Predicting the Growth of *L. monocytogenes* in Meat under Fluctuating Temperatures: a Specific Software Tool

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Introduction

Development of user-friendly software tools is important to facilitate the practical use of predictive models. For most pathogens, models for growth or inactivation have been included in applications that can be freely downloaded from the Internet (Pathogen Modeling Program, Growth Predictor). However, these do not allow growth predictions for a pathogen such as *L. monocytogenes* under fluctuating temperatures. The objective of this work is to describe the development of a specific software tool to predict the growth of *L. monocytogenes* in chilled meat products under either constant or fluctuating temperatures.

Mathematical Model

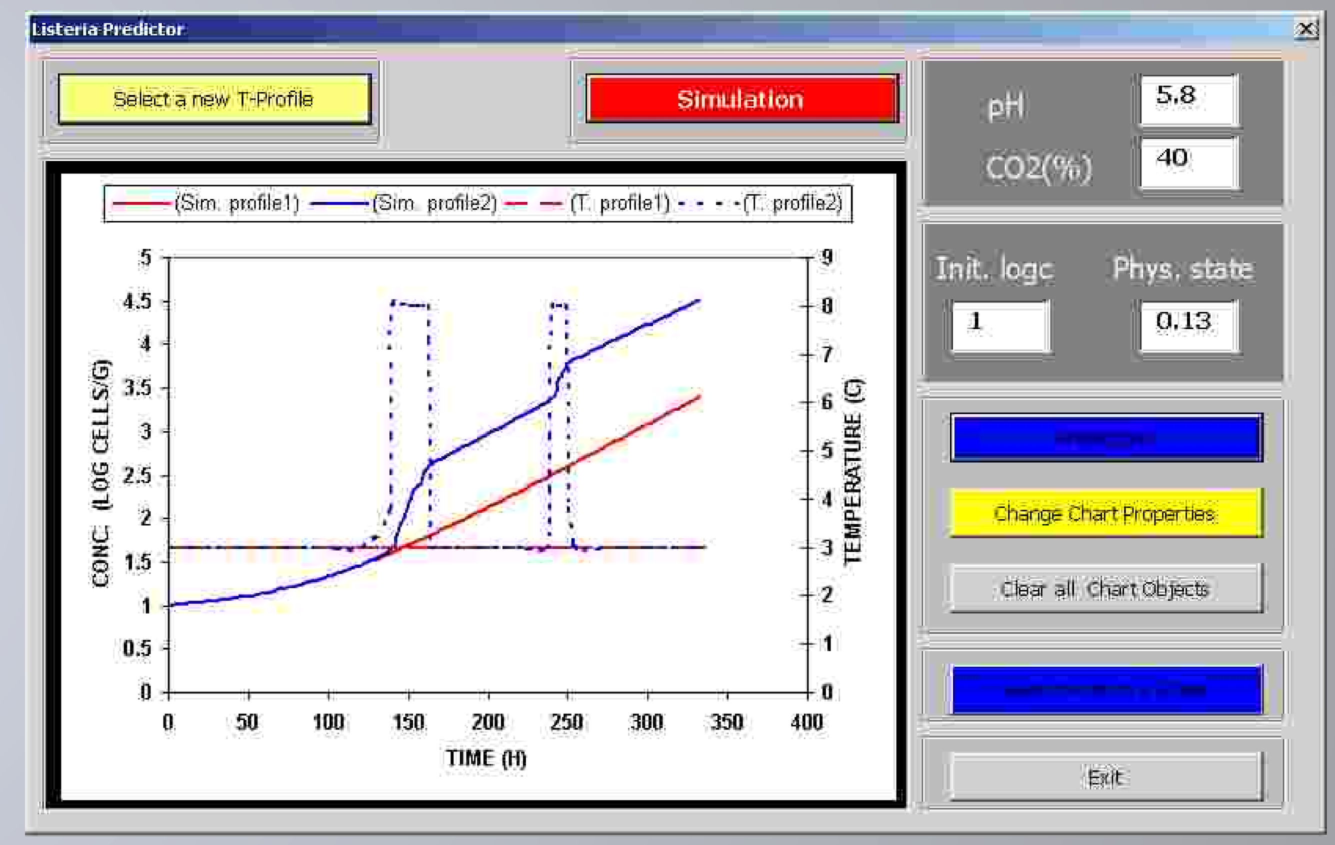
The mathematical model applied is the dynamic model of Baranyi and Roberts (1994). To model the effect of temperature, pH and CO2 concentration on the specific growth rate of *L. monocytogenes*, a quadratic model was developed using data from the ComBase database (see www.combase.cc). The system of equations was then solved numerically by programming a fourth order Runge–Kutta method.

User Interface

The program (an Excel Add-In developed in Visual Basic for Applications) makes it possible for users to input their own temperature profiles. Profiles should be formatted in an Excel sheet in X,Y columns of time, temperature. Data for inclusion in predictions are selected simply by mouse clicking after highlighting the temperature profile.

The inoculum and the initial physiological state of the cells (described by a dimensionless number between 0 and 1 expressing the suitability of the cells to the actual environment) can be set up by the user.

