MICROWAVE SPECTROSCOPY APPLIED FOR MEASURING WATER HOLDING CAPACITY IN PORK

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Abstract – Microwave spectroscopy has been applied in numerous of applications in the non-food industry, and recently in the food industry, for non-destructive meat quality measurements. In this study, the water holding capacity (WHC) for 40 pork loin samples was measured using microwave spectroscopy, with a rectangular microwave cavity resonator. The WHC was also measured using the reference method, EZ driploss. Attained results indicate that microwave spectroscopy might be a promising technique for determination of WHC in pork.

Key Words – driploss measurements, pork loin.

I. INTRODUCTION

Microwave spectroscopy is a non-destructive technology that can be implemented cheaply, yet be used for a wide range of applications in a robust manner. The non-food industry has applied microwave spectroscopy for measurements in the last few years, including applications for determining particulate blend composition on-line, humidity detection, and biomedical measurements [1-4]. Recently, microwave spectroscopy has also been applied in the food industry with promising results. A previous study showed a good correlation between water activity and microwave measurements in a dry-cured ham model [5].

The ability of meat to retain its water during cutting, heating, grinding and pressing is referred to as water holding capacity (WHC), and is one of the most important quality parameters in pork. WHC affects eating quality (juiciness), amount of saleable product and further processing yields.

Predicting WHC has long been an unsolved measurement challenge that would offer many possibilities in terms of controlling pork processing. The current standard measurement of WHC is offline and destructive, and non-destructive and rapid on-line measurements would simplify and improve the production, by making it possible to measure WHC in trimmings for sorting of carcasses on-line.

The microwave sensor operates in a wide range of microwave frequencies, providing selectivity in real time detection of WHC. The main goal with this study was to investigate whether WHC can be predicted using microwave spectroscopy.

II. MATERIALS AND METHODS

A total of 40 pork loins were selected for measuring WHC in this experiment. The loins were selected after presorting on the slaughter line, based on pH and breed, to obtain as large variation in WHC as possible. The microwave measurements were conducted 24 hours post mortem, and the samples were measured over a period of 4 days. In addition to microwave measurements, all samples were measured using the reference method EZ-driploss (24 hours post mortem).

Preparation of samples for both microwave measurements and EZ-driploss measurements were similar. The samples were prepared as shown in Fig.1. Two slices of approximately 20 mm thickness were taken from the middle of each loin, one slice for microwave measurements and one slice for EZ-driploss measurements. From each of the slices, two samples were taken with a 25 mm diameter borer utilized to cut samples of meat. The meat samples were placed into polypropylene tubes with a lid prior to measurements. The samples analysed using microwave spectroscopy were measured for 30 min at 4°C. The EZ-driploss samples were left for 24 h at 4°C and the weight of the sample before and after, and the amount of water collected below the sample were measured (g).

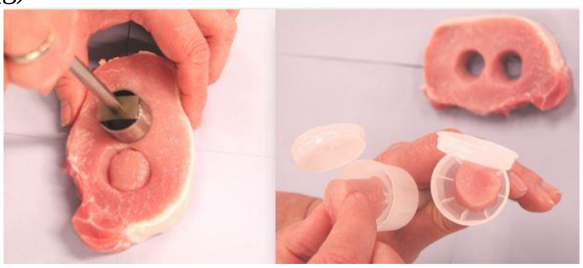

Figure 1. Preparation of samples for microwave measurements. A sample was taken from a slice of pork loin with a 25 mm diameter borer utilized to cut samples of meat. The meat sample was placed into polypropylene tube with a lid prior to measurement.

Microwave measurements of samples were registered at the interval 2-6 GHz. Both the power reflected (S_{11}) from and transmitted (S_{21}) through the sample were registered. The cavity used for microwave measurements is illustrated in Fig.2. This is the same rectangular cavity as designed and used for measuring water holding capacity in raw meat in a pre-study [9].

