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MAPPING THE WATER CONTENT AND WATER ACTIVITY IN CROSS-SECTION OF TRADITIONAL NORWEGIAN DRY-CURED SAUSAGE DURING THE DRYING PERIOD

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I. INTRODUCTION

During the last years, the focus on sustainability in the meat industry has increased. Nortura, the largest meat company in Norway, has been involved in many projects dealing with digitalization and automation at their factories - and thereby developing more sustainable production processes. In the project *DigiSpek - Digital and continuously learning dry cured sausage process*, the goal is to make the production time for dry-cured sausages produced at Nortura's plant in Sogndal more predictable. In addition, the aim is to reduce variation, increase yields and improve the final quality. To accomplish this, it is important to get a better understanding of the variation in raw material and production process – this knowledge can be used to develop dynamic process models for monitoring and management of the production process.

The drying process of dry-cured sausage can be modelled mathematically by considering the *internal transport* of heat and water, and the *surface exchange* with the surroundings. Two key components of such a model are the diffusivity for internal water transport, and desorption isotherm describing the relationship between water content and water activity [1]. Water content and water activity vary greatly from the start to the finish of the production process for dry-cured sausages. By mapping those components throughout the drying period, improved understanding of the processes occurring inside the sausage is achieved. Measuring the weight loss gives additional information regarding the drying rate. These are all important process parameters and are vital for a prediction model. Such a model can be used for improved process control, which will result in e.g., reduced energy consumption and waste, and increased efficiency. The aim of this experiment was to map the water content and water activity in cross-sections of dry-cured sausages and study the relationship between these parameters and the weight loss.

II. MATERIALS AND METHODS

Dry-cured sausages were produced from beef and pork raw material. Meat and backfat were mixed with salt, sugar, vegetable fiber, spices (mustard, garlic, aroma), hydrolyzed vegetable protein (corn), starter culture, and other additives (antioxidant, color, preservative) in a chopper. The meat batter was stuffed into fiber casing with a diameter of 10 cm. Each sausage was around 1 m in length, with circumference of about 30 cm. The sausages were placed in a smoking chamber for one week, where temperature and RH were set as follows: 20°C and 60-70% on day 1; increased to 22-26°C and 90-95% on day 2; then gradually reduced to 18-20°C and 80-85% from day 3. After fermentation and smoking, the sausages were transferred to a drying chamber with a temperature and RH set of 16°C and RH 70-75%, respectively. The batch size was approximately 570 sausages, of which 56 sausages were included in the experiment. The experiment lasted for about 6 weeks.

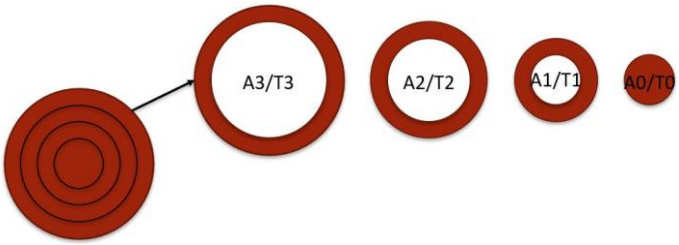


Figure 1. Sample slice for water activity and water content cut into 4 concentric circles, 4 segments from inner to outer part (A0/T0-A3/T3).

Weight loss was measured twice a week, and water content and water activity were measured once a week. As water content and water activity measurements require cutting, samples were replaced by new sausages to prevent empty drying spaces during the trial. Samples were taken from three sausages each week, from two sections of each sausage. Three slices were taken from each section: one 3.8 cm thick for water content; two 0.8 cm thick for

water activity. The sample slice for water content, and one slice for water activity, was cut into 4 concentric circles (Figure 1). The segments were labelled A0/T0-A3/T3 from inner to outer part for water activity and water content, respectively. Water content and water activity were measured for each segment. From the second slice for water activity, a circle of approximately 4 cm in diameter was cut out. This is the same method as the industry applies for their water activity measurements. Salt, protein and fat content were measured in finished sausages. Water activity was measured by a water activity meter (Aqualab, USA). The water content, and other chemical components, was measured by an accredited lab (Eurofins, Norway). Statistical testing was performed with SAS/STAT ® (v.13.1).

III. RESULTS AND DISCUSSION

The average starting weight for sausages was 6.46 kg, and the average final weight loss was 28.6%. The average salt and fat percent were 4.8 and 37.1 %, respectively. The correlation between segments A0-A3 for water activity ranged from 0.9762 to 0.9937. The greatest variation was for the outermost segment, A3 – but all over there were small differences. The water activity values for the different segments, together with the number of drying days, can be combined in a model suitable for estimating the water activity across the dry-cured sausage. The correlation between segments A0-A3 and the industry method for water activity was also high, indicating that the industry method can also be applied for estimating water activity across the dry-cured sausage. As expected, the water content reduced with increased number of drying days. However, the water activity is not a pure function of the water content – as shown in Figure 2.

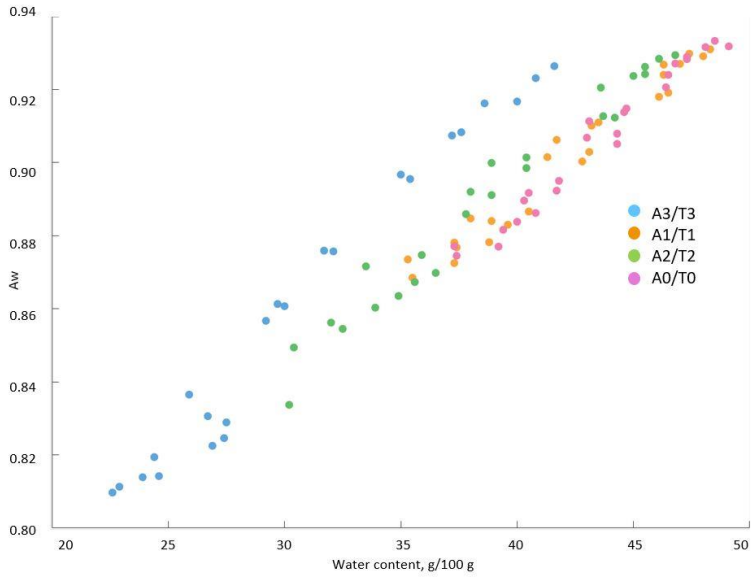


Figure 2. Water activity and water content (g/100 g) in segments of dry-cured sausages during drying, from inner to outer part (A0/T0-A3/T3).

IV. CONCLUSION

The results provide actual data on water activity and water content radially dissolved at different times of the drying process, which makes it possible to study radial water transport directly. The data provides a good basis for modeling the diffusion of water in dry-cured sausages. Further work aims to apply the data for mathematical modelling of the drying process of dry-cured sausage. Please note that, for the mathematical model, only the surface desorption isotherm is relevant. Consequently, only samples from the outermost layer will be included in the regression used in the mathematical model.

ACKNOWLEDGEMENTS

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