Keeping Probiotics Alive - Technological and Applications Challenges

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INTRODUCTION AND OBJECTIVES

Probiotic survival in food is influenced by the surrounding environment during processing and storage: e.g. temperature, moisture, oxygen and pH (Manojlovic et al., 2010). Maintaining the viability of probiotics at ambient temperatures and intermediate water activities is highly desirable, but also a major challenge in commercial applications (Crittenden et al., 2006). Creating a physical barrier between the cell and the environment provides protection to the probiotic cells and helps keep them alive for longer when added into a range of functional food products (Vidhyalakshmi et al., 2009). The process of selecting the materials, formulation and processing conditions to produce a probiotic microcapsule presents itself some complexity. The choices can be influenced by the probiotic strain and the final food application. There is no one-off solution to the varied range of strains and applications available.

This presentation will discuss some of the technological and applications challenges encountered during processing and drying, during storage and in final product applications. The effect of drying method and its subsequent influence on probiotic stability were investigated. The probiotic viability during storage in an intermediate moisture food and low pH juice are discussed. The importance of maintaining physical characteristics of encapsulated probiotics during long term storage will be presented.

MATERIALS AND METHODS

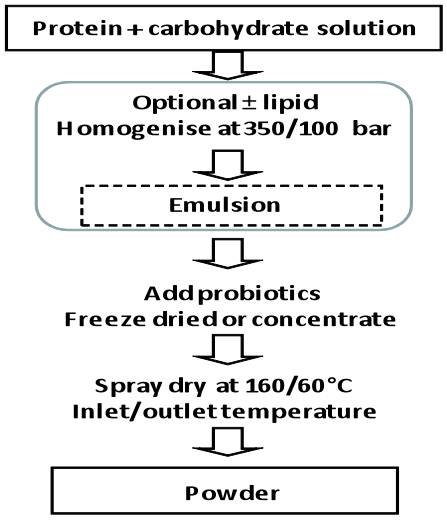

Figure 1 Process flow diagram for the preparation of microencapsulated probiotics.

Freeze dried probiotics were obtained commercially and encapsulated in a protein, carbohydrate or protein-carbohydrate-lipid emulsion based matrix formulation, and processed as shown in Fig 1. The viability of probiotics was analysed using a traditional plating method.

RESULTS AND DISCUSSION

Effect of drying method on probiotic survival during processing and storage at intermediate humidity.
Higher probiotic survival was obtained by freeze drying for non-encapsulated LGG but similar survival after freeze drying and spray drying was obtained for encapsulated LGG (Fig 3A). This is expected as spray drying can cause cellular injury due to exposure to higher temperature (Fu et al., 1995). However, the spray dried encapsulated LGG has highest survival (6 log10) after 5 weeks storage at 25°C /0.55 Aw when added into a dairy based powder formulation (Fig 3B), whereas the freeze dried LGG were below the detection limit after 5 weeks. The stability at 25°C /0.55 Aw in dairy based powder application directly correlates with stability of the freeze dried and spray dried microencapsulated probiotic reported by Ying et al (2010).

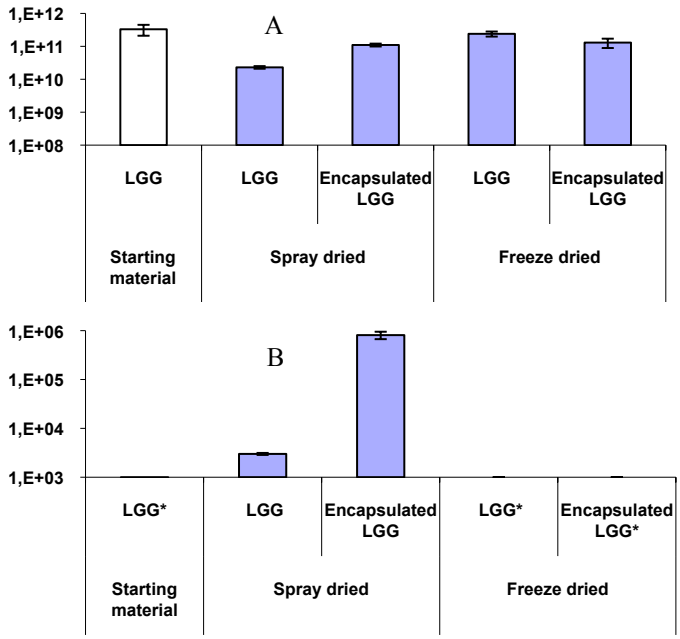

Figure 3. Viability (cfu/g) of LGG microencapsulated after drying (A), and after 5 weeks storage at 25°C / 0.55 Aw when added into a milk powder (B)

Effect of encapsulant matrix formulation on stability of LGG in a low pH aqueous environment.

