Rapeseed/canola protein isolates for use in the food industry

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Abstract

Burcon has developed and patented a process that is significantly different from conventional protein purification technologies that deal with plant protein sources. The Burcon process uses only water and salt to extract the proteins from the meal and it does not require the conventional isoelectric precipitation. Burcon's process is based around a micelle formation step, which results from a reduction in the ionic strength of the protein solution. Rapeseed/canola protein isolates produced by this original process, which does not require any harsh chemicals, are superior in their organoleptic as well as their physical functional properties compared to canola proteins made through traditional methods. Currently, there are two protein products available: Puratein© and Supertein™.

Key words: Rapeseed protein isolate, extraction, protein functionality, Puratein®, Supertein™

Introduction

Rapeseed/canola is the second largest oilseed crop in the world and is an excellent source of protein with its meal having protein concentrations up to 40%. The meal, which is left after oil extraction, is currently almost exclusively used as animal feed, although, with a balanced amino acid composition and appreciable levels of sulphur amino acids, rapeseed protein would be an excellent human food source. According to a recent study (Millward, 2006), rapeseed protein garners a protein score of 100% based on the new FAO/WHO age-related scoring patterns for children and adults. The nutritional value of rapeseed proteins has also been found to compare favourably with that of animal proteins (Friedman, 1996).

Although many studies have been published concerning rapeseed/canola protein, attempts to make an acceptable rapeseed/canola protein product commercially available for the food industry have been unsuccessful. Protein isolates made through conventional technology usually have undesirable flavour and colour and are limited in their physical functional properties. Typically, researchers have described an alkaline extraction followed by an isoelectric precipitation step (Rutkowski, 1975; Chen et al., 1992; Vioque et al., 1999). However, the major drawback of alkaline extraction is that oxidation of phenolics, which are extracted from the meal along with the protein, results in the unacceptable colour and flavour of the final protein product. There are also other extraction solvents described in the literature, such as a methanol/acetone/water mixture (Lacroix et al., 1988), a solution of sodium hexametaphosphate (Tzeng et al., 1988) or a solution of copper sulphate (Kroll et al., 1991).

This paper describes a new patented process for the production of rapeseed/canola protein isolates that overcomes the hurdles of traditional processes.

Materials and Methods

Rapeseed protein isolate production

Rapeseed protein isolates were produced using a proprietary process. Rapeseed meal was prepared using a pilot-scale oilseed crushing and extraction facility. A salt solution was used to extract rapeseed protein from the rapeseed meal. The protein depleted meal was removed by several purification steps producing a clarified extract. This extract was subjected to an ultrafiltration step, through which the protein solution was concentrated and purified.

The concentrated protein solution was then diluted into cold water, which caused a fraction of the proteins to aggregate in the form of micelles. As the micelles aggregated, they settled out and were removed by decantation or centrifugation. The protein micellar mass that was removed from the dilution step was spray dried to form the first canola protein isolate product (Puratein®). The supernatant from the dilution was further processed and finally spray dried to generate the second rapeseed protein isolate product (Supertein™). Figure 1 shows a general scheme of the protein production process.

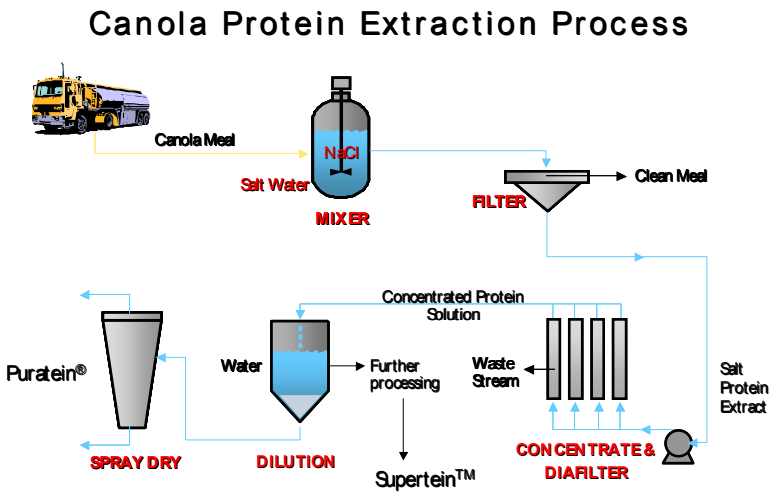

Figure 1. Scheme of Burcon's Canola Protein Isolate Production Process

Functionality testing

Functional properties were evaluated by basic testing and also demonstrated by preparing model food systems. Solubility of Supertein™ was tested in water at different pH values and also demonstrated in various acidic beverages including soft drinks and sports drinks. The ability of Supertein™ and Puratein® to produce foams was evaluated by whipping 5% w/v protein solutions for various lengths of time. The foam properties of Supertein™ were demonstrated by preparing nougat, while the heat stability of Puratein® foam was demonstrated by preparing foam and chocolate cakes. Gelling of Puratein® was evaluated by puncture testing gels prepared by heating 8% w/w dispersions of Puratein® in water for 90°C for 30 minutes. Ingredient binding capabilities of Puratein® were demonstrated by preparing chocolate chip cookies and vegetable (bean) burgers.

