The Cereal Protein and Cellulose Program $(CP)^2$

AN OVERVIEW

Mission: To create competitive advantages for western Canadian crops in value-added product development.

Vision:

1. Components from Alberta crops will be profitable and competitive in world markets that are dominated by soy, whey, corn, alginates and synthetics
2. We will develop natural and sustainable alternatives to replace synthetic ingredients

Goals:

1. Expand the current understanding and the utilization of cereal proteins and cellulose in industrial and food applications
2. Connect the technologies and innovations that are developed through the program with industry partners
3. To develop direct connections with industry partners for the purpose of developing new projects that address industry problems

Location: The University of Alberta, Edmonton AB. Canada

Collaboration and/or Investment:

You can benefit directly by investing in or collaborating directly with $(CP)^2$ projects. The most significant benefits that you can gain include:

1. Ongoing access to specialized expertise and skill sets
2. Direct access to innovative and cutting edge research
3. Direct access to equipment and facilities (bench top, scale up, and pilot plant)
4. Ability to leverage project funds or gain access to new/alternative avenues of funding
5. Direct access to new intellectual property or commercializable innovations
6. A cost effective alternative to internal research projects

The Key Ingredients:

Extracted Proteins (Barley)

Extracted from Cereal Grains

Barley[1]

Cellulose (Cotton)

Extracted from Wood Pulp and Cotton

Trembling Aspen Trees (Wood Pulp Source)

[1] Alberta Barley Commission Stock Photo

Areas of Potential Application:

- Agriculture and the Environment
  - Biodegradable Plastics
    - Temporary shelters
    - Row, bale and silage covers
  - Environmental Reclamation
  - Fertilizer
    - Controlled release delivery system for fertilizers, nutrients, etc.
  - Horticulture
    - Biodegradable mulch covers
    - Soil moisture additives
  - Pets and Livestock
    - Animal health
      - Wound care
      - Vaccine delivery system
    - Livestock feed additives
    - Pet food and products
      - Delivery system for bioadditives, vitamins, nutrients
- Food and Nutrition
  - Beverages
    - Energy drinks, juices
    - Emulsions
  - Confectionery
    - Encapsulated flavours
    - Encapsulated fragrances
  - Food seasoning and ingredients
    - Delivery systems
      - Aromatics and fragrances
      - Flavours
    - Fat replacements/substitutes
    - Meat product additives
  - Packaging
    - Biodegradable thermo-plastics
    - Semi-permeable and impermeable films
- Industrial
  - Construction and building supplies
  - Bio-composites, filters
- Medicine and Health
  - Pharmaceuticals and nutracueticals
    - Delivery systems
    - Encapsulations (vegetarian)
  - Medical and first-aid supplies
    - Wound care, bandages
    - Masks, gowns, etc
- Personal Care
  - Cosmetics
    - Applicators
    - Packaging
    - Fragrance, and creams
  - Health and beauty
    - Skin and hair care products
  - Cleaning Supplies
    - Natural and eco-friendly ingredients
    - Fragrance delivery systems
  - Absorbent products
    - Wipes
    - Biodegradable diapers
- Textiles
  - Biodegradable cloth and fabric

Program Highlights:

1. We have developed an economically efficient process to produce micro-encapsulations (1-5um)
   a. We have the capability for micro-encapsulation processing and measuring of particle size
   b. Used to incorporate nutraceuticals (fatty oils, carotenoids, vitamins) into functional foods and cosmetics
   c. Used to incorporate essential oils, antioxidants, anti-microbial and anti-inflammatory reagents into cosmetics
   d. Can be utilized to incorporate bioactive compounds into livestock feeds and pet foods
   e. Aid in the controlled release of pesticide, herbicide or fertilizer
2. We have developed technically feasible processes to produce nano-encapsulations (30-200nm) from barley proteins
   a. We are capable of determining the absorption of encapsulated nutraceuticals and pharmaceuticals in replicated human stomach and intestine conditions
   b. We have the capability of utilizing these encapsulations for the oral administration of insulin and other peptide drugs
   c. Potential delivery system for cancer drugs, DNA and stem cells to targeted tissues or cells
   d. Utilized for the buccal, nasal and trans-dermal administration of animal vaccines
3. We have developed high emulsifying/foaming proteins
   a. We possess a high pressure homogenizer
   b. We have the capability to make emulsions that are customizable and suitable for food, beverage, and cosmetic applications
   c. Can be used as natural and effective functional ingredients for various food (salad dressings,

