Modelling the growth of *Listeria monocytogenes*: what we have learned from the ListeriaPredict Project

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Application of novel predictive microbiology techniques to shelf-life studies on *Listeria monocytogenes* in ready-to-eat foods

The Consortium

- University College Dublin (UCD) (Coordinator)
- Instituto Politecnico de Braganca (IPB)
- Istituto Zooprofilattico Sperimentale dell'Abruzzo e del Molise "G. Caporale" (IZSAM)
- University of Cordoba (UCO)

Objective

- Enhance capacity across Europe in applying predictive microbiology techniques to shelf-life studies on *Listeria monocytogenes* in ready-to-eat foods

Background

- Recently several guidance documents have emerged relating to the conduct of challenge studies relating to *Listeria monocytogenes* in RTE foods
- The EC/DG SANCO document, entitled “Guidance document on *Listeria monocytogenes* shelf-life studies for ready-to-eat foods, under Regulation (EC) No. 2073/2005 of 15 November 2005 on microbiological criteria for foodstuffs
- EURL Lm Technical Guidance Document for conducting shelf-life studies on *Listeria monocytogenes* in ready-to-eat foods (amended 2019)
- ISO 20976-1 “Microbiology of the food chain — Requirements and guidelines for conducting challenge tests of food and feed products

Role of predictive microbiology

- To compliment recent developments in detailed and practical information on how to conduct shelf-life studies on Listeria monocytogenes in ready-to-eat foods to ensure food safety with advanced predictive microbiology techniques to best leverage the amount of information gathered from shelf-life studies

Work Programme

- Work Package One: Knowledge transfer activities
- Work Package Two: Knowledge exchange activities
  - The project is a combination of knowledge transfer between “knowledge provider” and “knowledge recipient” organisations and knowledge exchange between “knowledge sharing” organisations through developing additional risk assessment capacity

Knowledge Exchange activities

Evaluation of *Listeria monocytogenes* growth, stored at two different dynamic temperature conditions, for 14 days and comparison of results with predictive models

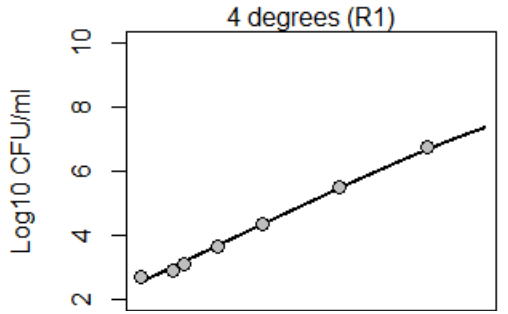
Isothermal growth experiments (primary)

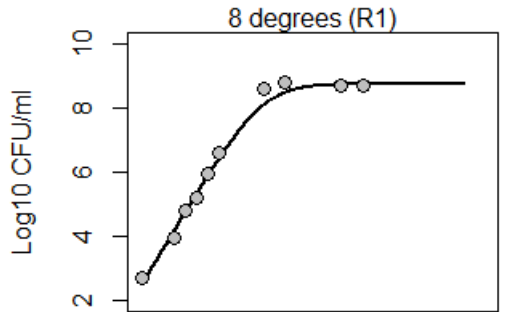
- One cheese-related strain, Lm 118M, grown in beef broth
- Three temperatures: 4°C, 8°C and 12°C
- Curves fit using model from Huang (2013)

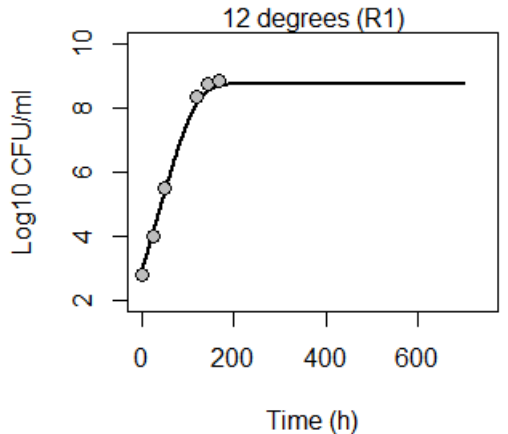
$$Y = Y_0 + Y_{max} - \ln\left\{e^{Y_0} + \left[e^{Y_{max}} - e^{Y_0}\right]e^{-\mu_{max}B(t)}\right\} \quad (1)$$

$$B(t) = t + \frac{1}{\alpha}\ln\frac{1 + e^{-\alpha(t-\lambda)}}{1 + e^{\alpha\lambda}} \quad (2)$$

