A PREDICTIVE GROWTH MODEL FOR PRO-TECHNOLOGICAL AND PROBIOTIC *Lacticaseibacillus paracasei* STRAINS FERMENTING WHITE CABBAGE

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1° SIMPOSIO FuturoINAREA

Lactobacillus spp. are species generally used as starters in food fermentation and/or as probiotics. A probiotic food should contain at least 10^9 viable cells per portion to exert its beneficial effects, but the processing conditions, including extrinsic (temperature) and intrinsic characteristics of the food matrix (a_w, pH) could limit the strain ability to reach this cell concentration in a fermentation process.

Objectives

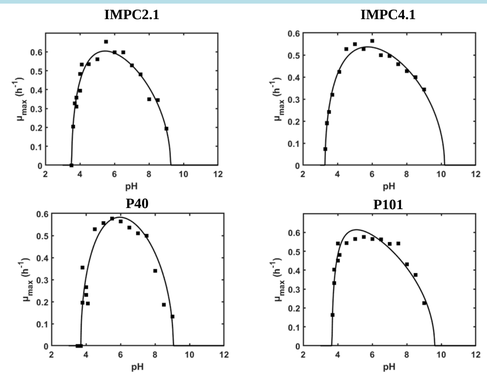
Investigating the growth abilities of *L. paracasei* spp. in different fermentation conditions to identify by mathematical modelling the fermentation conditions and the time needed to reach the **targeted probiotic level (7 $\log_{10}$ CFU/g)** in white cabbage

1

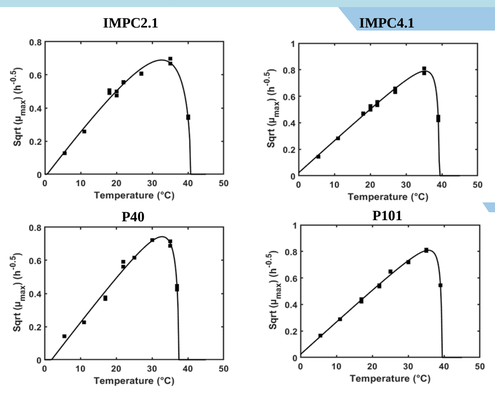
Cardinal growth values of *L. paracasei* strain in broth

Strains were grown in modified MRS broth at 10 temperature (from 5.5 to 40°C) and 15 pH (from 3.2 to 9.1) values to determine the growth cardinal parameters (minimal, optimal and maximal) . Each factor was tested in a mono-factorial design.

Effect of pH: new equation were proposed based on a previous study of Presser (2001)



Effect of temperature: Cardinal Temperature Model with Inflection (CTMI, Rosso *et al.*, 1993)



$\mu_{max}(T, pH) = \mu_{\mathrm{opt,MRS}}\, \tau(T)\gamma(pH))$ *(1)* multiplicative model where τ *(T)*, γ *(pH)* are the normalized effects of temperature, pH, $\mu_{opt,MRS}$ the optimum maximum specific rate (μ_{max}) in modified MRS.

2

Growth fitting in cabbage

To compare the ability of blanched white cabbage to support the growth of the studied strain in comparison to the growth obtained in culture medium, the food correction factor C_f was introduced. The *correction factor* compares the ability of a certain food matrix to support the growth of the studied strain in comparison to the growth obtained in culture medium (Buss da Silva *et al.,* 2017; Ellouze *et al.,* 2021). A correction factor closes to 1 indicates similar growth of the studied strain in the food product and in the culture medium. The μ_{max} value predicted in white cabbage is:

$\mu_{max}(T, pH) = C_f\ \mu_{opt,MRS}\ \tau(T)\gamma(pH)$ (2)

