Stability of apple juice fermented and fortified by microencapsulated *Lactobacillus plantarum 299V* during storage

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Introduction

Microcapsule

Microcapsules are small particles containing active ingredients or core materials coated by a wall or shell. Sometimes each microcapsule may contain some core materials (either the same component or different components).

Fortified apple juice

A fortified beverage refers to a type of beverage made by adding certain nutrients required by the human body or ingredients with special needs for certain people into the formula during the beverage production process.

Fermented apple juice

Fermented apple juice is a product quite different from original apple juice. After apple juice is fermented by lactic acid bacteria, the content of vitamin C, B1, and B2 is significantly increased, and the content of nutrients such as amino acids, lysine, and lactic acid are also higher than before.

Aims

To check the effect of different polysaccharides (maltodextrin (MD) and resistant starch (RS)) with diverse formulation, fermented and fortified method, and different temperatures (4℃ and 25℃) on the viability of *Lactobacillus plantarum 299V* during storage in apple juice.

Materials and Methods

Materials

- Microencapsulated *L. plantarum* 299V (**Table 1**)
- High-quality HAZÁNK apple juice was purchased from a local Supermarket

Table 1
Composition of sample solutions

Core-to-wall ratio	Wall material formulation	Wall materials ratio (w/w)	MD (g)	RS (g)	*L. plantarum 299V* (wet weight,g)	Feed solution concentration (% w/w)
1:1	MD	-	10.00	0.00	10.00	20.00
	MD+RS	1:1	5.00	5.00	10.00	20.00
	RS	-	0.00	10.00	10.00	20.00

Methods

To check the change of pH and cells numbers of microencapsulated Lactobacillus plantarum 299V in fermented and fortified apple juice at 4℃ and 25℃, 3 samples were used, i.e., core-to-wall ratio=1:1, MD; core-to-wall ratio=1:1, MD: RS=1:1; and core-to-wall ratio=1:1, RS (Call them S1, S2, S3 later, respectively) (**Table 1**). Experiments were carried out by adding 0.2 g powder into 90 mL apple juice that has been modified to pH 6 by 4 N NaOH. For the fermented samples, keep them at 37℃ and stop the fermentation when the pH reached 4.0-5.0. After that, both fermented and fortified samples were stored at 4℃ and 25℃ for future analyzing and the samples were taken twice a week.

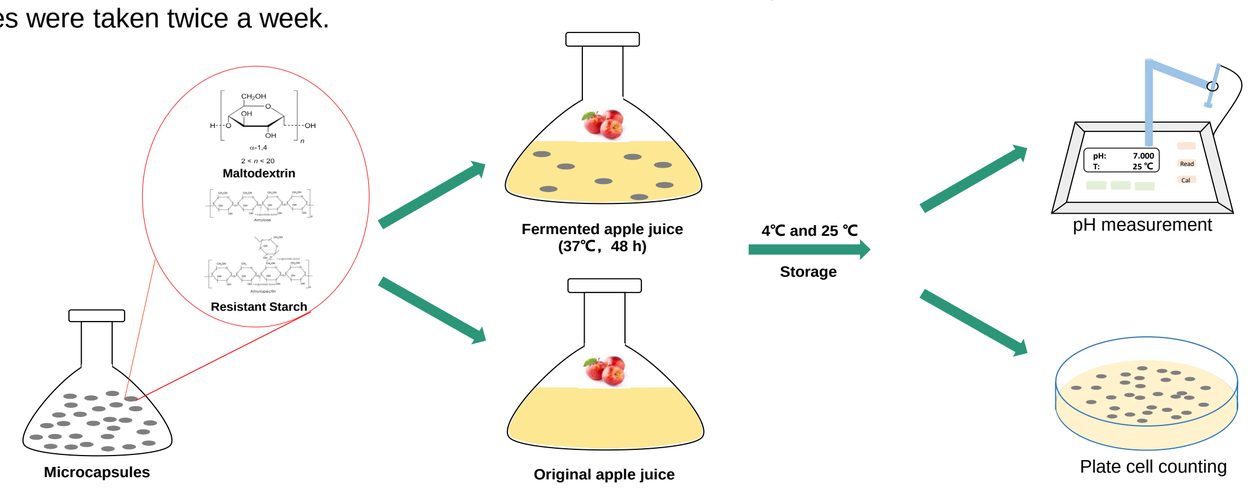

Fig. 1. Scheme of experiment process of storage survival ability of microencapsulated *Lactobacillus plantarum 299V* on fermented and fortified apple juice

