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PROJECT INTERIM PROGRESS REPORT

1. Project Title: Development of an oat based beverage rich in dietary fiber and protein

2. Project Start Date: (07/01/2016)	3. Project Completion Date: (06/30/2019)
4. This is an interim report for the ___2nd___ year of this ___3___ year project.	DATE: 24/06/2018

5. Research Team Information

The personal information being collected is subject to the provisions of the Freedom of Information and Protection of Privacy Act.

a) Research Team Leader: (requires personal data sheet)		
<i>Name</i>	<i>Institution</i>	<i>Expertise Added</i>
Lingyun Chen	University of Alberta	Oat processing, oat protein
b) Research Team Members (each member requires a personal data sheet) <i>Additional rows may be added if necessary.</i>		
<i>Name</i>	<i>Institution</i>	<i>Expertise Added</i>
1. Wendy Wismer	University of Alberta	Food sensory
2. Vera C. Mazurak	University of Alberta	Human nutrition
3. Darren Walkey	University of Alberta	Business development
4.		
5.		
6.		

6. Project Overview (max. 2 pages)

a) Background (provide a brief statement indicating what this research is about and why it is considered important.

The majority of Canadian oats is currently used in the Canadian feed market. As traditional markets become increasingly challenging, development of value-added applications for human consumption is important to enhance revenue return to the producers. The human food market for oat has been gaining momentum due to recognition of health benefits of beta-glucan for reducing blood cholesterol and regulating blood glucose levels. Oat also has higher protein level among cereals with a superior amino acid profile. Studies have demonstrated that oats are tolerated by the majority of people suffering from celiac disease. Beverages made from oats are popular in European countries. In Sweden, milk oat drink has been developed as a supplement for people who are intolerant to lactose. Efforts to develop oat beverages from Canadian oat are still limited. Oatdeal® is a Canadian company that produces oat smoothies with dairy milk. Oatdeal's current product lines require customers to make their own blended beverages using a powder mixture. This has created consumer

dissatisfaction with beverage consistency and preparation time. A ready-to-drink oat based beverage that is beta-glucan/protein enriched is required, so that consumers will have access to storable, nutritious beverage that is convenient. Replacing milk protein with plant based alternatives such as pulse protein will enable Oatdeal to expand into lactose free and vegetarian/vegan markets. Cereal and pulse proteins are complementary in essential amino acids and represent close to optimum essential amino acid profile.

Cancer is the leading cause of death in Canada. In 2015, nearly 200,000 Canadians will be diagnosed with cancer. Malnutrition remains the most frequent and inadequately managed problem that affects cancer patients. However, it is our view that restoring the status of nutrients known to be deficient improves nutritional status to enhance outcomes in people with cancer, as well as in those with other age-related chronic diseases. The majority of currently available nutritional products are not targeted toward the dietary needs of cancer patients and are unpleasant due in part to altered senses of taste and smell. The oat drink presents a good base to develop a nutritionally-enhanced beverage for cancer patients because both beta-glucan and high protein diets are recommended and a ready to drink formula is appropriate for cancer patients. The challenge is to develop a commercially feasible processing to optimize protein and beta-glucan amount and quality, then to make these into a ready-to-drink beverage with shelf-life of one year. The second challenge is to further develop a nutritionally-enhanced beverage that meets the nutritive and sensory requirements of cancer patients.

b) Objectives of the Project

1. Develop a processing to concentrate protein and beta-glucan from oat grains
2. Develop a ready-to-drink beverage enriched in beta-glucan and protein by combining oat and pulse and determine if this development results in shelf-stable products
3. Enhance the beverage with nutrients known to be deficient in cancer patients (omega-3 fatty acids and vitamin D) and study the acceptability of the beverage with the cancer patients

c) Key Results Expected

1. Optimized processing to concentrate protein and beta-glucan from oat grains
2. Establishing a new technique to develop a ready-to-drink from oat and pulses
3. Basic drink platform to develop a nutritionally-enhanced beverage for target populations (e.g. cancer patients and aged population)
4. Strengthen collaborations with oat and pulse producers and processors
5. This research will lead to training of highly qualified personnel, scientific papers, conference presentations

7. *Progress to Date* (max. 2 pages)

a) Provide a concise report of the results achieved to date. It should contain a summary of the data collected and any preliminary conclusions made. The report should clearly state whether the results expected under the action plan for the proceeding year have been achieved. If they have not been achieved, please provide explain. Please also include all changes/modifications that have been made to the original plans and provide clear explanation for the changes.