Huang, L., 2013. Optimization of a new mathematical model for bacterial growth. Food Control 32, 283–288. https://doi.org/10.1016/j.foodcont.2012.11.019





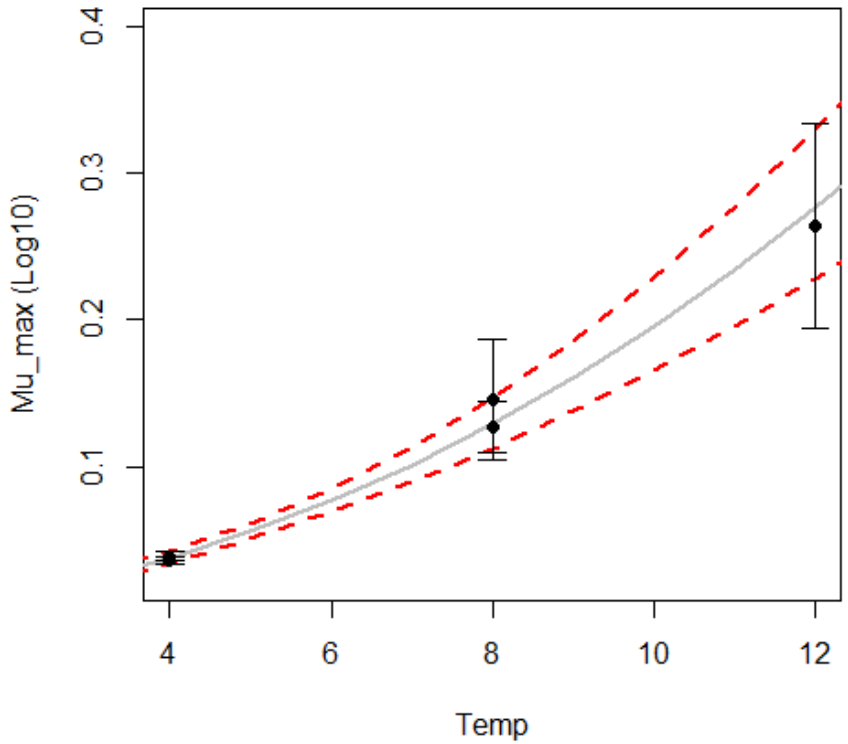


Isothermal growth experiments (secondary)