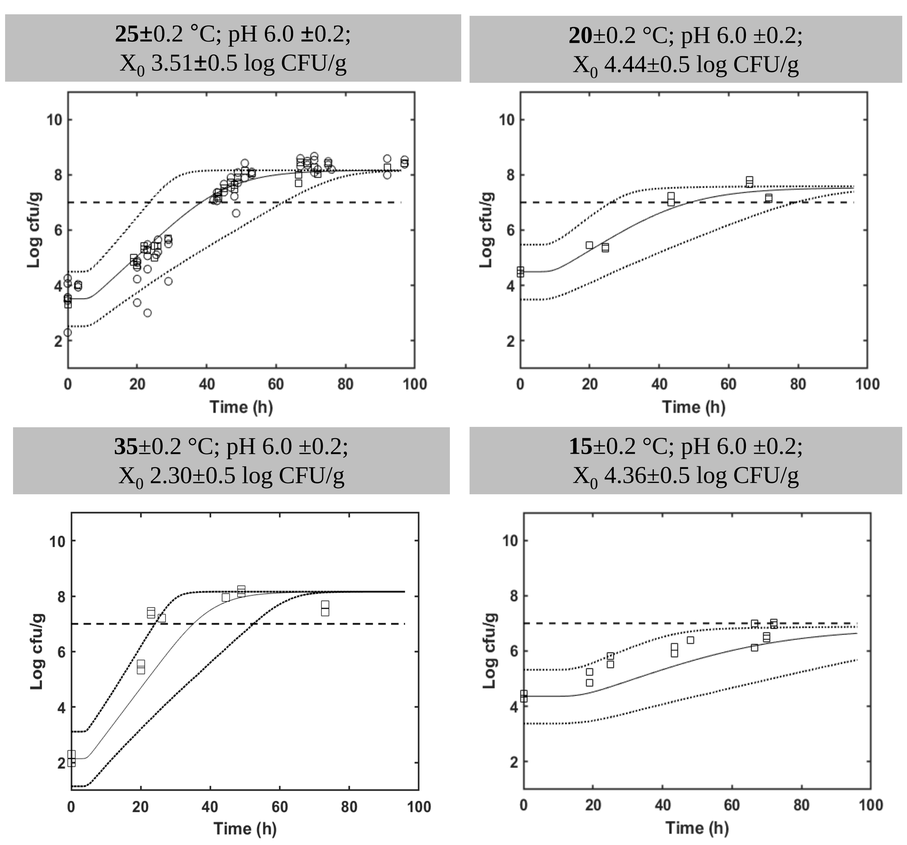
The μmax value predicted in white cabbage was in good agreement with experimental observations (Bf=0.97; Af=1.18).

25±0.2 °C; pH 6.0 ±0.2; X_0 3.51±0.5 log CFU/g

20±0.2 °C; pH 6.0 ±0.2; X_0 4.44±0.5 log CFU/g

35±0.2 °C; pH 6.0 ±0.2; X_0 2.30±0.5 log CFU/g

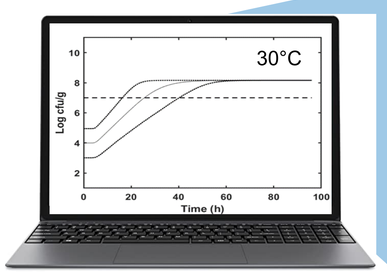
15±0.2 °C; pH 6.0 ±0.2; X_0 4.36±0.5 log CFU/g



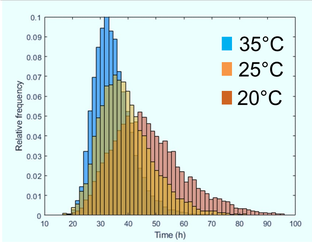
3

Predictive *in silico* simulations

The growth simulations were used to estimate the probability to reach the targeted probiotic level as a function of time. For the parameters C_f, and N_{max}, the value and the model developed for strain IMPC2.1, respectively, were applied in the simulations.



pH 6.0±0.2; X_0 4.0±0.5 log CFU/g



RESULTS: The predictive growth model developed for *L. paracasei* strains allowed to select the fermentation conditions to reach the targeted probiotic level of 7 $\log_{10}$ CFU/g of fermented cabbage corresponding to food portions containing about 9 $\log_{10}$ CFU probiotic viable cells. A storage temperature (30°C) close to the T_{opt} value of *L. paracasei* strains (ranging from 32.63 to 35.67°C) allowed to reduce time of food processes to about 24h. Further efforts will aim to characterize *L. paracasei* strains for other parameters and to increase the robustness of the model by generating a database of growth parameters of other *L. paracasei* strains (to account for strain variability) and generate challenge test data for these strains in other food matrices.

Conclusions: This study aims to widen the field of food microbiological research to the application of predictive microbiology to pro-technological microorganisms for *in silico* fermentation process optimization in an industrial context.

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