Pulse flour milling and utilization in food products

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SPG Contributions	Project Status	Duration/Timeline of Project (Year to Year)	Co-funders	Total Project Cost
$346,000.00	Completed	July 2010 – March 2014	Agriculture & Agri-Food Canada – Canadian Agriculture Adaptation Program	$1,491,000.00

Project Description

Although pulse flours (including bean, pea, lentil, and chickpea flours) are beginning to appear in grocery and health food stores in North America and Europe, their adoption by food processors remains relatively low despite their nutritional advantages and suitability for gluten free and low glycemic food applications. This is due to a limited understanding of the properties of pulse flours and their potential applications in food products. At present, there is limited Canadian pulse processing expertise, and the functional properties of various pulse flours have not been well characterized. In addition, only limited research and development work has been done to test pulse flours in food formulations. Use of pulse flours by the food industry could provide an important value-added opportunity for Canada's pulse sector. Furthermore, the development of a pulse flour industry in Canada may provide an alternative and possibly higher value market outlet for visually degraded whole seed pulses.

Acceptance by the food industry requires knowledge on how pulse ingredients can be incorporated into food products with minimal change to end product quality. In short, introducing pulse flours as competitive alternative ingredients to cereal based products will require an in depth understanding of how pulse flours impact functionality and other quality attributes like shelf life, colour, flavour, and texture.

The aim of this project is to build on existing knowledge in the development of commercial formulations and prototypes. In addition, the food industry will be engaged throughout the project to provide their input to ensure the research and product development is relevant for their possible adoption.

Hypothesis: A systematic study of how milling techniques can influence flour characteristics and performance of pulse flours in food applications resulting in a better understanding of pulse flour manufacture and utilization and lead to increased interest, acceptance, and uptake of pulse flours by the food industry.

The project was led by the Canadian International Grains Institute (CIGI) with collaboration with food development centres and research institutions across Western Canada. A steering committee was established consisting of collaborating researchers, key stakeholders, and funding partners to identify opportunities and to review project progress. Collaboration with specific food companies took place to help establish product priority areas and to guide prototype development.

The main project activities included: the milling and testing of pulse flour quality, systematically testing the flours in a range of foods (noodles, pasta, baked goods, snacks and batter coated products and gluten-free products), obtaining feedback from food companies on their specific requirements, and determining ways to optimize milling technologies so that flours of specific quality can be produced.

Outcome

1. Milling procedures specific to pulses were developed using 4 commercial milling technologies (pin, hammer, stone, roller mills). The procedures outline the impact of adjusting milling parameters on flour quality and helped ingredient processors understand how adjustments can be made to processing equipment to target flour quality desired by the food industry.

2. A combination of milling technologies such as pin and roller mill were integrated to optimize flour quality. For instance, peas that were roller milled produced a coarse fibre 'by-product' i.e. pea hull, therefore the hulls were re-milled using a pin mill and then reincorporated back with the cotyledon flour to achieve "whole flour", or flour that contains the original fibre content of intact seed.

3. Tempering whole pulses prior to milling was shown to affect functional properties such as water absorption, viscosity and starch damage—functional properties that directly influence food quality. Although tempering was only tested at the lab scale, pilot research should be addressed in future studies as this will also impact storage stability.

4. The roller mill process demonstrated the ability to produce pea flour streams of variable protein content and particle size. Flours of low, medium, and high protein contents (21, 24, 27% protein) as well as coarse and fine particle sizes were made.

5. Better understanding of pulse flour quality produced from the different milling processes and technologies: composition (protein, fibre, starch); physical properties (particle size, colour); nutritional properties (protein, dietary fibre, micronutrients); and functional properties (water and oil absorption, foaming capacity, emulsification, viscosity, and pasting properties). The full analysis of results have been provided as "Pulse flour specification sheets" available on the CIGI website.

6. Flours with different protein contents and particle sizes were better suited in certain food applications over others. For example, pulse flours with fine particle size and low protein produced noodles with preferred textural integrity, while for puffed snacks, coarse flour with low protein was more suitable for making a larger volume and 'crunchier' product, etc. This information helped companies to start determining the pulse flour quality that works best in their product applications.

7. Pulse flours were systematically applied to 12 generic food products, demonstrating the degree of impact that flour quality can have on food quality (e.g. degree of cookie spreading, puffiness in snacks, noodle hardness, leavening of pan bread, roll-ability in tortillas, crispiness in crackers or chicken nuggets, etc).

8. Ingredient processors or suppliers have improved knowledge of pulse processing technologies that can be used to create functional flours for targeted applications.

On-site demonstrations helped them to better understand the resources and infrastructure potentially required for future scale up of flour milling operations, and to produce value-added flour streams that can be sold into a range of markets in the food industry (e.g. gluten free, high protein, healthy snack categories, etc.)

1. The project addressed the challenge of milling Canadian pulses (peas, lentils, chickpeas, beans) into functional flour ingredients and tested them in a variety of food products. Key lessons learned included the following:
a) Not all pulse flours are produced the same way, nor do they need to be produced the same way.
b) Different food products require different functional properties from their ingredients. Therefore, one type of pulse flour does not necessarily fit all food applications.
c) It is critical for processors to understand the link between processing and flour quality, while food companies need to understand the flour quality they are sourcing for their application.
d) There are various ways to modify the milling process to influence the quality of flour, including pre-treatments, integration of different milling units, adaptation of mill flows, etc.

2. Optimization of existing flour technologies (pin mill, stone mill, hammer mill, roller mill) produced pulse flours of commercial scale with unique functionalities for development of high quality food products.

3. Twelve (12) food products were developed with pulse flours with results summarized in a report targeted towards product developers. Products included noodles, tortillas, pan bread, pita bread, gluten-free pizza crust, gluten-free pita bread, crackers, extruded snack foods & crisps, pasta, chicken nuggets and cookies. The results demonstrate the degree of impact that flour quality can have on food quality, providing a foundation and starting point for food companies to pursue new product development with pulses. Product quality data and photos were developed.

4. The flour quality data analyzed at CIGI provided a baseline for researchers to conduct new studies. Examples include researchers in China through the cooperation of the Chinese Cereals & Oils Association (CCOA) testing pea and lentil flours in Asian noodles, steam buns and biscuits.

5. The flour milling project stimulated the interest of food manufacturing companies to test the pulse flours in house (e.g. Pita Bread Company, Campbell's company, a North American bread company, Batter and Breading/Ingredient Company Canadian ingredient supplier, Chinese Flour and Bakery Company, UK Bread and Bakery Company). These companies would like to remain engaged in future research related to pulse flour processing and food development as their companies continue to consider innovative ways to incorporate pulse in their product lines.

Value to Producers:
Canada is one of the largest producers of pulses in the world (~4.0 million tonnes) and yet pulse utilization in Canada is only 125,000 tonnes (1.25 million tonnes in Canada and US). With this information on pulse flour processing, there is opportunity for pulse flours to complement or be used as substitutes in food products using conventional cereals. Increased interest by the food industry to include pulse flours will drive the domestic demand for pulses.

Value to food industry:
– Commercial availability of pulse flours for use in food applications
– Expanded options for using pulse ingredients
– Technical support to assist with prototype development and formulation challenges

Research Objective

OBJECTIVE 1
To compare the composition and functional properties of flours made from various pulse market classes using a variety of milling technologies, and to demonstrate the applications of pulse flours in a range of food products.