Dependency of the fat content on the effective diffusion of water in raw sausage mass

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Background

The industrial process of raw sausage ripening should not only be based on practical experiences. For an optimization of the drying process of raw sausages the physical transport properties of these process need to be known. By knowledge of the transport phenomena inside the sausages optimal conditions for an new strategy on raw sausage ripening can be found.

In literature only a few data concerning the determination of the diffusion coefficient in meat, respectively in dry sausage can be found (Mittal *et al.* 1983; Motarjemi, 1988; Rödel & Hofmann, 1982; Ruiz-Cabera, 1998).

Objectives

In this work results from a new method described from *Kottke et al.* 1996 and Leutz 1999 are presented. The diffusion coefficient inside the sausages is examined by a combination of measurement and numerical simulation (Damm *et al.* 1998). The influence of the fat content on the inner transport parameter is studied.

In food and especially in sausages, the mass transport is not just pure diffusion, but it is based also on other transport mechanisms, for example salt transport towards the core of the dry sausage (Rödel & Hofmann, 1982). Therefore, for the description of the overall water transport an effective diffusion coefficient D_{eff} was introduced by Spiess & Wolf (1989). A mathematical formulation of this diffusion coefficient in dependency on the local water content is given.

Methods

A numerical model of the raw sausages is built within the commercial CFD-program (computational fluid dynamics) FIDAP. In this model the exact geometrical data of the sausage samples are built by a set of finite elements, to which the initial conditions of the measurements are implemented as well as the time dependent mass flux derived from measurement data. An instationary analysis of the problem, focusing on the distribution of the water content in the samples, is performed. By comparison of the results of the simulation and the measurements the effective diffusion coefficient can be evaluated iteratively in dependency on the local water content in the sausage mass (Fig. 1).

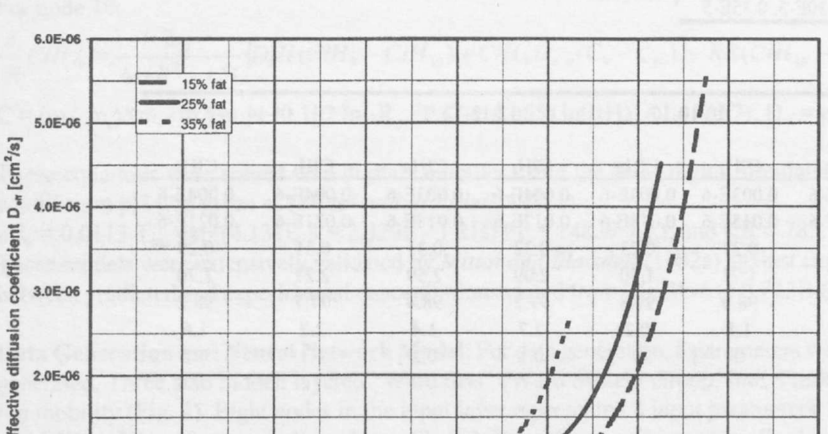

Fig 1: Effective diffusion coefficient of water D_{eff} in dependency on the local water content c_w in raw sausage mass at different fat contents.

With the generally approved assumption, that fat has no interaction with the water transport in the sausage mass the local water content c_W in sausage can be transformed by the following equation to a local water content in the lean meat content c_{WM}:

$$C_W = \frac{M_{Water}}{M_{Water} + M_{Fat} + M_{Meat}} \quad \text{leads to :} \quad C_{WM} = c_W \cdot \frac{(M_{Meat} + M_{Fat})}{M_{Fat} + c_W \cdot M_{Meat}}$$

with the mass of water M_{Water}, the mass of fat M_{Fat} and the dry mass of the lean meat content M_{Meat}. Now the dependency on the local water content of the effective diffusion coefficient in the sausages as well as in the lean meat without fat can be calculated (Fig. 2).

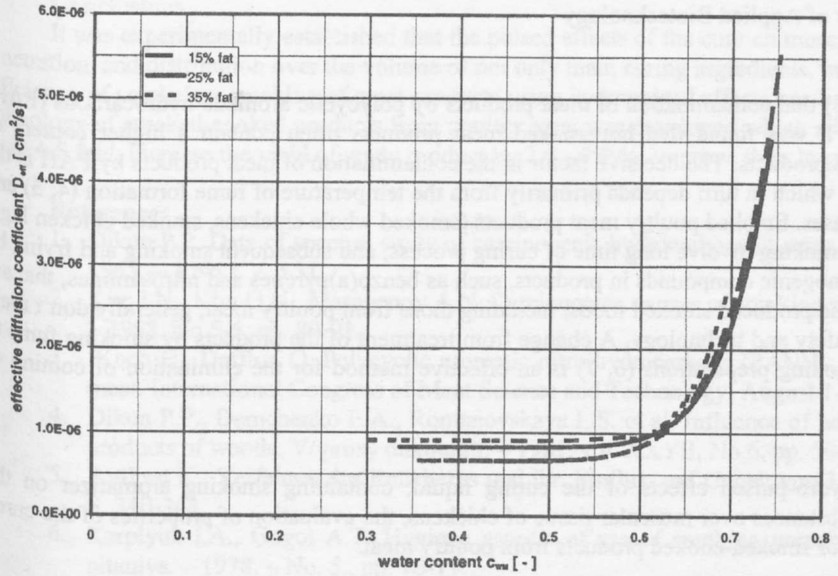

Fig 2: Effective diffusion coefficient of water D_{eff} in dependency on the local water content c_{wM} in the lean meat content of raw sausage mass at different fat contents.

Results and discussion

In Fig.1 the determined effective diffusion coefficients of water in raw sausage mass at different fat contents are presented. It shows the effective diffusion coefficient at a fat content of 15%, 25% and 35% versus the local water content in the sausage mass at pH = 5 and temperature T =20°C. In Fig.2 the same data are presented versus the local water content in the pure meat rate where the fat rate is eliminated as shown above. These Diagram shows, that the influence of the fat content on the effective diffusion can be calculated by a combination of the above discussed equations and the following one, which describes the mapped curves.

$$D_{eff} = A \cdot \exp\left(\frac{-B}{c_W}\right) + C$$

Conclusions

These data can now be used to perform calculation on real sausages with any fat contents to get optimal condition for the drying process.

Acknowledgement

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Pertinent Literature

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