Absence of *L. monocytogenes* growth during raw milk cheesemaking: a modelling approach

Kieran Jordan, Sol Schvartzman,
Teagasc, MFRC, Ireland

Alexandre Maffre, Fanny Tenenhaus-Aziza,
Moez Sanaa, CNIEL, Paris, France

Francis Butler, UCD, Ireland

Background

Predictive Microbiology

Domain Modelling

Modelling growth

Conclusions

Background - Motivation

- Lack of data on growth during cheesemaking
- Most predictions based on lab. media experiments under static conditions
- Dynamic conditions of food not accounted for
- Data showing differences between models in liquid and solid media
- Need for models in food

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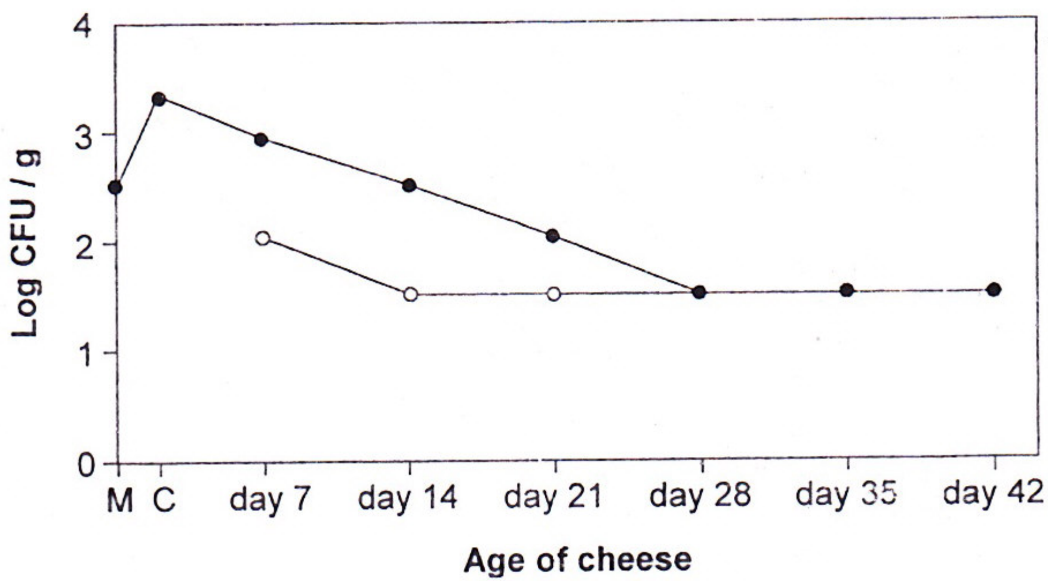
Literature data

- Inaccurate data from literature – apparent growth
- We used cfu/g dry wt – compare liquid and solid directly



