ULST Timisoara
Multidisciplinary Conference on Sustainable Development
21-22 May 2026

2026 MULTIDISCIPLINARY CONFERENCE ON SUSTAINABLE DEVELOPMENT

Impact of Different L. plantarum Strains on the Nutritional Profile of Various Fruit Juice Matrices: A Review Study

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Abstract:

The fermentation of fruit juices with *Lactiplantibacillus/Lactobacillus plantarum* strains produced significant changes in physicochemical, microbiological, and sensory parameters. In all analyzed matrices, a decrease in pH was observed for instance, from 6.2 to 4.2 in pineapple juice and from 5.9 to 3.02 in cactus juice concurrently with an increase in bacterial viability, reaching values of 10–10.84 log CFU/mL in blueberry and orange juices.

Fermentation also led to a reduction in sugar content; glucose decreased from 21 to 2.31 g/L in rambutan juice and from 71.4 to 41.4 g/L in cactus juice. The increase in acidity and the accumulation of lactic acid directly influenced the sensory profile of the products. Fermented pineapple juice exhibited a sweet-sour taste and high acceptability, whereas in the case of dragon fruit and cactus, the increased acidity reduced consumer preference.

Additionally, fermentation with *L. plantarum* modified the aromatic profile through the transformation of organic acids, amino acids, and phenolic compounds. The results highlight that the effects of fermentation depend on both the plant matrix and the specific strain used; optimizing this pairing is essential for obtaining fermented beverages with balanced functional and sensory properties.

• Introduction

The concern for a balanced diet is more relevant than ever, given the increasing prevalence of digestive disorders caused by hereditary factors or lifestyle choices. Probiotics play a crucial role in this process, being live microorganisms that, when properly administered (in the form of supplements or through diet), restore the balance of intestinal microflora and support immunity (Nagpal et al. 2012).

Probiotic bacteria, known as beneficial microflora, contribute substantially to GI health beyond simple nutrition. When this balance between the digestive and immune systems is disrupted, the body becomes susceptible to disease and inflammation (Drisko et al. 2003). A large number of probiotic bacteria are used to prepare probiotic foods, especially fermented dairy products (*Lactobacillus rhamnosus GG, L. reuteri, L. acidophilus*) (Verse și Schrezenmeir, 2008). Even though the production of fermented foods has evolved and grown exponentially nowadays, new challenges arise, such as developing fermented foods adapted to the needs of people who have developed intestinal deficiencies such as Crohn's disease, intolerances or vegan lifestyle (Voidarou et al. 2021). For these individuals, another alternative of food to contain lactic acid bacteria has been developed: fruit juice. Beyond being rich in antioxidants, vitamins, minerals, and fiber, juices are free from common allergens and milk-specific sugars (such as lactose). Consequently, fruit juices represent an ideal carrier for probiotics, providing a healthy alternative for those who cannot consume dairy products (Nagpal et al. 2012).

In order to highlight the nutritional changes generated by lactic acid bacteria in fruit juices, this work focuses on the species *L. plantarum*, which is a model organism used extensively in research on these types of matrices.

• Material and method

The documentation for this review paper was carried out using the scientific databases Web of Science and ScienceDirect. The following keywords were used to identify relevant studies: "fruit juice", "lactic acid bacteria", "lactic fermentation", and "probiotic".

Articles published between 2020 and 2025 were selected, including relevant review papers and experimental studies investigating the use of lactic acid bacteria in fruit juice fermentation and their probiotic potential.

Studies irrelevant to the topic, articles without access to complete data, as well as papers analyzing food products other than fruit juices or microorganisms other than lactic acid bacteria, were excluded.

The information was analyzed through a comparative evaluation of the results and conclusions presented in the selected studies, with the aim of highlighting the effects of lactic fermentation on the nutritional, functional, and probiotic properties of fruit juices.

Authors	Juice	Strain
Zhang et al. 2025	rambutan	*Lactiplantibacillus plantarum HNU082*
Fonseca et al. 2021	passion fruit	*Lactiplantibacillus plantarum CCMA 0743*
	haruka	*Lactobacillus plantarum SI-1*
	mandarin	*Lactobacillus plantarum SI-1*
Yuasa et al. 2020	orange	*Lactobacillus plantarum SI-1*
Isas et al. 2020	Cherimoya	*Lactiplantibacillus plantarum CRL 2030*
Zhang et al. 2025	*H. megalanthus*	*Lactiplantibacillus plantarum 082;*
		L. plantarum S-811
Veron et al. 2023	*Opuntia ficus-indica*	*L. plantarum S-TF2*
Liu et al. 2025	*Aronia melanocarpa*	*Lactobacillus plantarum 1243*
Laosee et al. 2022	winter melon and pineapple	*L. plantarum TISTR 1465*
		Lactiplantibacillus plantarum LSJ-TY-HYB-T7
		Lactiplantibacillus plantarum LSJ-TY-HYB-T9
		Lactiplantibacillus plantarum LSJ-TY-HYB-T10
Li et al. 2021	blueberry	*Lactiplantibacillus plantarum LSJ-TY-HYB-T15*
Yang et al. 2022	apple	*Lactiplantibacillus plantarum BNCC 337796*
Palachum et al. 2021	pineapple	*Lactiplantibacillus plantarum WU-P19*
Muhialdin et al. 2019	dragon fruit	*Lactobacillus plantarum FBS05*

