

Meta-regression models describing the effects of essential oils and added lactic acid bacteria on *L. monocytogenes* inactivation in cheese

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Cofinanciado por:



MOTIVATION

- *L. monocytogenes* (LM) has been described as a prevalent foodborne pathogen in goat (12.8%) and sheep (3.61%) milk cheeses (Gonzales-Barron et al., 2017)
- Soft and semi-soft cheeses sampled at retail: level of LM contamination up to 5% (EFSA report 2017)
- In faulty fermentations, pathogens can survive and even grow during the brining and ripening stages





MOTIVATION

- **Biopreservatives** have been proposed as **hurdles** to increase microbiological safety and stability of cheeses:
 - ✓ plant-based antimicrobials (essential oils, plant extracts)
 - ✓ bacteriocinogenic starter cultures
- **Meta-regression models** can be used to understand LM growth, allowing optimisation of hurdles that provide long term stability and safety to cheeses



OBJECTIVES

 To summarise the effectiveness of (i) **lactic acid bacteria (LAB)** and
(ii) **essential oils (EO)** on *L. monocytogenes* inactivation in cheese

 To evaluate other affecting factors and possible interactions



META-REGRESSION MODELS

METHODOLOGY



LAB meta-regression model

24 studies, N = 429

Mixed-effects linear models with weights

- Exposure time as nested fixed effects in application type

EO meta-regression model

23 studies, N = 754

Mixed-effects linear models with weights

- Exposure time and antimicrobial concentration as nested fixed effects in application type

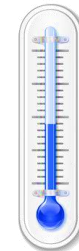
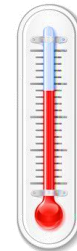
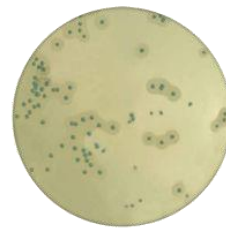
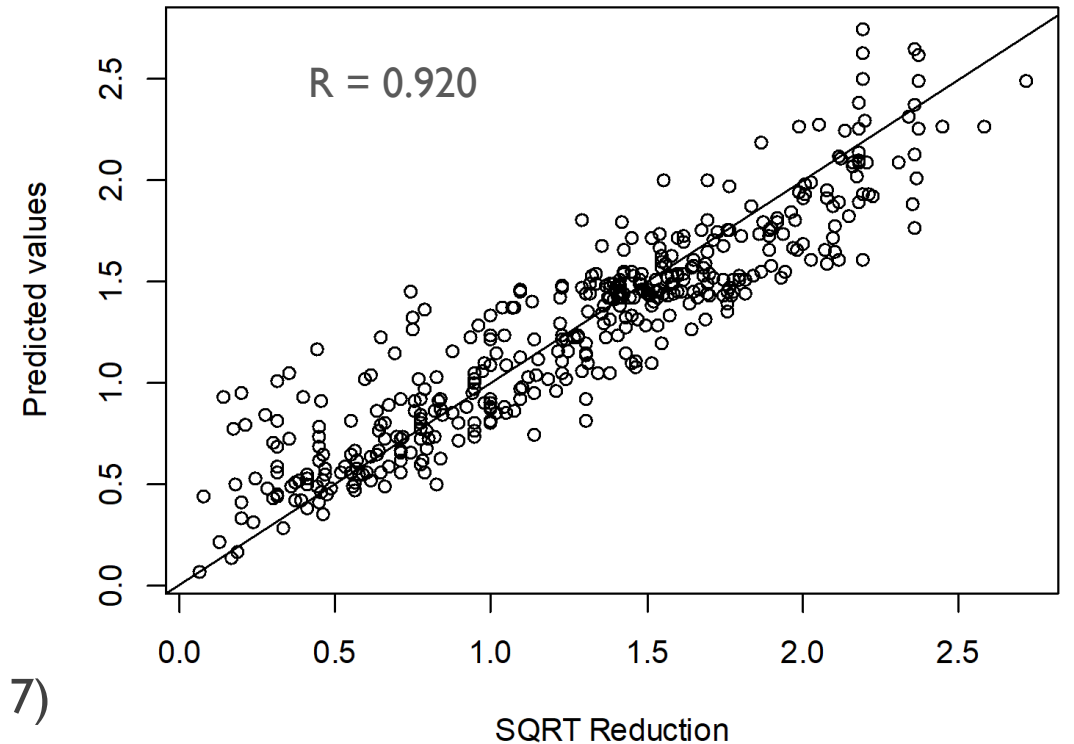
RESULTS

(i) LAB meta-regression model

■ Significant impact on LM inactivation in cheese:

- ✓ application type ($p < .0001$)
- ✓ pathogen inoculum level ($p = 0.0007$)
- ✓ storage temperature ($p = 0.001$)
- ✓ application type / exposure time ($p < .0001$)

~~✗~~ LAB concentration showed no significant effect ($p = 0.317$)



