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COOKED SAUSAGE BATTER – PHYSICAL PARAMETERS

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Introduction

Much about the technology of successful production of cooked sausage batter is known. Some became published in the “Kulmbacher Reihe” in the volume "Technologie der Brühwurst" (Technologie der Brühwurst, 1984). Additionally, factors, which cause the ability of the salted meat to stabilize the heated sausage, are identified (Hamm, 1972). On combining of these areas of knowledge and regarding general principles of chemistry, reasons for strong water and fat- separation of the sausage, for unsatisfactory bite and in principle for all product properties and/or their lack can be found.

Our institute cooperates with 12 other research institutes within the European Union on the research- project REDALL. Within the frame of this project the allergenicity of food of animal origin shall be reduced. It is likely that by each treatment of food, and then of meat, its allergenicity can be affected. The comminution during chopping of meat, for instance, for the production of cooked sausage batter, surely is an intensive treatment. During the cutting in a bowl chopper energy is applied to the batter. This application of energy can contribute to a change of the allergenicity of the meat/ the cooked sausage. The following has to be considered.

The chopper is electrically propelled. The electricity is converted into energy of movement of the knives. Thereby some losses develop before the knives rotate. These losses can be quantified only very heavily or not at all.

So we are observing transformation of electricity into kinetic energy of the chopper-knives. The energy consists of several components, which are not easily separable from each other. We assume that a part of the energy is used for the size reduction of the raw materials. Further the raw materials are moved. That means that another part of the energy is used for the transportation of the batter. During cutting and local movement friction develops. The friction between batter and knives leads to a transformation of mechanical energy into heat- energy. So the energy, which is consumed during chopping, has to be differentiated:

1. Some part of the kinetic energy is transformed into heat energy. It determines the temperature- history of the batter during the process of chopping. The developing heat can be explained by friction between knives and batter. That is, viscosity- effects arise. Therefore it is of importance to follow the viscosity of the batter.

2. The second area of investigation concerns the electricity consumed by the chopping- knives and/or the shaft of the chopper.

Objectives

The following questions arise:

Does the energy, consumed by the knives, change with increasing destruction of the meat and – connected with that - with rising temperature of the batter?

Or, the other way:

Which effect has the transfer of energy into the batter, in how far do its physically measurable characteristics change?

Which physical methods are suitable for a description of the batter changes?

Methodology

We measured the viscosity with a modern equipment (Rheometer AR2000 from TI, see fig. 1), which permitted the measurement of the tested material at different temperatures. The opinion, the temperature rise of the batter during the chopping results from an increasing viscosity of the batter during chopping, is frequently expressed - it should be examined however.

We proceeded as follows: Batters were chopped up to 0°C or up to 20°C. In the rheometer the measurements were made at either 0 or 10 or 20°C. That is, a batter for example chopped to a temperature of 0°C was measured three times, at 0, at 10 and at 20°C. Measuring was made in each case with a new sample. The investigations were repeated 4 times.

It is known from direct observation of the chopping process and examination of the batter with the hand (hand- feeling), that the batter changes during the chopping process. It appears to become tougher and tougher, as long as the temperature doesn't rise over about 12°C. For the sensitivity of sensory perceptions of the hand there is so far no other method. It appeared however not senseless to fasten a geometry, which is immersed into the batter, to a scale and measure the strength, with which the batter in the chopping process flows against that geometry (fig. 2). These results should explain at least a part of the hand impression. It was interesting whether there is a relationship between the results of the strength measurement and those of the viscosity measurement.

Further, in the past due to the measurement of the electrical power, which is consumed by the chopper, criteria were developed at which time the chopping process can be stopped (Grabein and Raeuber, 1988). During the chopping process the consumed power shows a typical curve, which exhibits a maximum. Briefly after this maximum the chopping should be terminated. Whether this consumption of power is correlated with the viscosity and the strength, which the batter causes by flowing against a geometry, was a further question which should be clarified.

