Intracellular trehalose accumulation in probiotics during freeze- and spray drying

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Background and objective

Intracellular accumulation of the disaccharide trehalose can protect microorganisms against harsh conditions during drying. In industrial drying of probiotics, carbohydrates are often used as extracellular protectants to improve survival of bacteria during the drying process and subsequent storage of the powders. However, for these processes, in particular freeze drying and spray drying, little is known about intracellular accumulation of carbohydrates and their role in maintaining the viability of the probiotics. Therefore the aim of this work was to investigate the intracellular trehalose accumulation in *L. plantarum* WCFS1 upon drying.

Spray drying

Approach

A culture of *L. plantarum* WCFS1 was spray dried in a 290 mM trehalose solution in a laboratory spray dryer with an inlet temperature of 120°C. Cell counts and intracellular trehalose were measured before and after drying.

Results

After spray drying the intracellular trehalose concentration in *L. plantarum* WCFS1 was greatly enhanced (Fig 1A). Survival after this process was approximately 70% (Fig 1B).

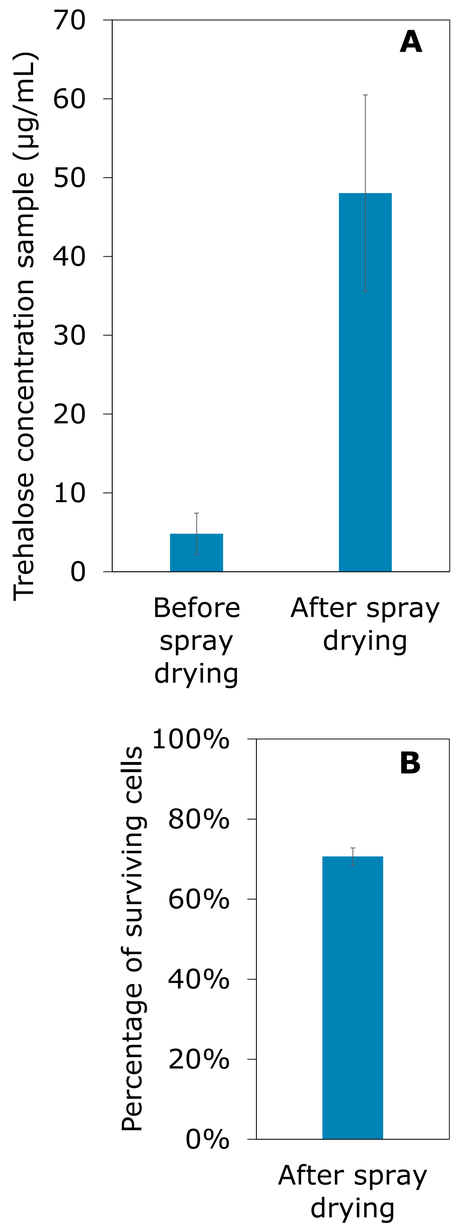


Figure 1. Trehalose concentration (A) and survival (B) after spray drying. Error bars represent standard deviations of biological duplicates.

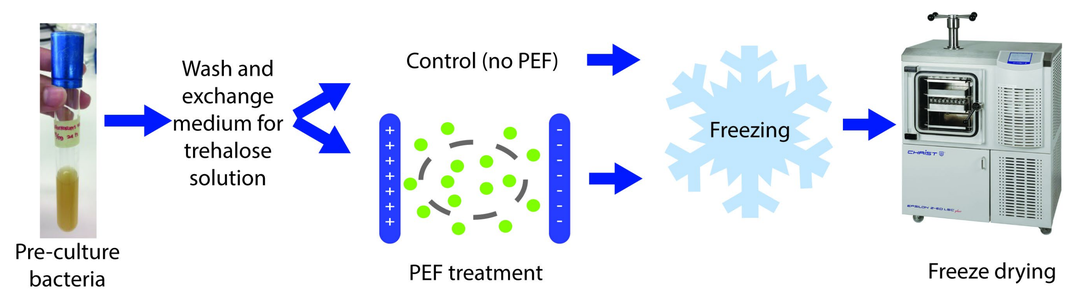
Highlights

- PEF pre-treatment increased intracellular trehalose in *L. plantarum* WCFS1
- Intracellular trehalose increased after the freezing step before the freeze drying process
- Spray drying resulted in an increase in intracellular trehalose in the cells

Freeze drying

Approach

A culture of *L. plantarum* WCFS1 was freeze dried in a laboratory freeze dryer. Part of the culture was pre-treated with pulsed electric field (PEF) treatment to enhance the intracellular trehalose concentration.