Acknowledgement: text

• Results and discussions

Studies on different probiotic strains demonstrated that the effect of fermentation strongly depends on both the bacterial strain used and the fruit juice matrix. The analyzed fruit matrices showed initial pH values ranging from 3.7 in Haruka juice to 6.5 in cactus fruit juice (*Opuntia ficus-indica*). After fermentation, pH values decreased to between 3.25 in cherimoya juice and 4.2 in pineapple juice. *Lactobacillus plantarum* strains showed good adaptability to acidic environments, maintaining viability particularly in citrus, blueberry, and aronia juices, where only minor pH changes were observed. These results highlight the important influence of the fruit matrix composition on probiotic survival, metabolic activity, and fermentation efficiency.

The analyzed studies showed that the viability of lactic acid bacteria generally increased after fermentation, reaching the highest values in orange juice fermented with *Lactobacillus plantarum SI-1* (10.84 log CFU/mL) and blueberry juice fermented with *Lactiplantibacillus plantarum* LSJ-TY-HYB strains (10–10.4 log CFU/mL). In contrast, lower viability was observed in aronia juice, where the value decreased from 7 to 4.5 log CFU/mL. A reduction in sugar content was observed in all fruit matrices, indicating the metabolic activity of the probiotic strains. The most pronounced decreases were recorded in cactus fruit juice, where reducing sugars decreased from 126.7 to 99.4–106.1 g/L, and in rambutan juice, where glucose decreased from 21 to 2.31 g/L. Lactic acid production varied depending on both the strain and the fruit matrix. The highest lactic acid concentration was obtained in orange juice fermented *with L. plantarum SI-1* (85.2 g/L), followed by mandarin juice (51.2 g/L), while the lowest values were observed in dragon fruit juice (0.94 g/L) and cherimoya juice (1.32 g/L).