- Background
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- **Domain Modelling**
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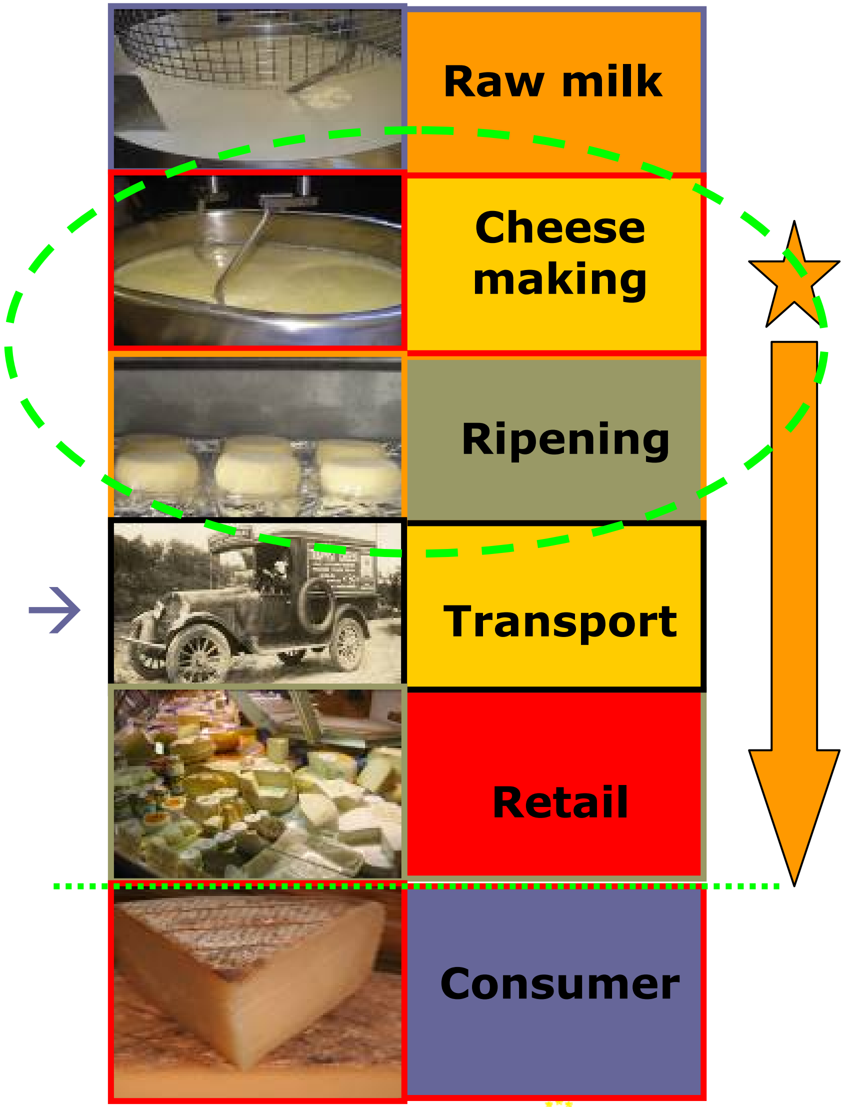
The bigger picture - Domain modelling

- BIG model comprised by several smaller models
- Food chain
- Each step of the production chain modelled →



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Pasteurised vs. Raw milk cheesemaking

- During Cheesemaking and Ripening
- Laboratory scale cheesemaking
- Pasteurised and raw milk
- Milk spiked with 2 strains *L. monocytogenes* (low numbers)
- 4 Replicates
- Populations monitored through cheesemaking and ripening
- Physicochemical parameters measured

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Materials and methods

Protocol	*Sampling*
Milk heated to 30ºC	Milk
Rennet addition – pH 6.55	Milk
Cutting of the gel	Curd
Cooked to 36ºC	Curd
Moulded	Cheese
Brined	Cheese
Smeared	Core/Surface
Ripened	Core/Surface

Cheesemaking **Ripening**

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Materials and methods

- Cheesemaking
  - *L. monocytogenes* counts:
    - Plate count enumeration
    - chromogenic agar ALOA
  - pH, water activity, temperature, lactose

- Ripening
  - *L. monocytogenes* counts:
    - Plate count enumeration
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SAMPLING OF CORE AND SURFACE

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Modelling methodology

- Qualitative interpretation of the data
  - **Comparison of the growth non growth model predictions with observed data**
  - **Extraction of the kinetics showing growth of L. monocytogenes during cheese-making and ripening**

- Quantitative interpretation of the data
  - **where growth occurred, adjustment of primary and secondary cardinal growth models with:**

    Y = Numeration in CFU/g dry wt.,

    Xi = Values of physicochemical parameters, cardinal values for Listeria

  - **Assessment of the optimal growth rate of *L. monocytogenes* for different phases**

- Novelty
  - **Dynamic physico-chemical conditions (SAS Model Procedure)**
  - **Dynamics of the matrix : liquid vs solid (CFU / gram of dry weight)**

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Determination of the optimal growth rate

