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Prediction of crude fat and crude protein contents of Canadian canola meal by Near-Infrared Spectroscopy

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Introduction

Close to 20 million metric tonnes of canola seeds are produced in Canada yearly, about half of which is crushed in Canada to produce canola oil and canola meal. Near infrared spectroscopy (NIRS) has been used on samples of whole seed to evaluate the quality of oilseed crops for over twenty-five years. The application of NIRS to processed canola is less established as a method for analysis and this poster details the first effort to employ NIRS in the analysis of oilseed processed products such as pre-press solvent extracted canola meal.

The goal of this project was to construct NIRS models to predict canola meal quality parameters such as crude fat and crude protein.

Materials and methods

Samples: 7 years of survey samples (N = 271) of canola meal from all Canadian crushing plants were finely ground to pass through a 1 mm sieve prior to NIRS scanning.

Moisture content: AOAC 925.00:1990 – oven dry method at 105°C overnight

Crude fat content: AOAC 920.39:1990 – petroleum extraction with Ankom system

Crude protein content: AOAC 990.03:1990 – combustion (Dumas) method (N x 6.25)

Each sample was analyzed in duplicate, oil and protein contents were reported on dry basis.

NIR Instrument: A FOSS DS2500 was used in reflectance mode (log 1/R) to scan the ground canola meal samples in the full spectral range 400 to 2500 nm at a resolution of 0.5 nm. Each sample was scanned three times and scans were averaged to develop the calibration models. NIRS calibration models were developed using spectral data in the 1108 to 2500 nm range.

Instrument and spectra acquisition: Unscrambler X (CAMO Analytics) was used to develop the near infrared (NIR) calibration models. Spectra were processed by applying a standard normal variate (SNV) transform followed by a Savitzky-Golay second derivative with 30 points of smoothing on either side of the central data point.

Data treatment and development of models: Samples were divided into 4 samples sets, 2/3 of the samples were assigned to a calibration development set (N = 181) and 1/3 of the samples were assigned among 3 independent validation sets (N = 30 samples, each) representative of the calibration set in terms of oil and crude protein content. Models were developed to predict crude protein and oil using the calibration sample set and were then tested separately on each of the validation sets to determine the impact of the number of model components on R-square (R^2) values and standard error of prediction (SEP) values. The number of components which globally minimized SEP values and maximized R^2 values for all three validation sets were the number of components used in the final predictive models.

Results

Table 1. Sample set description:

	Crude fat (%, dry basis) by reference method							Crude Protein (%, Dry basis) by reference method						
	Mean	St. Dev.	Median	Min	Max	SEP/C	R^2	Mean	St. Dev.	Median	Min	Max	SEP/C	R^2
Calibration set N = 181, 15 expeller type, 72 pellet type, 94 mash type)														
Reference data	4.16	2.73	3.47	0.54	16.02	0.385	0.979	41.19	2.12	41.36	33.59	47.02	0.583	0.923
Validation 1 (N = 30, 2 expeller type, 12 pellet type, 16 mash type)														
Reference data	4.05	2.11	3.51	2.3	11.51			40.92	1.98	40.72	35.35	45.45		
Predicted data	3.91	2.24	3.51	2.05	11.95	0.57	0.911	41.14	1.78	40.76	36.35	45.54	0.59	0.913
Validation set 2 (N = 30, 3 expeller type, 12 pellet type, 16 mash type)														
Reference data	3.88	2.74	3.15	1.77	12.15			42.11	1.59	42.21	36.88	44.49		
Predicted data	3.95	2.74	3.14	1.86	12.62	0.47	0.985	42.04	1.55	42.13	37.26	45.03	0.55	0.968
Validation set 3 (N = 30, 2 expeller type, 12 pellet type, 16 mash type)														
Reference data	3.75	2.32	3.38	0.37	11.79			41.57	1.94	41.29	36.6	45.27		
Predicted data	3.87	2.17	3.32	2.07	11.74	0.91	0.845	41.41	1.74	41.69	35.86	44.25	0.81	0.825

