WAGENINGEN
UNIVERSITY & RESEARCH

Impact of variability on growth and inactivation kinetics of *Listeria monocytogenes* and *Lactobacillus plantarum*: effect of food matrix versus strain variability

M.H. Zwietering, D.C. Aryani, H.M.W. den Besten

Introduction and Objective

Microbial growth and inactivation kinetics in food can be predicted when the effects of food properties and environmental conditions on microbial responses are available. However the effects of these intrinsic and extrinsic variables on microbial kinetics are often obtained using laboratory media, and deviations between predictions and true behaviour might occur if the specific effect of a food product is not known or considered in the prediction. Therefore, knowing the food specific effect on microbial kinetics might not only result in a more realistic growth and inactivation prediction, but also extend the knowledge on factors influencing growth and heat resistance.

Material and Methods

In this study, growth predictions obtained with gamma-models and inactivation predictions of *Listeria monocytogenes* and *Lactobacillus plantarum* were validated in laboratory media and in milk and ham as model food products (Ariani et al. 2016a). Also, the effect of food matrix on the kinetic parameters was compared with strain variability to prioritize the importance of these two variability factors.

Results

A good agreement between the predicted and observed growth kinetics (obtained with plate counts) in laboratory media highlighted the possibility to predict μ_{max} based on cardinal growth parameters obtained from OD-based measurement. Generally, the food product validation data were within the 95% confidence bands of the predictions. However these band widths were large due to strain variability. The large strain variability was expanded further by the fact that the estimated gamma product factors differed largely per strain (Figure 1).

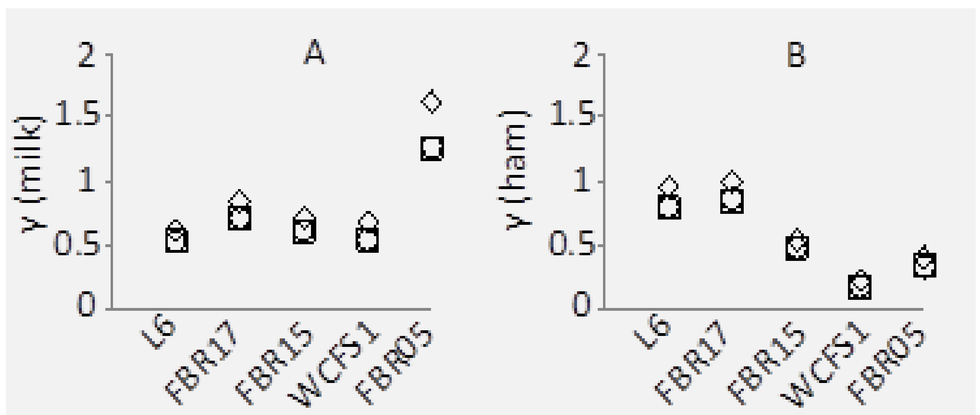

Figure 1. The gamma product factor of *L. monocytogenes* L6, FBR17 and FBR15 and *L. plantarum* WCFS1 and FBR05 in A) milk and B) ham estimated using ◇ Gompertz model □ logistic model and ○ Baranyi model.

This strain dependency of food product specific effects further complicates accurate growth prediction.

For both species the effect of strain variability on thermal inactivation was similar to the food specific effects, and the latter was mainly determined by the effect of ham as heating medium (Figure 2). The combination of both effects explained (almost) all variability found in literature, however, with some bias (Figure 3).

