IMPROVING THE PROCESS OF SMOKING FRANKFURTERS BY MEASURING THE SURFACE ACTIVITY OF WATER

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Background

Smoking Frankfurters, especially using natural casings, still causes problems regarding the smoked color, the smoked taste and the chewing impression. The reactions for building the smoked color and hardening the casing structure have been well known for a long time [1, 2, 3], but there are no systematic studies whereby this process is affected.

Objectives

The aim of this study was to establish an easy-to-handle method of measurement for recording data of physical measurands to describe the smoking process and perhaps even have the process controlled. The internal and external parameters of the smoking process can therefore qualitatively and quantitatively be assigned to the smoking result. One understands parameters like the composition of the formula and the sausage casings used as internal factors here, while external factors include specific parameters like temperature, relative humidity, air flow velocity and the program step sequence. The smoking process can be affected by these parameters but they don't supply any exact description of the sausage surface because the measured values (chamber temperature, relative humidity etc.) differ strongly depending on the position of the measuring sensors within the chamber. The measuring therefore of the surface activity of water ($a_w s$), a measurand which was known only from the area of the raw sausage ripening [4, 5] util now, has been transferred to the issues of smoking with high temperatures (50 - 60°C).

Methods

Production of the sausages

All sausages were produced with the following standard formula: 30% lean pork (approx. 11% fat), 23% fat trimmings (approx. 70% fat), 15% pork belly (approx. 50% fat) and 10% lean beef (approx. 20% fat), as well as 22% ice. The following ingredients were added per kg of sausage mass: 20 g nitrite curing salt; 2.3 g diphosphate; 5 g spice mixture; 0.5 g ascorbic acid and 0.5 g monosodium glutamate. All batches were produced to a predefined scheme of chopping [6]. The batter was then stuffed with the help of a vacuum filler in natural sheep casings diameter 20/22 (CDS, Crailsheim, Germany). Each batch was packed in PE-foil and stored at 0 °C until the smoking process.

Execution of the smoking process

In this work we used a universal smoking chamber, type "Unigar 1800 (Ness & Co. GmbH, Remshalden, Germany)" with a friction smoke generator. This plant smokes in the closed system (NESS-Circo-Smoke System®) using the air circulation principle without exhaust gas after-treatment. One understands plants as a closed system with the possibility to work in all process steps in the circulation principle. Before the sausages were rinsed, 1mm NiCrNi thermocouples were attached just under the casings (Fig. 1). These thermocouples were part of a data acquisition system (Ahlborn, Holzkirchen, Germany) with whose help all essential data (chamber temperature, relative humidity, surface temperature, core temperature and the surface activity of water) were taken and recorded during the process (Fig. 2).

Results and discussion

The sausages became darker with higher surface temperature. It seemed, however, that at one specific surface temperature (approx. 53°C) the sausages were a little brighter again. Starting at this temperature, a greasy film, which is called "sweat out)" and which handicaps the absorption of the coloring smoke components, exuded on the surface. One does not achieve the success of the smoking process, however, until after rinsing the sausages since this washes out some of the grease and thus also the smoke particles. Various colorings which let the sausages seem stained are also frequently a broader result of this "sweat out".

The time and the manner of the "sweat out)" depended very strongly on the quality of the sausages, conditional on raw materials, formula and way of production. One therefore could not generalize the 53°C found here to be optimum but must adapt the maximum temperature to the formula and the method of production. The dependence of the surface moisture which was expressed by the $a_w s$, was similar (Fig. 3).

The sausages in the natural casings had to be watched; those with a higher $a_w s$ and those with a damper surface got a darker smoked color. A limit could also be noticed here, because an $a_w s$ of over approx. 0.950, the sausages became brighter again. These sausages seemed partly stained. While it was the grease exuding from the surface which handicapped the absorption of the coloring smoke components at high temperatures, it was the free, unbound water which did so to the damp surface.

Upon the sensory examination the trend was that the intensity of the smoked taste correlated positively with the smoked color. The darker a sausage was, the more intensive its smoked taste was. An unpleasant tarry taste arose primarily in batches with high $a_w s$ (> 0.940) and low surface temperature (< 45°C).

It was also noticed that when batches with either very dry ($a_w s$ approx. 0.800) or very damp ($a_w s$ approx. 0.940) surfaces were smoked, these was a tendency towards tougher casings.