Figure 1. Visualisation of the effect of storage conditions on the kinetics of *L. monocytogenes* in meat (pH=5.8, CO_2=40%).

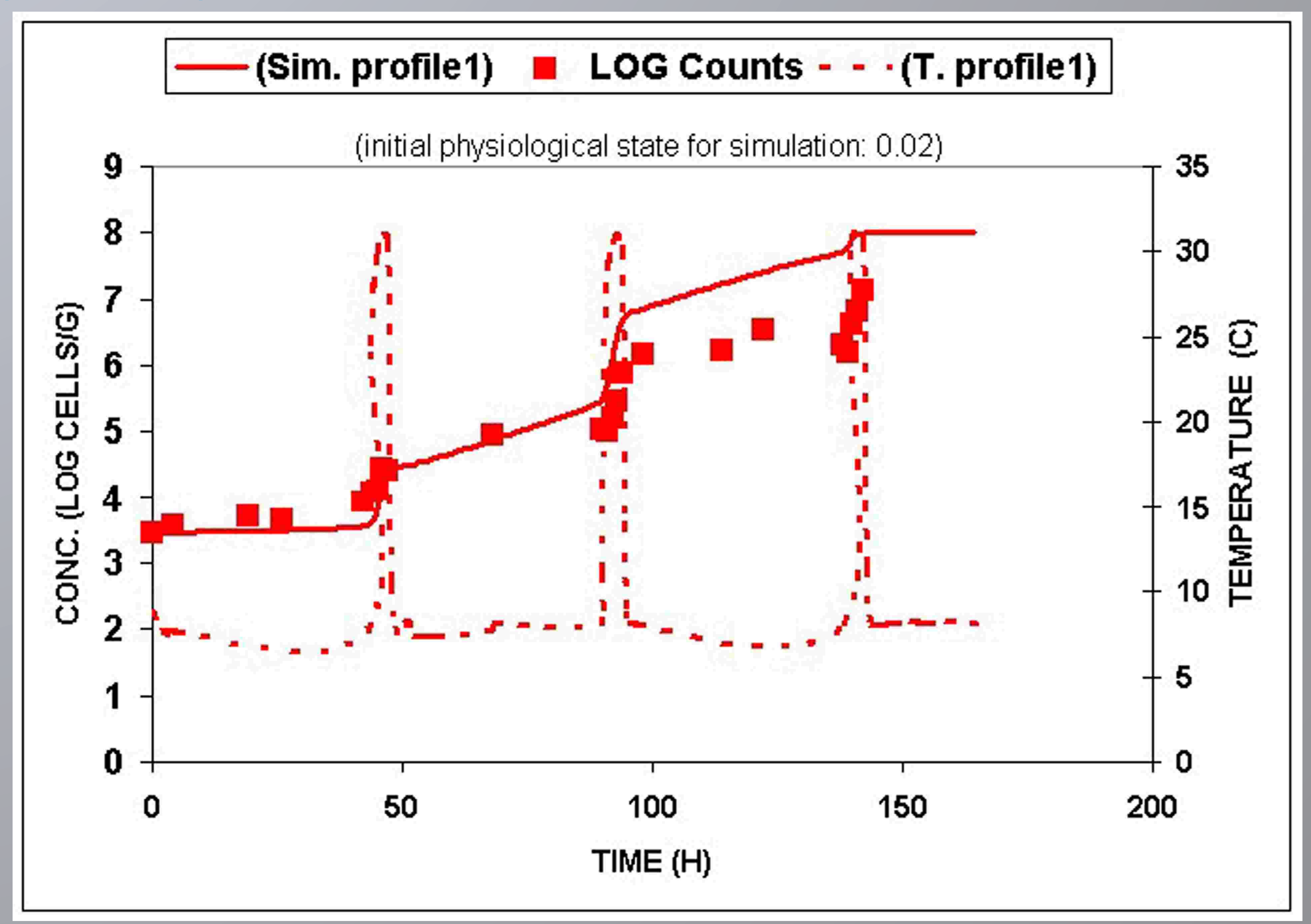


Applications

Up to three simulations can be run simultaneously allowing visualization of the effect of different processes or storage conditions on the growth of *L. monocytogenes*. Figure 1 shows the effects of temperature increasing from 3 to 8°C after 140 and 240 hours of incubation on the kinetics of *L. monocytogenes* in meat at pH 5.8 and 40% CO2.

Simulation outputs (charts, predicted bacterial concentration as a function of time, time to one log increase…) can be saved in an Excel sheet and then compared with experimental data sets using standard chart options (Figure 2).

Figure 2. Observed and predicted kinetics of *L. monocytogenes* in a meat product. Experimental data from Bovill *et al*., 2000.



Conclusion

Accurate prediction of the response of *L. monocytogenes* during food processes will improve risk assessments of this microorganism in chilled meat products. This user-friendly program can be a useful tool to validate predictive models for *L. monocytogenes* in dynamic conditions.

References

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Bovill, R.A., Bew, J., Cook, N., D'Agostino, M., Wilkinson, N., Baranyi, J., 2000. Predictions of growth for *Listeria monocytogenes* and *Salmonella* during fluctuating temperature. Int. J. Food Microbiol. 59, 157–165.

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