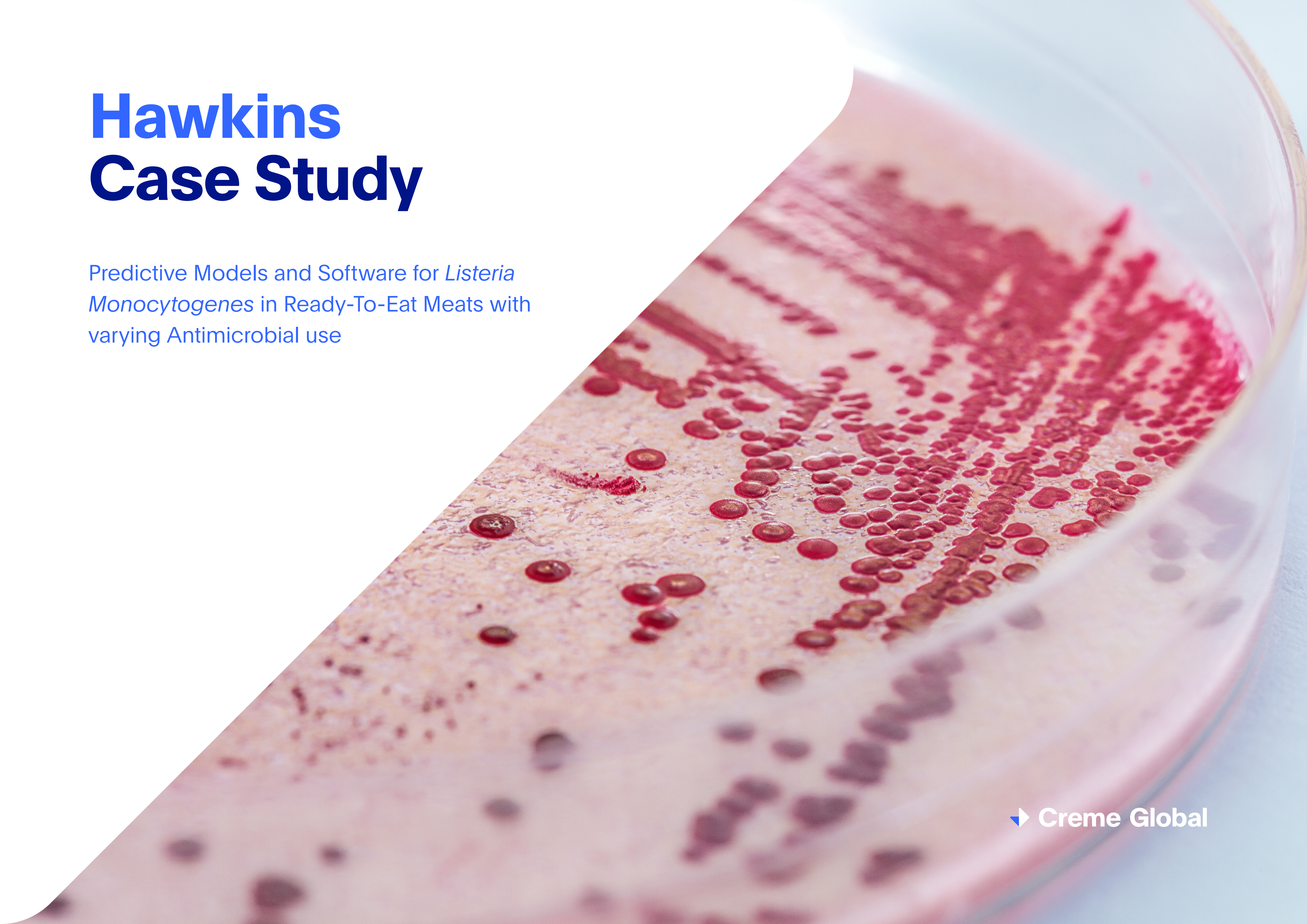
Hawkins
Case Study

Predictive Models and Software for *Listeria Monocytogenes* in Ready-To-Eat Meats with varying Antimicrobial use



About the Project

Antimicrobials are used to control the growth of microorganisms in foods under different product formulations, and predictive models derived from experimental data can be used to estimate microbial growth. The goal of this work was to develop a predictive model and software application that will estimate the growth of *Listeria monocytogenes* in ready-to-eat meats with different formulations and anti-microbial concentrations.

