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Rabeler, Felix; Skytte, Jacob Lercke; Feyissa, Aberham Hailu

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Modelling the colour changes of chicken breast meat during convective roasting

Felix Rabeler, Jacob Lercke Skytte and Aberham Hailu Feyissa

Food Production Engineering Group, National Food Institute, Technical University of Denmark
email: felra@food.dtu.dk

The color of cooked chicken meat is the first quality parameter evaluated by the consumer even before the actual consumption. The aim of this study was to combine the mechanistic model of heat and mass transfer with kinetic models to predict the color development (CIELAB lightness parameter, $L^*$) of chicken breast meat during convective roasting. This will further our understanding of the cooking process and improve predictions and control of the product quality.

**Model of heat and mass transfer**

Heat transfer:

$$c_{p,cm} \rho_{cm}\frac{\partial T}{\partial t} = \mathcal{V}(k_{T,m} \frac{\partial T}{\partial x}) - \mathcal{V}\rho_w c_{pw} \frac{\partial w}{\partial t}$$

Mass transfer:

$$\frac{\partial C}{\partial t} = \mathcal{V}(-D \mathcal{C} + C \frac{\partial w}{\partial x})$$

**Modelling the browning process**

The browning of the surface is mainly a result of Maillard reactions. It was modelled with a first order reaction and the reaction rate constant described as function of temperature and water activity:

$$\frac{\partial L^*_b}{\partial t} = -k_b(T, w) L^*_b$$

$$k_b = \rho_0 + \frac{\rho_1}{w_0} \exp\left(-\frac{p_2 + \rho_1}{w_0} \frac{1}{T(t)}\right)$$

**Combined modelling of color changes**

The kinetic model for whitening and browning was combined with a step function $f$ which allows the prediction of the color development of both stages

$$\frac{\partial L^*_c}{\partial t} = f \frac{\partial L^*_w}{\partial t} + (1-f) \frac{\partial L^*_b}{\partial t}$$

First, the missing kinetic parameters ($\rho_0, \rho_1, p_2, p_3$) were estimated (Fig. 3 A). Subsequently the model was validated with an independent data set, as shown in Fig. 3 B and C.

**Conclusion**

- A combined modelling approach was used to simulate the color changes of chicken breast meat during roasting.
- The developed model is able to predict the color change inside and at the surface during roasting for different process temperatures.
- The developed model can be used to control and optimize the roasting process to ensure the safety and quality of the product for the consumer.