Modelling the effect of lactic acid bacteria from starter- and aroma culture on growth of Listeria monocytogenes in cottage cheese

Four mathematical models were developed and validated for simultaneous growth of mesophilic lactic acid bacteria from added cultures and Listeria monocytogenes, during chilled storage of cottage cheese with fresh or cultured cream dressing. The mathematical models include the effect of temperature, pH, NaCl, lactic- and sorbic acid and the interaction between these environmental factors. Growth models were developed by combining new and existing cardinal parameter values. Subsequently, the reference growth rate parameters (μref at 25 °C) were fitted to a total of 52 growth rates from cottage cheese to improve model performance. The inhibiting effect of mesophilic lactic acid bacteria from added cultures on growth of L. monocytogenes was efficiently modelled using the Jameson approach. The new models appropriately predicted the maximum population density of L. monocytogenes in cottage cheese. The developed models were successfully validated by using 25 growth rates for L. monocytogenes, 17 growth rates for lactic acid bacteria and a total of 26 growth curves for simultaneous growth of L. monocytogenes and lactic acid bacteria in cottage cheese. These data were used in combination with bias and accuracy factors and with the concept of acceptable simulation zone. Evaluation of predicted growth rates of L. monocytogenes in cottage cheese with fresh- or cultured cream dressing resulted in bias-factors (Bf) of 1.07–1.10 with corresponding accuracy factor (Af) values of 1.11 to 1.22. Lactic acid bacteria from added starter culture were on average predicted to grow 16% faster than observed (Bf of 1.16 and Af of 1.32) and growth of the diacetyl producing aromaculture was on average predicted 9% slower than observed (Bf of 0.91 and Af of 1.17). The acceptable simulation zone method showed the new models to successfully predict maximum population density of L. monocytogenes when growing together with lactic acid bacteria in cottage cheese. 11 of 13 simulations of L. monocytogenes growth were within the acceptable simulation zone, which demonstrated good performance of the empirical inter-bacterial interaction model. The new set of models can be used to predict simultaneous growth of mesophilic lactic acid bacteria and L. monocytogenes in cottage cheese during chilled storage at constant and dynamic temperatures. The applied methodology is likely to be applicable for safety prediction of other types of fermented and unripened dairy products where inhibition by lactic acid bacteria is important for growth of pathogenic microorganisms.