- Simple Ratkowsky square root model fit to growth rates

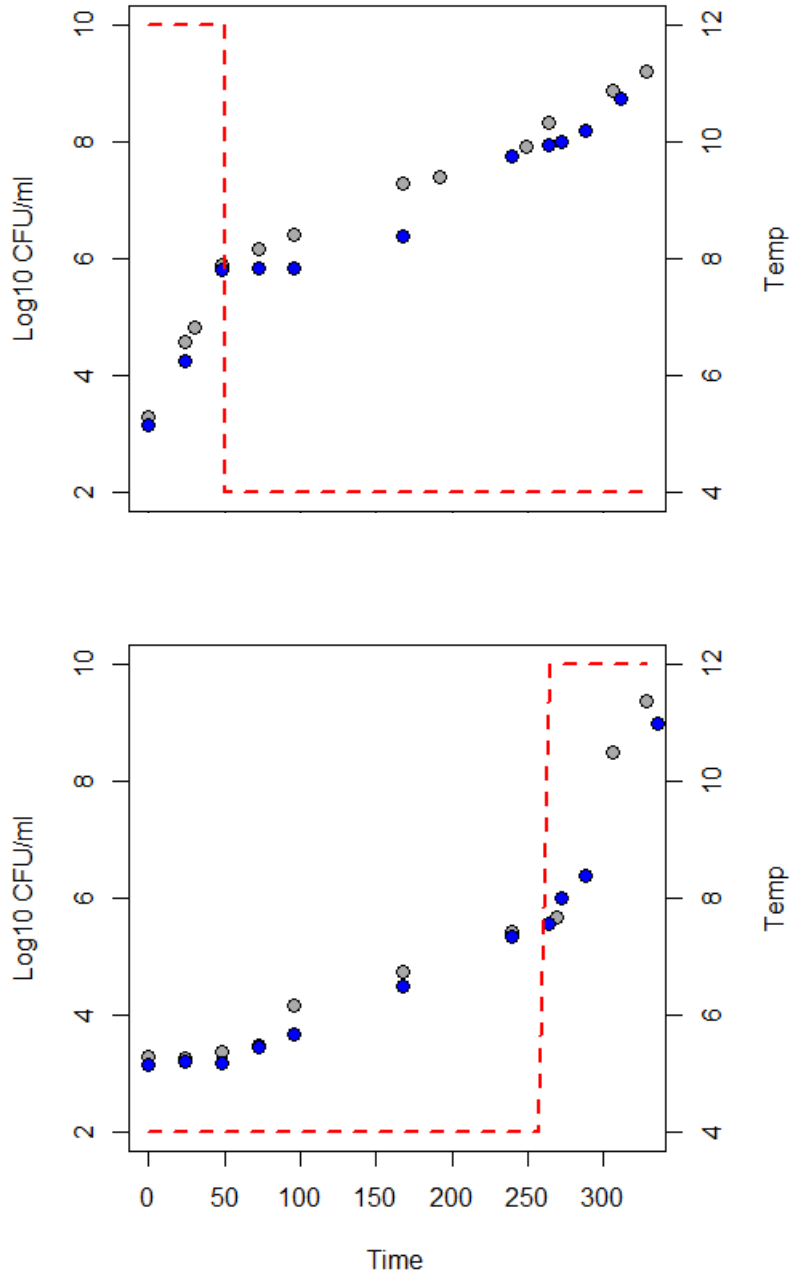
$$\sqrt{r} = b(T - T_0)$$

(All values fitted to Ln, and presented as Log10)

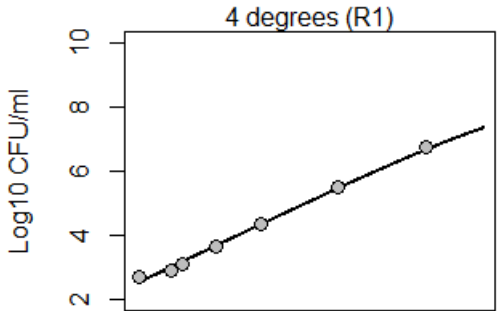


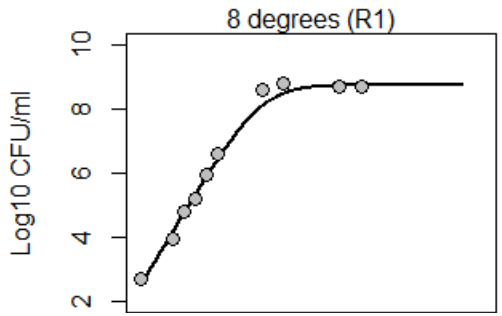
Dynamic growth experiments

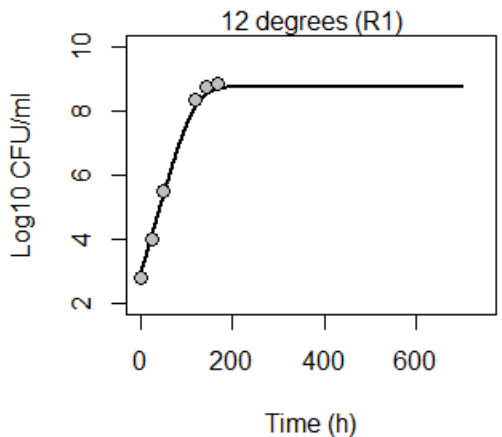
- Same strain Lm 118M then grown under dynamic conditions
- Two conditions:
  - 4°C for 264 hours, then 12°C (x2)
  - 12°C for 48 hours, then 4°C (x2)



