Optimization of the drying conditions for orange juice incorporating a probiotic culture by spray-drying

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Introduction

Spray-drying is an advantageous method used for converting liquid food products into dry powder. Fruit juices become extremely sticky during spray-drying, due to their low glass transition temperatures. The usual solution to overcome this problem is the addition of some materials with high molecular weight such as maltodextrins and gum Arabic (Martinelli et al., 2007; Tonon et al., 2010).

A product that could combine orange juice and probiotics could be enjoyable for many consumers that, nowadays, are looking for diversified and healthy food products.

This work aimed to develop an orange juice powder containing viable probiotic lactic acid bacteria (LAB). The LAB chosen were *Lactobacillus plantarum* 299v and *Pediococcus acidilactici* HA-6111-2 (a potential probiotic strain), which were incorporated separately into the orange juice, and their survival was evaluated both during drying and storage (at room temperature and 4 °C).

Methods

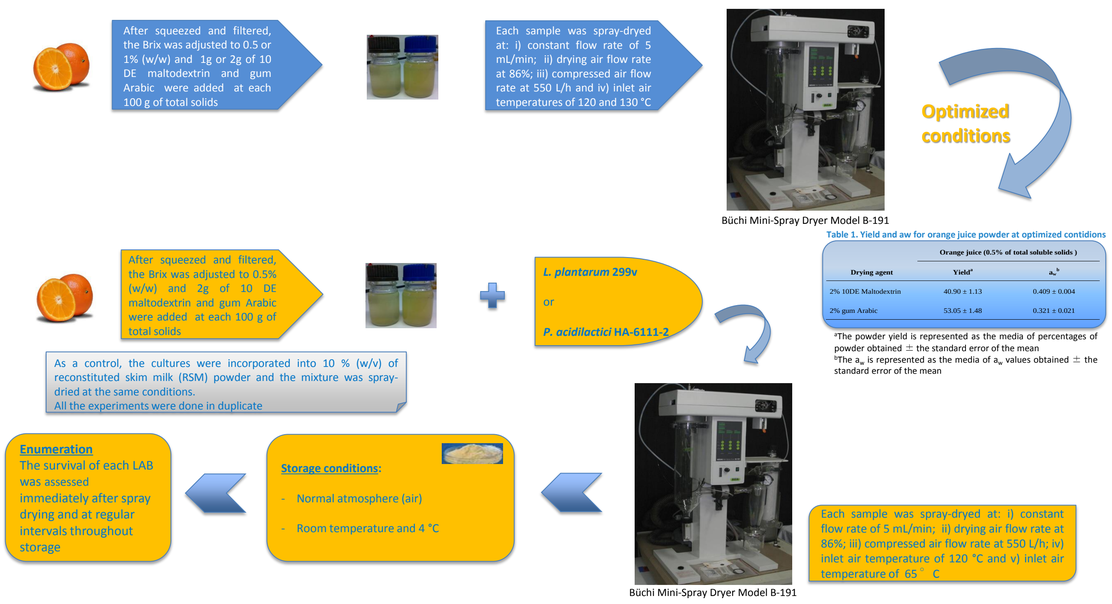

Table 1. Yield and aw for orange juice powder at optimized contidions

	Orange juice (0.5% of total soluble solids)	
Drying agent	Yield[a]	a_w[b]
2% 10DE Maltodextrin	40.90 ± 1.13	0.409 ± 0.004
2% gum Arabic	53.05 ± 1.48	0.321 ± 0.021

[a]The powder yield is represented as the media of percentages of powder obtained ± the standard error of the mean
[b]The a_w is represented as the media of a_w values obtained ± the standard error of the mean

