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Lactic acid fermentation of papaya and mint: physicochemical parameters and bioactive compounds

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INTRODUCTION & AIM

Fermentation has been used for centuries to produce traditional foods and beverages, offering benefits like extended shelf-life, improved nutritional value, and enhanced flavor. Lactic acid fermentation, commonly driven by lactic acid bacteria (LAB), is widely applied to fruits and vegetables, yielding metabolites that promote health (Ayivi et al., 2020). Papaya *(Carica Papaya)*, a tropical fruit rich in vitamins, minerals, and bioactive compounds, has shown potential as a functional food ingredient (Saeed et al., 2014; Pandey et al., 2016). Alongside, mint *(Mentha piperita)*, known for its phenolic compounds and unique flavor, is a popular ingredient in food and beverages (Salehi et al., 2018). Both are highly perishable, and their combination in fermented smoothies could meet growing consumer demand for healthy, flavorful products, while reducing food waste (Dahiya & Nigam, 2022). Despite their nutritional benefits, few studies have explored the lactic acid fermentation of papaya and mint in smoothie form. This study investigated the development of functional smoothies through lactic acid fermentation, and its effects on physicochemical and bioactive properties.

The aim of this study is to evaluate the effectiveness of lactic acid fermentation using *Lactobacillus plantarum* and *Bifidobacterium bifidum* in developing a functional papaya-mint smoothies.

METHOD

Preparation of fermentation smoothies

Fresh mint and papaya were sourced from Brisbane supermarkets, washed, pureed, pasteurized (80°C, 10min) and fermented by 1% w/w of *Lactobacillus plantarum* and *Bifidobacterium bifidum* strains at 37°C for 48 h. The treatments included control (uninoculated papaya), uninoculated mint-papaya, *L. plantarum-papaya* (PL), *B. bifidum-papaya* (PB), *L. plantarum-mint-papaya* (PML), and *B. bifidum-mint-papaya* (PMB).

Samples were analyzed for pH, Total Soluble Solid (TSS), viable colony counts (MRS agar, 30°C, 48 h), and color parameters. Bioactive compounds were extracted, and total phenolic content (TPC) and antioxidant capacities were determined.

Fig 1. Fermentation process of papaya-mint smoothies at different time intervals

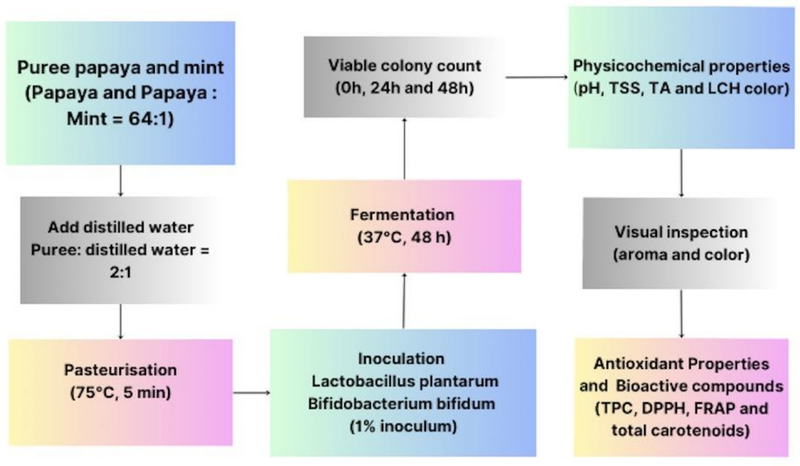

Fig 2. Overview of the fermentation process of papaya and papaya-mint smoothies

RESULTS & DISCUSSION

- **pH value and Titratable Acidity (TA)**

Fermentation led to a significant decrease in pH, with both *L. plantarum* and *B. bifidum* reducing the pH of papaya and papaya-mint smoothies to below 3.5 after 48 h. The titratable acidity (TA) also increased, indicating lactic acid production, with the highest TA observed in papaya-mint smoothies fermented by *L. plantarum* (0.799%). This demonstrates the ability of lactic acid fermentation to improve acidity, which enhances preservation and flavor.

