minimise animal protein in their formulae for economic and health-related reasons.

In addition to the above-mentioned functional and nutritional values, Puratein is highly digestible and contains minimal amounts of the anti-nutritional factors often found in plant proteins. A research study (*Aquaculture Nutrition* 5:73-82,

#### Applications in food, nutritional supplements and personal care products

Due to its range of impressive properties, Puratein has a number of potential applications. One main area is as a food ingredient. Initial product application work has been performed using Puratein in baking applications to either partially reduce or completely replace dried egg white in baked goods. Since significant quantities of egg white are used by the baking industry, Puratein should be especially useful in this area. Other food applications being investigated include meat analogue products (veggie burgers), protein beverages and high-protein athletic foods.

As a nutritional supplement, Puratein could be used in protein-bars, powershake mixes, geriatric supplements and in liquid and enteral diets. For those allergic to dairy or soy products, it could replace whey and its nutritional profile is superior to soy.

Puratein's excellent functional qualities and relatively native structure will allow it to capitalise on the shift toward using natural ingredients in personal care products such as shampoos, lotions and cosmetics. Down the road, there are also opportunities for specialised isolates to be developed from this product.

#### Future prospects

The next steps in Puratein's development are for Burcon to prove-up its extraction technology at the 10,000-litre batch level and to gain regulatory approval in various countries as a food ingredient safe for human consumption. It is also extending patent protection to more than 23 countries around the world, including North America, all of Europe, Australia,

China, Japan, India and others.

The company is also proceeding to establish its own modular commercial processing facility after the current development stage and is investigating the development of a full-scale commercial facility. In addition, the company has held discussions with a number of potential international joint-venture partners. In areas outside North America, Burcon is looking to establish collaboration agreements that would also include support for Burcon's efforts in obtaining regulatory approval in those same countries or regions.



Photo courtesy the Canola Council of Canada



**Rapeseed offers the possibility of a vast new plant protein source that rivals traditional animal sources.**

The drive to make Puratein an important ingredient in international food manufacturing requires more than just demonstrating commercial potential and gaining regulatory approval. It's recognised that products such as dried egg white and soy protein isolate have been used in the food processing industry for many years with successful results. Major companies in the international food processing industry have invested hundreds of millions of dollars in brand and product development. By nature, they will be conservative when dealing with potential new ingredients that are unproven. A long acceptance period may be required to establish Puratein's position in the world food marketplace.

Yet, how often does a new source of protein come along? In a world that badly needs a cost-effective source of high-quality plant protein to feed a burgeoning global population, it is possible the acceptance of this new protein by the international marketplace may come a lot faster than anticipated. If Mother Nature really has been as good to rapeseed protein as she has been to rapeseed oil, Puratein is exciting news for global food producers.

**Changing the economics of oilseed crushing**

Burcon's protein extraction process could have a substantial positive impact on rapeseed, canola and other oilseed crushers.

The reason: Unlike soy, where crushers receive significant value from both the protein meal and the oil, rapeseed's value is driven mainly from its high-quality oil content.

Rapeseed meal, which approximates 60 percent of the crushed seed, sells as a lesser-valued livestock feed. However, using the protein meal as the input to Burcon's extraction process, the economic value of rapeseed could shift from being largely oil-centred toward being meal- and protein-focused, with high profit potential.

Here's why. In Canada, a typical large rapeseed crusher will crush 1,000 tonnes of rapeseed seed per day. On a per-annum basis, this implies about US\$65 million in oil revenue and US\$24 million in canola meal revenue. However, if the same meal were further processed to produce protein isolate, it could yield a further US\$80 million of revenue with significant value remaining in the spent rapeseed meal. With gross margins on the protein isolate revenues estimated to be as high as 55-75 percent, the profit potential of the emerging rapeseed protein market is impressive.

In addition, this process can work with other oilseeds, raising the intriguing possibility that the protein in the meal left over from the production of such oils as flaxseed could be developed as high-value protein isolates for a wide variety of uses. And it's a development that could lead to significant changes in the economics of oil production and the creation of new plant proteins for the global food industry.

**About the author:**

*Don Murray, BSc., MSc., Ph.D., is one of the world's leading researchers in canola and canola protein chemistry. Dr Murray was professor and head of the Food Science Department at the University of Manitoba for 12 years. His background also includes being the founding president and CEO of the Guelph Food Technology Centre (an independent technology transfer centre specialising in developing new food processes and products) from 1994-97 and four years as senior vice president and chief technology officer of Export Packers Co. Ltd. in Winnipeg.*



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