Stability of fermented and fortified apple juices by protein microencapsulated *Lactiplantibacillus plantarum* 299v during storage

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Introduction

Microcapsules

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 analyze the effect of different proteins (whey protein (WP) and denatured whey protein (DWP)) with diverse ratios of core-to-wall, ratios of wall materials, fermented and fortified method, and different temperatures (4 °C and 25 °C) on the viability of *Lactiplantibacillus plantarum* 299v during storage in apple juice.

Materials and Methods

Materials

- Microencapsulated *Lp. plantarum* 299v (**Table 1**)
- Unfiltered apple juice was purchased from a local Supermarket

Table 1. Composition of sample solutions for microencapsulation.

Ratio	Wall Materials Formulation	Wall Materials Ratio (*w*/*w*)	WP (g)	DWP (g)	*L. plantarum* 299v (Wet Weight, g)	Microcapsule Solution Concentration (% *w*/*w*)	Total Weight (g)
1:1	WP	-	20	0	20	20	200
	WP:DWP	3:1	15	5	20	20	200
	WP:DWP	1:1	10	10	20	20	200
	WP:DWP	1:3	5	15	20	20	200
	DWP	-	0	20	20	20	200
1:1.5	WP	-	30	0	20	20	250
	WP:DWP	3:1	22.5	7.5	20	20	250
	WP:DWP	1:1	15	15	20	20	250
	WP:DWP	1:3	7.5	22.5	20	20	250
	DWP	-	0	30	20	20	250

Methods

Unfiltered apple juice was applied as the matrix for the application of microencapsulated probiotics samples in the fermentation and fortification process. The pH of apple juice was adjusted to pH 6 by 4 N NaOH solution.

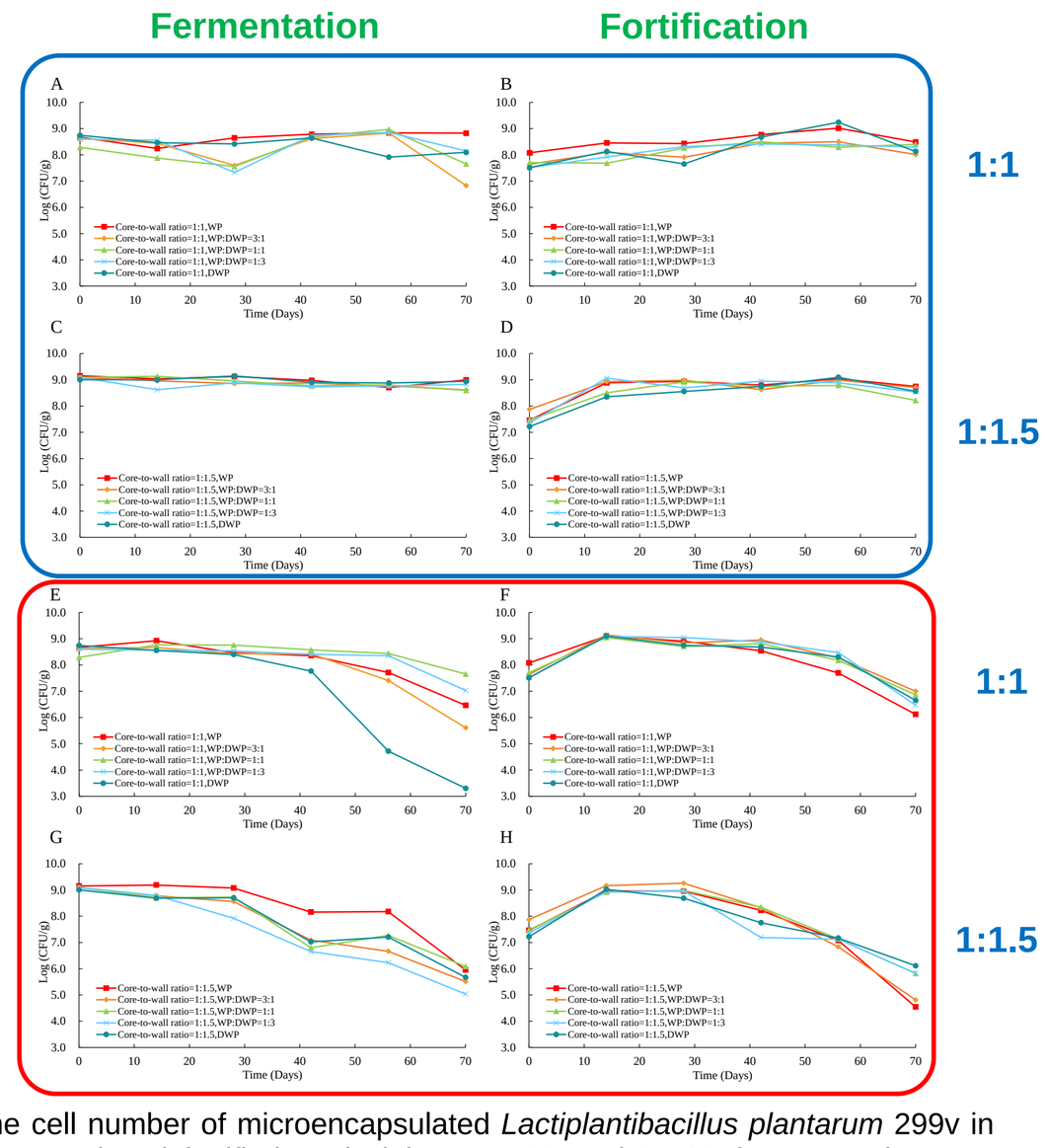
Fermented probiotic apple juices: 0.2 g microcapsules of each sample were added to 90 mL pH adjusted apple juice and incubated at 37 °C for the fermentation process till the pH decreased within 4.0 to 5.0,

Fortified probiotic apple juices: 0.2 g microcapsules of each sample were directly added into 90 mL pH adjusted apple juice.