- **Total Soluble Solids (TSS)**

TSS slightly decreased over the fermentation period due to sugar consumption by LAB. The reduction in TSS (from ~6°Bx to ~5.6°Bx) indicates fermentation's potential to reduce the sugar content of smoothies, making them more suitable for low-sugar diets.

- **Viable Colony Counts**

LAB counts reached 10^8 CFU/mL within 24 h, stabilizing by 48 h. This indicates rapid bacterial growth and confirms the potential probiotic benefits of the smoothies.

- **Antioxidant Properties**

Total phenolic content (TPC) and DPPH activity were largely maintained during fermentation, with minor reductions in the control group. B. bifidum enhanced DPPH antioxidant activity in papaya-mint smoothies. The FRAP assay also showed better antioxidant retention in fermented samples compared to controls.

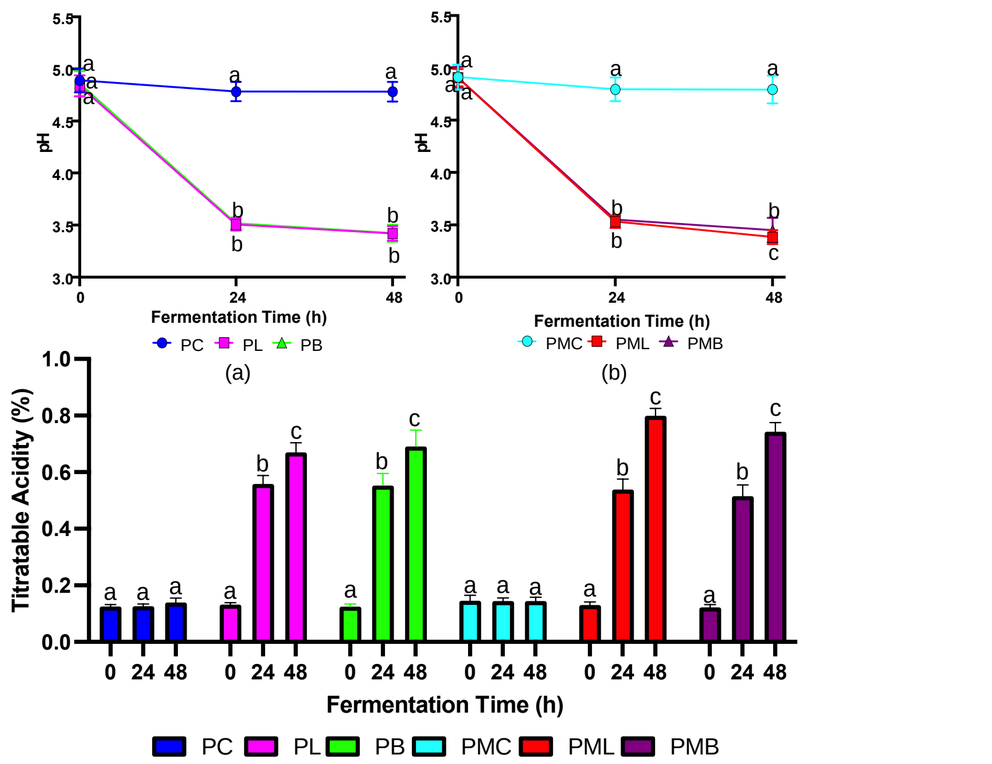

Fig. 3. Evolution of pH value and titratable acidity (%) in papaya smoothies and papaya-mint smoothies during 48 h fermentation at 37 ℃. Error bars indicate the standard deviation of three replicates. Different small letters for each time-point represent significant difference (p<0.05). PC, papaya-control; PL, papaya-*L. plantarum*; PB, papaya-*B. bifidum*; PMC, papaya-mint-control; PML, papaya-mint-*L. plantarum*; PMB, papaya-mint-*B. bifidum*.