A casein based emulsion matrix provides more protection to LGG in apple juice, than a hydrolysed whey protein based emulsion matrix (Fig 4). After 2 weeks storage 5.5 $\log_{10}$ cell remain viable, but after 4 weeks, there were no viable cells detected when unencapsulated LGG powder was added to juice.

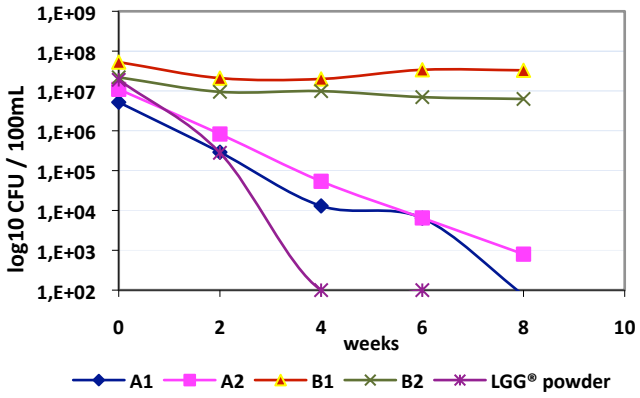

Figure 4. Stability of LGG in apple juice (pH 3.6) at 10°C storage for 8 weeks. A1, A2 (casein based emulsion), B1, B2 (hydrolysed whey protein based emulsion) are spray dried LGG microencapsulated formulations, LGG® powder is (freeze dried commercial powder).

Effect of encapsulant matrix on long term stability of a probiotic ingredient.

Both the stability and physical properties (e.g. colour and flowability) are important for overall quality and acceptability of a probiotic ingredient in a final application. These are influenced by a combination of factors during storage. Generally loss in viability during encapsulation and spray drying of LGG is <1 log10 for all formulations. During storage at 25°C / 0.25 Aw, the viability of LGG over 12 months is significantly influenced by the encapsulant matrix surrounding the cells (Fig 5). The commercial freeze dried probiotics (FDLGG) and the best formulation (1) has <1.5log10 loss over 12 months compared to formulation 2, 3 & 4 (Fig 5). The unencapsulated freeze dried LGG (FDLGG) turned into a brown solid lump but all the microencapsulated LGG maintained its colour and free flowing properties (Fig 6).

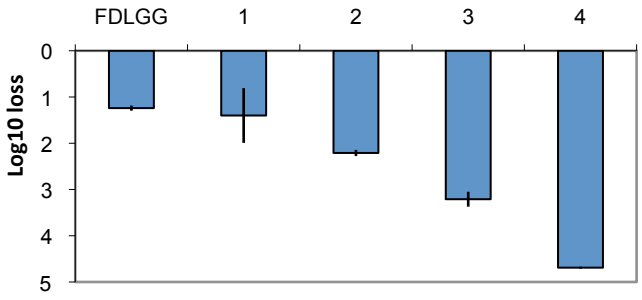

Figure 5. Survival (Log10 loss) of commercial freeze dried LGG (FDLGG) and microencapsulated LGG formulations (1, 2, 3, 4) over 12 months storage at 25°C, 0.25Aw.

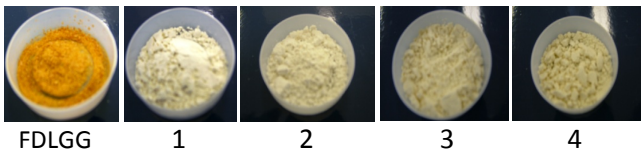

Figure 6. Colour and physical appearance of commercial freeze dried LGG (FDLGG) and microencapsulated LGG formulations (1, 2, 3, 4) over 12 months storage at 25°C, 0.25Aw.

CONCLUSIONS

Freeze drying emulsion based LGG microcapsule formulations resulted in more viable cells after drying however spray drying may provide the better option for shelf-stable intermediate food applications. For a juice application, a casein based emulsion matrix provided better protection during storage than a hydrolysed whey protein based emulsion matrix. Finally, for long term stability of the dried probiotic ingredient, maintaining its physical characteristics e.g. colour and flowability is just as important as keeping them alive during storage, specially for dry powder blend applications.

Acknowledgements

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