Government of Saskatchewan
Ministry of Agriculture

ADF Project Progress Report Format

1. **Project title, ADF file number and reporting period.**

   Project title: Understanding the Impact of Particle Size on Physicochemical Properties and Nutritional Benefits of Pulse and Oat Flours

   ADF Project #: 20180182

   Reporting period: March 2019 - February 2020

2. **Name of the Principal Investigator and contact information.**

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3. **Name of the collaborators and contact information**

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4. **Abstract (Not more than 250 words).** *Describe in lay language the progress towards the project objectives over the last reporting period. Include any key findings and any interim conclusions. Include any deviations from the original methodology.*

   In Year 1 of this project, good progress has been achieved in the milling and fractionation of pea, lentil and oat flours. Particularly for oats, dehulling and heat stabilization were properly carried out at Prairie Agricultural Machinery Institute (PAMI; Humboldt, SK, Canada) to pre-treat the oat seeds for flour preparation. The whole pea, whole lentil, and dehulled and heat stabilized oat seeds were milled and sieved at AGT Food and Ingredients (Dr. Mehmet Tulbek) to prepare the respective whole, coarse and fine flours. Through sieving using a sieve shaker installed with a 0.15-mm screen, 36.8%-47.4% coarse and 53.0%-61.0% fine flours were obtained from the three crops. The optimization of the conditions for dehulling (oats only), heat stabilization (oats only), milling, and sieving of pea, lentil and oats to produce the whole, coarse and fine flours was time-consuming. In Year 2, the research team will work more efficiently to determine the chemical compositions, functional properties, nutritional profiles, and glycemic effects of the different flour fractions.

5. **Introduction:** *Brief project background and rationale.*

   The primary objective of this project is to investigate the effects of milling/processing of pulse and cereal flours on technological and physiological functionality in foods. The secondary objective is to provide evidence towards the substantiation of postprandial glycemia health claims for pulse and cereal foods.

Pulses and cereal grains are two major crops grown in Saskatchewan and are of great importance to the agriculture and agri-food sector. Among the pulses, lentil and pea are the leading pulse crops in the province, and in 2016 their production reached 2.74 and 2.35 million tons, respectively. Among the cereal crops, the production of oats in 2016 was 1.65 million tons, making it a major cereal grain cultivated in Saskatchewan (statistics cited from Agricultural Statistics Pocket Reference released by the Saskatchewan Ministry of Agriculture in May 2017). However, the majority of the pulses and cereal grains produced in Saskatchewan are exported as raw agricultural commodities at low prices. Despite being a major producer and exporter of pulses, consumption of pulses in Canada remains very low. As a result, the agri-food sector has developed novel processing techniques for the production of value-added flours for consumer use. This includes dehulling, splitting and milling of pulses to create flours for various food products, such as pasta products, meat products, snacks, batter and breading (Pulse Canada, 2017). Furthermore, a secondary processing step (fractionation) separates pulses as well as cereals into protein concentrates and isolates, starch-rich flours, and fibers (e.g., oat fiber) for ingredient use in functional food formulations. For example, β-glucan rich fractions can be obtained by wet milling followed by sieving and solvent extractions. These approaches result in concentrates (8-30% β-glucan) or isolates (95% β-glucan) with greater purity. However, extraction of pure β-glucan isolates is complex and relatively expensive (Brennan and Cleary, 2005). Thus, oat bran or oat flour fractions are typically used by the food industry (El Khoury, Luhovyy and Anderson, 2012).Similarly, pea and lentil protein isolates can be produced but at higher costs and are more time-consuming and labour intensive than milling into flours (with no fractionation step). As a result, the food processing sectors in Saskatchewan and in Canada are exploring new strategies for ingredient development, which will add value to these crops.

The milling industry is a critical component of the food supply chain (Agriculture and Agri-Food Canada, 2016), and milling is one of the most efficient methods for the value-added processing of pulses and cereal grains. Milling can produce a diverse group of ingredients, including pulse and cereal flours, pea hull fiber, pulse protein concentrates (protein content >60% dry weight), oat bran and oat hull fiber. This increases the utility of pulses and cereal grains for use by national and international food manufacturing companies to create a broad range of food products, including snacks, breakfast cereals, porridges and pasta products, expanding their commercial uses. Their functional potential in food systems is two-fold: (1) they can impart technological functionality due to their physicochemical properties and potential to act as a gelling agent, a thickener, a binder, and a stabilizer for emulsions and foams in various food systems; (2) they can be used as ingredients in functional foods due to their favorable macro- and micronutrient profiles and deliver nutrients and physiological functionality, such as postprandial blood glucose reductions.

However, to our knowledge no studies to date have reported the effect(s) of milling on the physicochemical properties of different pulse (e.g., pea and lentil) and/or cereal grain (e.g., oats) flours of different particle sizes while simultaneously determining in vivo health outcomes. The latter is a particularly important component of our study as dietary modifications are a cornerstone for prevention as well as management of cardiovascular disease and type 2 diabetes (T2D).

Postprandial glycaemia is recognized as a factor to control in preventing and managing T2D. It is well documented that high postprandial glycaemia increases risk of complications in diabetic patients (Sudhir and Mohan, 2002). The Canadian Diabetes Association recommends eating nutritious meals and snacks. The Canadian Food Guide includes pulses and cereals as part of a healthy well-balanced diet. As well, the recent Health Canada's Guiding Principles document highlights an intent to encourage consumption of plant-based foods and diets to counter current disease trends, consistent with WHO recommendations (Government of Canada, 2017). As a result, it is timely and important to identify novel ingredients for foods that can be recommended to reduce the risk of developing markers associated with T2D.