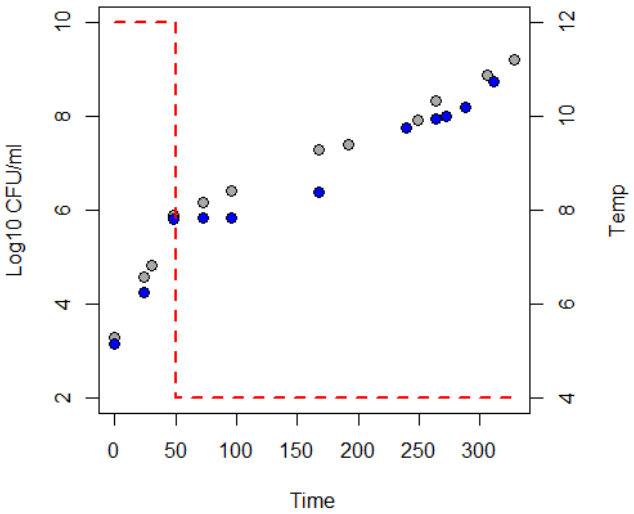
Static

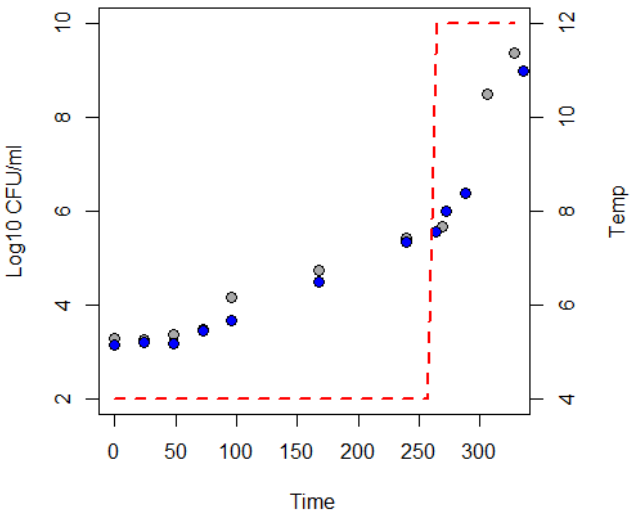




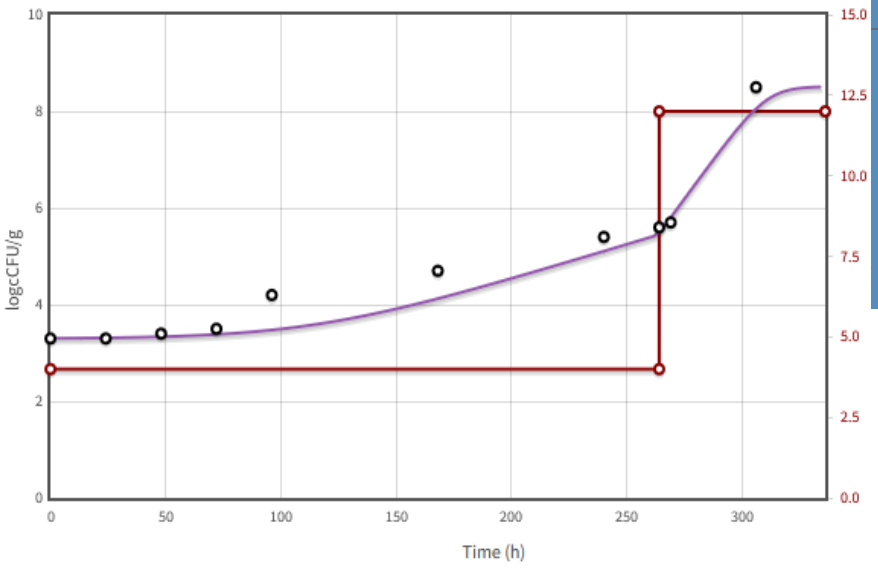