Results & Discussion

First we regard the viscosity of the batter, as affected by the measuring temperature, the temperature of the rheometer- geometry (fig 3). Clearly the rheometer temperature

affected the viscosity of the batters. At rheometer temperatures of 20°C the batters were low viscous. On measuring at 10°C, they behaved more viscous. The highest viscous, most tough, the batters were, when they were measured at a temperature of 0°C. The connection between viscosity and temperature of measurement existed as well for batters chopped to only 0°C as for very intensively, to 20°C, chopped batters. Due to these results it was completely clear that the temperature of measurement had a substantial influence on the viscosity results.

After recognizing these effects of the measurement temperature, it was clear that for pursuing the change of viscosity during the chopping, a constant rheometer- temperature could not be used. Namely the knives move a batter, which exhibits different temperatures at different times. The viscosity at the respective chopping temperature must therefore be of interest.

If the temperatures of the batters and their measuring temperatures were the same, another picture resulted (fig 3). It is obvious, that batters chopped to higher temperatures were less viscous than those, chopped to a lower temperature. With rise of the chopping temperature, the knives have to transport a less viscose, a less tough mass.

There is by viscosity measurements no hint about the formation of a batter structure, a so-called secondary structure, on chopping.

As it is well known, the batter temperature drops first under 0°C (fig. 4), if ice and not water is added. On further chopping it stays for a short time at these temperature and rises then monotonously, but not linearly up to the desired chopping end-temperature.

The electric power taken up by the chopper is transferred without large losses to the batter. At the beginning of the chopping only the tissue particles are cut by the knives, later they are primarily mixed and rubbed. These changes corresponded with the power and strength measurements. Three sequential phases of consumed electrical power could be recognized (fig. 4): An initial rise of the electrical power to a maximum, afterwards a nearly constant phase and a following flatter decrease of the electrical power.

The strength of the batter – measured with a geometry, which was immersed into the batter during chopping, corresponded, however temporally retarded, approximately to the electrical power consumption of the chopper (fig. 5). With increasing gluing of the chopped components and the increase of their specific surface, probably also with the increase of protein swelling, it was more and more difficult for the batter to flow around the geometry. The batter had to develop an increasing strength. In the second phase the strength decreased, probably because with rising temperature viscosity effects dominated increasingly.

Up to the maximum of the strength and up to the plateau of the power consumption the batter became chopped more and more intensively and became more and more sticky. At later times, and after the temperature curve bent, effects of viscosity dominated. The exact time of bending of the temperature curve depended on a couple of effects. We found so far an influence of shaft revolution, batch size and recipe. The phenomenon arose at approximately 5 to 9°C.

A connection between the shear viscosity and the results of the strength and power measurements did not exist. Conditions in the shear gap of the rheometer and in the chopping bowl are not comparable.

Concerning the transformation of kinetic energy of the knives into friction, there were two cases to differentiate: Sliding friction between batter and knives and the innner or

viscose friction between the batter particles. Only influences of the viscose friction can be identified by viscosity measurements with the rheometer.

The heat development resulting from friction of the knives in the batter was measured with a high-speed IR camera. It turned out that the knives do not warm up very much. The knife edges became at most about 5°C warmer than the batter (fig 6).

Conclusions

On chopping cooked sausage batters, the viscosity decreases with a rising temperature during comminution.

The strength of the batter increases during chopping and until a temperature of about 6 to 10 °C is achieved. At higher temperatures the strength decreases.

The consumed electrical power shows three phases. After starting the chopping process it rises (phase 1). After continuing the chopping a plateau develops (phase 2). After that the consumption of electrical power decreases.

The temperature of the chopper knives is maximally 5°C higher than the temperature of the batter.