whipped creams, coffee foams, etc) and cosmetic (shampoos, shower gels, lotions, creams, etc) applications

4. We have developed techniques for creating a variety of custom flexible and edible films from barley proteins
   a. We have hot press equipment to transform biopolymers into customizable films
   b. We have the capability to laminate protein polymers with other polymers
   c. Capable of testing the tension and compression strengths of films
   d. Suitable for use as vegetarian friendly encapsulations or as an edible food packaging
5. We have identified anti-oxidant peptides from barley protein hydrolysates
   a. These novel/natural antioxidants can replace synthetic antioxidants to prevent lipid oxidization in food systems
6. We have successfully converted cotton and wood pulp cellulose into gels and non-woven fibers
   a. We have electro-spinning and wet-spinning capabilities
   b. We have the capability to producing filters that are fine enough to filter out bacteria and to purify gases
   c. Our knowledge of cellulose can be used to develop commercial opportunities for Alberta cereal crop cellulose
   d. The hydrophilic gels can be utilized in wound care, soil additives, and cosmetic skin, hair, and personal care products
   e. The fibres can be utilized for cloth, bandages, cosmetic applicators, and wipes
7. Protein extraction pilot processing
   a. We have developed a successful pilot scale up process for the efficient extraction of proteins from Alberta cereal crops

Our Innovations:

All of the innovations that have been created through the program can be customized to meet specific industry needs or requirements.

Micro/Nano-Encapsulations:

A new micro-/nano-encapsulation technique based on plant materials to stabilize micro-nutrients protect them during passage through the stomach and improve their oral bioavailability.

Mircoencapsulated Fish Oil

Our research has demonstrated that these new micro-/nano-encapsulations have an excellent capacity to protect bioactive molecules (such as vitamins, omega-3 fatty acids, carotenoids, Co-enzyme Q10) against temperature, humidity during food processing and storage, and acidic conditions in human stomach. These encapsulations break down in human small intestine to release the compounds thereby increasing their absorption. This new technique enables preparation of encapsulations of controllable sizes ranging from 50 nanometers to several micrometers and can be incorporated in diverse food formulations (liquid, semi-liquid and solid food). Our data showed that even in liquid foods (juice, milk etc) these encapsulations can well preserve the activity of the bioactive compounds, and can significantly prolong the shelf-life of the products. These micro-/nano-encapsulations are based on plant materials, and have been shown to be advantageous when compared to those existing in the market owing to their safety (no BSE and religious concern), relatively low cost, and suitability for vegetarians. Additionally, the size of these encapsulations can be controlled to be very small; thus they are promising to bring new a solution to solve the low absorption problems facing many bioactive compounds such as carotenoids, Coenzyme Q10 etc. This new technique is feasible for scale up using existing food processing facilities. The potential use of this new encapsulation method will be further explored and can be of great interest for use in the cosmetic, pharmaceutical, and food industries.