In 2016-2017, we developed a wet processing to effectively concentrate protein and beta-glucan from oat

grains by centrifuge to remove starch. The raw oat flours contain 60.7% starch, 13.7% protein, 3.4% beta-glucan and 5.6% moisture, and the remaining 16.6% include other carbohydrates and fat. After concentration, the protein and beta-glucan content increased to 55.2% and 8.9% (on dry base) respectively, meanwhile, the starch content decreased to 7.4%. Then we aimed to develop a ready-to-drink beverage enriched in beta-glucan and protein. A major challenge was to remove the starch which precipitates during storage. In 2017-2018, we continued to develop the ready-to-drink beverage and conducted sensory evaluation of the oatdeal products by cancer patients. The research progresses are reported as follows.

3. Enhance the beverage with nutrients known to be deficient in cancer patients and study the acceptability of the beverage with the cancer patients

Inadequate nutrition is highly prevalent among cancer patients. The presence of symptoms that interfere with eating promote decreased dietary intake, which contribute to muscle wasting and weight loss, both associated with poor patient outcomes. Recommendations to reach the required caloric and nutrient intake in malnourished patients include the use of both dietary counselling and/or the consumption of commercially available oral liquid nutritional supplements such as Boost or Ensure. However, currently not all patients can receive personalized dietary counselling and liquid nutritional supplements are not used consistently. Factors such as changed sensory preferences for foods and the presence of taste and smell changes or other symptoms can present barriers to continued use of liquid nutritional supplements.

As alternatives to increase nutrient intake among cancer patients, this study used oat-based products under the brand Oatdeal®, which is a dry mix of skim milk, gluten-free whole oat flour and sugar, with three different flavors (vanilla, cinnamon and chocolate). The dry product is designed to be mixed with hot or cold water or milk. The product contains oats which provide valuable nutrients (dietary fibre, β -glucan, proteins, unsaturated-fatty-acids, vitamins, minerals and antioxidants). Furthermore, it is a source of calcium, iron, protein and vitamins A and D. When mixed with milk, the protein and vitamin D contents are increased. The oat beverage project is comprised of three studies:

a. Assessment of the acceptance and consumption intention of the current oat beverage product at a cancer hospital setting.

Cancer patients can experience a variety of symptoms that may affect their sensory experience. Therefore, it is important to complete a sensory evaluation of any product intended to be consumed over multiple days by this specific population to determine its sensory acceptance. Ethical approval for this study was granted by the Human Research Ethics Board of Alberta – Cancer Committee and Operational Approval was granted by the Cross Cancer Institute. To assess that sensory acceptance, six different products were evaluated: three flavours of Oatdeal mixed with milk (2% milk fat) at two different temperatures (4°C and 60°C). Samples containing 80mL of the beverage were evaluated by the participants. Adult cancer patients, caregivers and hospital staff were recruited at the Cross Cancer Institute in highly transited areas and during patient wait times. Anonymous electronic questionnaires were filled by the participants using a tablet. The following information was collected: Self-reported demographics: Age, gender, “role” (cancer patient, caregiver/accompanying a patient, healthcare professional, other) and primary tumor type; symptoms influencing food intake; product evaluation: opinion about the sweetness, thickness and flavor intensity using a Just-About-Right scale, overall liking of the product using a 9-point hedonic scale from “Dislike extremely” to “Like extremely”, selection of the most and least liked attributes of the product, willingness to consume the product as part of the diet and time of day when the participant would prefer to consume it.

In total, 228 participants evaluated the products. The demographic characteristics are presented in Table 1. The acceptance (liking) results were analyzed statistically through Analysis of Variance (ANOVA) showing no significant difference in liking among the different flavors and temperatures, nor between cancer and non-cancer patients. The average liking results for the different flavors are presented in Figure 3.

Moreover, the results for attribute liking of sweetness, thickness and flavor intensity, as presented in Figures 4-

6, indicated that most of the participants perceived the attributes' intensity to be "Just-About Right", especially for thickness and flavor intensity. However, for sweetness of the vanilla and cinnamon flavors, over 25% of the participants consider the products to be either "Slightly too sweet" or "Much too sweet", indicating that those flavors might be improved with a reduction in the sugar content. Importantly, as shown in Figure 7, when asked if they would consume this product(s) regularly, 61.8% of the participants responded as either "Agree" or "Strongly agree", while 25.9% were undecided, mainly because they said it depended of the price of the product or where they could buy it. The high consumption intent was also reflected by several participants showing interest in the product they evaluated and asking where they could buy it. Finally, when asked about at what time of day they would prefer to consume the product, 52.5% of the participants selected breakfast, 20.5% indicated morning snack, 16.5% said that it could be consumed anytime and the remaining 10.5% of the participant would prefer to consume it at lunch, as an afternoon snack or at dinner.

Overall, the results of the product evaluations at the cancer treatment centre setting indicated that the products are liked by a majority of the participants, independent of product flavor, temperature or if they are cancer patients or not. These evaluations, therefore confirmed that the product might be suitable to be consumed by cancer patients in order to increase their nutrient and caloric intake.

b. Fortification of the oat beverage with nutrients of specific interest for cancer patients while maintaining product acceptance.

