Reducing cooking time of sous vide cooked pulled pork using proteolytic enzymes

L. Hofer[1], L. Kristensen[1*], and M. Tørngren[1]
[1]Danish Meat Research Institute, Danish Technological Institute
*Corresponding author email: lrk@dti.dk

I. INTRODUCTION

Sous vide cooking has become more common in private households and foodservice as well as on an industrial scale. Low cooking loss and quality improvements are some of the benefits of using sous vide because the process can be performed at 55-65°C for a prolonged time. Longer cooking times are mainly for cuts that need tenderization. When sous vide cooking is optimized for large-scale production, it is important to minimize the cooking time to increase productivity. The application of proteolytic enzymes from plants ([1-6]) or microorganisms ([2, 3]) has previously been used to improve meat tenderness. Plant-derived proteases used as meat tenderizers include papain from papaya, bromelain from pineapple and actinidin from kiwi. Some plant proteases, such as papain and bromelain, tend to lead to an over-tenderization of the meat ([2, 6]) where actinidin has shown to be less aggressive and leads to a more suitable tenderness avoiding a spongy texture (4). The aim of this study was to investigate if the cooking time can be reduced by injection of actinidin and to determine the tenderizing effect of actinidin.

II. MATERIALS AND METHODS

Pork neck from 36 female pigs slaughtered at a commercial Danish slaughterhouse (pH 5.79-6.12) were divided into two. The half from the head-end was used for cooking time evaluation, and the half from the loin-end was used to determine the tenderizing effect. The necks were brine-injected to obtain a weight gain of 10% including the following additives: 1) “reference”: 0.6% NaCl; 2) “actinidin 0.02%”: 0.02% actinidin (Ingredient Resources, Warriewood, Australia) and 0.6% NaCl; “actinidin 0.08%”: 0.08% actinidin and 0.6% NaCl. The weight was recorded, and the cuts were vacuum packed and stored at 2°C for 14 hours.

For investigation of cooking time reduction, the necks were cooked using three different treatments in a sous vide bath (40 kg Classic Gastro, Denmark). The following treatments were applied: 1) 80°C (in the core) with 0 h holding time and cooled to 5°C; 2) 80°C (in the core) with 4 h holding time and cooled to 5°C; 3) 80°C (in the core) with 8 h holding time and cooled to 5°C. A descriptive sensory analysis was performed in two sessions. Before each session, the muscles were reheated to 56°C, and the weight was recorded to calculate the cooking loss. Half a pork neck was divided into eight pieces of equal size. Each panellist received samples from the same location on the neck in all assessments. The samples were evaluated using a 15 cm line scale (0=slight and 15=intense). The evaluated attributes were: tenderness, pulliness (how easy it was to separate the meat using two forks in 20 sec.), juiciness, flavour and colour. For determining the tenderizing effect of actinidin, the following sous vide treatment was applied for the reference and actinidin 0.08%: 56°C (in the core) with 1 h holding time. After sous vide cooking, the necks were stored at 5°C for 12 h, 60 h or 156 h. Area of force was measured by Texture Analyser TA-HDK*i* (Stable Micro Systems, UK) using Warner Bratzler jaw on meat pieces from the muscle Serratus Ventralis cut out using an electrical drill with a plug centre bit (D=1.3 cm and L=4.5 cm).

III. RESULTS AND DISCUSSION

The average weight gain after injection was 11±3% for the neck-end and 13.6±1.3% for the loin-end. The concentration of actinidin was therefore higher than expected, especially in the neck-end samples.

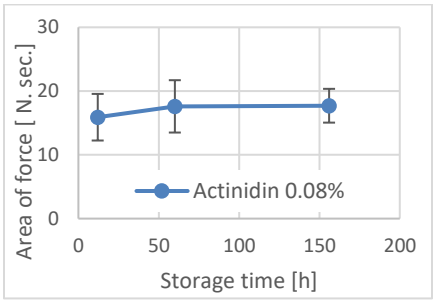
Injection of actinidin had a positive effect on the tenderness and pulliness of pulled pork. Compared to the reference, tenderness was maintained at a 4 h reduced holding time by using 0.02% actinidin. The pulliness was not as greatly affected by the addition of actinidin, a holding time reduction of four hours led to a lower level of pulliness. The addition of actinidin did not affect colour or juiciness, flavour was for some treatments significantly higher than the reference although no systematic effect was observed. The

concentration (0.02 vs. 0.08%) of actinidin did not affect the sensory attributes of the pulled pork, thus, to optimize the technology, it should be considered to keep the enzymes active for a longer time (Table 1). The total force needed to cut through the samples did not change during storage at 5°C (Figure 1) indicating that the tenderizing effect of actinidin had been stopped after heat treatment to 56°C.

Table 1. Sensory attributes of pulled pork with different actinidin concentrations and holding times at 80°C. Different letters within a row indicate significant differences between treatments at 5% level.

	Actinidin						Reference
Concentration, %	0.02	0.08	0.02	0.08	0.02	0.08	0.00
Holding time, h	0	0	4	4	8	8	8
Cooking loss	33.6^{a}	36.0^{b}	40.4^{d}	39.4^{cd}	38.8^{c}	38.8^{c}	38.7^{c}
Tenderness	7.6^{a}	7.7^{a}	9.9^{b}	10.4^{bc}	12.4^{c}	12.5^{c}	11.6^{bc}
Pulliness	3.0^{a}	4.3^{b}	9.0^{c}	9.4^{c}	13.2^{e}	13.2^{e}	12.2^{d}
Juiciness	7.2^{a}	7.0^{a}	7.3^{a}	7.2^{a}	7.6^{a}	8.8^{a}	8.0^{a}
Flavour	1.6^{b}	2.0^{b}	2.1^{b}	1.5^{ab}	1.3^{ab}	1.6^{ab}	0.5^{a}
Colour	10.2^{a}	10.3^{a}	10.5^{ab}	11.2^{ab}	11.4^{b}	11.0^{ab}	10.6^{ab}

Figure 1. Total force needed to cut through the muscle Serratus Ventralis.



IV. CONCLUSION

Injection of a brine containing actinidin did not affect flavour, colour, juiciness or cooking loss. For pulled pork, it was possible to obtain comparable tenderness at a reduced cooking time of 4 h instead of 8 h, when actinidin was added as a tenderizer. Actinidin did not have any tenderizing effect after heat treatment to a core temperature of 56°C probably due to denaturation of the active enzyme.

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