Results and Discussions

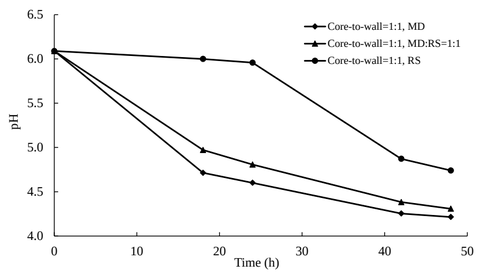

Fig. 2 The change of pH during the fermentation process of *L. Plantarum 299V*

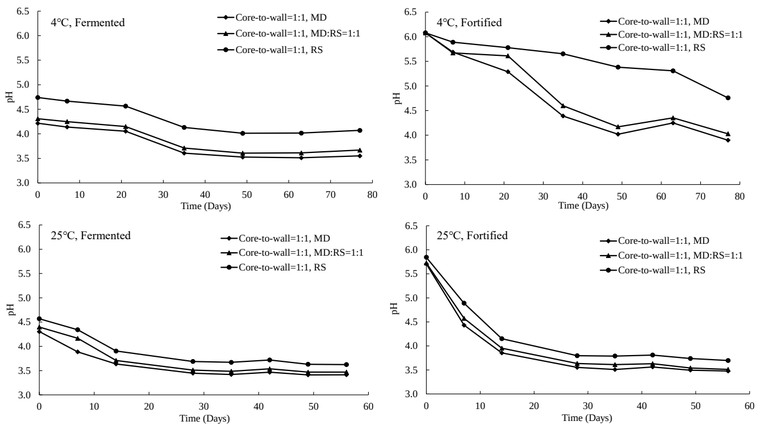

Fig.3. Change of pH of microencapsulated *Lactobacillus plantarum 299V* in fermented and fortified apple juice at 4℃ for 11 weeks and 25℃ for 8 weeks. MD- maltodextrin, RS- resistant starch.

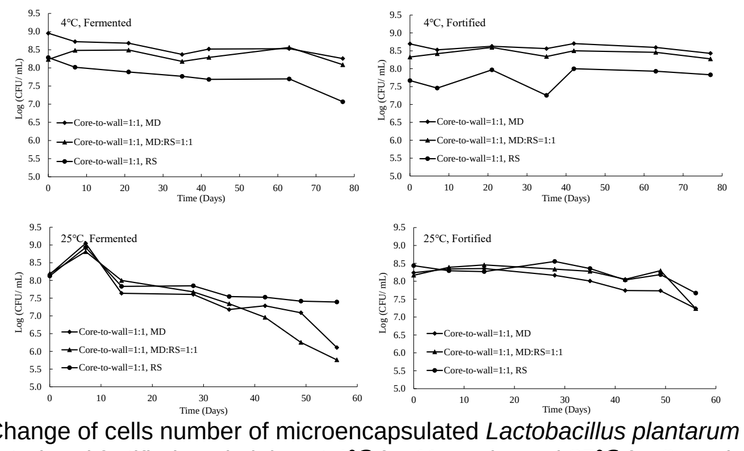

Fig.4. Change of cells number of microencapsulated *Lactobacillus plantarum 299V* in fermented and fortified apple juice at 4℃ for 11 weeks and 25℃ for 8 weeks. MD-maltodextrin, RS- resistant starch.

The change of pH during the fermentation process of *L. plantarum 299V*

The pH of microencapsulated Lactobacillus plantarum 299V during the fermentation process is demonstrated in **Figure 2**.

——The pH of S1, S2, and S3 at 18 hours were 4.714, 4.972, 6.000, respectively.

——The pH of S1, S2, and S3 at 48 hours were 4.215, 4.308, 4.740, respectively.

The pH change during storage at 4 ℃ and 25℃

The pH of microencapsulated Lactobacillus plantarum 299V in fermented and fortified apple juice at 4℃ for 11 weeks and 25℃ for 8 weeks is shown in **Figure 3**.

——At 4℃, after 11 weeks of storage, as for fermented samples, the pH were 3.552, 3.669, 4.071 for S1, S2, S3, respectively; as for fortified samples, the pH were 3.899, 4.029, 4.758 for S1, S2, S3, respectively.

——At 25℃, after 8 weeks of storage, as for fermented samples, the pH were 3.145, 3.470, 3.625, for S1, S2, S3 respectively; as for fortified samples, the pH were 3.478, 3.511, 3.696 for S1, S2, S3, respectively.

The effect of microencapsulated *L. plantarum 299V* on cells number change in fermented and fortified apple juice at 4 ℃ and 25℃

The cell number of microencapsulated Lactobacillus plantarum 299V in fermented and fortified apple juice at 4℃ for 11 weeks and 25℃ for 8 weeks is shown in **Figure 4**.

——At 4℃, after 11 weeks of storage, as for fermented samples, the cell number were 8.26, 8.09, 7.07 CFU/mL for S1, S2, S3, respectively; as for fortified samples, the cell number were 8.43, 8.28, 7.83 CFU/mL for S1, S2, S3, respectively.

——At 25℃, after 8 weeks of storage, as for fermented samples, the cell number were 6.11, 5.76, 7.39 CFU/mL for S1, S2, S3, respectively; as for fortified samples, the cell number were 7.24, 7.24, 7.67 CFU/mL for S1, S2, S3, respectively.

Conclusions

- The change of pH of Lactobacillus plantarum 299V in apple juice varies from sample to sample. The pH of S1, S2, and S3 at 18 hours were 4.714, 4.972, 6.000, respectively. The pH of S1, S2, and S3 at 48 hours were 4.215, 4.308, 4.740, respectively.
- The pH change of samples in figure A(4℃, Fermented), figure C (25℃, Fermented) and figure D (25℃, Fortified) had the same trend and reached the state of steady pH after storage for 5, 4 and 4 weeks, respectively and the pH were in the range of 3 to 4. Samples in figure B (4℃, Fortified) haven't reached the state of steady pH after storage for 11 weeks.
- The best conditions for the application of *Lactobacillus plantarum 299V* in apple juice to achieve the goal with high survival ability in this functional beverage are listed as following: core-to-wall ratio=1:1, MD:RS=1:1 for the coating material, with a fortified method, and storage at 4℃. The viability of the cells was 8.28 CFU/g after 11 weeks storage.

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