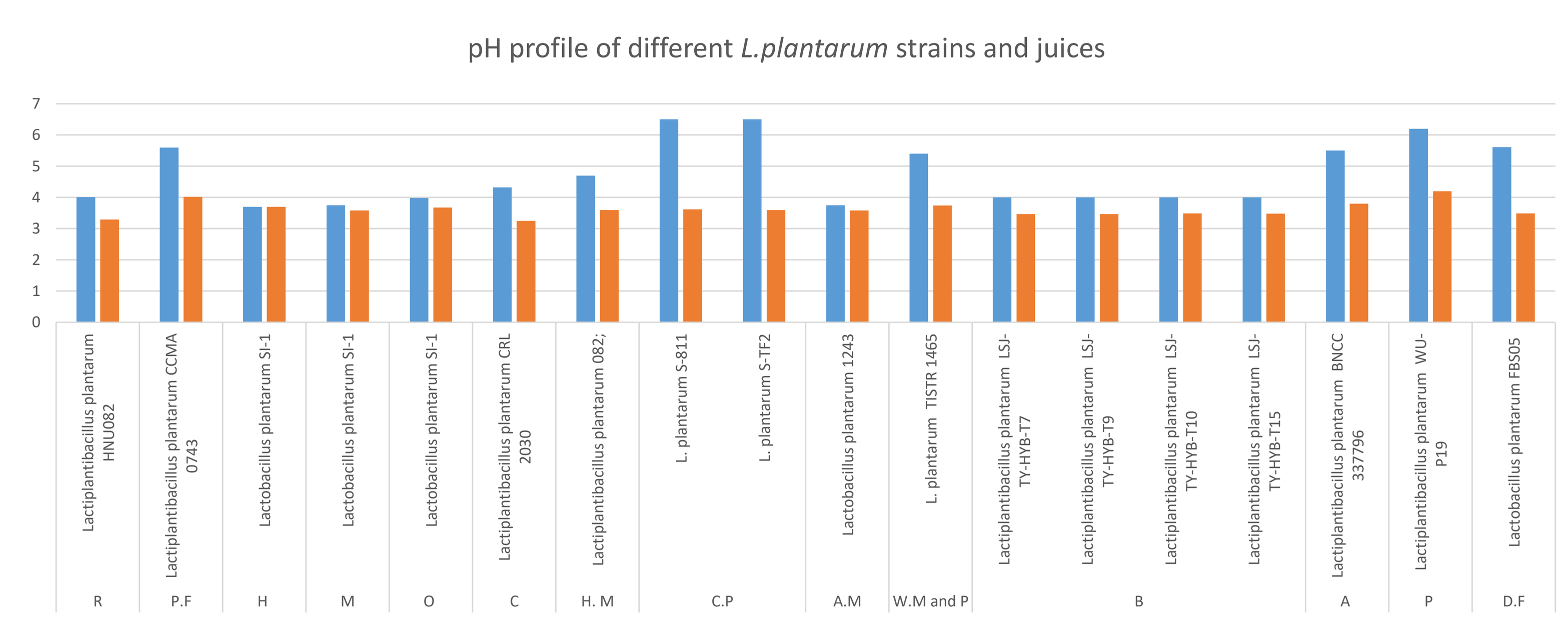
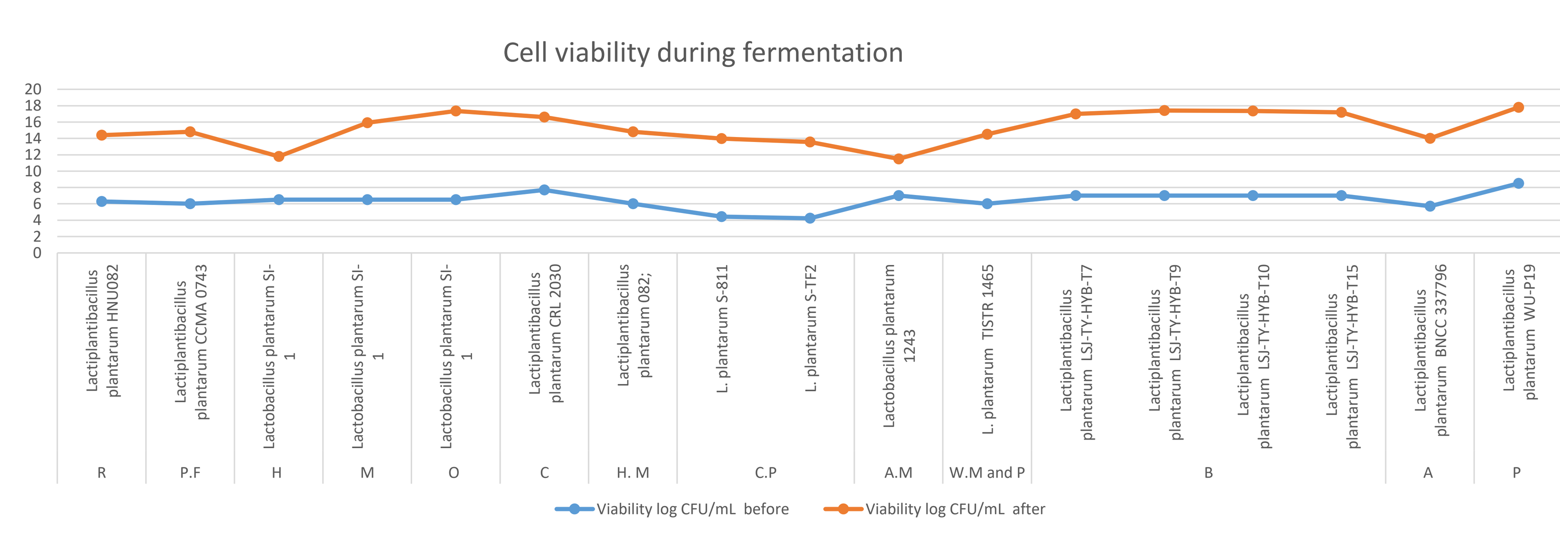


Figure 1. pH variation before and after the fermentation. R- rambutan, P.F- passion fruit, H- haruka, M- mandarin, O- orange, C- cherimoya, H.M- *H. megalanthus,* C.P- cactus pear, A.M- *Aronia melanocarpa,* W.M and P- winter melon and pineapple, B- blueberry, A- apple, P- pineapple, D.F- draon fruit.



• **Figure 2.** Pre- and Post-Fermentation Viability. R- rambutan, P.F- passion fruit, H- haruka, M- mandarin, O- orange, C- cherimoya, H.M- H. megalanthus, C.P- cactus pear, A.M- Aronia melanocarpa, W.M and P- winter melon and pineapple, B- blueberry, A- apple, P- pineapple, D.F- draon fruit.

• Conclusions

The best matrix–strain combinations in terms of probiotic viability were orange juice fermented with Lactobacillus plantarum SI-1 and blueberry juice fermented with Lactiplantibacillus plantarum LSJ-TY-HYB strains, while the highest lactic acid production was recorded in orange and mandarin juices fermented with L. plantarum SI-1. From a sensory perspective, fermented pineapple juice appeared to be the most promising matrix, showing higher consumer acceptability compared to the non-fermented juice, likely due to the improvement of its aromatic profile during lactic fermentation.