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Effects of Salt, Carbohydrate, and Their Mixture on the Collapse and Viable Cell Count of Freeze-Dried Lactic Acid Bacteria

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Summary

It is known that structural collapse occurs when freeze-drying temperature is higher than freeze-concentrated glass transition temperature (T_g'). Trehalose is a good protectant for freeze-dried lactic acid bacteria (LAB), but structural collapse occurs readily during freeze-drying in spite of relatively high T_g'. As the reason, it was suggested that co-existed materials such as phosphate buffered saline (PBS) and LAB reduced the T_g' of trehalose. The purpose of this study was to understand effects of PBS and LAB on the T_g' of trehalose. In addition, effect of structural collapse on the survival rate of freeze-dried lactic acid bacteria was investigated. The T_g' of sample was investigated using a differential scanning calorimetry. Trehalose and PBS aqueous solution samples showed freeze-concentrated glass transition and eutectic, respectively. In the case of trehalose-PBS aqueous solution sample, eutectic of PBS was prevented by trehalose, and the T_g' decrease with increase in PBS content. There was no effect of LAB on the T_g' of trehalose. The T_g' change was summarized as a T_g'-curve in trehalose-PBS pseudo binary system. The T_g' of PBS was predicted to be -78 ºC. On the other hand, structural collapse occurred when the sample was freeze-died at much higher temperature than T_g'. There was negligible effect of structural collapse on the survival rate of freeze-dried LAB. From these results, it was suggested that biological stability of LAB could be maintained if there was no re-crystallization of trehaose induced by structural collapse.