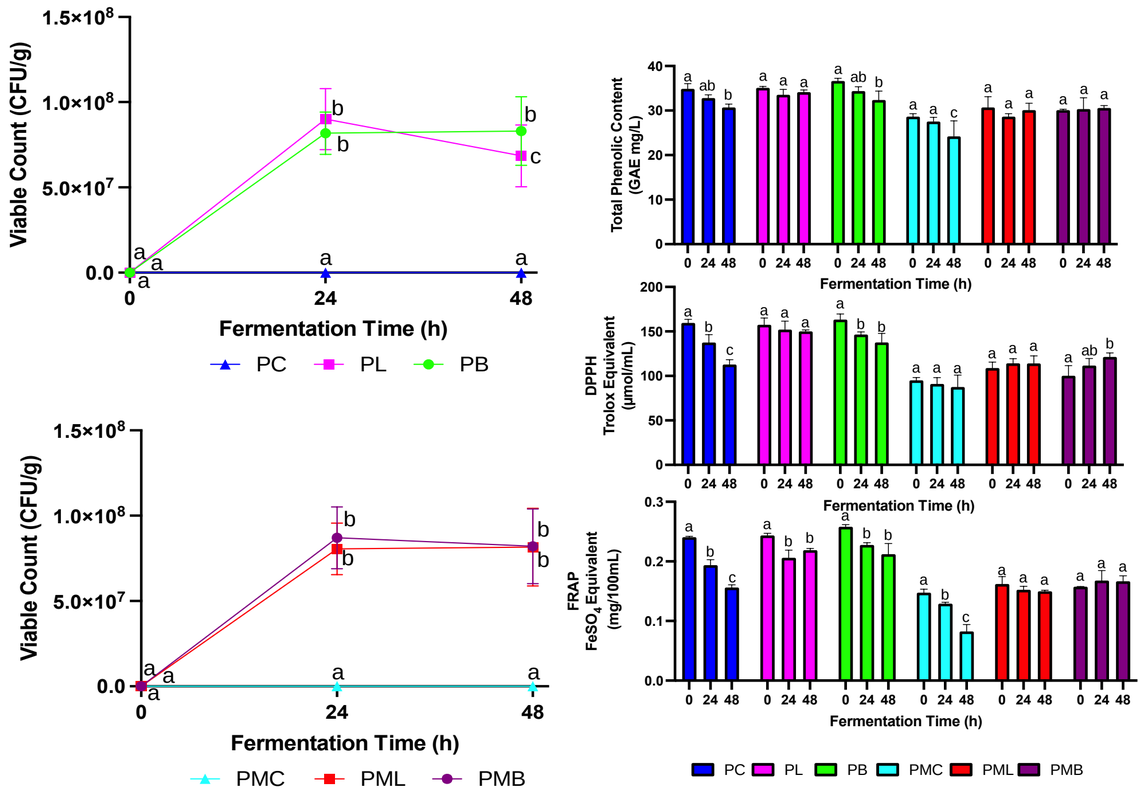

Fig. 4. Evolution of Evolution of viable count (CFU/g), total phenolic content (GAE mg/mL), ferric reducing ability of plasma (FRAP) (mM) and 2,2-Diphenyl-1-picrylhydrazylin test (DPPH) (μmol/mL) in papaya smoothies and papaya-mint smoothies during 48 h fermentation at 37 ℃. Error bars indicate the standard deviation of three replicates. Different small letters for each time-point represent significant difference (p<0.05). PC, papaya-control; PL, papaya-*L. plantarum*; PB, papaya-*B. bifidum*; PMC, papaya-mint-control; PML, papaya-mint-*L. plantarum*; PMB, papaya-mint-*B. bifidum*.

CONCLUSION & FUTURE WORK

This study successfully fermented papaya and papaya-mint smoothies using *L. plantarum* and *B. bifidum*. Key findings include:

- Significant reductions in pH (p<0.05) as well as increase in TA was observed during fermentation. Furthermore, antioxidant properties were maintained during fermentation.
- Extending fermentation to 48h further reduced sugar content without significantly affecting antioxidant activity.
- Antioxidant properties were better maintained during 48 h fermentation by *L. plantarum.*

Future remarks:

- Explore additional LAB strains *L. acidophilus* and *Streptococcus thermophilus*, or a combination of LAB, to enhance fermentation outcomes.
- Comprehensive Sensory study is needed to assess taste, aroma, and overall acceptance, which is essential for optimizing fermentation process and market potential.

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