



Evaluation of Natural Ingredients as Nitrite Replacers: A Case Study on Pork Ham

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INTRODUCTION

Different ingredients can be included in the formulation of processed meat products being commonly used meat, fat, flour, salt, nitrite, phosphate, ice, and various spices. The type, quantity, and quality of these components can impact human health both positively and negatively [1]. The main reasons to use nitrites are to improve the colour providing a bright red appearance; to prevent the grow of microorganisms like *Clostridium botulinum*; to give the characteristic texture and aroma of cured meats; and to prevent the oxidation of lipids preventing rancidity [1,2]. Besides their advantages, nitrites can produce compounds like nitrosamines which are associated with carcinogen risks to consumers [1]. This way, the European Union has established revised limits for the use of nitrites (E249 and E250) as food additives. Consequently, companies are looking to new technologies and/or natural ingredients (eg., herbal extracts, essential oils and encapsulated antimicrobial compounds) to replace nitrites or to reduce their concentration in processed meat products [1,2]. In this context, the main goal of the present project was to evaluate the effectiveness of different commercial solutions in pork ham.

METHODS

1ST STEP – IN VITRO TESTS

Commercial Blend 1 (B1)

Vinegar powder, rosemary extract, acerola juice powder, radish and beet juice powders.

Commercial Blend 2 (B2)

Natural flavour, salt, dextrose, ascorbic acid and sunflower oil.

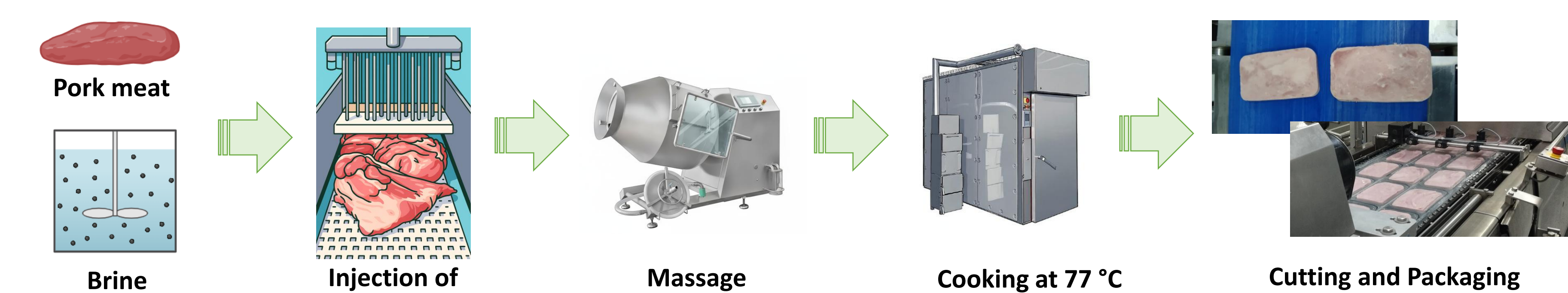
Commercial Blend 3 (B3)

Green tea, rosemary extracts, buffered vinegar and red radish extract.

CODE	SPECIES
LAB 1	<i>Lactobacillus sakei</i>
LAB 2	<i>Lactobacillus sakei</i>
LAB 3	<i>Lactobacillus sakei</i>
LAB 4	<i>Enterococcus hermanniensis</i>
LAB 5	<i>Enterococcus hermanniensis</i>
LAB 6	<i>Lactococcus garvieae</i>
LAB 7	<i>Lactococcus garvieae</i>
LAB 8	<i>Lactobacillus sakei</i>
LAB 9	<i>Lactobacillus sakei</i>
LAB 10	<i>Lactobacillus sakei</i>
LAB 11	<i>Lactobacillus sakei</i>
LAB 12	<i>Lactobacillus sakei</i>
LAB 13	<i>Lactobacillus sakei</i>
LAB 14	<i>Lactobacillus sakei</i>
LAB 15	<i>Lactobacillus sakei</i>
LAB 16	<i>Enterococcus hermanniensis</i>
LAB 17	<i>Enterococcus hermanniensis</i>

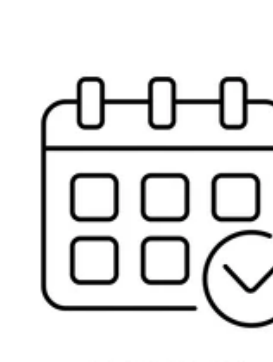
2ND STEP – TESTS IN PRODUCT

1. Ham Development



2. Ham Characterization

Texture profile (TPA) and mechanical properties
TA,HD Plus with P/75 probe and Film Support Rig (HDP/FSR), Stable Micro Systems



Shelf-Life Evaluation

Escherichia coli, *Staphylococcus aureus*, *Salmonella*, *Staphylococcus coagulase*, *Listeria monocytogenese*, *Clostridium perfringens*, *Clostridium botulinum*, total viable microorganisms at 30°C and lactic acid bacteria.

