Entrapment of heart healthy oils using lentil protein isolates by spray drying

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SPG Contributions	Project Status	Duration/Timeline of Project (Year to Year)	Co-funders	Total Project Cost
$59,225.00	Completed	November 2015 – November 2019	Saskatchewan Ministry of Agriculture – Agriculture Development Fund (ADF)	$246,225.00

Project Description

The overall goal of the project is to re-formulate a pre existing lentil protein-based wall material for entrapping omega-3 fatty acid rich oils to deliver between 20 and 40% oil. Flaxseed, canola, and fish and oils contain essential fatty acids, increasingly recognized for their role in reducing the risk of diseases and maintaining human health. However, the incorporation of these oils into foods is hindered by their inherent instability against oxidation (ex. rancidity). Microencapsulation technology (encasing or coating the oil within a wall material) can be utilized to protect oil from oxidation. This project has 3 phases: 1) microcapsule wall re-formulation; 2) improved oxidative stability of oils using synthetic or natural antioxidants; and 3) scale up to the pilot plant scale, followed by product development.

Outcome

Phase 1.

Different combinations of oil concentration and wall materials (type and concentration) were used in the encapsulation of canola oil and characterized by emulsion stability, droplet size, viscosity, surface oil and entrapment efficiency. The combination of 2% LPI, 17% maltodextrin, and 1% sodium alginate, to deliver 20% oil, represented the best wall material to produce microcapsules with the highest entrapment efficiency (~88%). This design was then used to encapsulate different types of omega fatty acid-rich oils (canola, fish, and flaxseed oils). All microcapsules displayed similar physical properties however the wall material provided the greatest protective effect to the fish oil relative to the other oils used. Furthermore, the different oils had different release properties under simulated conditions. Overall, it was concluded that the capsule design could be potentially used as a universal platform to deliver healthy oils.

Phase 2.

The effects of different types of natural antioxidants on the oxidative stability of flaxseed oil (FSO) were compared to a synthetic antioxidant. On mass concentration basis, all-natural antioxidants were less effective than the synthetic antioxidant, however the natural antioxidants, except alpha tocopherol, did delay primary and secondary oxidation, and increase the oxidative stability index (i.e. improve the shelf life of the FSO). Antioxidant capacities, and the ability to replace minor components from the oil-water interface (where the oil layer meets the water layer) were crucial for the protection of FSO. Polyphenols are micronutrients found in plants that are powerful antioxidants. By irreversibly binding these polyphenols with lentil protein, protein polyphenol conjugates are formed. These conjugates could be used as an encapsulation wall material to improve the stability of oil. However, first information on the structure and functionality of the conjugates is needed. Lentil protein and polyphenols (quercetin, rutin, ellagic acid, gallic acid) were used to produce protein-polyphenol conjugates. Antioxidant capacities were highest in the protein-quercetin and protein-ellagic acid conjugates. The conjugation process led to changes to the protein structure and reduced solubility. Such conjugation provides a novel and an efficient way to combine the advantages of using plant protein and polyphenols in developing a healthier food ingredient for the Canadian food industry.

The combination of lentil protein isolate (LPI), maltodextrin, and sodium alginate represented as the best wall material to produce microcapsules with the highest entrapment efficiency (~88%) and oxidative stability.

The second part of the study investigated the use of a lentil protein isolate-MD-SA-based microcapsule design as a platform for entrapping different types of omega fatty acid-rich oils (e.g., canola, fish, and flaxseed oils). The wall material provided the greatest protective effect to the fish oils relative to the other oils. However, scaling up the process induced oxidation of the microcapsules. When stored at room temperature, the oxidative reactions progressed over a 60 d observation period, whereas when frozen no further oxidative processes occurred. Microencapsulated powders were added to prototype food products at the SK Food Industry Development Centre where it was found they could be added to gravy, chocolate milk and hummus at low levels in order to avoid a fishy taste.

Research Objective

OBJECTIVE 1
To re-formulate wall formulations to increase payloads.

OBJECTIVE 4
To produce kg quantity lentil proteins ingredients within the pilot plant.

OBJECTIVE 7
To carry out product development using the new encapsulated ingredients.

OBJECTIVE 2
To examine a range of oil types within the encapsulation system.

OBJECTIVE 5
To scale up encapsulation process from benchtop to pilot plant.

OBJECTIVE 3

To examine the impact of synthetic and natural antioxidants on oil stability.

OBJECTIVE 6

To characterize the resulting encapsulated ingredient.