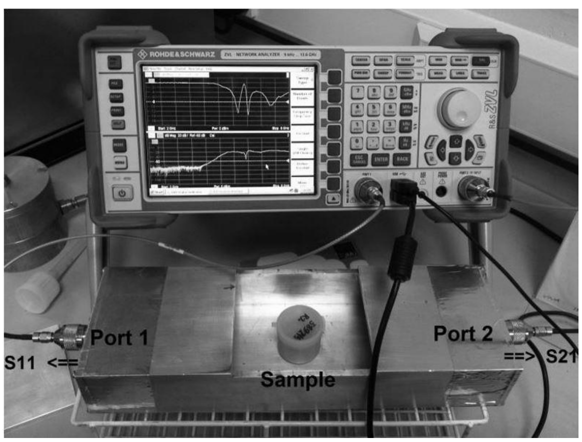

Figure 2. Illustration of the microwave cavity structure, showing where measurements of S_{11} (reflection) and S_{21} (transmission) are required, and position of the sample during measurements.

III. RESULTS AND DISCUSSION

The S_{11} spectra (reflected) was analysed, and a correlation between microwave measurements and EZ-driploss for all 40 samples included in the experiment was observed (Fig.3). The correlation (R^2) was 0.58.

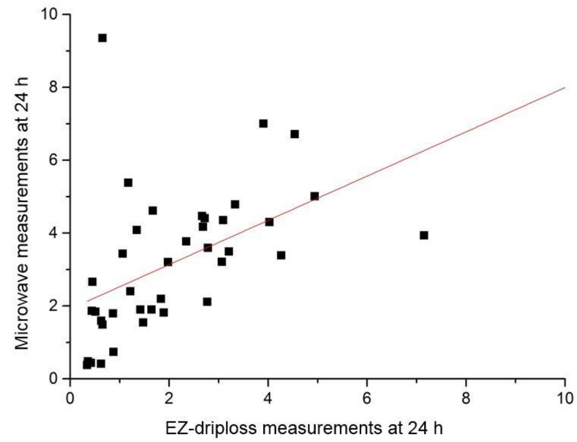

Figure 3. Correlation (R^2 = 0.58) between microwave measurements of S_{11} (reflection) and EZ-driploss measurements for all 40 samples. Both measurements were conducted at 24 h post mortem.

However, for the first 17 samples the sample height in the container was too large, causing pressure (and higher water loss) on samples. From sample 17 onwards, a slight modification to the preparation method was made. The results clearly showed that modification on sample size had impact on measurements, causing an evident grouping of samples (data not shown). Figure 4 shows the correlation between the microwave measurements and EZ-driploss for samples 18-40 (the first 17 samples removed). The new correlation (R^2) was 0.88, and implicates that conclusion can only been drawn from 26 of the 40 samples.

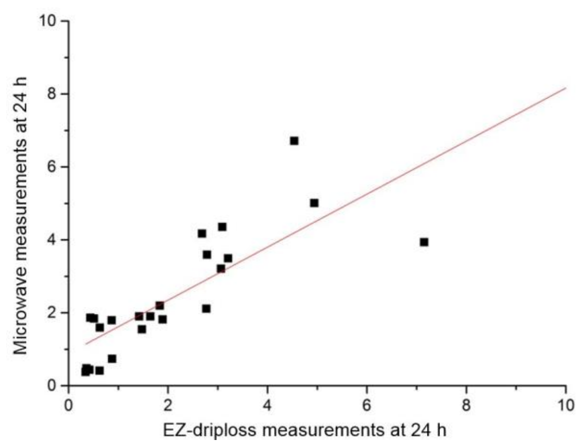

Figure 4. Correlation (R^2 = 0.88) between microwave measurements of S_{11} (reflection) and EZ-driploss

measurements for samples 18-40. Both measurements were conducted at 24 h post mortem.

The results presented here aimed at investigating whether it was possible to predict WHC using microwave spectroscopy. The experiment included only few pork loin samples. For further confirmation of the results presented, a study analyzing larger experimental groups should be conducted.

IV. CONCLUSION

A correlation was observed between microwave measurements and EZ-driploss measurements of WHC in the pork loin samples. The measurements were conducted at 24 h post mortem. These results indicate that microwave measurements might be a promising technique for determination of WHC, making it possible to measure WHC in trimmings for sorting of carcasses on-line. Further studies should include investigation of a larger experimental group, with a wider range in driploss.

ACKNOWLEDGEMENTS

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