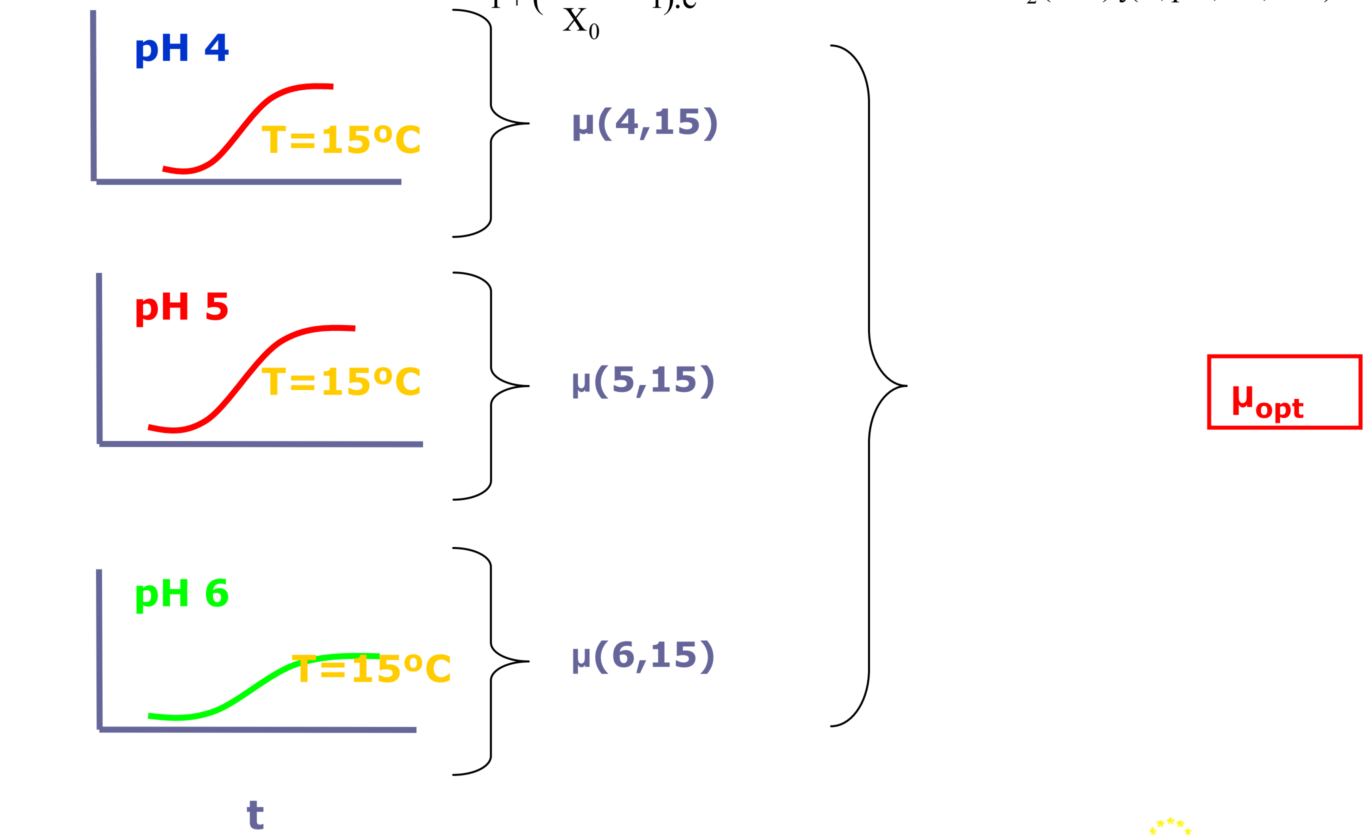
USUAL APPROACH

Primary model

$$x(t) = \frac{X_{max}}{1 + (\frac{X_{max}}{X_0} - 1).e^{-\mu.t}}$$

Secondary model

$$\mu_{max} = \mu_{opt} CM_2(T) CM_1(pH) SR_1(aw) SR_2(Lac) \zeta(T, pH, aw, Lac)$$



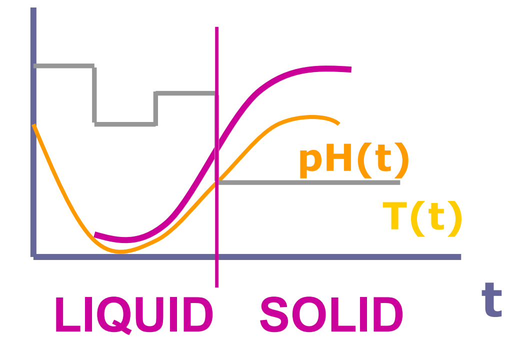
Cardinal Model (*Augustin et al. 2005, JAM, 99, 1019-1042*)

