Canola protein concentrate for use as a high-valued animal feed ingredient

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Abstract

Conventional processing of canola (*Brassica napus*) generates a high valued oil plus a low valued protein containing meal. The meal is generally used as a feed ingredient for livestock and the low value is a direct result of high levels of fiber and antinutritional factors such as phytic acid. One method of increasing the value of canola is to develop a process to concentrate the protein into high valued products low in fiber and antinutritional factors. MCN BioProducts Inc. has developed a proprietary process for the production of canola protein concentrates. An insoluble canola protein concentrate (IP) and a soluble canola protein concentrate (SP) are produced from solvent extracted starting material. The process can also be applied to non-solvent expelled canola cake with the production of the IP product. The products are greater than 60% protein, have 0 detectable phytic acid and less than 5 μmole/g of total glucosinolates. The protein concentrate obtained from non-solvent expelled canola meal contains 5-10% crude fat. The balance of essential amino acids on a % of nitrogen basis in the protein concentrate products resembled that of the starting material. The products have utility in diets for carnivorous fish and other animal species requiring high valued, highly digestible protein concentrates of plant origin.

Key words: canola protein concentrate, rapeseed protein concentrate, phytate

Introduction

MCN BioProducts has developed a proprietary process for the fractionation and production of high valued protein concentrates from solvent extracted canola white flake and from non-solvent expelled meal. The paper describes dry matter, protein and crude fat mass flows and the nutrient and antinutrient contents of the protein concentrate and by-products outputs.

Materials and Methods

Solvent laden oil extracted canola was obtained from a local crushing facility. This material was air-desolventized to generate non-toasted solvent extracted canola white flake. Whole seed canola was obtained from a local supplier and processed through a non-solvent double press procedure (POS Pilot Plant, Saskatoon, SK, Canada) consisting of flaking, conditioning, pre-press the full press expelling. The white flake or non-solvent expelled cake was initially slurried in water and then processed through the proprietary MCN aqueous fraction process to generate the protein concentrate and by-product streams. Dry matter and crude fat mass flows were monitored through the process. Dry matter was determined by weight differential upon evaporation of moisture using an HB43 Halogen Automated Moisture Analyzer. Crude fat was determined by solvent extraction using an Ankon XT20 automated fat analyzer. Glucosinolates and phytates were determined by high pressure liquid chromatography.

Results

1. Solvent Extracted White Flake Process.

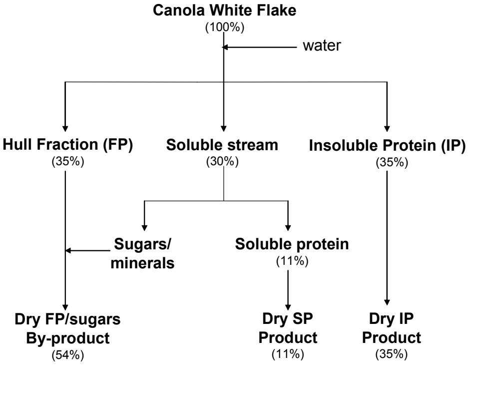

Fig. 1. Aqueous fractionation of non-toasted canola white flake.

1.1 Mass Flows. Figure 1 outlines the product streams obtained from the aqueous fractionation scheme applied to non-toasted solvent extracted canola white flake. The process generates a hull enriched by-product fraction (FP), a fraction enriched in insoluble protein (IP) and a third fraction containing residual solubles. The solubles stream is then further fractionated to generate a concentrate of soluble protein (SP) and a by-product stream enriched in sugars and minerals. The by-products streams can be mixed and co-dried or dried separately.

Table 1 summarizes the mass flows obtained from 4 separate runs of the process. The combined by-product streams account for an average of 51% of dry matter and 21% of protein mass flows. The dry matter protein content averaged 70% for the IP product and 66% for the SP product.

Table 1. Dry matter and protein flows through the aqueous fractionation process*.

	Protein (% of d.m.)	Mass flows (% of White Flake)	
	Protein	Dry matter	Protein
Starting White Flake	42.0		
FP/sugars	17.4±1.0	51.3±6.7	21.3±1.4
Insoluble Protein	69.6±3.1	33.5±4.6	55.5±7.3
Soluble Protein	66.0±4.2	9.8±2.1	15.4±1.0
Total % recovery		94.6	92.2

*Results are expressed as the mean and standard deviation obtained from triplicate runs of the proprietary fractionation process.

2.1 Product Compositions and protein solubility. Table 2 shows the key nutrient and antinutrient contents of the 3 product streams. The process includes a dephytinization step applied after removal of the hull fraction. This step results in 0 detectable phytic acid in the protein concentrates and the sugars/mineral by-product stream. The phosphate associated with the phytate in the starting material is largely converted to available inorganic phosphate. Glucosinolates and other water soluble antinutritional factors are washed from both the insoluble and soluble protein concentrates during the process. The balance of essential amino acids expressed on a per unit of protein basis is similar to that of canola meal. The protein dispersibility index (PDI) values were consistent with the water solubility of the products.