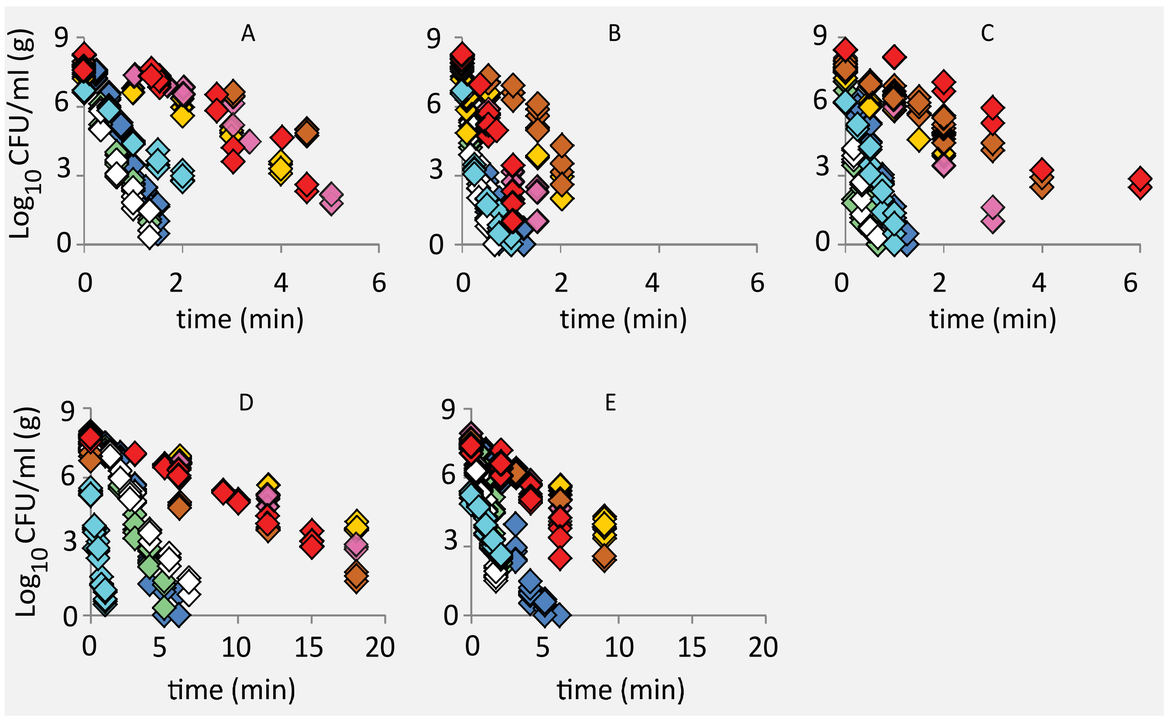

Figure 2. The thermal inactivation of *L. monocytogenes* at 65°C: A) L6; B) FBR17; C) FBR15 and *L. plantarum* at 60°C: D) WCFS1; E) FBR05 as influenced by preculturing and heating media. ◆ Grown in BHI/MRS at 30°C inactivated in BHI; ◆ grown in BHI/MRS at 7°C/15°C inactivated in BHI/MRS; ◇ grown in BHI/MRS at 7°C/15°C inactivated in milk; ◆ grown in BHI/MRS at 7°C/15°C inactivated in commercial ham; ◆ grown in BHI/MRS at 7°C/15°C inactivated in in-house produced ham; ◆ grown in milk at 7°C/15°C inactivated in milk; ◆ grown in commercial ham at 7°C/15°C inactivated in commercial ham; ◆ grown in in-house produced ham at 7°C/15°C inactivated in in-house produced ham.

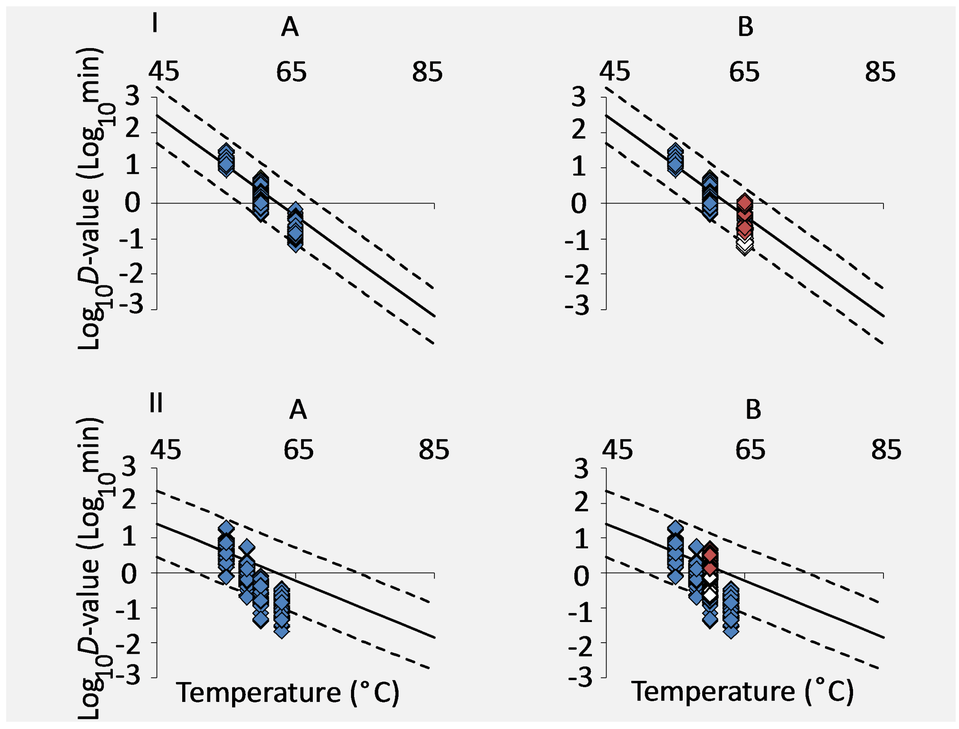

Figure 3. The benchmarking of *D*-values of *L. monocytogenes* (I) and *L. plantarum* (II) to literature data. Panel A: the effect strain; B: the effect of strain and food products. ◆ log *D*-values of various strains; ◇ log *D*-values in milk; ◆ log *D*-values in ham; the mean prediction (solid lines) and the 95% prediction intervals calculated from all literature data of *L. monocytogenes* (dashed lines) (Aryani et al., 2015) and *L. plantarum* (Aryani et al., 2016b).

Conclusions

- Food product specific effects should be included in models for realistic prediction of growth and inactivation kinetics.
- Certain effects are much larger than others, for example the effect of food product on heat resistance was mainly determined by the effect of ham as a heating medium.
- This effect was comparable to the effect introduced by strain diversity.
- Quantifying and benchmarking these variability factors is crucial for prioritizing experimental work to characterise organisms but also to determine factors to better control food safety and spoilage.

Wageningen University & Research
Laboratory of Food Microbiology
P.O. Box 17, 6700 AA Wageningen
Contact: marcel.zwietering@wur.nl
T + 31 (0)317 482233
www.fhm.wur.nl

Aryani et al. 2015 IJFM 193: 130-138
Aryani et al. 2016a IJFM 238: 326-337
Aryani et al. 2016b AEM 82: 4896-4908