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Application of competitive models in predicting the simultaneous growth of *Staphylococcus aureus* and lactic acid bacteria in milk

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Abstract

The simultaneous growth of *Staphylococcus aureus* and lactic acid bacteria (LAB) starter culture was studied in milk at different temperatures and LAB inoculums (ranging from 12 °C to 30 °C and 10^3 to 10^7 CFU ml^{-1}, respectively). The modelling and predictive ability of three competition models were evaluated. Competition coefficients representing mutual population influence were incorporated into two of the models. This enabled the use of model parameters from individual *S. aureus* and LAB growth curves as well as those from co-culture growth in milk. Both the results and their statistical indices showed that incorporation of averaged competition coefficients resulting from individual co-culture trials improved the prediction of *S. aureus* behaviour in co-culture with LAB.

Keywords:

Growth in co-culture, Lactic acid bacteria, *S. aureus*, Milk; Competition model; Prediction

1. Introduction

Mathematical models have been useful tools in efforts to predict microbial behaviour for several decades. Efforts to describe and predict competitive or antagonistic behaviour of microbial populations have been addressed by research mostly in the last decade (Brocklehurst, 2004; Giménez and Dalgaard, 2004).

Microbial interactions involved in biocontrol of pathogenic or spoilage organisms by the addition of lactic acid bacteria (LAB) still provide a challenge for the application of competitive models. This is illustrated by the case of artisanal raw milk cheese manufacture. The safety and quality of raw milk cheeses are generally determined by the potential presence of pathogenic and spoilage microorganisms, their interaction with LAB, and by the effects of intrinsic, extrinsic and technological factors (Görner and Valík, 2004). During raw milk fermentation and the early phase of cheese ripening, coagulase-positive staphylococci, pathogenic or saprophytic *E. coli* strains, and *Listeria monocytogenes* are the most frequent undesirable microbial species with highly adverse health effects on consumers. Among these pathogens, *S. aureus* belongs to the most frequent raw milk and artisanal cheese contaminants.

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