Table 2. Composition of Product Streams from Aqueous Fractionation of Canola White Flake (typical single batch analysis)

Composition (% of d.m.)	Insoluble Protein Concentrate (IP)	Soluble Protein Concentrate (SP)	FP/sugars By-product
Protein	69.7	63.1	21.9
PDI*	4.8	72.3	----
Crude Fiber	3.98	0.45	16.9
Ether Extract	0.27	0.23	0.40
Ash	10.4	10.2	10.2
Antinutritionals			
Phytic acid	0.00	0.00	0.60
Glucosinolates (umole/g)	3.53	4.01	3.58

*Protein Dispersibility Index (soluble protein as a percentage of total protein in the sample)

2 Non-Solvent Expelled Meal Process

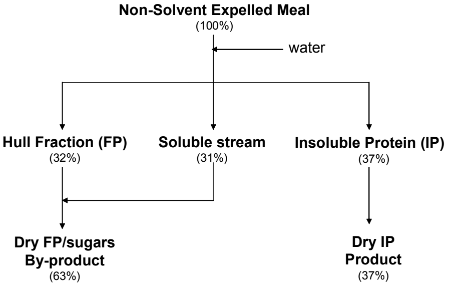

Fig. 2. Aqueous fractionation of non-solvent extracted expelled canola meal.

2.1 Mass Flows. Figure 2 outlines the product streams obtained from the aqueous fractionation of non-solvent expelled canola meal. This process differs from that applied to canola white flake in that a concentrate of soluble protein is not produced. The soluble stream can be mixed with the hull enriched by-product fraction as shown in figure 2 or can be dried separately. The concentrate of insoluble protein (IP) is the high valued product output from the core process.

Table 3 summarizes the mass flows obtained from 3 separate runs of the process. The starting material contained 40% protein and 12% crude fat. The high valued protein concentrate fraction accounted for 36% of dry matter, 56% of protein and 33% of crude fat flows from the expelled cake starting material. The solubles stream accounted for 40% of the original crude fat in the expelled meal.

Table 3. Dry matter, protein and crude fat flows through the aqueous fractionation process*

	Composition (% of d.m.)		Mass flows (% of starting cake)		
	Protein	Crude fat	d.m.	Protein	Crude fat
Starting cake	39.8	12.4			
Hull fraction	31.8±1.0	6.25±0.9	26.3±1.7	21.3±1.4	14.5±1.0
Protein concentrate	61.9±1.1	10.0±0.8	36.2±4.6	55.5±7.3	33.2±6.6
Solubles stream	13.1±0.4	12.0±1.0	36.9±3.1	11.9±1.0	40.4±6.4
Total % recovery			99.4	88.7	88.1

*Results are expressed as the mean and standard deviation obtained from triplicate runs of the proprietary fractionation process.

2.2 Product Composition. Table 4 shows the key nutrient and antinutrient contents of the 3 product streams from the process. Phytate is removed from the dehulled extract and soluble antinutritional factors are washed from the high valued protein concentrate. The residual crude fat in the expelled cake starting material accumulates in the solubles stream and, to a lesser extend, in the protein concentrate outputs from the process.

Table 4. Composition of Product Streams from Aqueous Fractionation of Non-Solvent Expelled Canola Meal (typical single batch analysis)

Composition (% of d.m.)	Insoluble Protein Concentrate (IP)	Hull Fraction (FP)	Solubles
Protein	67.4	32.5	9.7
PDI*	3.2	---	----
Crude Fiber	6.61	26.9	0.20
Ether Extract	5.65	7.42	11.6
Ash	5.78	3.06	34.8
Antinutritionals			
Phytic acid	0.00	0.00	0.0
Glucosinolates (umole/g)	3.74	1.09	11.3

*Protein Dispersibility Index (soluble protein as a percentage of total protein in the sample)

Discussion

The protein concentrate products generated by the processes are initially targeted for use as high value feed ingredients in diets for carnivorous farmed fish diets and in other animal feeding applications requiring highly digestibly, high quality protein concentrates. Previous work demonstrated that dephytinized canola protein concentrates can replace up to 50% of the fishmeal diets fed to rainbow trout with no effects on any measured parameter (Thiessen et. al. 2004). An earlier study found that, with inclusion of attractant, dephytinized canola protein concentrates can replace 100% of fishmeal in diets for rainbow trout without compromising performance (Higgs et al 1995). These studies indicate the feeding value of canola protein concentrates.

References

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