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Tables and Figures

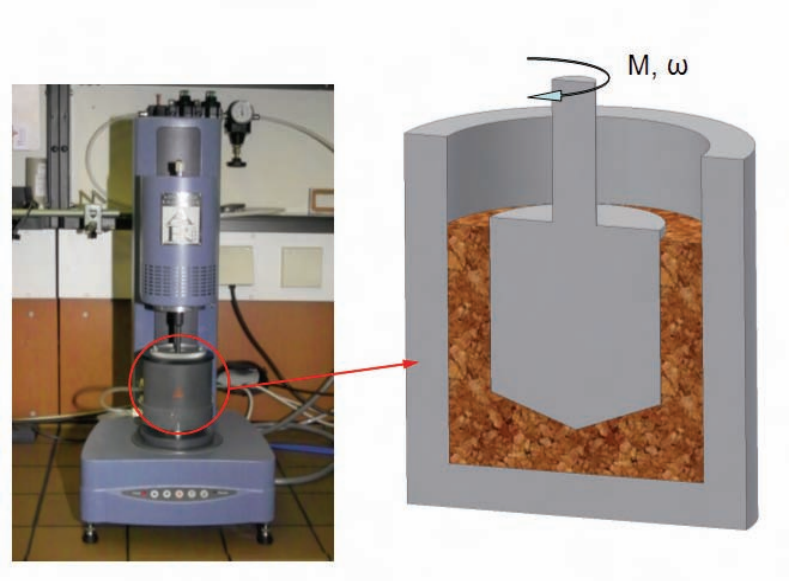

Fig. 1: Rheometer for measurement of viscosity. Searl- geometry (see right side) attached.