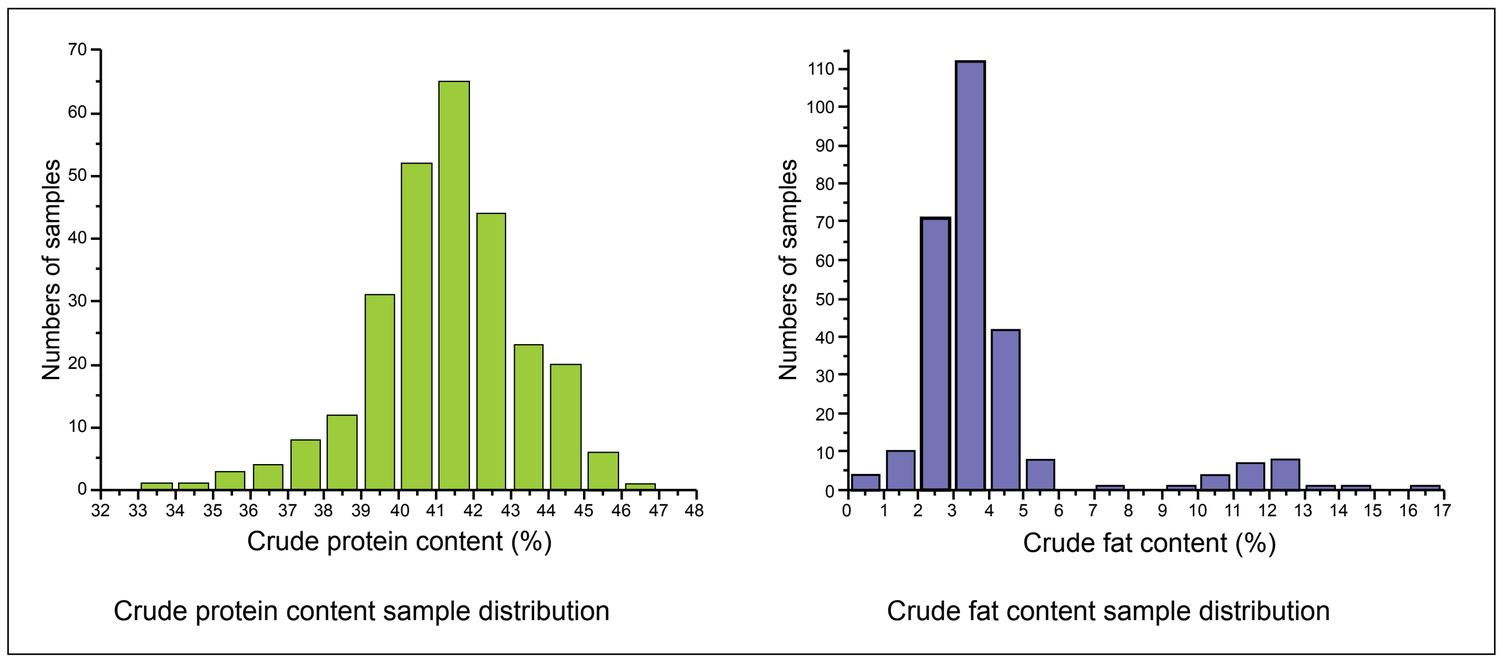
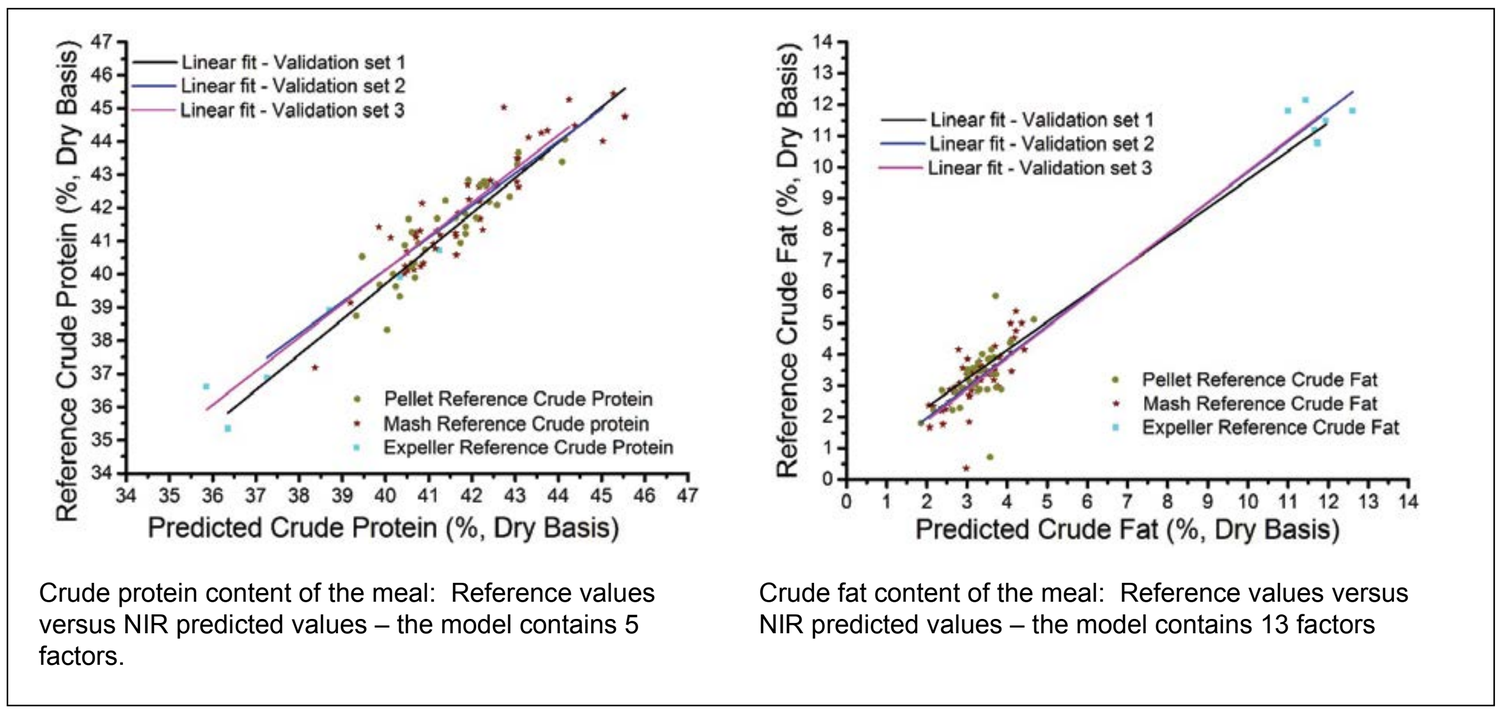


Figure 1: Sample distribution



Crude protein content of the meal: Reference values versus NIR predicted values – the model contains 5 factors.

Crude fat content of the meal: Reference values versus NIR predicted values – the model contains 13 factors

Figure 2: Reference values versus NIR predicted values

The crude fat content model gave better statistical results than the crude protein content model as the crude fat content range was slightly larger than that for protein content – about 16% range for crude fat content versus 13% for crude protein content. It was interesting to note that the outliers in the verification sets were pellet and mash type samples (and not expeller type samples) even though the expeller type samples (directly obtained from an expeller press without solvent extraction) had a very different composition than the other two types (pellet and mash) which were obtained from expeller press followed by solvent extraction.