VERSITA

Chemical Papers 67 (7) 737–742 (2013)
DOI: 10.2478/s11696-013-0365-1

ORIGINAL PAPER

# Evaluation of temperature effect on growth rate of *Lactobacillus rhamnosus* GG in milk using secondary models

**Ľubomír Valík*, Alžbeta Medveďová, Michal Čižniar, Denisa Liptáková**

*Department of Nutrition and Food Quality Assessment, Faculty of Chemical and Food Technology, Slovak University of Technology in Bratislava, Radlinského 9, 812 37 Bratislava, Slovakia*

Received 18 October 2012; Revised 17 January 2013; Accepted 21 January 2013

The application of secondary temperature models on growth rates of *Lactobacillus rhamnosus* GG, the much studied probiotic bacterium, is investigated. Growth parameters resulting from a primary fitting were modelled against temperature using the following models: Hinshelwood model (H), Ratkowsky extended model (RTK2), Zwietering model (ZWT), and cardinal temperature model with inflection (CTMI). As experienced by other authors, the RTK2, ZWT, and CTMI models provided the best statistical indices related to fitting the experimental data. Moreover, with the biological background, the following cardinal temperatures of *L. rhamnosus* GG resulted from the study by the model application: $t_{\min} = 2.7\,^{\circ}\mathrm{C}$, $t_{\mathrm{opt}} = 44.4\,^{\circ}\mathrm{C}$, $t_{\max} = 52.0\,^{\circ}\mathrm{C}$. The growth rate of the strain under study at optimal temperature was 0.88 $\log_{10}(\mathrm{CFU\ mL^{-1}\ h^{-1}})$.


**Keywords:** temperature, growth modelling, *L. rhamnosus* GG

## Introduction

Quantitative food microbiology and predictive modelling are usually closely focused on issues limiting food safety and quality. Within the risk assessment tools, quantification is generally concerned with the presence and growth of pathogens in foods and the proper determination of food shelf-life (Gibson & Roberts, 1989; McMeekin et al., 1993; McKellar & Lu 2004; Brul et al., 2007). Several primary and secondary models are used in quantitative or predictive microbiology to characterise the growth of microorganisms in relation to time and food environmental factors, respectively. On the other hand, they also serve as a basis for tertiary model systems used for the prediction of microbial behaviour in foods (Ross & McMeekin, 1994). However, the areas of food safety and food quality still provide relevant challenges for predictive microbiology, one of which is the growth description of lactic acid bacteria during food fermentations or probiotic microorganisms in food matrices. This would enable the use of modelling methodology not only in dairy product quality but also in product functionality. These ideas were endorsed by the review by Roupas (2008).

*Lactobacillus rhamnosus* is a Gram-positive, non-spore forming, facultative anaerobic or microaerophilic, non-motile, and catalase-negative microorganism. It is a mesophile but, depending on the strain, may grow at temperatures below 15 °C or above 40 °C. The optimal pH value for its growth is in the range from 6.4 to 6.9 (Liew et al., 2005) and the minimal pH can be found within the range from 4.4 to 3.4, depending on the buffering capacity of the medium (Helland et al., 2004). Its growth requirements include folic acid, riboflavin, niacin, pantothenic acid, and calcium (Curry & Crow, 2004). The metabolism of *L. rhamnosus* is facultative heterofermentative (lactobacilli Group 2). It converts hexoses into L(+) lactic acid, in accordance with the Embden–Meyerhof pathway; due to aldolase and phosphoketolase, pentoses are also fermented. Up to 1.5 % of lactic acid is usually produced in a glucose medium. In the absence of glucose, it produces lactic acid, acetic acid, formic

*Corresponding author, e-mail: lubomir.valik@stuba.sk