Novel functional breakfast cereals fortified with freeze-dried immobilized probiotics with potential antidiabetic capability

Grigorios Nelios, Valentini Santarmaki, Anastasios Nikolaou, Gregoria Mitropoulou and Yiannis Kourkoutas

Laboratory of Applied Microbiology & Biotechnology, Department of Molecular Biology & Genetics, Democritus University of Thrace, Alexandroupolis, GR-68100, Greece

email: grigoriamitropoulou@gmail.com

Introduction

Nowadays, a growing interest in developing novel foods enriched with beneficial microorganisms (probiotics) and prebiotic fibers that promote human health, such as the restoration of gut microbiome in Type-1 Diabetes mellitus (T1D), is witnessed. Probiotics are defined as "live microorganisms which, when administered in adequate amounts, confer a health benefit on the host". Since the use of wet cultures is incompatible with the commercial and industrial needs, a preference to dried cultures is witnessed due to multiple technological advantages. However, the drying and the food production process, as well as storage is usually related to a significant reduction of cell viability. To overcome such deficiencies, immobilized cell technology is proposed. Hence, the aim of the present study was the production of novel functional breakfast cereals (muesli) containing freeze-dried immobilized cells of a *Lacticaseibacillus rhamnosus* (previously classified as *Lactobacillus rhamnosus*) strain on cereals and fruit pieces that resulted in significant a-glucosidase inhibition activity.

Methods

- Wild type LAB strains isolated from fermented traditional Greek products were screened for potential a-glucosidase inhibitory activity (Chen et al. 2014; Muganga et al. 2015).
- *Lacticaseibacillus rhamnosus* OLXAL-1 strain, resulted in high a-glucosidase inhibitory activity, was initially grown on food grade medium.
- Immobilization on oat, wheat, banana and apple pieces was performed and the immobilized *L. rhamnosus* OLXAL-1 cells were subsequently freeze-dried.
- Freeze-dried immobilized cells were incorporated in the newly developed functional breakfast cereals.
- Cell concentration of immobilized cell cultures, water activity (a_w), moisture content (%) and spoilage were monitored during storage of the new products at room and refrigerated temperature for a period of 30 days.

Results

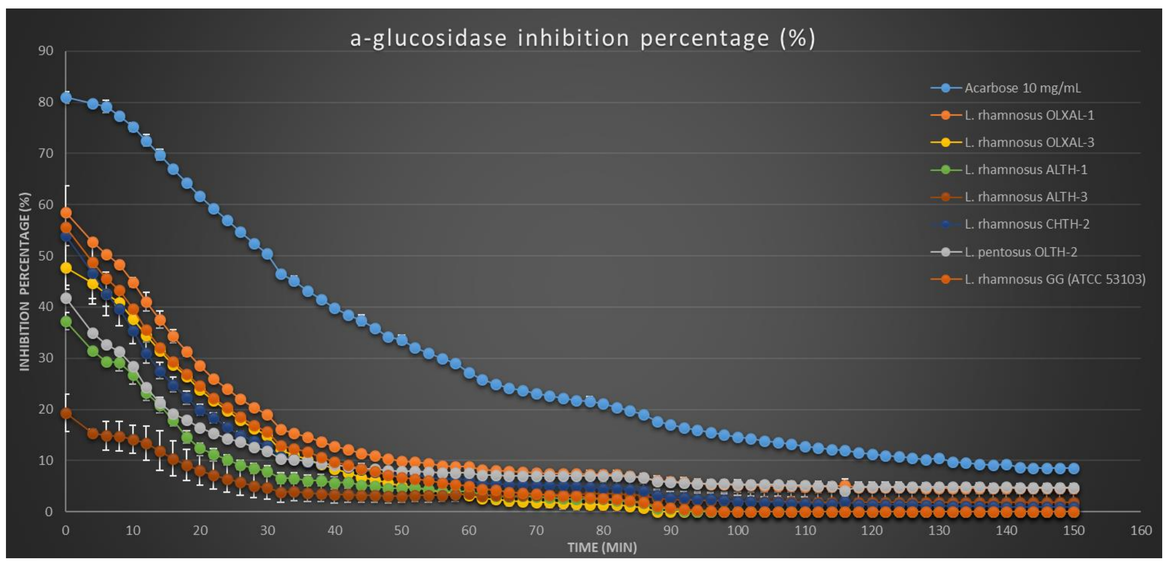
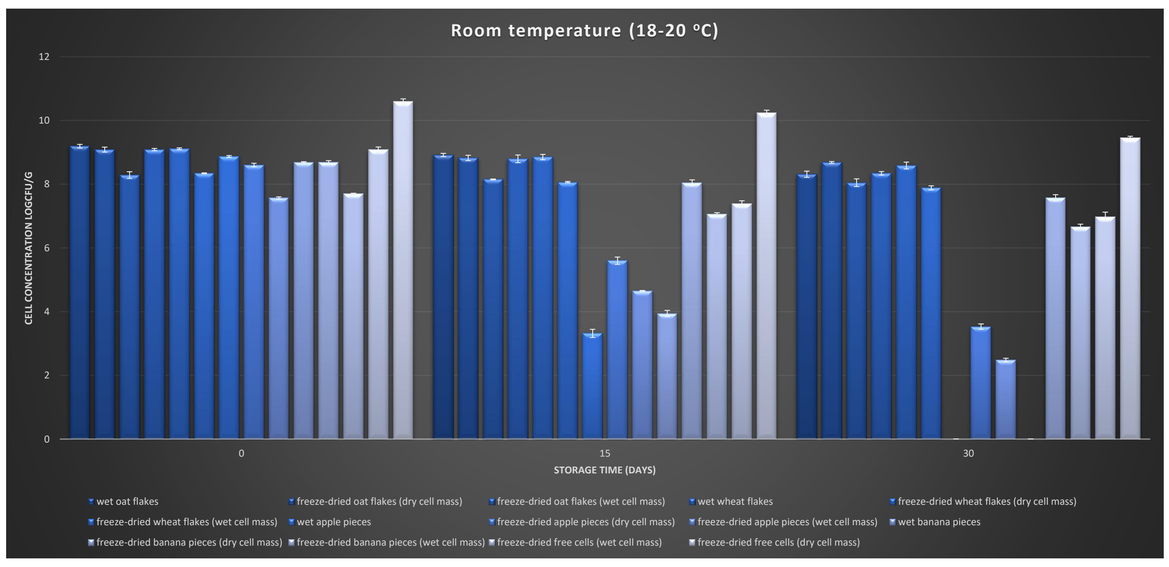