Upon the successful validation of the models, both were incorporated into a web-based application with an easy-to-use interface. The model allows the user to predict the patterns of microbial growth and death for different combinations of environmental conditions for which experiments were not previously carried out.

Who are Hawkins?

"Hawkins is recognized as a leader in the development, production and application of antimicrobial systems. Our primary lines, UltraLac, Ultra-Pure and e(Lm)inate, are based on the proven science of lactates, diacetates, acetates and vinegar to help you control *Listeria* and pathogens, extend shelf life and improve food safety."

Services Provided

Advanced Model Creation
Software Development
Safe Data Collection
Data Wrangling

Methods

Environmental variables such as pH, moisture and salt, are determinants of growth. Here the levels of such quantities are used to define the different meat products, and are the inputs for the modelling of bacterial growth.

In order to understand how different combinations of conditions affect the growth of *Listeria* in the product, two mathematical models of bacterial growth were developed. The first mathematical model describes the effect of changing the environmental conditions (moisture, NaCl, pH) for different concentrations of the antimicrobial used. The second model describes the effect of changing the environmental conditions (moisture, NaCl, pH) where no antimicrobial formulation was used.

18 experimental data sets describing microbial growth with different levels of moisture, NaCl, pH, and the antimicrobial e(Lm)inate LAD were used to develop the model, including controls. In experiments where growth was observed, the Baranyi Roberts model was used, and a linear model was used where inactivation due to the use of antimicrobial was observed. Secondary modelling to examine the influence of formulation parameters involved the use of Locally Weighted Polynomial Regression (LOESS), and the final results were integrated into a web-based software application.

