ARGO
Agriculture Research Grant Organizer

2022N006R:

Due Date

01/15/2023

Project Overview

Project number:	2022N006R
Project title:	Development of healthy food products by combining proteins and dietary fibers from oats and pulse
Project start date:	
Project completion date:	
This is an interim report for the reporting period to	

Research Team

Principal Investigator:	
Name:	**Institution:**
Lingyun Chen	University of Alberta
Research team members:	

Project details

Review the following from your original proposal:

a. **Background**
b. **Objectives**
c. **Anticipated Results to Industry**
d. **Methodology**

Are there any changes to your original proposal?

Clearly indicate any changes made to the project and how they will affect the successful achievement of approved outcomes. Please note that making significant changes to the project without prior consent from the funder(s) could constitute sufficient grounds for termination of funding.

a. Background: A dietary pattern that provides plant protein, dietary fiber and low fat has been shown to decrease the risks of chronic diseases. The milling oats in Canada are good sources of both fiber and protein (at least 4.5% β-glucan); some varieties contain high protein (15-20%). Oat fractionation into value-added ingredients has provided a strategy to promote oat human consumptions. Oat β-glucan has cholesterol-lowering and glycemic control effects. Oat protein has high nutritive value. Oat starch and oil also attract interests as cosmetic ingredients. The combination of the fractionation capability and the emerging interest in plant-based ingredients has created a product development opportunity from oats. In addition, the mixture of oat and pulse proteins provides a strategy to address the nutritive issues of plant protein-based food products. Even though pulses and oats lack some essential amino acids, produced with their mixture contain all essential amino acids.

b. Objectives: The long-term objective of this research is to develop high quality protein and fiber ingredients from oats for healthy food development. The short-term objectives in the next 2 years are to: 1) screen oat variety & optimize processing to develop high quality protein (or mixture with dietary fiber) ingredients, and 2) develop new techniques to combine oat/pulse protein and dietary fiber ingredients to fabricate microgels as fat replacers and texturized vegetable protein products (TVP) for meat analogue applications.

c. Anticipated Results to Industry include: 1) Industry recommendation of oat varieties that are advantageous to produce high quality protein and fiber ingredients; and 2) new technique to combine functionalities of plant proteins and dietary fibers to develop fat-replacers and TVP products

d. Methodology: 1. Commercial oat varieties of high protein and β-glucan will be subjected to milling/air classification processing. 2-3 milling oat varieties that allow smooth processing to generate fractions high in both protein and β-glucan will be recommended to oat industry. 2. Develop microgel: The functional properties of protein and dietary fibers will be combined to prepare gels with viscoelastic property similar to solid fat particles. Then microgels will be prepared by size reduction of the bulk gels using homogenization. Microgels <10um are reported to have lubrication effect similar to fat. The optimized microgels will be evaluated as fat replacers in low fat food products such as yogurt and ice cream. 3. Develop TVP: A lab twin screw extruder will be applied to prepare the TVPs. The processing will be first established to fabricate TVPs from pulse protein. Then oat fraction (protein + β-glucan) will be combined with pulse protein in the formulations. The optimized TVPs will be scaled up in Food Processing Development Center for further food development such as veggie burgers and crumbles as Taco fillers.

No change to the original proposal.

Research Progress

> Provide a concise report of the results achieved to date.

1. Screen oat variety to develop protein/fiber ingredients: Two commercial oats high in protein (~16% protein) and β-glucan (~ 4.5%) were focused in the first step: Cavena Nuda oats (naked oats) and gluten-free oats. A combination of a series of particle sizes (250-1000μm) and air-classification wheel speeds (2500-5500 rpm) was studied for concentration of protein and dietary fiber in oat flours. A fine fraction and a coarse fraction were obtained after the air classification (Fig.1). The fine fractions are rich in β-glucan with the content of 7-13% (Fig. 2-3). The higher β-glucan of 13% were obtained at the milling size of 500-750μm and air classification wheel speed of 3500-4500rpm, achieving a β-glucan enrichment of around 2.5-3 folds. The fine fractions also possess higher protein (20-23.5%, Fig. 5-6). The protein enrichment degree was lower (1.5 folds) than β-glucan. On the positive side, the fractions with highest β-glucan (11-13%) also contain the highest protein (20-23.5%), therefore can be regarded as a good source of both plant protein and β-glucan for food applications.

2. Microgel: The results demonstrated the feasibility of improving pea protein gelling capacity by combining with oat β-glucan. Pea protein (15%) alone could not form gels by heating (95oC); however, self-standing gels were prepared by adding 0.5% β-glucan (Fig. 6). The gels prepared from pea protein + oat β-glucan showed compressive strength of 6kPa, which was further increased to 8 kPa with the addition of κ-carrageenan (Fig.7). The formation of strong gel network was supported by the gel microstructure observation using the Scanning electronic microscopic photos (Fig. 8).

3. TVP: The first step aimed to establish the low moisture extrusion conditions to fabricate TVPs from pea and faba bean protein. Protein and moisture content were 60-80% and 50-55%, respectively, in the formulation. All other extrusion parameters were optimized and held constant throughout the experiment (Table 1). The expansion ratio (ER) significantly increased when the protein content was increased from 70% to 80% for faba bean protein, whereas from 60% to 70% for pea protein (Fig.9). Pea protein has significantly higher expansion ratio than faba bean protein when prepared at the same extrusion conditions. Protein source and content had an impact on bulk density such that pea 70% and 80% protein at 55% moisture levels were significantly lower in bulk density than other extrudates (Fig.10). Generally lower bulk density of pea extrudates suggest that larger or more air pockets are formed from the pea protein. The water holding of the extrudates was significantly lower at 80% protein (Fig. 11), possibly due to the conformational changes in protein structure from the extrusion process. The pea extrudates were more variable in water holding capacity. Extrusion improved oil holding capacities for each protein source (Fig.12).

Research challenges and project risks

> **Describe the challenges you have encountered in the project** (environmental impacts, availability of materials, qualified personnel, financing etc.) that may affect the successful completion of the project.

The hiring of the postdoctoral fellow (PDF) has been delayed due to the visa issue. Thus, a lab technician has been working on the project until the PDF is in place in May.

Research and action plans for upcoming reporting periods

> Indicate the expected milestones and activities for the remaining reporting period(s) in the project.

1. Screen oat variety and by-product streams to develop quality protein/fiber ingredients
• The appropriate processing conditions identified in year 1 will be fine-tuned to prepare fractions rich in both β-glucan and protein from milling oats of different varieties.
• The remaining fine fraction will be studied for protein separation from starch by further air classification processing.
• The optimized processing will be scaled up to a larger pilot level to generate oat protein and dietary fiber fraction for microgel and texturized vegetable protein products (TVP) development

2. Combine oat/pulse protein and oat dietary fiber to fabricate microgels as fat replacers
• Oat protein will be added in the gel formulation and the protein/β-glucan/κ-carrageenan ratios will be adjusted to modulate the rheological properties to better simulate solid lipids
• Microgels will be prepared by size reduction of the gels by homogenization
• The performances of the microgels as a fat-replacer will be evaluated in food formulations

3. Develop texturized vegetable protein products (TVP) for meat analogue applications
• Oat fractions enriched with protein and β-glucan and the oat protein concentrate (extracted from the fine fraction by wet extraction) will be added in the pea and faba bean protein based extrudate formulations for improved TVP texture
• The impact of oat β-glucan on the protein extrusion will be studied with the hope to combine protein and dietary fibers to fabricate TVP of improved nutritive value
• Food prototypes will be developed from the optimized TVP and their sensory quality will be evaluated