Staphtox predictor – a dynamic mathematical model for predicting the formation of staphylococcus enterotoxin during processing of meat

Annemarie Gunvig, Mette S. Andresen and Claus Borggaard
DMRI, Danish Technological Institute,
Gregersensvej 9, 2630 Taastrup, Denmark

CÓRDOBA, SEPTEMBER, 2017
ICPMF10
INTERNATIONAL CONFERENCE ON PREDICTIVE MODELLING IN FOOD

DANISH MEAT
RESEARCH INSTITUTE

INTRODUCTION

- Existing growth models for *S. aureus* predict growth in relation to temperature, a_w/NaCl and pH. The assessment of Staphyloccus Enterotoxin (SE) formation is based solely on the number of *S. aureus*
- High numbers of *S. aureus* do not necessarily result in SE formation (Notermans & van Otterdijk, 1985)
- There is a significant increase in the growth rate for bacteria in the planktonic state compared to immobilised bacteria on surfaces (Becker et al., 2001; Beenken et al., 2004)
- Data - from experiments conducted in meat, including measurements of both the number of bacteria and SE formation in combination with relevant variables - will result in more reliable predictive models

OBJECTIVE

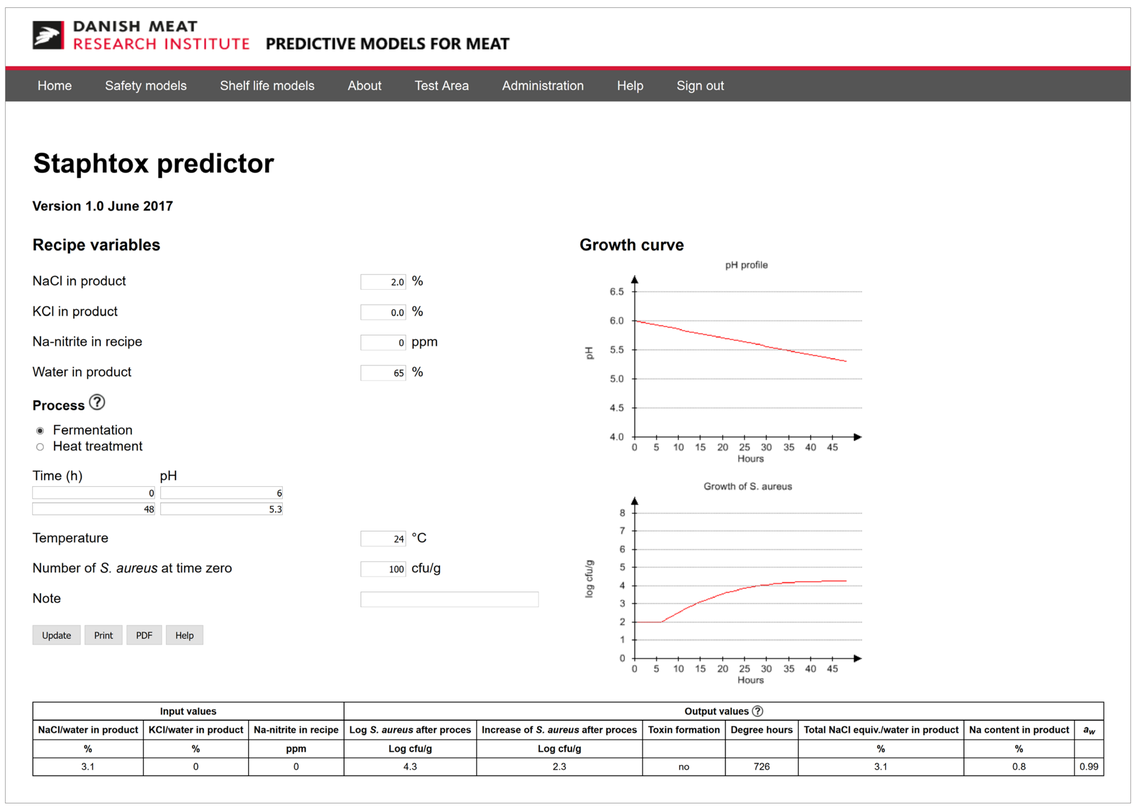
The objective was to develop a mathematical model that predicts the probability of SE formation and the increase in the numbers of *S. aureus* during mild heat treatment or fermentation of meat.