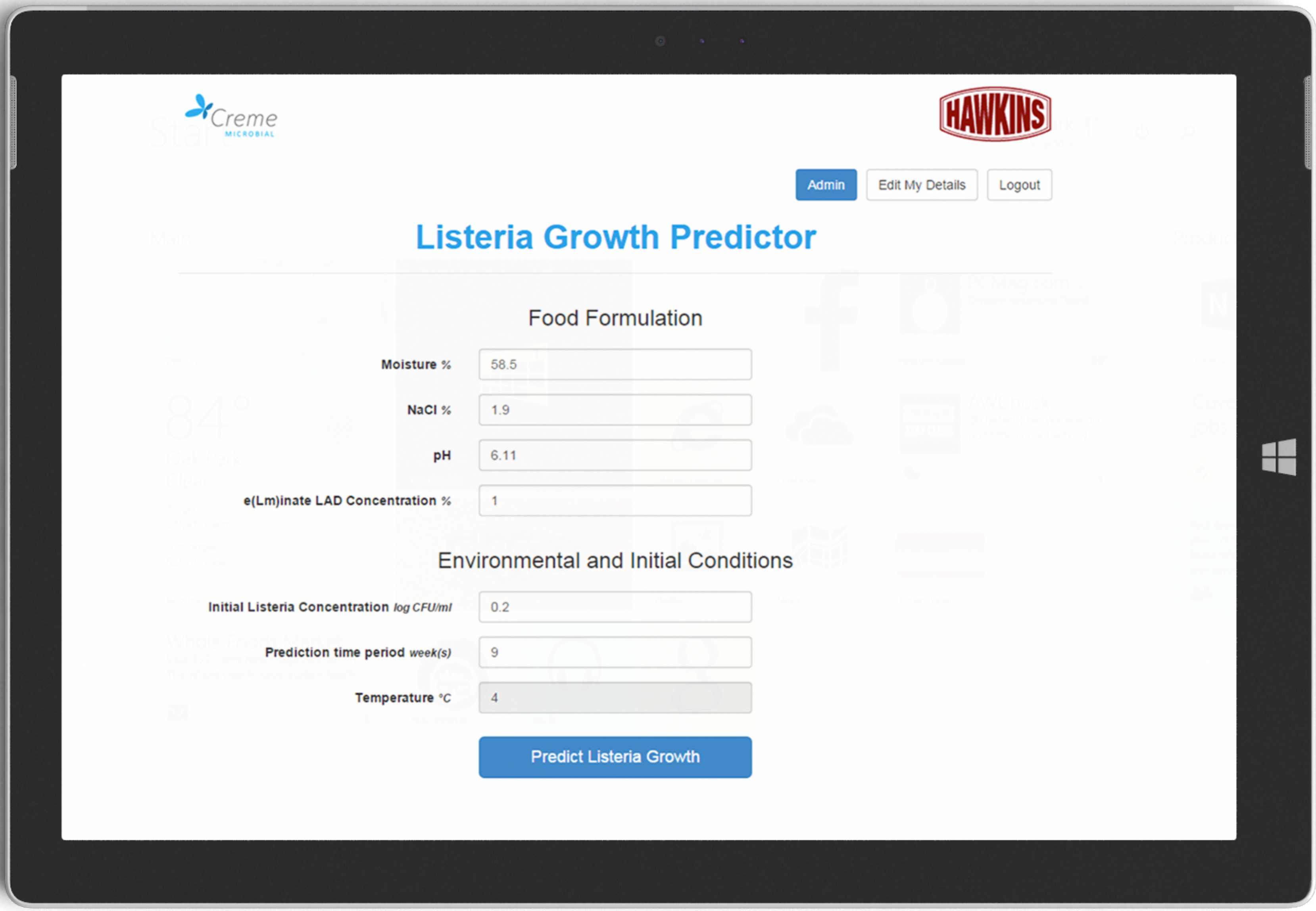
Best Model Selection

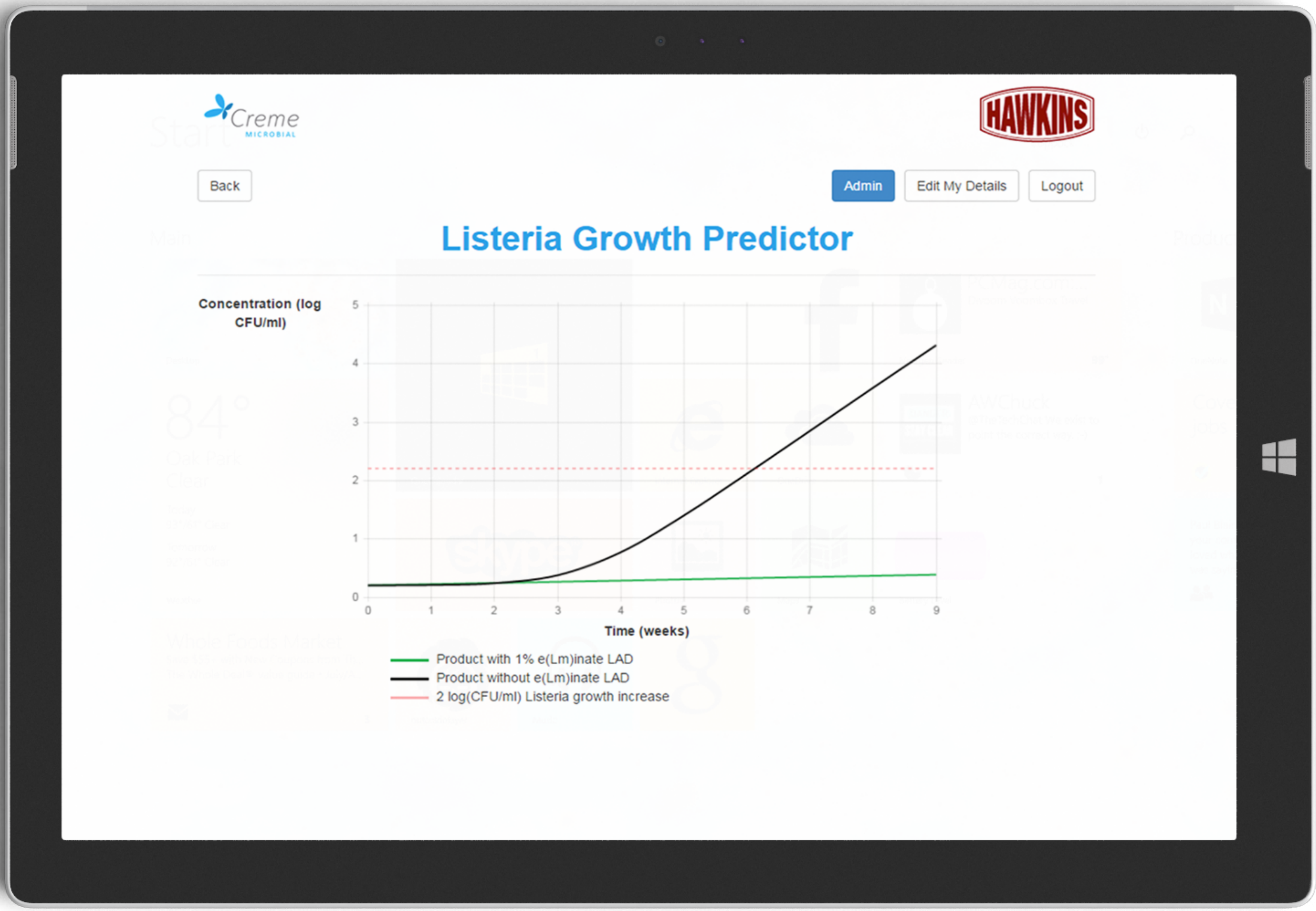
The best statistical model to estimate the parameters of growth was selected using the following criteria:

- Biological significance: Parameters of the selected model should be biologically meaningful.
- Parameter significance: The estimates of model parameters should be significant.
- Residual analysis: The difference between observed and predicted values should be minimized; model assumptions such as normality of residuals should be satisfied.
- Akaike Information Criterion (AIC): The quality of the model is measured and compared against other candidate models. AIC estimates the information lost when a given model is used to represent the process that generates the data. Since the aim is to minimize the amount of information lost, the model which minimizes AIC is selected to be the best fit.

Results

The results of primary and secondary models were used to develop a user friendly *Listeria* Growth Prediction tool. The full range of experimental conditions were used as options in the final software application. This tool allows for prediction of lag time and the growth rate at NaCl, moisture and pH values for different concentrations of e(Lm)inate. The tool can be used to estimate the number of weeks it would take for *Listeria* to show 2 log count increase under specified environmental conditions.


Creme
MICROBIAL
HAWKINS
Admin
Edit My Details
Logout
Listeria Growth Predictor
Food Formulation
Moisture % 58.5
NaCl % 1.9
pH 6.11
e(Lm)inate LAD Concentration % 1
Environmental and Initial Conditions
Initial Listeria Concentration log CFU/ml 0.2
Prediction time period week(s) 9
Temperature °C 4
Predict Listeria Growth


Creme
MICROBIAL
HAWKINS
Back
Admin
Edit My Details
Logout
Listeria Growth Predictor
Concentration (log CFU/ml)
Time (weeks)
Product with 1% e(Lm)inate LAD
Product without e(Lm)inate LAD
2 log(CFU/ml) Listeria growth increase

References

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3. Mafart P, Couvert O, Gaillard S, Leguerinel I (2002) On calculating sterility in thermal preservation methods : application of the Weibull frequency distribution model. International Journal of Food Microbiology, 72, 107-113.
4. Geeraerd AH, Valdramidis VP, Van Impe JF (2005) GInaFiT, a freeware tool to assess non-log-linear microbial survivor curves. International Journal of Food Microbiology, 102, 95-105.
5. Baranyi J., Pin C. and Ross T. (1999). Validating and comparing predictive models. Int. J. Food Microbiol. 48, 159-166.

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