Figure 1. *Saccharomyces cerevisiae* a-glucosidase inhibitory activity (%) of cell-free supernatants of LAB strains.



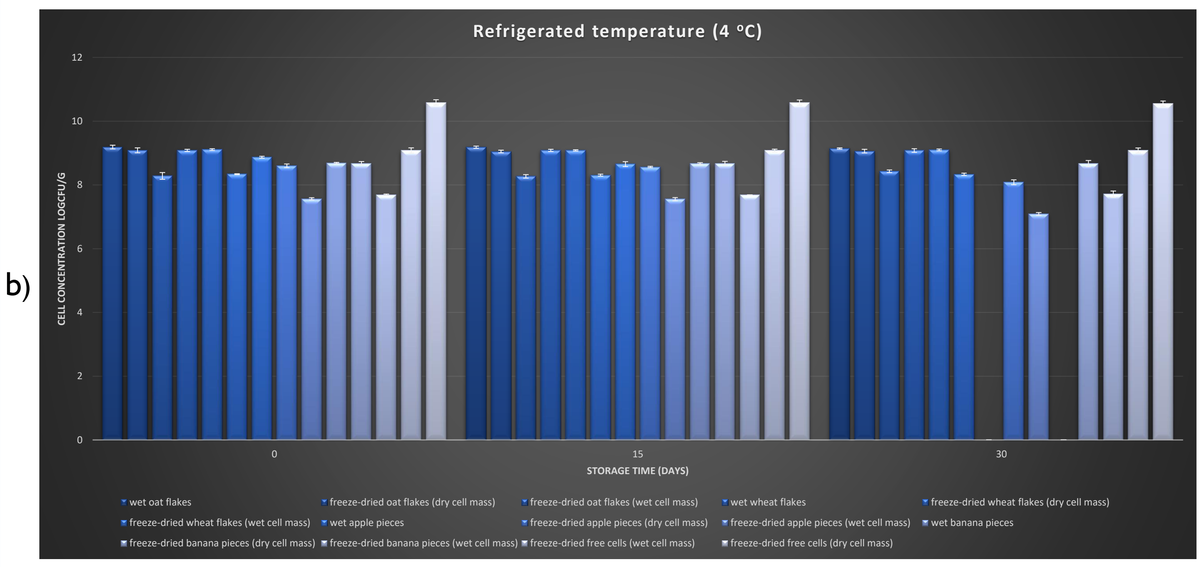


Figure 2. Populations of wet and freeze-dried free and immobilized *Lacticaseibacillus rhamnosus* OLXAL-1 cells on oats, wheat, banana and apple pieces after storage at 4 or 20 °C for 30 days. a) Cell concentration (logcfu/g) at room temperature (18-20 °C), b) Cell concentration (logcfu/g) at refrigerated temperature (4 °C). When spoilage was detected, no further determinations were carried out (data missing in the graphs).

