Inoculated fermentation of immature-tomato with potential probiotic *Lactiplantibacillus plantarum* and *Weissella parameseteroides* starter cultures

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Introduction

In the tomato industry, high quantities of unripe tomato (green tomato) are discarded, per year, at field level (on average 9 tons/ha but can reach 25 tons/ha) [1]. The lactic fermentation of green tomatoes to produce a food ingredient is a viable alternative to add value to these non-used fruits. Using starter cultures of selected lactic acid bacteria (LAB) instead of natural fermentation (spontaneous fermentation) gives greater assurance to obtain fermented products with better sensory acceptance and potentially probiotic characteristics [2]. This strategy meets customers' demand for products that provide health benefits beyond their nutritional value and adds value to these fruits to support circular economy-oriented innovation [3,4].

Objective

The aims of this study were:

- Assessment of the use of two lactic acid bacteria – C244 and C1090 (*Lactiplantibacillus plantarum* and *Weissella parameseteroides*, respectively) with *in vitro* probiotic potential, as starter cultures on green tomato fermentation.
- Assessment of NaCl effect on the fermentation of green tomato.

Material & Methods

- **All samples were set up in triplicates: control samples (non-inoculated; Id: Sp) and inoculated samples (Id: C244 and C1090). The samples were tested throughout 14 days (at 0, 24, 48, 72 h, 7 and 14 days) for the following parameters:**
  - pH, titratable acidity (TA, g lactic acid/100 g FW), and solids soluble content (SSC, ºBrix);
  - LAB count (log_{10} CFU/mL);
  - Total phenolic content by Folin-Ciocalteu method (TPC, mg GAE/100 g FW);
  - Antioxidant activity by DPPH method (AOx, µmol TE/100 g FW);
  - Sensory evaluation (aspect, consistency, colour, aroma and global appreciation) at 14th day;
  - Variance analysis (ANOVA) and Tukey's HSD test were applied using the Statistica™ v.8 software.

Results & Discussion

Figure 1 (A and B) shows LAB counts of all samples (Sp, C244 and C1090) without and with NaCl addition, respectively, for 14 days. LAB growth was not affected by the salt content. Both tested LAB strains – C244 and C1090 – were able to grow on green tomato, with no significant differences.

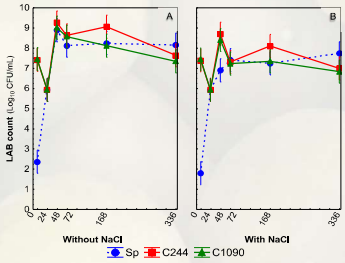

Fig. 1 | LAB counts (log_{10} CFU/mL) of spontaneous fermentation (Sp) and controlled fermentation with two single starter cultures (C244 and C1090) of green tomato without (A) and with (B) NaCl for 14 days.

Figure 2 (A and B) shows pH values of all samples (Sp, C244 and C1090) without and with NaCl addition, respectively, for 14 days. Evolution patterns of pH (as well as TA and SSC; data not shown) did not significantly change during storage nor depending on salt addition. The green tomato pulp fermented by LAB strains showed faster acidification of the medium than spontaneous fermentation.

The evolution patterns of the samples' TPC and AOx during the tested period were also not affected by salt content (data not shown). Its final values remained without significant differences from the initial ones (from *ca.* 37,8 to *ca.* 35,0 mg GAE/100 g FW and *ca.* 1222,2 to *ca.* 1270,3 µmol TE/100 g FW, respectively).

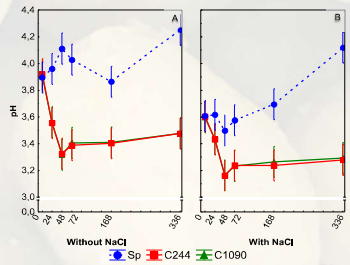

Fig. 2 | pH evolution patterns of green tomato's spontaneous fermentation (Sp) and controlled fermentation with two single starter cultures (C244 and C1090) without (A) and with (B) NaCl for 14 days.

Figure 3 (A and B) shows the sensorial evaluation of aspect, consistency, colour, aroma and global appreciation of all samples (Sp, C244 and C1090) without and with NaCl addition, respectively, after 14 days of storage. The inoculated pulps exhibited more appealing sensory attributes than non-inoculated pulps (particularly aroma) which resulted in its better acceptance.

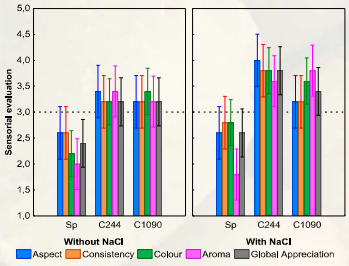

Fig. 3 | Sensorial evaluation of green tomato's spontaneous fermentation (Sp) and controlled fermentation with two single starter cultures (C244 and C1090) without (A) and with (B) NaCl after 14-days storage.

Conclusions

- The addition of salt did not affect the fermentation efficiency. The use of strains C244 and C1090 as culture starters in green tomato fermentation proved to speed up the fermentation process and develop fermented products with higher sensory acceptance (mainly at the high aroma level).
- This approach could be valuable for promoting the development of a food ingredient based on the lactic acid fermentation of green tomatoes, considering the probiotic potential of the strains used.

References: **[1]** Santos, R. et al. (2019) "Development of a fermented green tomato base for dressings and sauces with high nutritional value", *Acta Horticulturae*, 1233, pp. 239–246. doi: 10.17660/ActaHortic.2019.1233.33. **[2]** Sabater, C. et al. (2020) "Valorization of Vegetable Food Waste and By-Products Through Fermentation Processes", *Frontiers in Microbiology*, 11(581997), pp. 1–11. doi: 10.3389/fmicb.2020.581997. **[3]** Soccol, C. R. et al. (2010) "The potential of probiotics: A review", *Food Technology and Biotechnology*, 48(4), pp. 413–434. **[4]** Pintado, M. E. e Teixeira, J. A. (2015) "Valorização de subprodutos da indústria alimentar: obtenção de ingredientes de valor acrescentado", *Boletim da Sociedade Portuguesa de Biotecnologia*.

Funding: This work was supported through national funds and where applicable co-financed by the FEDER, within the PT2020 Partnership Agreement, and PDR2020-101-031499 GreenTaste