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Physical phenomena in meat science and technology: Approaches to finding new solutions to food formulation and processing problems (#42)

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Short Abstract

Meat products constitute an important food product category in terms of overall volume and sales in the meat industry. In some countries such as for example Germany, more than 70% of all meat is consumed in the form of meat products. The manufacture of meat products involves a series of sequentially carried out process operations to transform the required raw materials into a final, shelf-stable product matrix. The properties of the so-created matrix and its shelf-life depends not only on microbiological or (bio) chemical processes. In fact, a great many physical phenomena may occur in these matrices, including for example mass transport, molecular and colloidal interactions, phase transitions and separations, surface or interfacial adsorption, deformation and flow, as well as light refraction, absorption and scattering. This can arguably have a substantial impact on the quality of products. An understanding of these phenomena may therefore facilitate an efficient and optimal process design, and improve formulation guidance. Knowledge of these phenomena could thus be quite valuable for the meat industry enabling for example the manufacture of higher quality products at lower cost. It may also allow for the development of completely new, yet unknown product concepts. Surprisingly though, knowledge of these physical phenomena as they occur in meat and meat products is relatively scarce. In this overview talk, we will thus attempt to look back at research done in our (and other) laboratories over the past 10 years where physical phenomena were increasingly found to play a significant role in the behavior and manufacture of various meat products. Specific examples that will be highlighted in the talk include firstly phenomena that occur during comminution and emulsification of meat and fat, i.e. the fact that certain size reduction processes are more or less effective yielding broader or more narrow particle size distributions, as well as generating more or less heat during the size reduction process. This can be attributed not only to volume specific energy inputs and residence time distributions, but also specific rheological properties leading to combinations of irreversible and reversible deformations in meat and fat. Moreover, the functionality of food additives such as antimicrobial or antioxidants in meat product matrices will be discussed. There, our studies have shown that mass transport phenomena, and in particular partitioning processes if additives are used e.g. in a dispersed form influence activity, and thus quality and safety of products. Next, the effect of addition of different non-meat macromolecules such as plant proteins or hydrocolloids to meat batters as well as the generation of such macromolecules by EPS generating starter cultures will be discussed. Here, results of our research have indicated that molecular interactions leading either to phase separation or macromolecular aggregation are responsible for wanted or unwanted textural changes in meat products. We will then have a look at the process of efflorescence formation in raw fermented sausages, which constitutes a case where mass transport coupled with crystallization lies at the root cause of the observed phenomenon. Finally, we will share some early insights into the issue of iridescence in hams, which appears to be due to a complex refraction processes caused by muscle fibers. There, destructive and constructive interferences in scattered light may take place leading to green to golden shimmering colors. Taken together, the talk is thus designed to provide evidence for the increasingly important and emerging role of physics and material science. In the end, we intend to highlight the usefulness of these disciplines for the field of meat science.

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