Technological assessment

Water activity meter Novasina – LabMASTER and pH meter Consort - C1010

RESULTS

IN VITRO TESTS

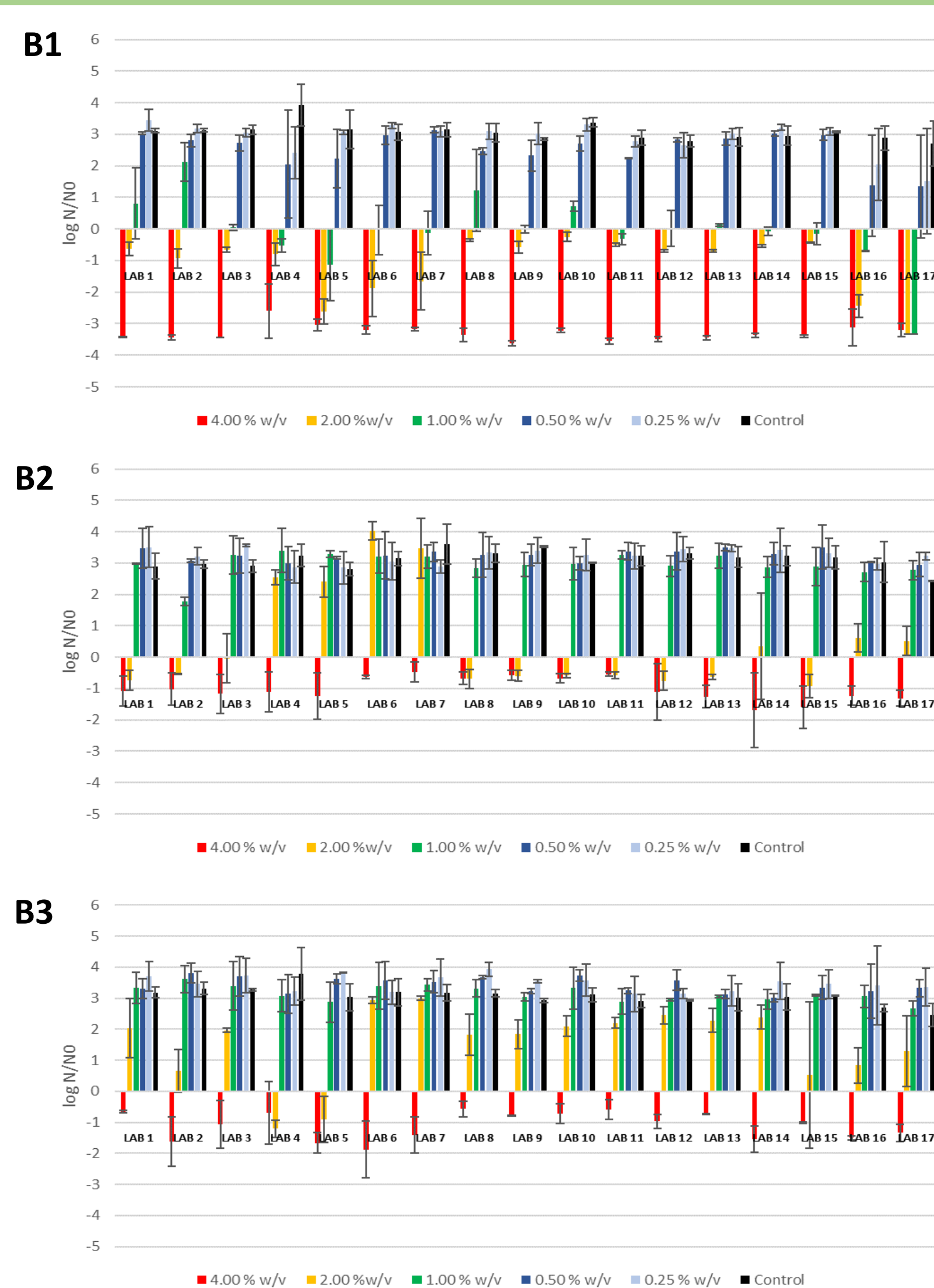


Figure 1. In vitro results for the commercial blend 1 (B1), commercial blend 2 (B2) and commercial blend 3 (B3).