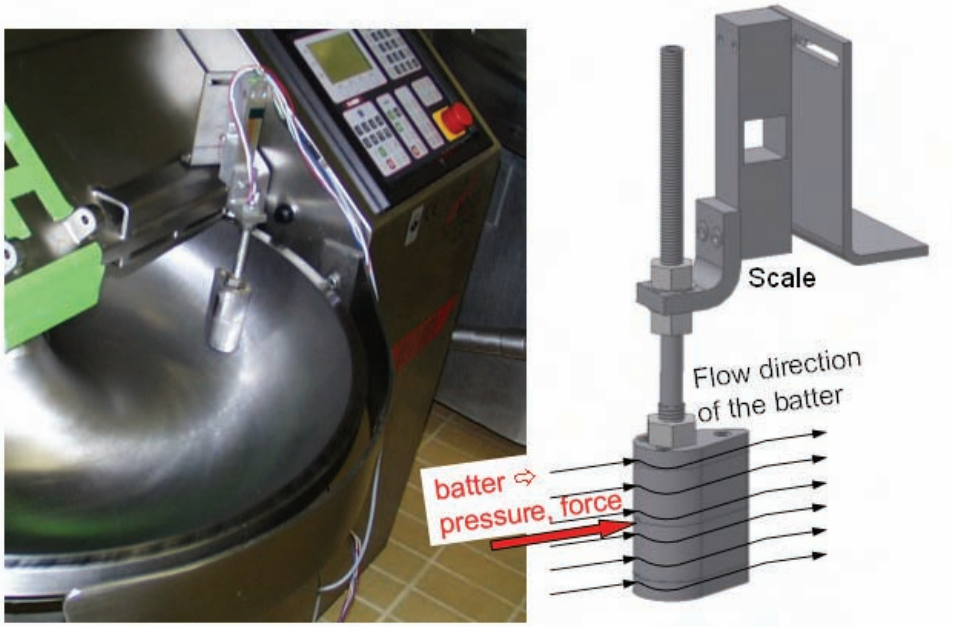

Fig. 2: Geometry in the batter for strength measurement

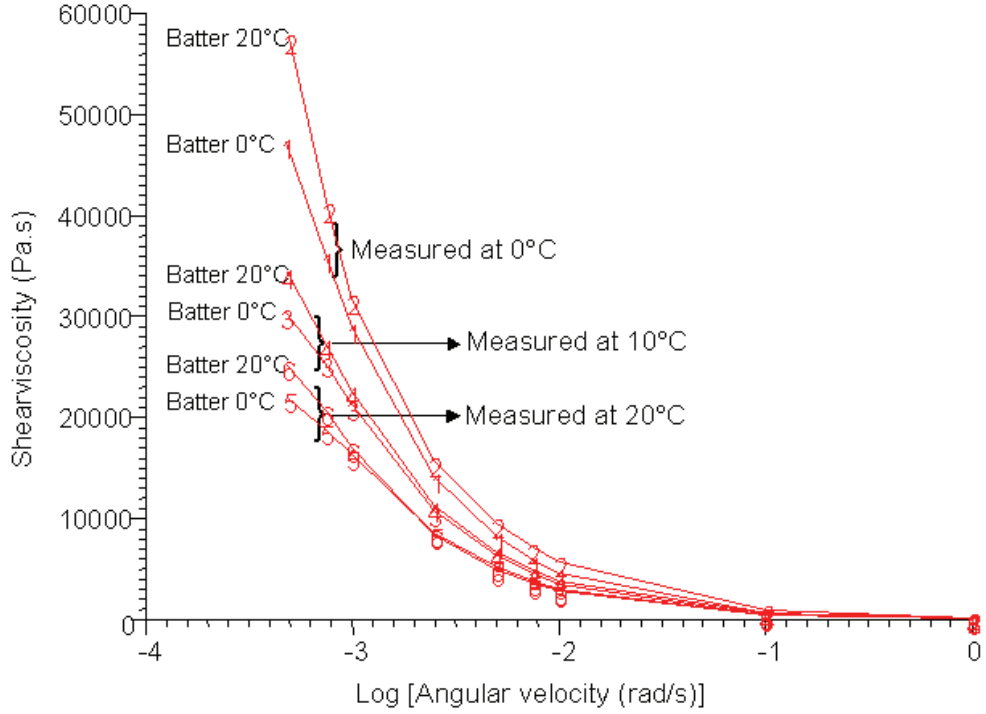

Fig. 3: Measurement of the shear viscosity of batters at different chopping temperatures and different measurement temperatures

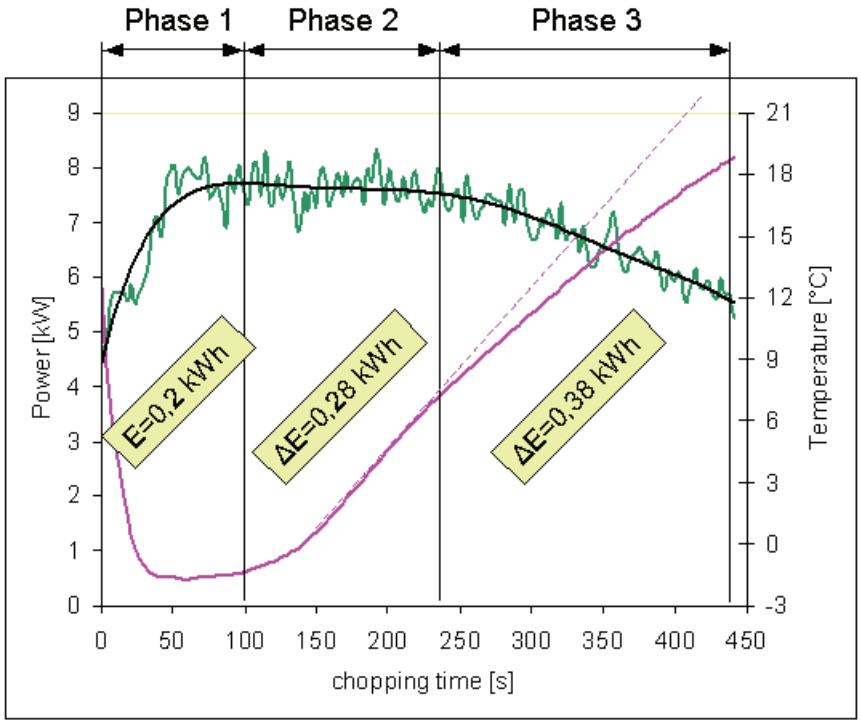

Fig. 4: Measurement of the electrical power consumption of a bowl-chopper and the temperature during the chopping process