Fortified and nutrient enhanced food and beverage products can increase the intake of nutrients of interest among a specific population. However, it is necessary to ensure that the products have sensory acceptability as this will determine the product's successful consumption. In this study, nutrients known to be recommended for consumption among cancer patients were added to the chocolate flavored Oatdeal®. The selected nutrients were protein either from animal or vegetable sources and omega-3 unsaturated fatty acids provided gratis by food ingredient suppliers. The ingredient samples were initially tested in the lab to confirm solubility in milk and water, as well as to detect the maximum level at which its addition was noticeable. After evaluating different levels of the nutrients and their combinations, two formulations were selected to be evaluated (together with the original Oatdeal) by a consumer sensory panel. The selected formulations and quantities to prepare 1L of the beverages are presented in Table 2. Ethical approval for this study was granted by the University of Alberta Human Research Ethics Board 2.

The milk and dry ingredients were mixed in a blender. Fifty mL of each formulation were served in 60mL cups and presented to participants at 4°C. The presentation order of the three samples was balanced among the participants. Sixty participants were recruited at the Ag-For building of the University of Alberta. The participants were asked to taste the samples in the order presented and indicate liking on a 9-point scale as well as attribute liking of sweetness, thickness and flavor intensity on 5-points Just-About-Right scales. The questionnaires and statistical analyses were completed using the sensory evaluation software Compusense (Compusense Academic Consortium, Compusense Inc., Guelph, Ontario, Canada). One-way analysis of variance (ANOVA) was used to determine whether there was a statistically significant difference in overall liking among the samples ($p \leq 0.05$), followed by Tukey's test to determine if there was a statistically significant difference in overall liking between the samples.

Most participants (73%) were female and between the ages of 18 to 29 years old (72%). The overall liking of the samples is shown in Figure 8. There was no significant difference in overall liking between the Regular beverage and Form 1 beverage. There was a significant difference in overall liking between Form 2 and the other two products, with Form 2 liked least. The results indicated that Form 1, including increased protein content and fish oil, is liked as much as the original chocolate Oatdeal product.

Finally, to determine if there was a significant difference for the liking of the regular chocolate flavored Oatdeal among participants at the university (with a lower average age) and those at the Cross Cancer Institute, a one-way analysis of variance was conducted. University participants liked the product significantly less than the participants at the cancer treatment centre setting. The mean liking values are presented in Table 3.

Summary

1. A processing has been developed to prepare ready-to-drink beverages from both gluten-free whole oat flours and oat fractions concentrated in protein and beta-glucan.
2. Sensory study confirmed that the products are liked by cancer patients during a one-sip tasting for both the Oatdeal products and those fortified with omega-3.

8. *Research and Action Plans for Upcoming years* (max. 1 page)

Specify by calendar year

2018-2019

1. Evaluate the nutritive value of the oat beverage (e.g. protein%, beta-glucan%, oil%, calorie value)
2. Add pea protein to further improve the protein nutritive value because oat and pea proteins are complementary in amino acid composition.
3. For the sensory study we will assess the feasibility of 14 days compliance with the consumption of the oat-based beverage mix and determine influences of intake over time on the product's acceptance. Moreover, factors known to influence sensory perception and preference (age, symptoms, taste or smell alterations, type of cancer treatment) will also be patient-reported to determine the presence of an association of those factors on the product's compliance and acceptance.

9. *Technology Transfer Plan* (max. 1 page)

a) **Please indicate all completed and future activities relating to the Technology Transfer Plan for this project.**

Phone conversations have been held with Oatdeal every 2 to 3 months to discuss the project. A meeting with the entire project team and Oatdeal at the University of Alberta will be arranged and held in the fall. During this meeting Oatdeal will see presentations from the project team, see samples of the developed formulations, provide feedback, and have the opportunity to network directly with the team.

We will continue to hold phone conversations with Oatdeal every 2 to 3 months for the purpose of keeping the company up to date on the progress of the research. These conversations will also provide Oatdeal with the opportunity to ask questions, provide feedback, and raise concerns or issues.

Oatdeal and the project team will start discussing the options for commercializing the beverage within the healthcare industry upon the completion of the project. These discussions will include the identification of potential healthcare industry partners who have the capacity to distribute and market the developed beverage formulation to cancer patients. Options for scaling up the beverage and developing stable commercial supply chains for the ingredients and raw materials will also be discussed with Oatdeal.

Any potential IP that is generated through this project will be protected and transferred to Oatdeal in accordance with the University of Alberta policies and protocols. Oatdeal will be pursuing some form of IP protection of the beverage, and the formulation. Oatdeal will be holding internal discussions at the start of July to determine which IP format will be most suitable for their current and future needs in commercializing this beverage product.

All non-proprietary knowledge will be distributed through workshops, conferences, scientific publications, reports, etc. to producers, academics, and consumers. Oatdeal will be provided with the opportunity to review all non-proprietary information before it is made public.