6. Objectives and the *progress towards meeting each objective*

Objectives (***Please list the original objectives and/or revised objectives if Ministry-approved revisions have been made to original objective. A justification is needed for any deviation from original objectives)***	**Progress (e.g. completed/in progress)**
1. To prepare pea, lentil and oat flours of coarse, granular and fine particle sizes	Completed.
2. To determine the performance, starch digestibility and dietary fiber contents of the obtained flours and resultant foods	In progress.
3. To examine the chemical compositions and functional properties of the flours with variations in particle size	In progress.
4. To examine the relationships between flour particle size and postprandial glycemia in humans	In progress.

7. **Methodology:** *Specify project activities undertaken during this reporting period. Include approaches, experimental design, tests, materials, sites, etc. Please note that any significant changes from the original work plan will require written approval from the Ministry.*

7.1 Materials

Certified seeds of pea (Meadow variety), lentil (Richlea variety), and oats (Summit variety) were purchased from Penwest Seeds Company (Three Hills, AB, Canada), Simpson Seeds Inc. (Moose Jaw, SK, Canada), and Ardell Seeds Ltd. (Vanscoy, SK, Canada), respectively.

7.2 Dehulling and kilning of oats

The obtained oats were firstly dehulled using an Entoleter Centrifugal Machine at 2,113 rpm with one pass. The dehulled oats were heat stabilized ("kilned") by steaming in a steam kettle for 8.0 min under ambient pressure.

7.3 Milling and sieving of pea, lentil and oats

Whole pea, whole lentil, and dehulled and kilned oat seeds were milled using a Micron Powder Systems Hammer Mill through a 2-step method. In the first step, the grains were milled to pass through a 5.0-mm screen. In the second step, the pre-milled samples were further milled using the same mill to pass through a 2.0-mm screen to obtain the whole ("non-fractionated") flours.

The whole pea, lentil and oat flours were sieved using an automatic sieve shaker to pass through a screen of 0.15-mm openings to separate them into coarse and fine fractions. The weights of the collected diffractions were recorded to calculate the yields after sieving. The milling and sieving were carried out in two independent batches for each crop at AGT Food and Ingredients.

8. **Results and discussion:** *Describe research accomplishments during the reporting period under relevant objectives listed under section 6. The results need to be accompanied with tables, graphs and/or other illustrations. Provide discussion necessary to the full understanding of the results. Where applicable, results should be discussed in the context of existing knowledge and relevant literature. Detail any major concerns or project setbacks.*

Table 8.1 Yields of coarse and fine pea, lentil and oat flours after sieving (0.15-mm screen)

Sample	Coarse (%) [a]	Fine (%) [a]
Pea	39.6 ± 0.6	60.0 ± 0.0

Lentil	47.4 ± 3.6	53.0 ± 2.0
Oats	36.8 ± 3.0	61.0 ± 1.2

[a] %Yield = (Weight of fractionated flour after sieving) / (Initial weight of whole flour before sieving) × 100.

Milling and sieving methods were successfully established to prepare whole, coarse and fine pea, lentil and oat flours. The sieving of whole flours generated 36.8%-47.4% coarse and 53.0%-61.0% fine flours from the three crops, respectively. The derived whole, coarse and fine flours will be utilized for the subsequent experiments described in the original proposal.

9. Interim conclusions (If any).

(1) Milling and sieving methods were well established to produce whole, coarse and fine flours from pea, lentil and oat seeds. The resultant flour fractions will be used for the follow-up analyses as indicated in the original proposal.

10. List any technology transfer activities undertaken in relation to this project: *Include conference presentations, talks, papers published etc.*

(1) Meeting with AGT Food and Ingredients to discuss the research plan. In Saskatoon, SK. October 17, 2019.
(2) Meeting with AGT Food and Ingredients to share the research progress. In Toronto, ON. November 06, 2019.

11. Identify any changes expected to industry contributions, in-kind support, collaborations or other resources.

None.

12. Appendices: *Include any additional materials supporting the previous sections, e.g. detailed data tables, maps, graphs, specifications, literature cited, acknowledgments.*

Literature cited:

Agriculture and Agri-Food Canada, *Canada's Grain and Oilseed Milling Industry.* [Internet]. 2016. Available from: http://www.agr.gc.ca/eng/industry-markets-and-trade/canadian-agri-food-sector-intelligence/processed-food-and-beverages/canada-s-grain-and-oilseed-milling-industry/?id=1449760479129

Brennan, CS., and Louise JC. "The potential use of cereal (1→ 3, 1→ 4)-β-D-glucans as functional food ingredients." *Journal of cereal Science* 42.1 (2005): 1-13.

El Khoury, D., et al. "Beta glucan: health benefits in obesity and metabolic syndrome." *Journal of nutrition and metabolism*2012 (2011).

Government of Canada. Guiding Principles. [Internet]. 2017. Available from: https://www.foodguideconsultation.ca/guiding-principles-detailed

Pulse Canada, *Pulse Industry.*[Internet] Pulse Canada 2017. Available from: http://www.pulsecanada.com/pulse-industry

Sudhir, R. and V. Mohan, Postprandial hyperglycemia in patients with type 2 diabetes mellitus. Treat Endocrinol, 2002. 1(2): p. 105-116.