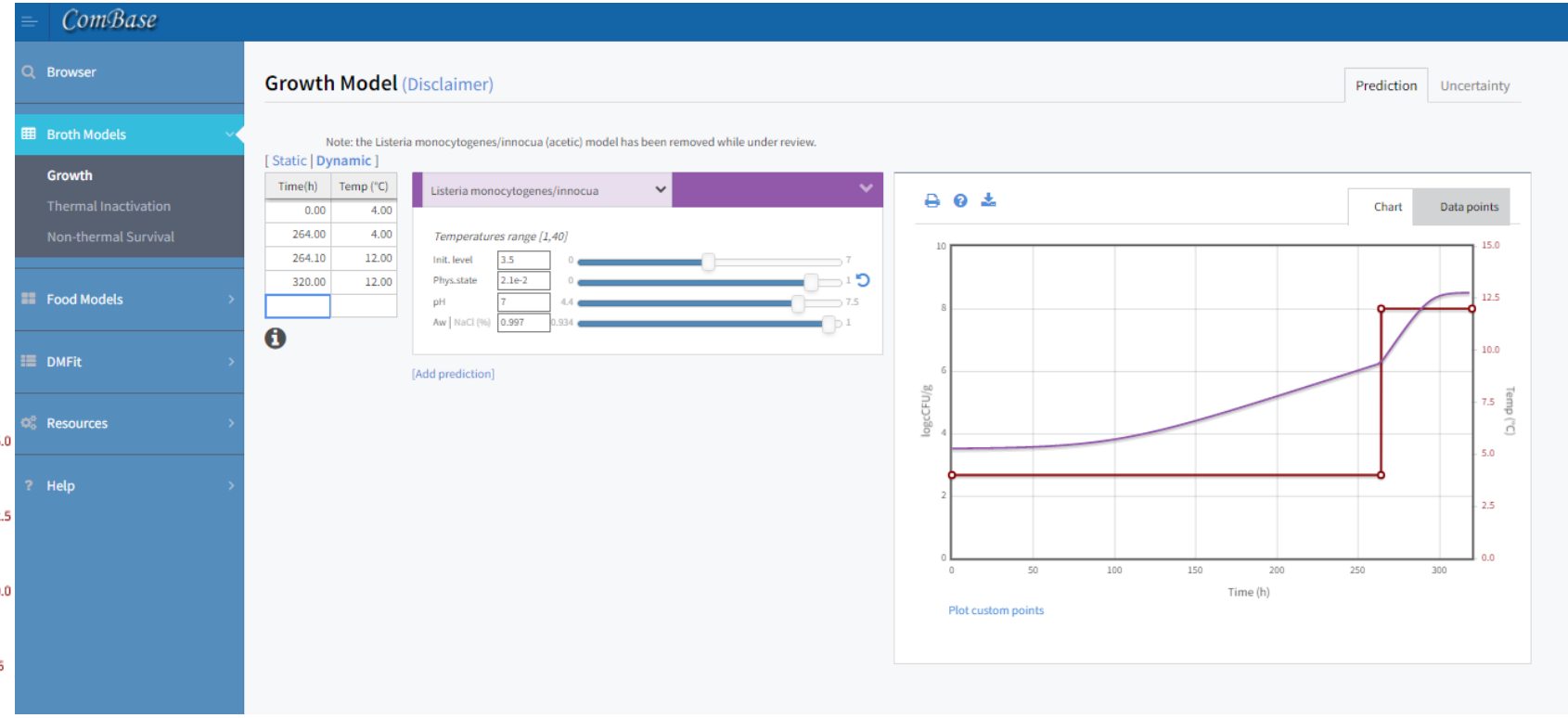
Dynamic





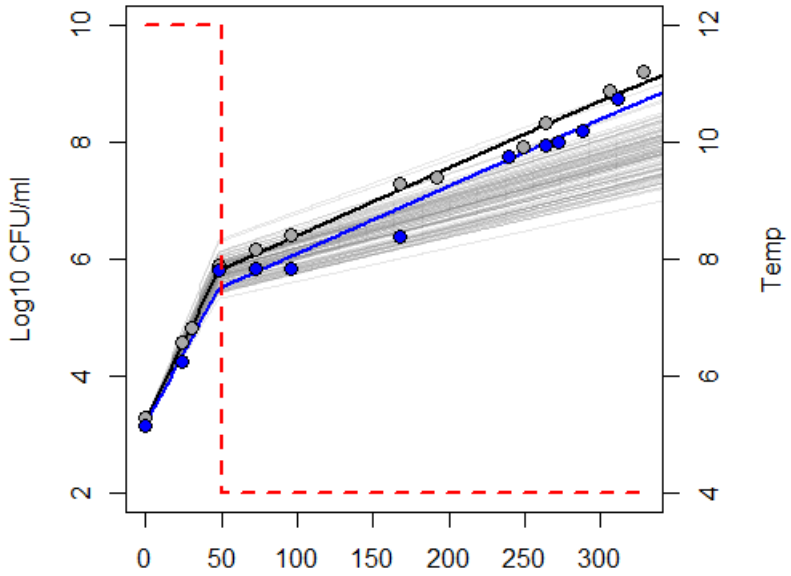
Prediction by ComBase at the same conditions

