Encapsulation of Lactic Acid Bacteria and γ-Amino Butyric Acid using Exopolysaccharides for Food Applications

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ABSTRACT

The demand for functional foods containing probiotics and bioactives is increasing. In this thesis, lactic acid bacteria as probiotics and GABA as a bioactive were coencapsulated using different techniques viz spray drying, freeze drying and double emulsion using ultrasonication in a biocompatible matrix. Bulk encapsulation was achieved using spray and freeze drying by optimizing the wall material composition. The optimum shell composition obtained by D-optimal mixture design was 0.4% inulin, 4.6% dextran, and 8.4% of maltodextrin respectively. Various homogenization techniques have been used to encapsulate bacterial cells via emulsification using homogenizers. However, the encapsulation of bacteria using ultrasound is relatively unexplored, and the survival of bacteria during ultrasonication is yet to be investigated. The possibilities of encapsulating *L. plantarum* and GABA in an inner aqueous phase of (W1/O) single emulsion using ultrasound was explored. The bacteria cells were treated using a 20 kHz, 3 mm microtip ultrasonic horn for varying sonication times at 10 W calorimetric power and the cell viability was assessed. No significant differences were observed in the bacterial counts of control and the sonicated samples. Single emulsions (W1/O) were prepared using W1 (2% w/v bacterial cells and 5% w/v GABA) and soyabean oil (O) with 1% w/w PGPR, with a volume ratio of 40:60 and ultrasonication (3 W/mL for 30 s) to produce a stable emulsion. Double emulsion microcapsules (W1/O/W2) were prepared using the single emulsion (W1/O) mixed with W2 (5% w/v dextran or 5% w/v whey protein solution, or 5% dextran and 5% GABA solution) by ultrasonication (3W/mL for 10 s) at volume ratio of 20:80. During sequential in vitro digestion, dextran capsules were stable in simulated stomach and small intestine juices. Dextran capsules were freeze dried to form shelf-stable true capsules. Spray dried (SD), freeze dried (FD), double emulsion (DE) and double emulsion freeze dried capsules (DFD) were compared and found that SD powders have good flowability and better shelf life compared to DFD powders.

A grain-based functional beverage premix and cookies were developed by incorporating SD and DFD microcapsules. SD powder was added at 10 or 20% w/w to beverage premix samples and stored for 75 days under refrigerated (5 ºC, 90% RH) or ambient (25 ºC, 40 % RH) conditions. Physicochemical properties such as nutritional profile, water absorption index (WAI), water solubility index (WSI), color, the viability of probiotics, GABA content, and sensory attributes were analyzed. The incorporation of 10% w/w microencapsulated probiotic powder was adequate to retain desirable functional properties in the resulting beverages. The results showed that beverage premix-maintained *L. plantarum* viability (>10^7 CFU/g) and GABA content (> 30 mg/g) during storage of up to 75 days. Microencapsulation improved the viability of *L. plantarum* during baking up to 15 min in oven at 160°C. GABA was stable during the baking process for both the control and microencapsulated cookies. Thus, the microencapsuled *L. plantarum* and GABA can be used in developing functional food products.

Keywords: Probiotics, GABA, Encapsulation, Ultrasonication, Functional food, Beverage premix