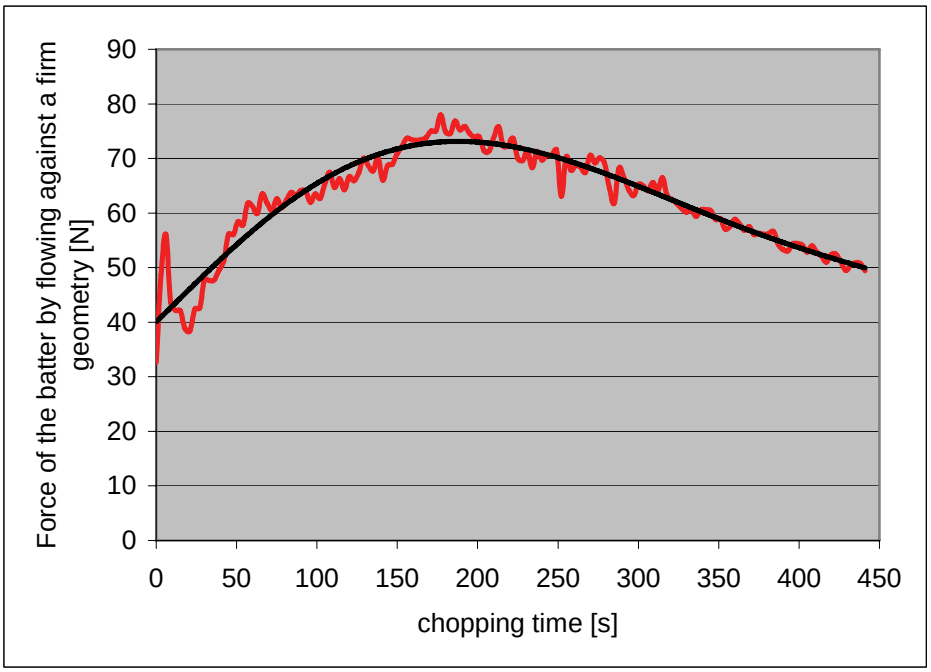

Fig. 5: Force of the batter by flowing against a firm geometry during the chopping process

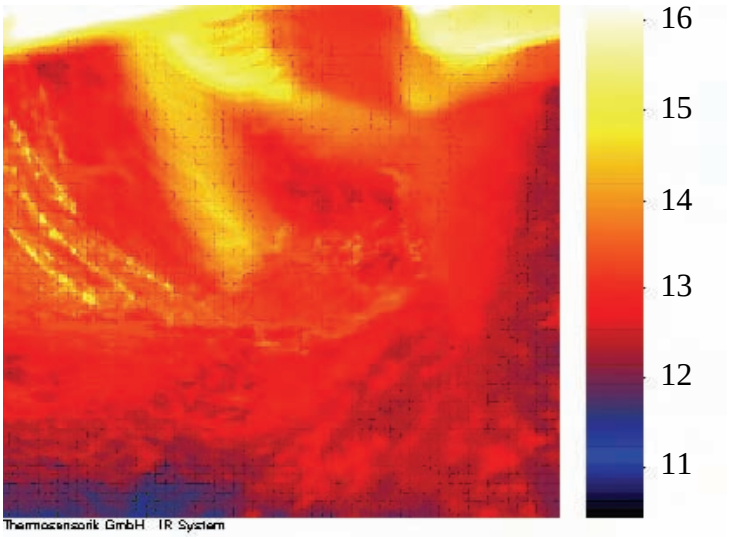

Fig. 6: Thermographic picture of the chopping process: traces of heat in the batter