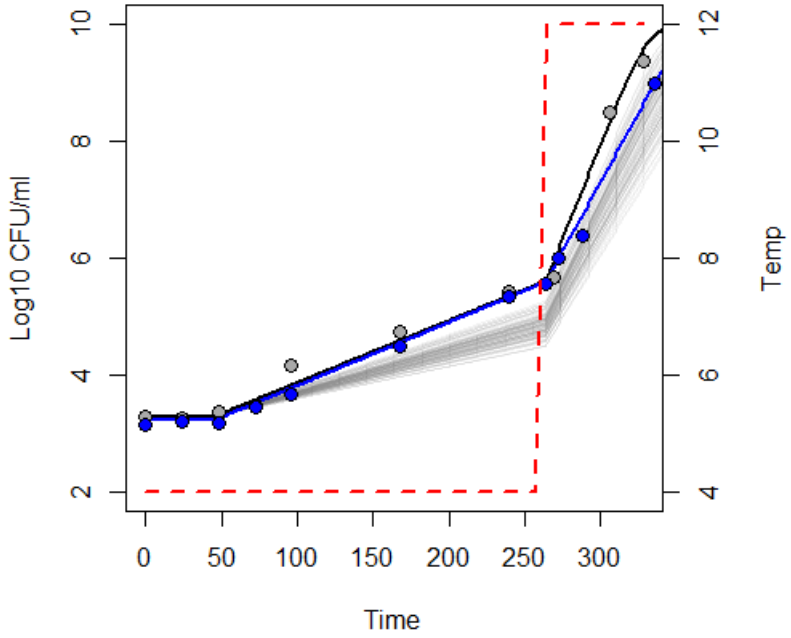




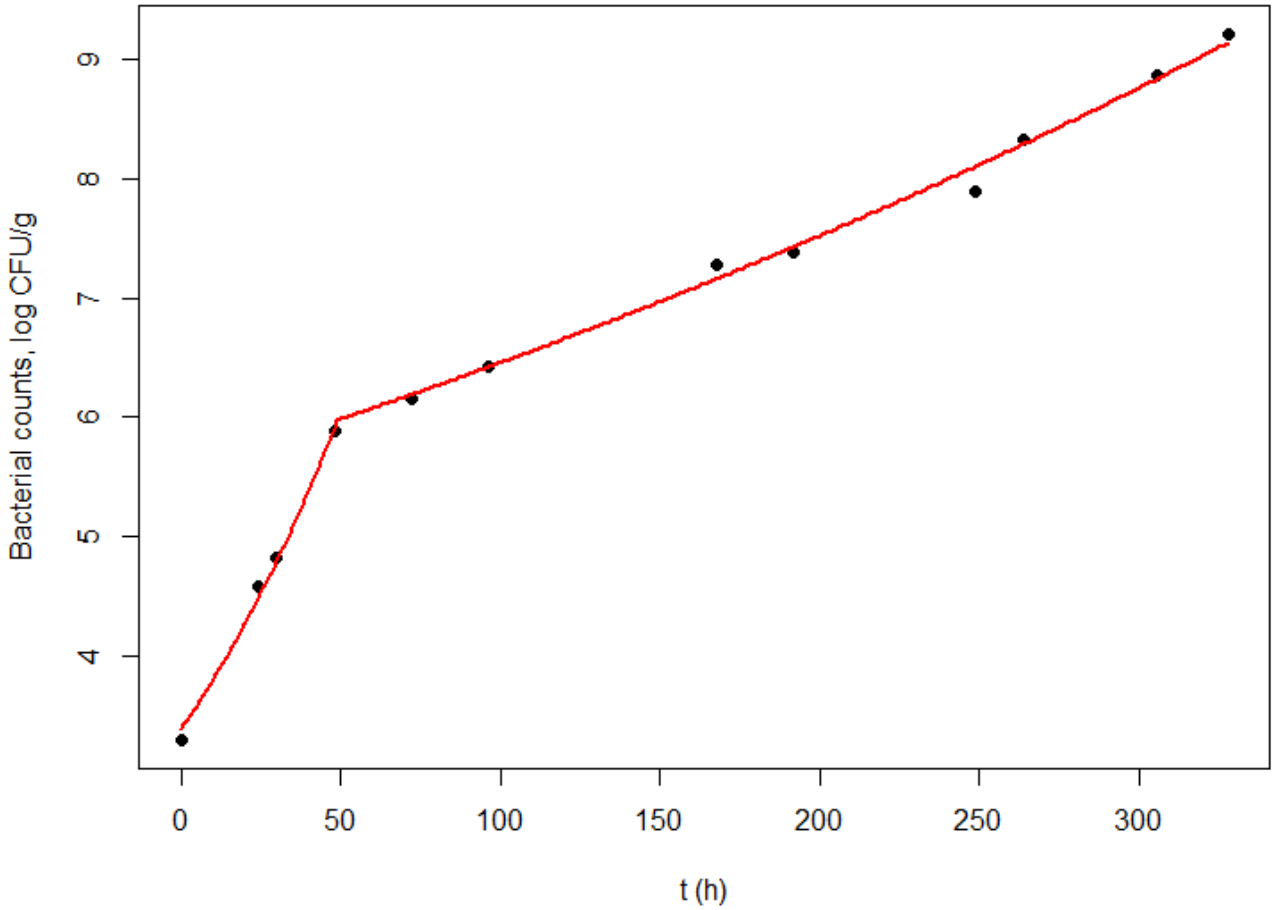
Comparing dynamic growth with predictions from isothermal models

- Modelling assumes no memory
- Is there memory effects?





Using dynamic data to determine growth rates



- Simple Ratkowsky square root model fit to growth rates

$$\sqrt{r} = b(T - T_0)$$

(All values fitted to Ln, and presented as Log10)

Conclusions

- In general the small scale EFSA Partnership Programme was a success
- Dynamic growth experiments open up interesting possibilities for challenge test studies
- Mathematics is more challenging
- Optimum dynamic profile to determine growth rate parameters
- Memory effects and their implication for dynamic conditions modelling

Acknowledgement

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