RESULTS

The growth model is fail-safe with a mean deviation of -0.078 $\log_{10}$ cfu/g and a mean absolute deviation of 0.65 $\log_{10}$ cfu/g

The SE model was able to predict all occurrences of toxin formation in the validation data set.

The model is implemented at the user-friendly interface at www.dmripredict (free access)



Input values			Output values						
NaCl/water in product	KCl/water in product	Na-nitrite in recipe	Log *S. aureus* after proces	Increase of *S. aureus* after proces	Toxin formation	Degree hours	Total NaCl equiv./water in product	Na content in product	a_w
%	%	ppm	Log cfu/g	Log cfu/g			%	%	
3.1	0	0	4.3	2.3	no	726	3.1	0.8	0.99

References

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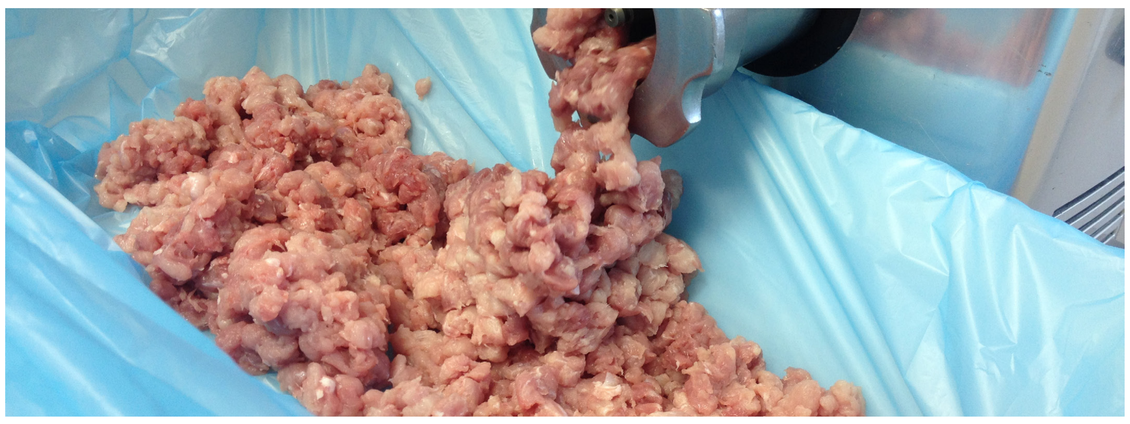
Acknowledgement

The project was funded by the Danish Pig Levy Fund

METHODS



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Adjustment of pH with GDL

Inoculation with a cocktail of 4 strains of *S. aureus* producing SE A-D

In total, 78 combinations of temperature (10-40°C), WPS (2.2-5.6%) (salt), pH (4.6-6.0) and nitrite (0-150 ppm)

Sampling over time and plate counting of *S. aureus* and total viable count (TVC)

Extraction of SE from samples with > 10^5 *S. aureus*/g. The extract was analysed for SEA-E by an ELISA method (Ridascreen Total SET from R-Biopharm, Art. no. R4105)

Calculation of lag phase and growth rate

DEVELOPMENT OF MODEL

- A neural network model for predicting the growth of *S. aureus*
- The predicted number of *S. aureus/g* is input for a logistic model that continuously is applied to calculate the probability of SE formation in combination with the temperature and pH during a dynamic process

$$z = -11.39 + 0.0358 \cdot T + 0.083 \cdot logCFU^2 + 0.0073 \cdot T \cdot pH + 0.012 \cdot T \cdot logCFU$$

$$Abs = 4 \cdot Abs_{norm} = 4 \cdot \frac{1}{1 + e^{-z}}$$

ANNEMARIE GUNVIG,
AGG@TEKNOLOGISK.DK