



# Study and mathematical description of the kinetics of microbial spoilage of foods by thermophilic endospore-forming microorganisms

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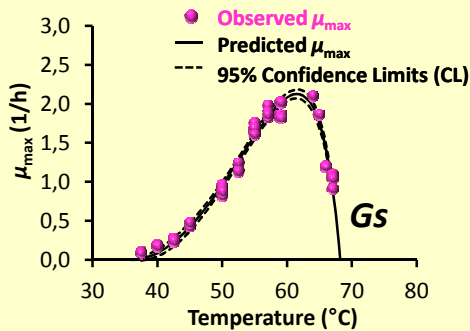
Aristotle University of Thessaloniki (1925)  
Faculty of Agriculture, Forestry and Natural Environment  
School of Agriculture (1928) (<http://www.agro.auth.gr/>)  
Department of Food Science and Technology (1982)  

- Food Processing and Engineering
- Food Chemistry and Biochemistry
- Dairy Technology (<http://food-science.agro.auth.gr/>)

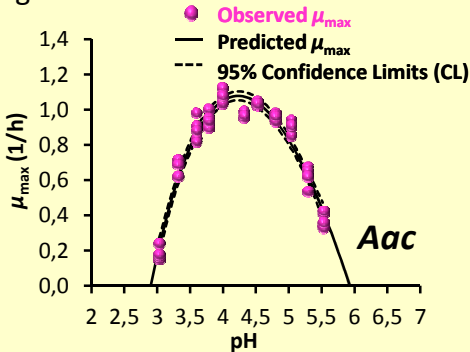
Food Microbiology and Hygiene (Head: K. Koutsoumanis)  
Maria Gougouli (PostDoc Researcher), Myrsini Kakagianni (PhD candidate), Zafeiro Aspidou (PhD candidate)  
**Research Interests**  
Quantitative (Predictive) Microbiology, Microbial Risk Assessment, Stochastic approaches in Food Quality and Safety, Food Quality and Safety Management Systems (ISO HACCP), Decision support systems for quality and safety optimisation, Development and application of novel methods for food preservation, Time Temperature Indicators (TTI) for monitoring food quality and safety, Microbial physiology, Microbial spoilage of foods, Single cell microbiology

## Model development in broth

- Effect of **temperature** on *Geobacillus stearothermophilus* (*Gs*) and *Alicyclobacillus acidoterrestris* (*Aac*) growth

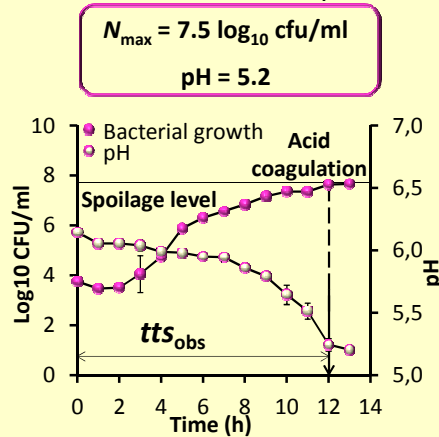


- Effect of **pH** on *A. acidoterrestris* growth



## Relation between microbial growth and food spoilage

- Acid coagulation** in evaporated milk by *Gs*
- Determination of **time-to-spoilage** ( $tts_{obs}$ ) based on **experimental** data ( $T_{opt}=62^{\circ}C$ )



- Guaicol production** in fruit juice by *Aac* ( $T_{opt}=48^{\circ}C$ )
- Determination of  $tts_{obs}$  based on **literature**

$$N_{max} = 5-6 \log_{10} \text{ cfu/ml}$$

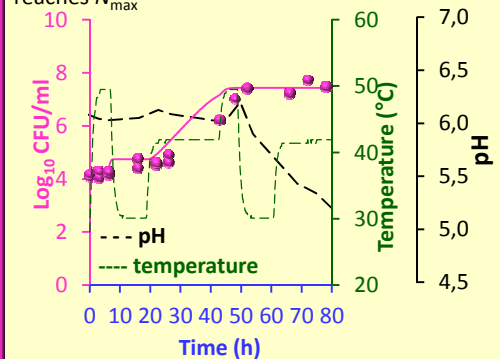
## Adjustment of the models to foods

- Validation under **dynamic temperature** scenarios in **evaporated milk** (*Gs*) and **fruit juices** (*Aac*)
- Prediction of bacterial **growth**

$$\mu_{max} = \mu_{max, \text{milk}(62^{\circ}C)} \times \rho(T)$$

$$tts_{pred} = t_{N_{max}(T)} + 10gt(T)$$

$t_{N_{max}}$ : time interval from inoculation until population reaches  $N_{max}$   
**Observed spoilage:**  $10 * gt(T)$  after population reaches  $N_{max}$



## TOOLS

## Predictive modelling approaches



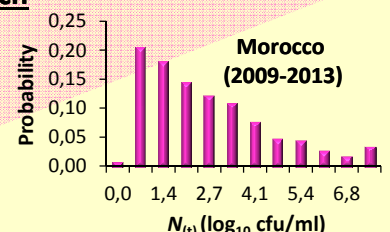
Estimation of risk of **evaporated milk** spoilage at the end of the shelf-life in the market of **various countries**

Estimation of risk of **fruit juices** spoilage at the end of the shelf-life in the market of **Greece**

### Sources of variability

- Temperature-time storage conditions
- Initial population level ( $N_0$ )
- Individual behavior of bacterial spores (lag phase)

- Deterministic approach**
- Stochastic approach**



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