Emulsions:

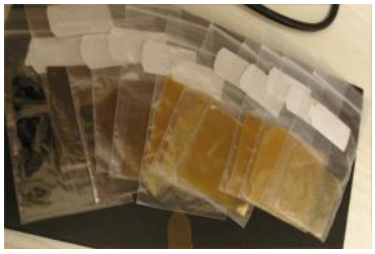
A new natural and effective emulsifier based on plant ingredient for food and cosmetic applications

This 100% natural alcohol free emulsifier is developed from an Alberta plant resource. We use it for emulsions where the ratio of oil: water can be is 2:1, 1:1, 1:3, 1:5, 1:9. The emulsifier usage in the system can be as low as 0.5%. This new plant ingredient has extremely strong capacity to bind oil products in general. Their addition in water will not increase the viscosity of the system and the pH remains stable. Their emulsifying property at a concentration of 0.5% is similar to those of lecithin at concentration of 2%, but is more cost effective. This ingredient has no special taste, smell or colour, thus can be used as "green" ingredient in diverse food (beverage, salad dressing, processed meat etc.) and cosmetic products (to stabilize essential oils, vitamins etc.).

Emulsions

Protein Films:

These films are completely biodegradable and are made completely from plant materials that are generally regarded as being safe. These films can be made to custom specifications and can be either hard or flexible, they can be dyed or utilized to encapsulate oils, liquids, emulsions or solid materials. Since these films are produced thermally there can potentially be utilized in the production of thermo-plastic packaging. The program is currently in the process of developing two innovative films, one that is semi-permeable for food packaging, and a second that is impermeable for agricultural and horticultural purposes.



Edible Films

Cellulose Gel:

Our cellulose gel is completely biodegradable and is made from sustainable plant materials. The gel is extremely hydrophilic and can be utilized for the controlled release of fertilizers, moisture, nutrients, nutraceuticals or supplements. In its dry state the gel is composed of dense foam blocks. However, once exposed to water the gel can absorb 20 to 30% of its dry weight. The hydrated gel is opaque and has a texture similar to that of gelatin.

Dehydrated Cellulose Gel

Non-woven Cellulose Fibres:

These non-woven cellulose fibres are natural, biodegradable and are made from sustainable plant resources. The patented production process allows us to make cloth, filters, wipes, and cosmetic applicators. Weaving of the non-woven fibre strands can be conducted on a nano-level, which allows for the development of filters that are capable of filtering gases and bacteria.

Our Expertise:

Dr. Lingyun Chen, *Science Director and Team Scientific Leader*: Dr. Chen has 12 years of experience in the R&D of value-added processing and applications of proteins and polysaccharides from agricultural resources for food, cosmetic and biomedical applications. She has successfully developed a cereal protein extraction process and has converted the extracted proteins into emulsifying and foaming reagents and micro/nano-encapsulations for food and cosmetic applications. Her education background spans three continents and is focused on biopolymer modifications and structure-function properties. Within the last five years she has published 17 refereed papers, 20 conference proceedings, 2 book chapters, 2 patents, and she holds 4 pending patent applications.

Mr. Darren Walkey, *Business Director*: The primary focus of his work is to effectively bridge the gap between academic research and industry needs. As a result he is responsible for building, maintaining, and developing industry partnerships and networks, while at the same time ensuring that the program's research is protected and utilized. His diverse background encompasses two distinct BA's and MSc in research valuation and commercialization.

Dr. Wang, *Post-Doctoral Fellow*: He possesses a strong background in cellulose chemistry and physics, and he has been successful in converting cellulose into gels, films, and fibers for diversified applications.

Dr. Bamdad, *Post-Doctoral Fellow*: She possesses a solid background in protein isolation, fractionation and structure characterizations, and she has experience with the development of protein based bioplastics.

Dr. Song, *Post-Doctoral Fellow*: His research is focused on cellulose modifications and structure function relationships.

Mr. Tian, *Lab Technician*: He is a very experienced lab manager with a solid background in the isolation and fractionation of agricultural resources including cereal proteins and marine lipids.

The remainder of the team is composed of 3 PhD students, and 5 MSc students.

Current Research Focus:

1. Protein nano-encapsulations
2. Protein structure-function relationships with a focus on emulsifying and foaming properties
3. Protein micro-encapsulation
4. Oat protein value-added processing
5. Cereal protein product development
6. Cereal protein value-added applications
7. Physiological properties of protein micro/nano-encapsulations in animal models

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