Determination of the optimal growth rate *in dynamic conditions*

NOVEL APPROACH

cfu/gdw(t)

cfu/ml(t) cfu/g(t)



$\int$ Primary model Secondary model

$$dx(t) = \frac{X_{max}}{1 + (\frac{X_{max}}{X_0} - 1).e^{-\mu.t}}$$

$$\mu_{max} = \mu_{opt} CM_2(T) CM_1(pH) SR_1(aw) SR_2(Lac) \zeta(T, pH, aw, Lac)$$

dt

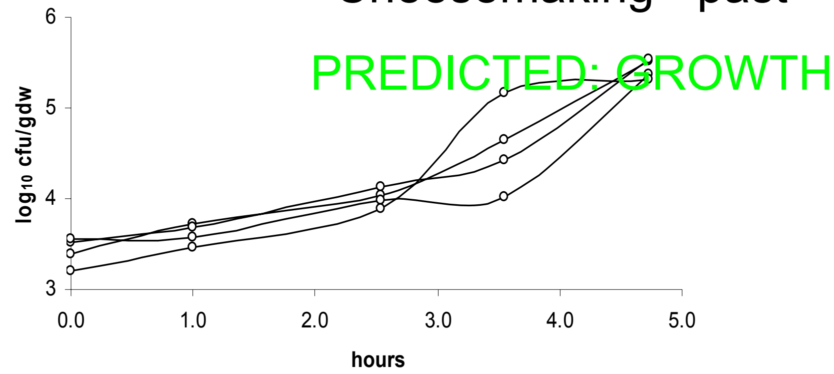
Physico-chemical parameters

$pH(t) = f(t)$
$T°(t) = g(t)$
$aw(t) = h(t)...$

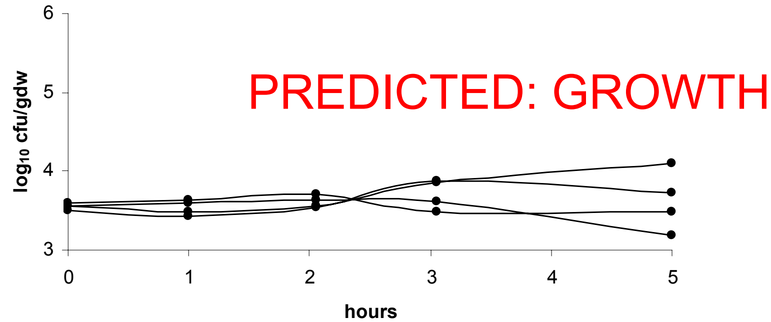
μ_{opt}

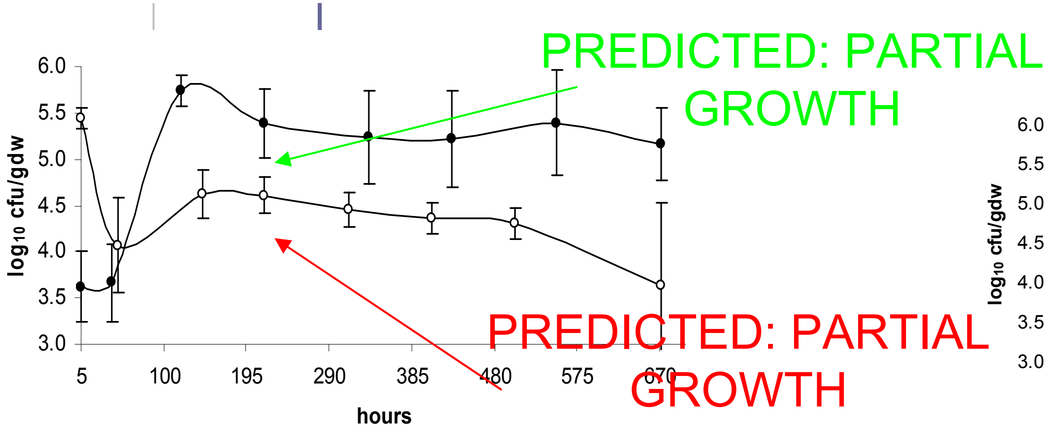
Observed data vs growth/no growth predictions