TESTS IN PRODUCT

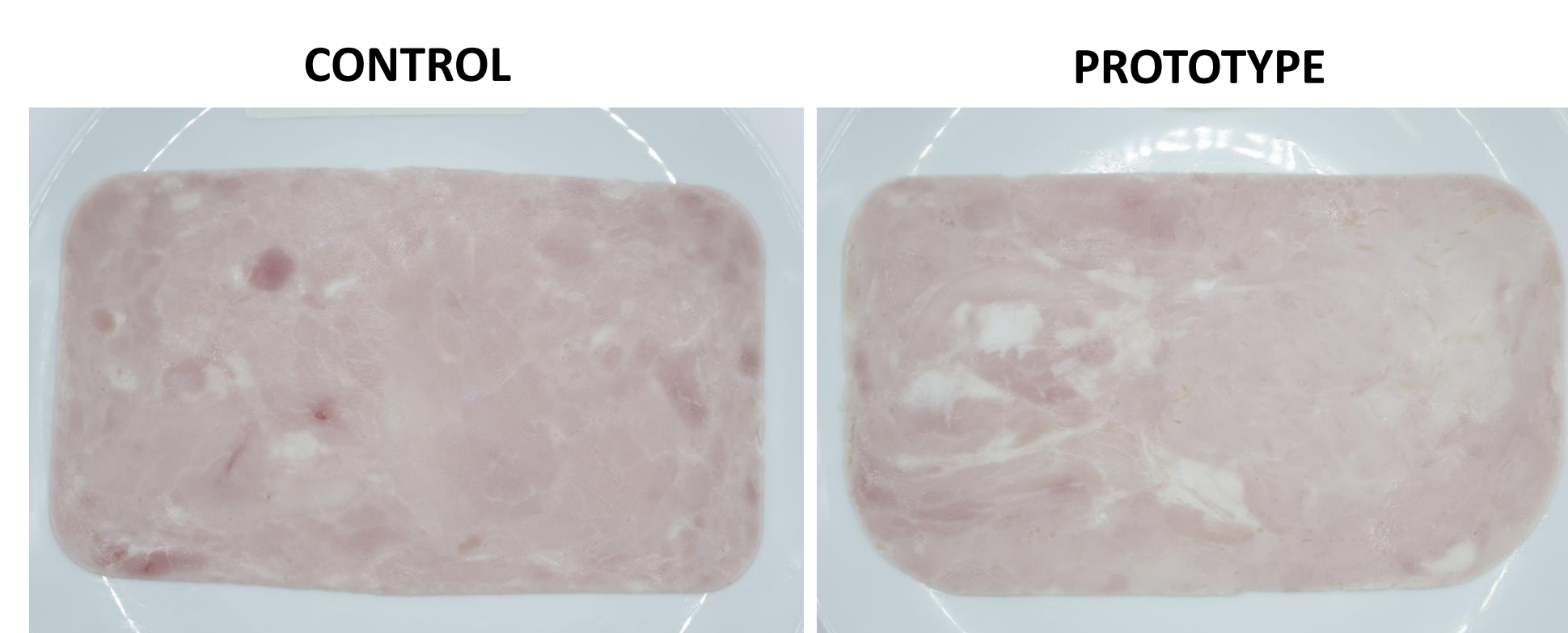


Figure 2. Representative photographs of control ham (with nitrites) and experimental prototype developed without nitrites and with Commercial Blend 2.

Table 1. Texture profile (TPA) of control ham and experimental prototype developed without nitrites using Commercial Blend 2.

	CONTROL	PROTOTYPE
HARDNESS (N)	275.93 (± 14.55)	235.30 (± 37,48)
FRACTURABILITY (N)	211.87 (± 17.00)	174.12 (± 22.76)
ADHESIVENESS (N X S)	-0.132 (± 0.067)	-0.211 (± 0.437)
CHEWINESS (N)	45.98 (± 7.28)	35.27 (± 10.30)
COHESIVENESS	0.249 (± 0.027)	0.219 (± 0.025)
SPRINGNESS (M)	0.786 (± 0.017)	0.674 (± 0.088)
GUMMINESS (N)	68.92 (± 6.63)	51.68 (±10.96)
RESILIANCE	0.076 (± 0.008)	0.069 (± 0.006)