Conclusions

By the use of the surface water activity value it is now possible to make a statement about the moisture of the sausage surface during the smoking process without interrupting this process. The smoked color depends mainly on the surface temperature and the $a_w s$ during the process at constant smoking times. The higher the surface temperature and the higher the $a_w s$ of the sausages, the darker they became. This holds, however, for the two results only up to a definite value limit. This limit value is 53°C at the surface temperature for the formula and method of production used here. If this value is exceeded, on the one hand, smoke spots from the grease issuing from the sausage and on the other hand, a wrinkled surface from excessive weight loss can arise. With a modified formula it is possible that even at a lower temperature, for a "sweat out)" to take place and therefore smoke spots arise. These spots arise also, if an $a_w s$ of 0.940 is exceeded.

Pertinent literature

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Fig.1: Attaching the temperature sensors

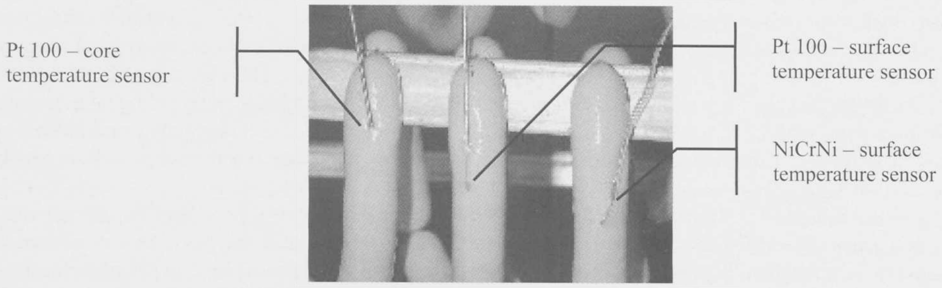

Fig.2: Recorded data during the smoking and cooking process

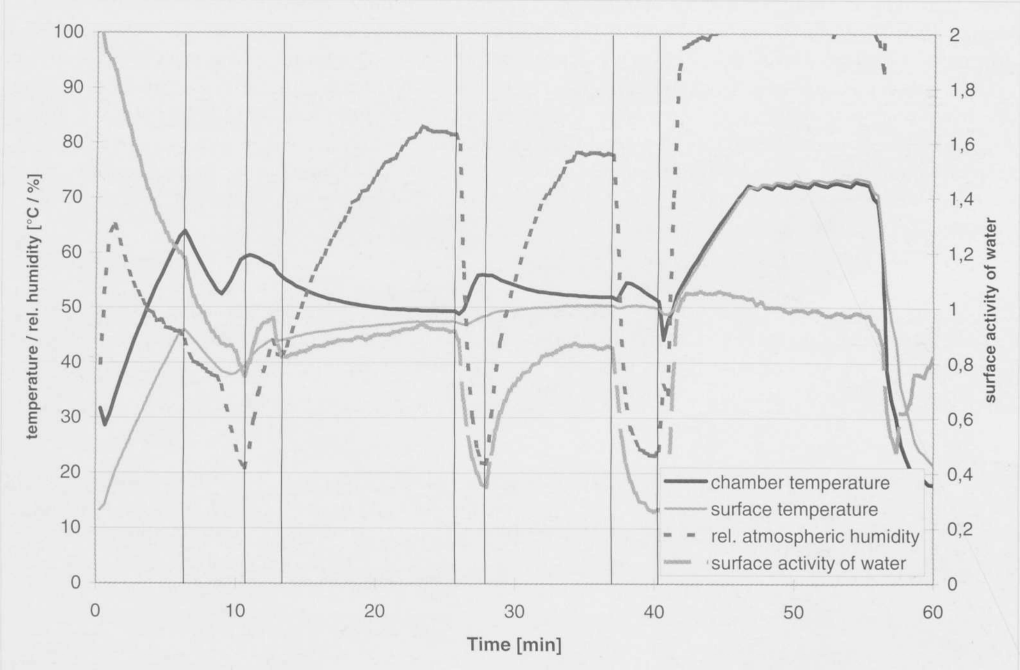

Fig.3: L - Values dependent on the average surface activity of water during the smoking process at constant surface temperatures