The effect of variety and processing on the protein quality of Canadian pulses

Dr. James House
University of Manitoba

SPG Contributions	Project Status	Duration/Timeline of Project (Year to Year)	Co-funders	Total Project Cost
$181,703.00	Completed	April 2014 – March 2018	Agriculture and Agri-Food Canada	$726,811.00

Project Description

This project was implemented to generate new knowledge on the effect of various processing methods (baking, boiling, generation of an extruded or puff-like snack) or genotype by environment factors (GxE; variety x cropping location x cropping year) on measures of protein quality in a range of pulse classes (beans, peas, chickpeas and lentils). Protein quality was determined by various methods, including those required by federal regulatory agencies (Health Canada; US FDA) for substantiating protein content claims, including the Protein Digestibility-Corrected Amino Acid Score (PDCAAS), the Protein Efficiency Ratio (PER), and the proposed Digestible Indispensable Amino Acid Score (DIAAS) methods. These methods require knowledge of the amino acid (building blocks of protein) composition of the pulses, as well as knowledge of how well the proteins are digested and absorbed (digestibility). The current regulated methods require the use of a rat assay to determine digestibility, and thus their required usage creates barriers for the food industry in trying to measure the quality of new protein products. An alternative approach would include the development of a test-tube (in vitro) method of measuring protein digestibility.

Pulses, including peas, beans, and lentils, represent important dietary sources of protein for the global diet. However, domestic consumption in Canada has been limited, despite growing demands for alternative protein sources. The pulse sector has the potential to position whole pulse flours and pulse fractions (concentrates; isolates) as ingredients within the food industry. However, the lack of data with respect to the impact of processing or variability associated with market class and growing conditions, on the quality of the protein represents a significant hurdle. In order to position foods or food ingredients as dietary sources of protein, the quality of the dietary protein must be assessed and made available to regulatory agencies (Health Canada; USDA). Existing and proposed methods for measuring protein quality rely on the use of data collected from animal-based studies. There is the need to not only measure the quality of pulse proteins using existing approved methods, but also for the development of alternative approaches to accurately assess protein quality. As such, the current research program was designed to address the following objectives:
– To determine the amino acid composition of Canadian pulses and pulse fractions
– To determine the impact of processing methods, as well as, varietal differences on measures of protein digestibility, a measure of the quality of dietary proteins
– To develop new models to predict the quality of pulse proteins without relying on the use of animal-based assays.

We will address these objectives by securing composite samples from 10 market classes of pulses (beans, peas, and lentils), as well as small lots secured from breeding programs in Manitoba and Saskatchewan. The composite samples will be milled and processed via a standardized heat treatment (baking) or extrusion or the use of consumer preparation methods. The samples will be measured for protein digestibility-corrected amino acid score (PDCAAS, the approved U.S. methodology), or the Canadian Protein Rating system (based on the Protein Efficiency Ratio). Additionally, we will measure all samples via the proposed system called the Digestible Indispensable Amino Acid Score (DIAAS), which represents a proposed refinement of the PDCAAS system. For the samples secured from breeding programs, we will measure the full amino acid profile, determine the major nutritional components, and assess the in vitro digestibility of all the samples.

Additionally, we will determine the impact of selecting for novel storage proteins on the quality of pulses. This research program will lead to new information to guide the pulse sector towards positioning pulse-derived protein sources for the food industry and guide the development of new approaches to systematically and efficiently determine the quality of dietary proteins via methods that do not rely on the use of animal-based assays, thus enhancing the pathway to innovation for the plant protein sector.

Outcome

Over the course of this project, it was shown that different processing methods can impact the protein quality of pulses, with boiling and extrusion typically yielding the highest quality numbers. The generation of the complete protein quality data set for 10 market classes of pulses (1 chickpea, 2 peas, 2 lentils and 5 beans) provides the pulse sector and the food industry we critical information to position these important protein sources to consumers. Furthermore, it was shown that the test-tube method for measuring protein quality provides a level of accuracy and precision that should meet the standards for regulatory purposes, and these new methods are being positioned as alternatives to animal testing. In the studies examining genotype by environment differences in measures of protein quality, an extensive data set was established to highlight the factors having the greatest influence on protein quality in pulses. For example, in both red and green lentils, the measured amino acid scores were higher in 2012 vs. those observed in either 2013 or 2014, highlighting the potential for cropping year to influence protein quality. The extensive data on the impact of variety, location and cropping year on measures of protein quality will guide pulse breeders and agronomists in the development of programs designed to yield the highest quality pulse-based proteins for human consumption.

Research Objective

OBJECTIVE 1
To develop new amino acid scores for Canadian pulses and pulse fractions.

OBJECTIVE 2
To determine fecal and ileal protein and amino acid digestibility of Canadian pulses, pulse fractions and processed pulse commodities.

OBJECTIVE 3
,To develop models for prediting in vivo ileal amino acid digestibility of pulse proteins to guide breeding programs and refine processing techniques.

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