Results

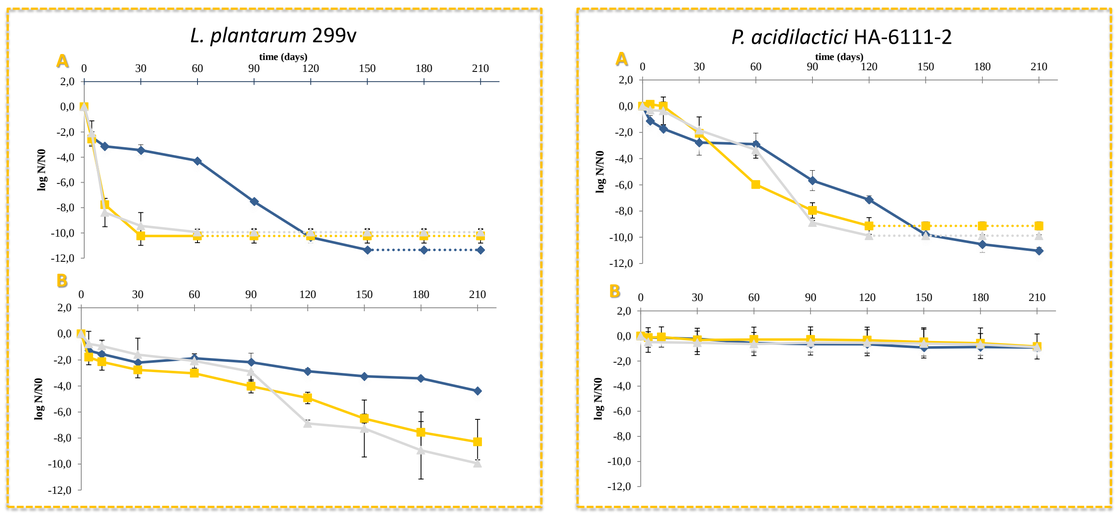

Figure 1. Logarithmic reduction of *L. plantarum* 299v and *P. acidilactici* HA-6111-2 incorporated in orange juice or RSM after spray-drying and during 210 days of storage at room temperature (**A**) and at 4 °C (**B**): (◆) control (inoculum in 10% (w/v) of RSM); (■) orange juice with 2% of 10 DE maltodextrin and (▲) orange juice with 2% of gum Arabic. The dotted lines mean that the isolate was reduced to values below the detection limited of the enumeration technique.

Conclusions

Optimization of a drying process is the initial step to gather the best conditions for obtaining a powdered product of good quality. The conditions that allowed the greatest powder yield and the lower water activity, were 0.5:2 as the ratio of soluble solids content of the orange juice and drying agent added to and 120 °C as the inlet air temperature of the spray-drying .

After the optimization of the process of orange juice powder production, we proceeded to the incorporation of each LAB to the juice with each drying agent – 10 DE maltodextrin and gum Arabic - and subsequent drying.

On storage at room temperature, both microorganisms were slightly protected by RSM, during 60 days of storage. In orange juice dried with drying agents, no significant differences were obtained between isolates regarding to their survival during storage ($p > 0.05$). The behavior of *L. plantarum* 299v and *P. acidilactici* HA-6111-2 was similar in orange juice dried with maltodextrin or gum Arabic, since none were able to survive in orange juice powder.

Significant differences were found among the additives used ($p < 0.001$) at 4 °C. The drying with RSM also conferred a protective effect for the two microorganisms during storage. The survival of *P. acidilactici* HA-6111-2 during storage under all the conditions was better than *L. plantarum* 299v, with a logarithmic reduction of less than 1 log-unit reduction. Orange juice dried with 10 DE maltodextrin conferred a slightly higher protection on the survival of the microorganisms.

Many authors reported the higher survival of spray-dried bacteria during storage at low temperatures (Gardiner et al., 2000; Teixeira et al., 1995). Of the drying agents used in this study, 10 DE maltodextrin allowed better results on the survival of the bacteria in comparison with gum Arabic. Other studies have demonstrated the importance of maltodextrin as a drying agent in fruit juices, as well as its protective ability of probiotic cultures during drying and subsequent storage (Anekella and Orsat, 2013; Reddy et al., 2009).

As conclusion, it could be possible to produce a functional non-dairy product such as an orange juice powder with viable LAB cultures incorporated with a shelf life of at least 7 months, when stored at 4 °C.

References

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