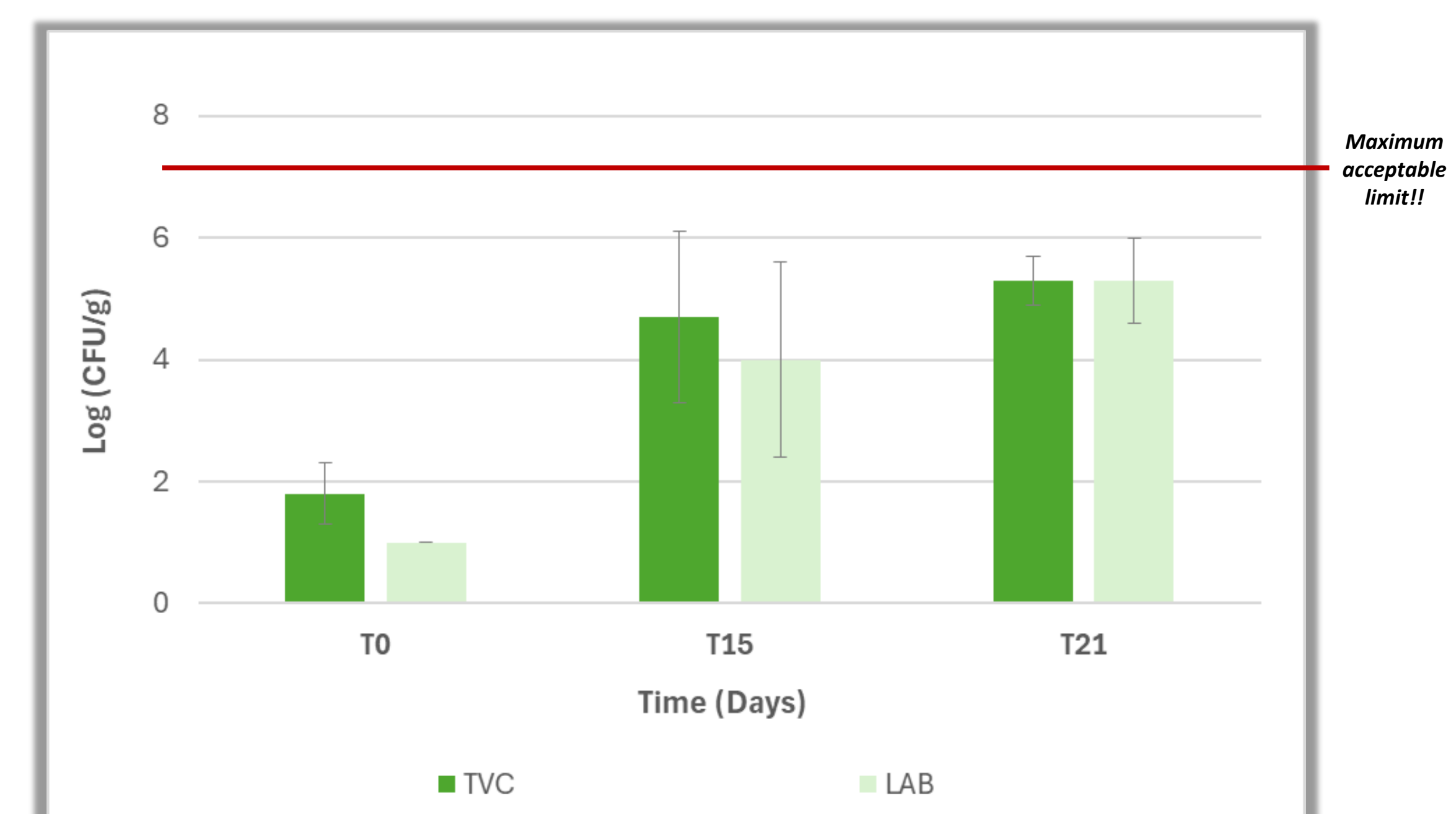


Figure 3. Results for Total Viable Counts (TVC) and Lactic Acid Bacteria (LAB) expressed as Log (CFU/g) during the sliced experimental prototype shelf-life (still ongoing).

✓ *Escherichia coli*, *Staphylococcus aureus*, *Salmonella*, *Staphylococcus coagulase*, *Listeria monocytogenese*, *Clostridium perfringens*, spores of sulfite-reducing *Clostridium* species: NOT DETECTED.

Table 2. Technological assessment of sliced experimental prototype throughout its shelf life (still ongoing).

	pH	aw
Day 0	6.1 (± 0.18)	0.94 (± 0.005)
Day 14	6.03 (± 0.03)	0,93 (± 0.002)
Day 21	6,07 (± 0.03)	0,94 (± 0.003)

CONCLUSION

- In terms of appearance, colour, and flavour, the experimental prototype showed no significant differences compared with the control.
- Up to 21 days of storage, the experimental prototype remained within acceptable quality limits (shelf-life of the sliced control is, normally, 35 days). However, shelf-life monitoring is ongoing;
- Although analyses are still in progress, preliminary results indicate that Blend 2 can be a promising alternative to replace nitrite in cooked pork ham.

REFERENCES

- [1] Toupchi, F. M., Pirs, S., Mohammadi, S. (2025) Hydrogel (pectin, oleogel oil/triglyceride) and bigel (alginate-oil/triglyceride) and their applications in meat products formulation, *Carbohydrate Polymer Technologies and Applications*, 9, Article 100715, <https://doi.org/10.1016/j.carpta.2025.100715>.
[2] Shakil, M.H., Trisha, A.T., Rahman, M., Talukdar, S., Kobun, R., Huda, N., Zaman, W. (2022) Nitrites in Cured Meats, Health Risk Issues, Alternatives to Nitrites: A Review. *Foods*, 11, Article 3355. <https://doi.org/10.3390/foods11213355>.