Survival after every process step was assessed by plate counting and trehalose content of the samples was measured via HPLC analysis.

Results

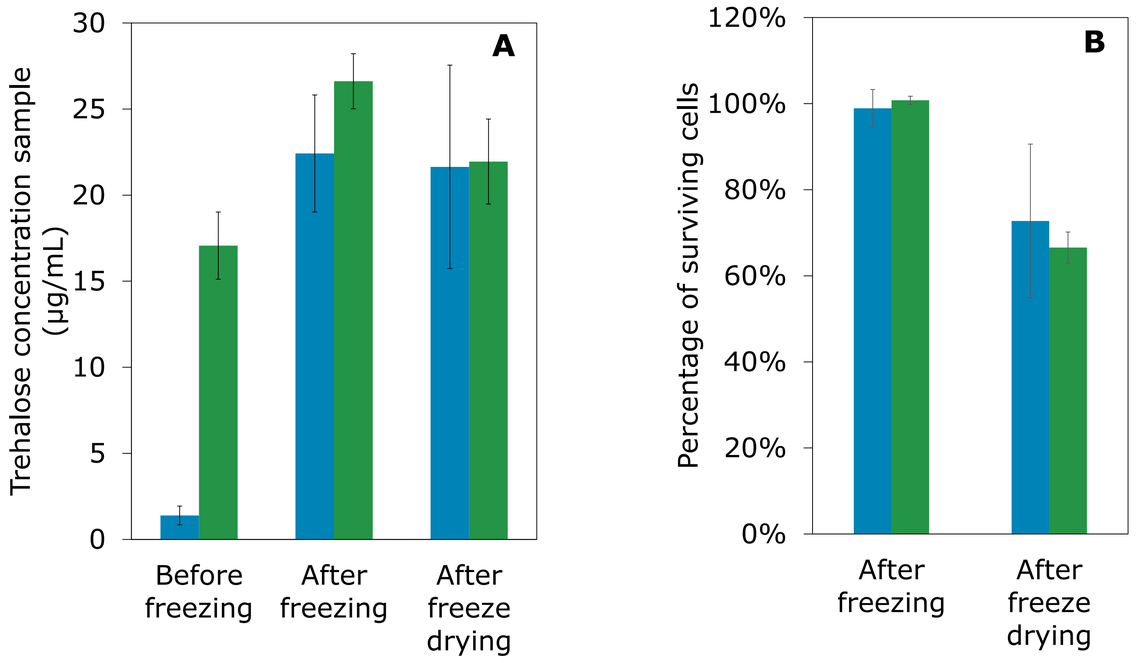


Figure 2. Trehalose concentration (A) and survival (B) in the sample with PEF treatment ( ) and without PEF treatment ( ). Each sample contained a similar amount of cells at the start of the experiment. Error bars represent standard deviations of biological duplicates.

- Before freezing we observed a big difference in trehalose content between control and PEF treated cells. (Fig. 2A)
- Intracellular trehalose increased greatly after the freezing step, especially in the control sample. (Fig. 2A)
- All cells survived freezing, approximately 60-70% survived this freeze drying process. (Fig.2B)

Conclusions and important notes

- Intracellular trehalose increased upon spay drying and during the freezing step of the freeze drying process.
- Survival of *L. plantarum* WCFS1 was similar for these freeze drying and spray drying processes.
- For the analysis of intracellular trehalose the bacterial powders were rehydrated. Rehydration might also affect intracellular trehalose concentrations.
- These results help us to understand the protective effect of carbohydrate matrices during drying of probiotics