Storage: Fermented and fortified samples were stored at 4 °C and 25 °C. The pH and cell count were determined once every two weeks.

Results and Discussions

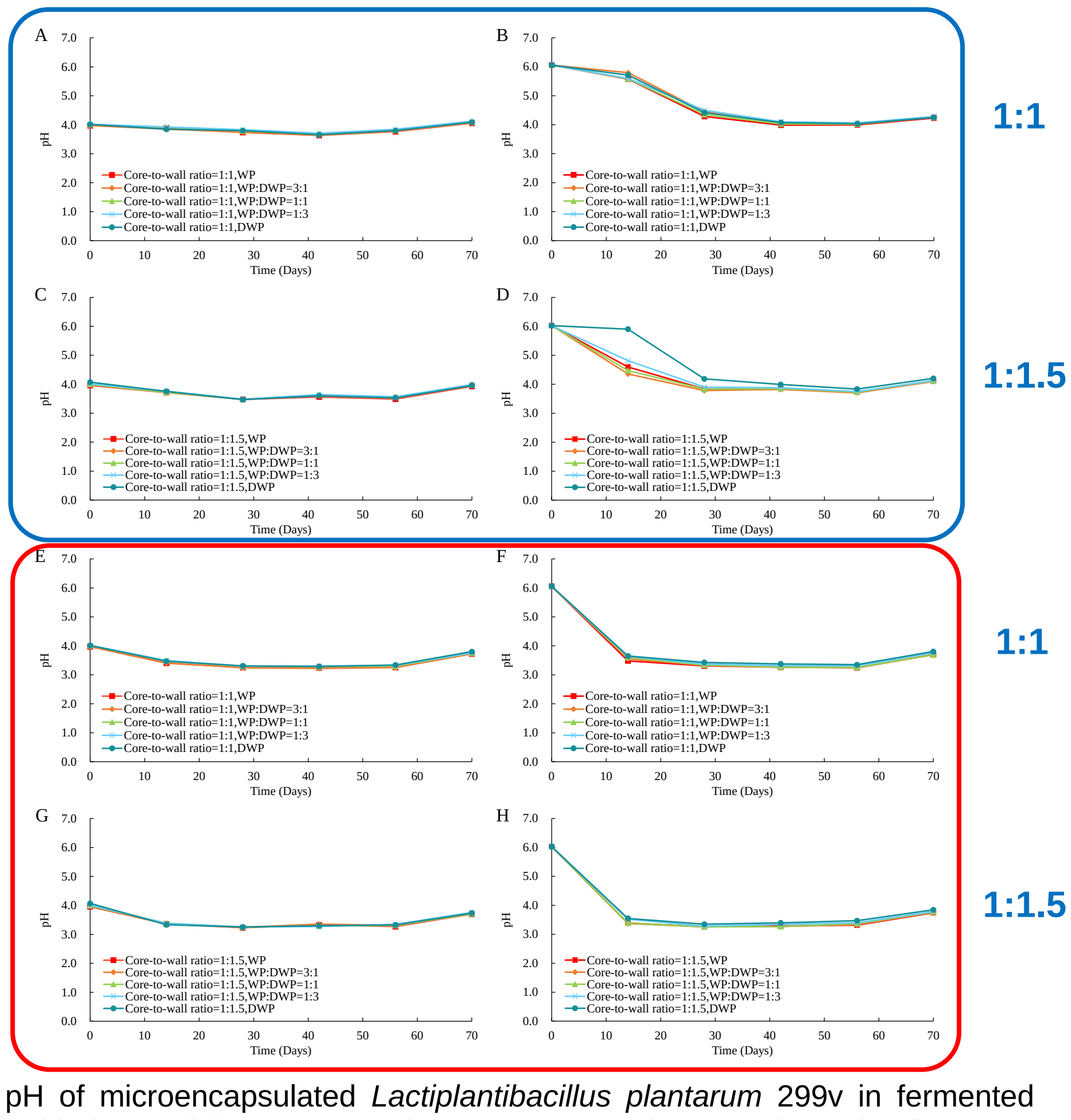
Cells number change in fermented and fortified apple juice at 4 ℃ and 25 ℃



The cell number of microencapsulated *Lactiplantibacillus plantarum* 299v in fermented and fortified apple juice at 4 °C and 25 °C for 10 weeks were shown in **Figure 1**.

(1) probiotic apple juices stored at 4 °C for 6 weeks kept the highest cell number at the end; (2) storage time and storage temperature are the two main factors that influence the viability of the probiotic cells in apple juice ; (3) while the ratio, formulation, fermentation and fortification technologies did not.

The pH change during storage at 4 ℃ and 25 ℃



The pH of microencapsulated *Lactiplantibacillus plantarum* 299v in fermented and fortified apple juice at 4 °C and 25 °C for 10 weeks were shown in **Figure 2**.

(1) probiotic apple juices fortified by microcapsules coated by WP:DWP 1:1 with a ratio of core-to-wall 1:1 and stored at 4 °C for 4–8 weeks exhibited a significantly lower pH value; (2) ratios of core-to-wall, storage time and temperature as well as fermentation or fortification methods significantly affected the changes of pH of probiotic apple juices during storage; (3) while the formulation of the microcapsules does not.

Conclusions

- **storage time and storage temperature are the two main factors that influence the viability of the probiotic cells in apple juice, while the ratio, formulation, fermentation and fortification technologies did not**
- **ratios of core-to-wall, storage time and temperature as well as fermentation or fortification methods significantly affected the changes of pH of probiotic apple juices during storage, while the formulation of the microcapsules does not**

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