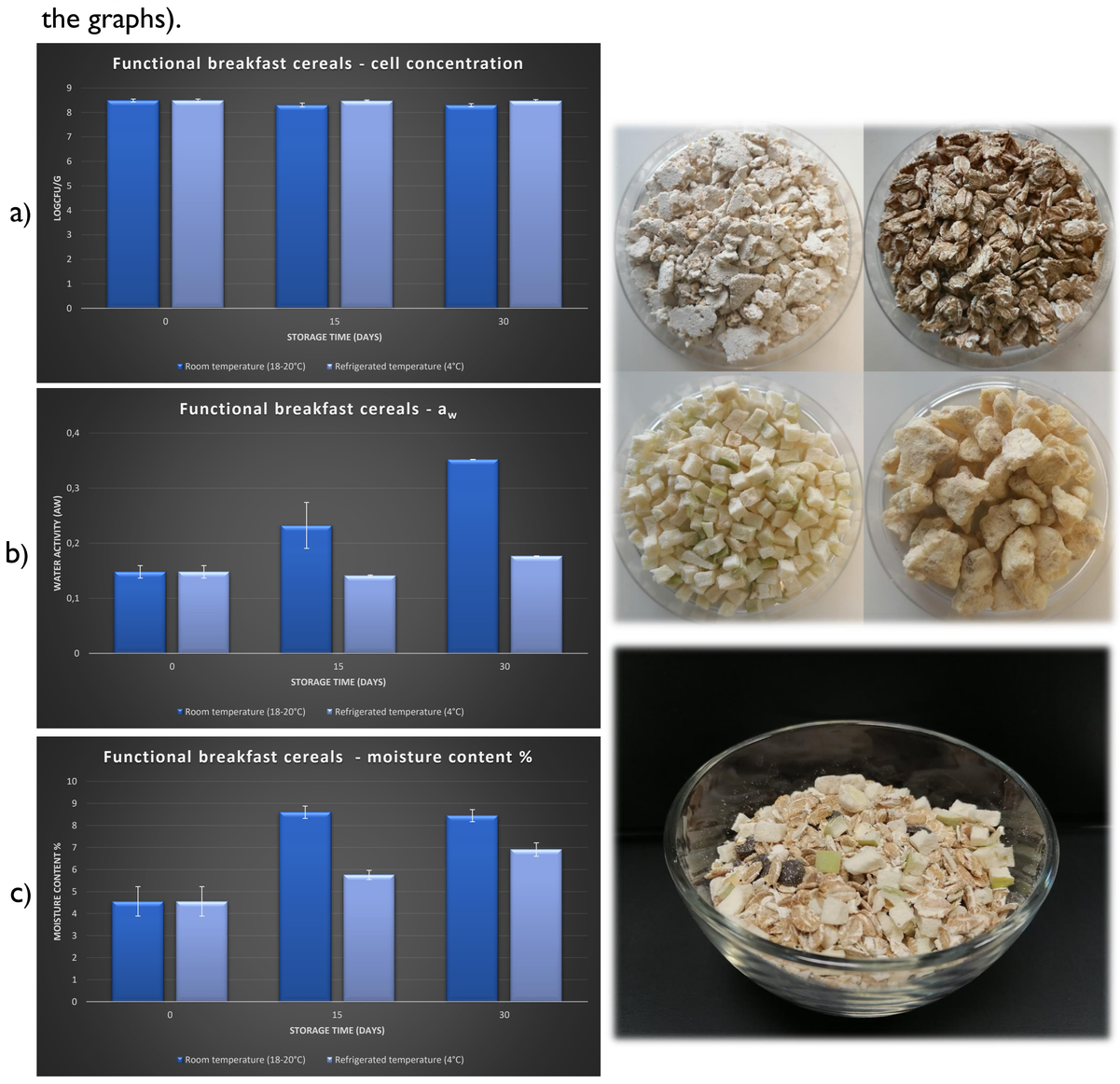


Figure 3. Effect of storage of the novel functional breakfast cereals at room and refrigerated temperature for a period of 30 days on a) cell loads (logcfu/g), b) water activity (a_w) and c) moisture content (%).

Conclusions

- *Lacticaseibacillus rhamnosus* OLXAL-1 exhibited high a-glucosidase inhibition.
- Cell populations of freeze-dried immobilized *L. rhamnosus* OLXAL-1 cultures on oat, wheat and banana pieces stored at room temperature for 30 days were recorded at levels > 7 logcfu/g.
- Freeze-dried immobilized *L. rhamnosus* OLXAL-1 cultures stored at refrigerated temperature for 30 days maintained their initial cell population (> 8 logcfu/g).
- Molds/yeasts were recorded at levels > 3 logcfu/g only on wet immobilized *L. rhamnosus* OLXAL-1 cells on apple and banana pieces after 15 days of storage.
- Novel functional muesli maintained cell concentration > 8 logcfu/g at both room and refrigerated temperature for a period of 30 days.

References

Chen, P., Zhang, Q., Dang, H., Liu, X., Tian, F., Zhao, J., Chen, Y., Zhang, H., Chen, W. (2014). Screening for potential new probiotic based on probiotic properties and α-glucosidase inhibitory activity. Food Control, 35(1), 65-72.

Muganga, L., Liu, X., Tian, F., Zhao, J., Zhang, H., Chen, W. (2015). Screening for lactic acid bacteria based on antihyperglycaemic and probiotic potential and application in symbiotic set yoghurt, Journal of Functional Foods, 16, 125-136.

Acknowledgment

The research work was supported by the Hellenic Foundation for Research and Innovation (H.F.R.I.) under the "First Call for H.F.R.I. Research Projects to support Faculty members and Researchers and the procurement of high-cost research equipment grant" (Project number: HFRI-FM17-2496, acronym: iFUNcultures).