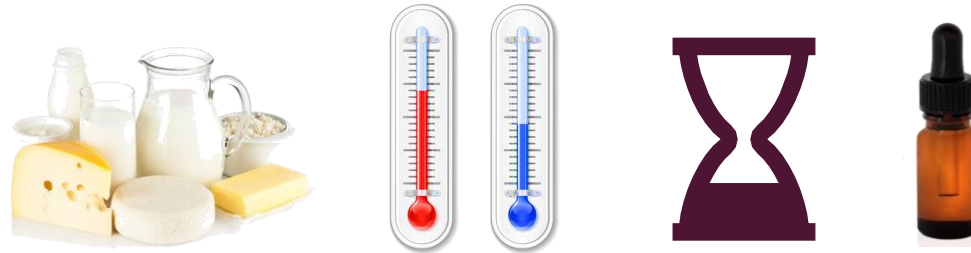
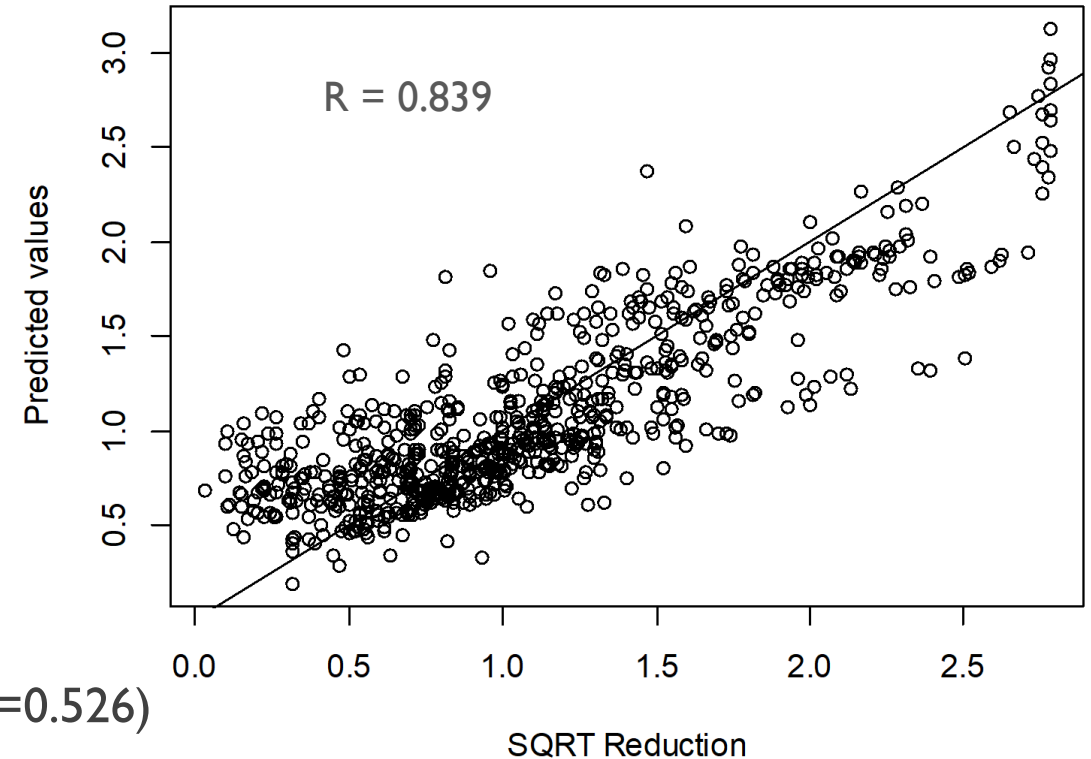
RESULTS

(i) EO meta-regression model

■ Significant impact on LM inactivation in cheese:

- ✓ application type ($p < .0001$)
- ✓ storage temperature ($p = 0.001$)
- ✓ application type / exposure time ($p < .0001$)
- ✓ application type / concentration applied ($p < .0001$)

✗ Pathogen inoculum level showed no significant effect ($p = 0.526$)



RESULTS

EO	N	RE
Black cumin seed	35	-0.652
Zataria multiflora boiss.	56	-0.406
Pink pepper	38	-0.391
Thyme	124	-0.196
Sage	12	-0.143
Rosemary	16	-0.141
Lemon balm	12	-0.105
Pennyroyal	24	-0.041
Basil	36	-0.036
Hogweed	15	-0.029
Tarragon	24	-0.015
Clove	68	0.028
Oregano	85	0.050
Mint	83	0.147
Salvia	34	0.471
Cinnamon	47	0.595
Bay	45	0.862



CONCLUSIONS

- Meta-analytical regression models were built, summarising the effects of LAB and EO on LM log reduction
- Antimicrobials' effectiveness depends on storage temperature, exposure time, [EO], application type
 - for the same exposure time, application in milk or surface cause greater log reduction (LAB model)
 - for the same exposure time, application in cheese causes greater log reduction; application in milk causes the lowest log reduction (EO model)
- Insight on the most effective EO for LM control in (soft) cheeses



Through **meta-regression modelling** it is possible to optimise manufacturing processes and the use of hurdles

→ ensure microbial stability and safety of cheeses ←

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