Results and discussion

Protein Isolate Production

The proprietary protein extraction and purification process resulted in two rapeseed protein isolates having protein concentrations greater than 90% on a dry basis. The high purity of the protein products was largely attributable to the ultrafiltration step as well as the dilution step. By using suitable membranes for the ultrafiltration step, the non-protein components were separated from the proteins. Ultrafiltration and similar selective membrane techniques permit low molar weight species to pass through into the permeate while retaining higher molar weight species in the retentate. The low molar weight species removed in the production of the canola protein isolates included not only the ionic species of the food grade salt but also low molar weight materials extracted from the meal, such as, carbohydrates, pigments etc.

The elimination of low molar weight species from the extracted solution without a substantial change in the ionic strength permitted the protein concentration to be increased without precipitation. Diluting the concentrated protein solution into cold water caused a reduction of ionic strength that resulted in the aggregation (Figure 2) of the high molar weight proteins while the low molar weight proteins stayed in solution. The proteins precipitated in the form of micelles as can be seen in Figure 3.

Figure 2. Precipitation of rapeseed proteins

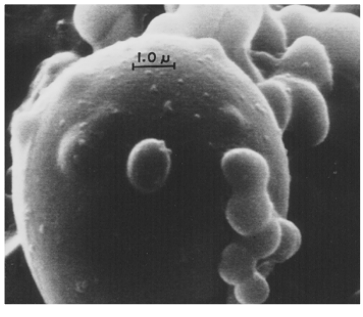

Figure 3. Electronic microscope picture of rapeseed protein micelles.

As is well reported, rapeseed contains two major proteins fractions: globulins, represented by cruciferin, and albumins, represented by napin. It appears that Burcon's process separated these two fractions very well and the majority of the globulin fraction was found in the Puratein® while the majority of the albumin fraction was found in the Supertein™. Table 1 shows the

composition of the two protein isolates.

Table 1. Composition of Rapeseed Protein Isolates

	Supertein™	Puratein®
Protein (N*6.25)	> 90% d.b.	> 95 % d.b.
Protein fraction	Majority: Albumins	Majority: Globulins

Functionality of Supertein™

The amino acid composition of Supertein™ was found to be especially rich in sulfur containing amino acids, which is particularly valuable from a nutritional standpoint.

Supertein™ was highly soluble and produced transparent solutions, even in acidic pH conditions. This makes it an ideal protein for use in fortified beverages. When compared with other available proteins such as soy, whey and egg white, Supertein™ was the only protein that formed a transparent solution in an acidic soft drink. Additionally, Supertein™ was very heat stable, which facilitates pasteurization where needed.

Supertein™ was found to form large volumes of foam with good foam stability. The foaming properties of Supertein™ compare favourably with those of egg white proteins. Acceptable nougat was produced with Supertein™

The flavour of Supertein™ has been observed to be bland and free of off-notes.

Functionality of Puratein®

Puratein® has been found to be a good emulsifier. A spoonable dressing with 67% oil was prepared with only 0.11% Puratein® as the emulsifying agent.

Puratein® was found to form strong heat induced gels at low acid conditions, performing better as a gelling agent than soy protein isolate.

Chocolate cake and foam cake were produced with Puratein® instead of egg ingredients, resulting in cakes with acceptable volume and texture. This demonstrated the ability of Puratein® to retain air when baked.

Puratein® was used to replace whole egg in chocolate chip cookies and vegetable burgers, showing its ability to function as an ingredient binder.

Puratein® was observed to have a very bland flavour with no off flavours noted.

Conclusion

Burcon's protein production The process is very clean and gentle, using only water, salt and rapeseed/canola meal. The process results in two rapeseed/canola protein products, Supertein™ and Puratein®, which are commercially viable products with a variety of functional properties. Applications for Supertein would include but are not limited to fortified beverages, nutrition bars and aerated desserts and confections, while applications for Puratein would include but are not limited to dressings, sauces, meat substitutes and baked goods. The findings suggest that rapeseed/canola proteins have the potential to open up some new food applications and to compete with major animal or plant proteins.

References

Chen M. and Rohani S. (1992). Recovery of Canola Meal Proteins by Precipitation, Biotechnology and Bioengineering. **40**, 63-68

Friedman, M. (1996). Nutritional value of proteins from different food sources. A review. J. Agric. Food Chem., **44**, 6-29

Kroll J., Kujawa M. and Schnaak W. (1991). Preparation of rapeseed proteins by extraction and ultrafiltration. Fat Sci. Technol., **93 (2)**, 61-65

Lacroix M., Amiot J. and Cheour F. (1988). Effect of methanol/acetone/water extraction and enzymatic hydrolysis on the nutritional value of unheated rapeseed proteins. Plant Foods for Human Nutrition. **38**, 343-353

Millward D.J. (2006). Oilseed Rape Protein in Human Nutrition. Proceedings of the Workshop Oilseed Rape for a healthier future, 30th September – 1st October, Madrid, Spain

Rutkowski A. (1975). "Technologische Richtlinien bei der Verarbeitung von Rapsproteinen zu Eiweiss konzentraten. Die Nahrung, **8/9**, 941-954

Tzeng Y.M., Diosady L.L. and Rubin L.J. (1988). Preparation of Rapeseed Protein Isolate by Sodium Hexametaphosphate Extraction, Ultrafiltration and Ion-Exchange. J. Food Sci, **53 (5)**, 1537-1541

Vioque J., Sanchez-Vioque R., Clemente A., Pedroche J, Bautista J. and Millan F. (1999). Production and Characterization of an Extensive Rapeseed Protein Isolate. JAOCS, **76 (7)**, 819-823