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Modelling and predicting growth of psychrotolerant pseudomonads in milk and cottage cheese

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Objective

To develop and validate mathematical models for growth of psychrotolerant pseudomonads in chilled milk and in cottage cheese with cultured cream dressing.

Introduction

Psychrotolerant pseudomonads are associated with sensory spoilage, due to production of fruity and nauseous off-odours in e.g. raw milk, pasteurized milk and cottage cheese. Predictive food microbiology models have the potential to evaluate the effect of temperature on microbial growth during distribution as well as be used to determine how product characteristics can be modified to reduce growth to an acceptable level. However, it is challenging to model and predict growth of spoilage or pathogenic microorganisms in fermented foods, such as cottage cheese, due to inhibiting substances produced by lactic acid bacteria during fermentation or later during storage and distribution (Østergaard et al. 2014).

Methods

Growth kinetics of psychrotolerant pseudomonads were determined using Bioscreen C experiments, challenge tests, storage trial and literature data. The effect of storage temperature and product characteristics on growth rates (μ_{max}) were described using a simplified cardinal parameter model and the gamma concept (Østergaard et al., 2014; Zwietering et al., 1992). The developed broth /Bioscreen C model included the effect of temperature, pH, NaCl/a_w, lactic-, sorbic acid and their interaction (Le Marc et al., 2002). Subsequently, the reference growth rate parameter (μ_{ref} at 25°C) was fitted to a total of 35 μ_{max}-values from cottage cheese with cultured cream dressing. Lag time models were developed from growth curves in products by calculation of relative lag times. μ_{max}-models for milk and cottage cheese were evaluated by calculation of bias (B_f)- and accuracy (A_f)- factors from literature and new experimental μ_{max} data (Table 1).

The acceptable simulation zone (ASZ) method was used to evaluate the performance of the combined lag time and μ_{max} models on growth (log CFU/g) at constant and dynamic temperatures (Fig.1).
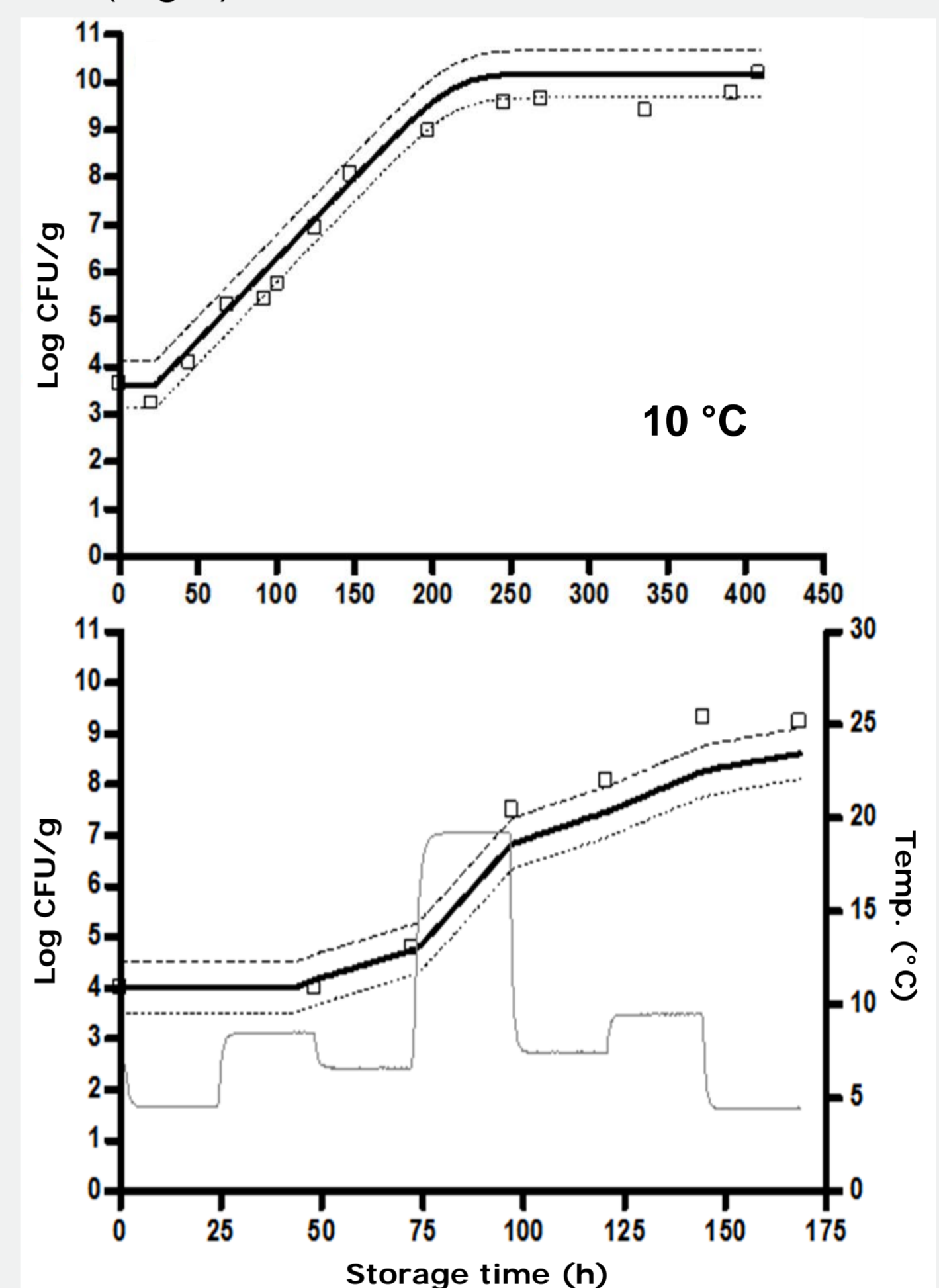

Figure 1. ASZ method used to compared observed and predicted growth of psychrotolerant pseudomonads in cottage cheese with cultured cream dressing (log CFU/g)

Results

The new models were successfully validated for 59 growth curves of psychrotolerant pseudomonads in dairy products (Fig. 1; Table 1). The ASZ method showed the new models for pasteurized milk (ASZ = 96%) as well as cottage cheese and raw milk (ASZ = 78%) to successfully predict growth of psychrotolerant pseudomonads at constant and dynamic storage temperatures.

Conclusions

The present study developed and validated mathematical models to predict growth of psychrotolerant pseudomonads in chilled milk and cottage cheese with cultured cream dressing. The cottage cheese model can be used to evaluate the effect of product reformulations on growth.

Table 1. Evaluation of growth rate models for psychrotolerant pseudomonads

Model	Data	n	B_f	A_f
Broth (μ_{ref} = 1.03 h^{-1})	**Pasteurized milk**	**33**	**1.08**	**1.32**
Calibrated to cottage cheese (μ_{ref} = 0.62 h^{-1})	**Cottage cheese and raw milk**	26	1.08	1.43

References:
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