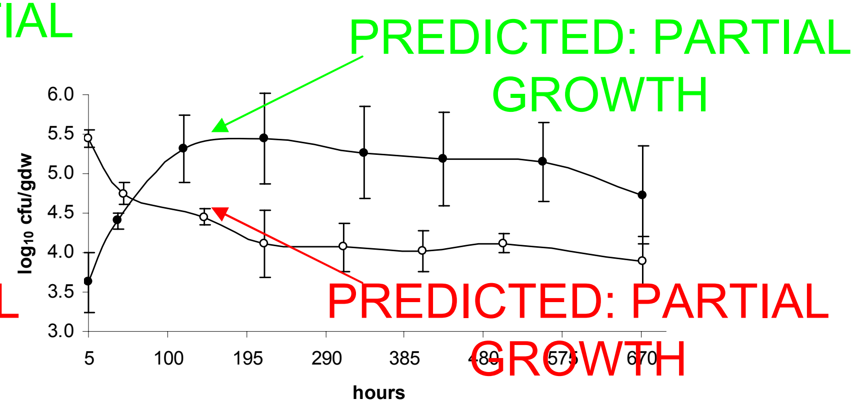
Cheesemaking - past



Cheesemaking - raw







Ripening / Core

● = raw

o = pasteurised

Ripening / Rind

● = raw

o = pasteurised

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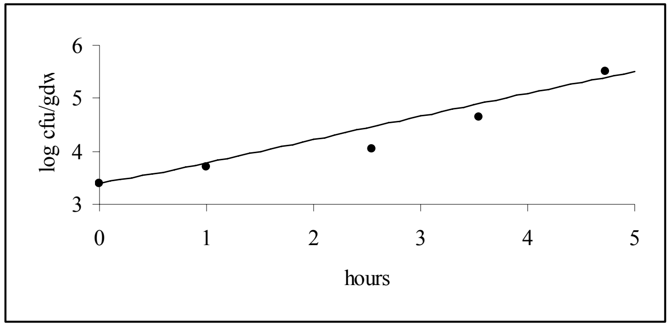
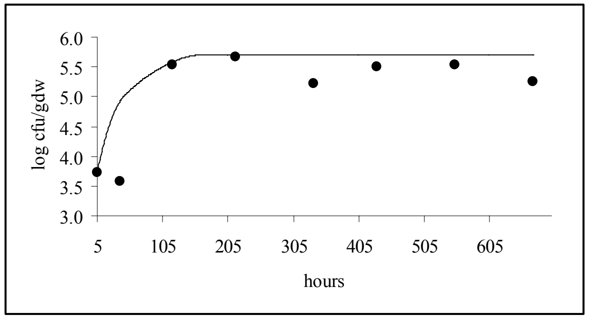
Optimal growth rates assessed



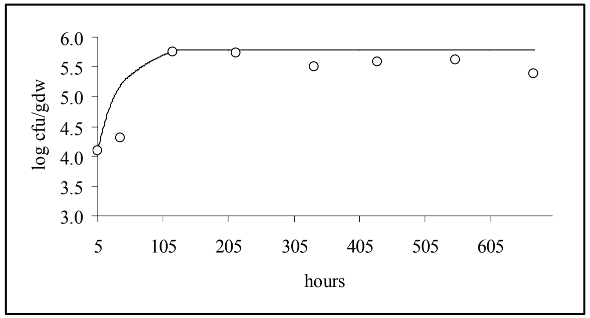
Cheese making / pasteurized milk

μ_{opt} ~ Normal (1.2; 0.01)



Ripening / raw / core

μ_{opt} ~ Normal (0.18; 0.002)



Ripening / raw / surface

μ_{opt} ~ Normal (0.16; 0.001)

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Summary

- **Cheesemaking**
  - Growth in pasteurised milk – no growth in raw milk
    - Raw milk – natural flora inhibited starter and listeria – low lactic acid production
- **Ripening**
  - Growth in raw milk cheese – inactivation in pasteurised milk cheese
    - Raw milk – low lactic acid and increasing pH allowed growth
- **Models in food are a useful tool in growth situations**

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Future Perspectives

- Predictive Modelling useful to understand, predict and describe behaviour in food
- Combase online tool → static environmental conditions
- More data in food systems is needed / Validation in foods
- Inactivation models in dynamic conditions need to be developed

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Thank You for your attention!