From challenge testing to predictive modelling: maintaining relevant food safety models for Listeria monocytogenes in meat products

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Introduction

DMRI Predict is an online toolbox of predictive models for food safety assessment of meat and meat products, including a growth model for Listeria monocytogenes [1]. For many years, DMRI Predict has supported quality managers, researchers and food authorities, and selected DMRI models for ready-to-eat products are also referenced by USDA FSIS [2]. Current work on the L. monocytogenes model focuses on keeping the tool relevant for present-day products and production conditions specifically:

1.verify that the existing model framework remains representative when the original strain cocktail is challenged against newer strains originating from food, food-chain, industry and outbreak settings

2.expanding the model to cover a broader formulation space, including higher-pH products and hybrid meat products containing vegetables, which includes the verification of similar growth rates in meat sausage vs. hybrid sausage.

Methodology

Test 1

Verifying the original L. monocytogenes cocktail against a new cocktail, which include recent outbreak strains, was conducted with data generated in 29 challenge tests (Table 1).

Table 1. The two L. monocytogenes cocktails (original and new) were tested in 29 different meat product setups covering variations in moisture contents, pH, and the concentrations of added preservatives: salt, nitrite, lactic acid, and acetic acid. Storage temperature between 2-12 °C, packed in MAP (30% CO_2/ 70% N_2).

	Moisture (% w/w)	Salt (% w/w)	Nitrite (ppm)	Lactic acid (% w/w)	Acetic acid (% w/w)	pH
Min.	65.6	1.4	0	0.35	0.00	5.2
Max.	68.6	3.8	150	2.7	0.34	6.9

Test 2

Expanding the pH-range of the original L. monocytogenes model for the inclusion of hybrid products was conducted in series of challenge tests using Bologna type sausage (40% pork and fat; 4-9% plant proteins (soy and pea), and 21-30% vegetables sweet potato, onion, carrot, parsnip). Test parameters are shown in Table 2.

Table 2. Range of pH, storage temperature and concentrations of added preservatives used in the challenge tests for the expansion of the L. monocytogenes model.

Test variables	
pH	6.3 -7.1
Na-lactate (%)	0, 1.2, 2.0, 3.0
Na-acetate (%)	0, 0.2, 0.4
Na-nitrite (ppm)	0, 60, 150
Salt/water (%)	2.7 - 5.2
Storage temperature (°C)	5, 8, 10, 12

Results of test 1

Verifying the original L. monocytogenes cocktail against a new cocktail. The growth data of the two L. monocytogenes cocktails were compared, and there was no statistically significant difference detected, which means that the original model can predict the growth of newer outbreak strains (figure 1).

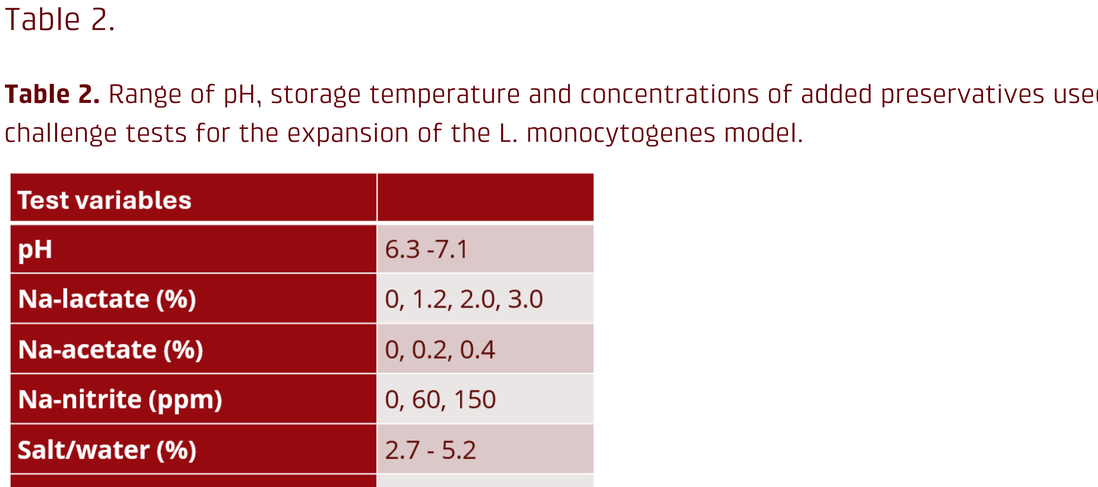

Figure 1. The maximum growth rate of the new L. monocytogenes cocktail vs. the original.

Conclusion

Verification of the original L. monocytogenes strain cocktail with a new five-strain cocktail showed that the practical variation range established by the original framework supports continued use of the L. monocytogenes model on DMRI Predict for food safety predictions. Expanding the pH range of the L. monocytogenes model ensures that the model can be used for the predictions of growth in hybrid meat products.

What´s next on DMRI Predict

- Expanding the L. monocytogenes model further to 90 days of storage.
- Expanding the ConFerm model predicting L. monocytogenes, Salmonella, and ST E. coli in fermented sausages to include low salt concentrations.
- New Bacillus cereus model (launch late 2026 / early 2027).
- Validating Clostridium botulinum model focusing on toxin production (work finalised in 2028).

Results of test 2

In the work with expanding the model to cover hybrid sausages it was seen that growth of L. monocytogenes in meat sausages is comparable to growth in hybrid meat sausages (all factors kept equal). The only factor to expand in the model was pH, as hybrid sausages can have higher pH compared to traditional sausages (figure 2).

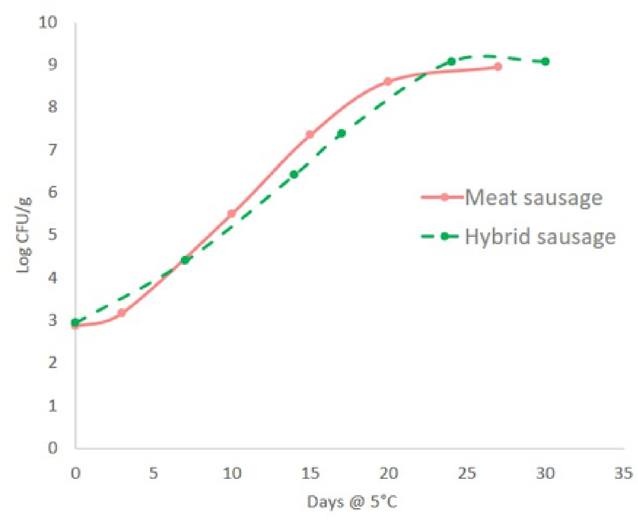

Figure 2. Growth of original L. monocytogenes cocktail in Bologna type sausages (meat vs. hybrid) at 3% salt/water and pH 6.7 during storage at 5°C (MAP 30% CO_2/ 70% N_2).

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References

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