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Effect of cooking bag and netting packaging on the quality of pork ham during water cooking

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Abstract

As a preliminary test for combining water cooking with vacuum cooling in soup of pork ham, three package treatments were designed to study the effect of cooking bag and netting on the quality of water cooked ham, i.e. ham cooked with a cooking bag and without a cooking bag (single netting and double netting). For treatments without a cooking bag, the results indicated that there was no significant superiority of ham cooked with double netting compared with ham cooked with single netting on the processing efficiency and quality characteristics. Although the hams cooked with a bag performed better in some chemical retentions and pigment, the water contents were significantly lower than those hams cooked in single netting ($P < 0.05$), and there was a higher shrinkage tendency compared with the hams cooked without a bag. For the processing characteristics and texture properties of pork ham, there were no significant differences observed among the treatments with and without a cooking bag in terms of the combined effect of cooking and cooling ($P > 0.05$). By considering the safety, convenience, cost, and the recovery effect on the quality changes of ham during vacuum cooling in soup, cooking with single netting is a better choice for future research.

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1. Introduction

Water bath cooking is one of the most important cooking methods in the meat industry. There are many advantages of water cooking for meat products, such as increase of the tenderness and yield, improvement of the microbiological safety through efficient heat penetration, easy availability of equipments, precise control over degree of doneness, uniform degree of doneness, low running cost, and less working space (Buck, Hickey, & Rosenau, 1979; Cyril, Castellini, & Dal Bosco, 1996). Previous research indicated that water bath cooking could be used to cook large meat joints with high processing efficiency, even at low cooking temperature, but provided compatible products quality with traditional processing methods (Cheng & Sun, 2004).

High quality ham processing involves not only sufficient cooking, but also efficient cooling treatment. As a rapid, evaporative cooling method, vacuum cooling has been proved to be several times quicker compared with conventional cooling methods, such as air blast, water immersion, or cold room for cooling large meat joints (Desmond, Kenny, Ward, & Sun, 2000; McDonald & Sun, 2000; McDonald, Sun, & Kenny, 2000). However, vacuum cooling results in a lower yield and a little deficiency in meat texture. Therefore, overcoming the mass loss during vacuum cooling is important for the successful application of vacuum cooling to the meat industry. Varied efforts have been made in the past including increasing the injection levels (McDonald, Sun, & Kenny, 2001), adjusting the evacuation rate (McDonald & Sun, 2001), and cooling the meat in a soup (Houska, Sun, Landfeld, & Zhang, 2003). Among these efforts, cooling meat in a soup produced the best

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result with no weight loss occurring during cooling. Instead, weight gain of about 7.7% could be achieved due to water penetration at the end of the vacuum cooling (Houska et al., 2003). Therefore, a reasonable assumption was that cooking in water and vacuum cooling in the remaining soup after cooking would improve the quality of cooked meat joints, and promote the application of water cooking and vacuum cooling to the meat industry.

To combine water cooking and vacuum cooling in a soup of meat products efficiently, it is necessary to have a thorough understanding of the factors that affect the quality of cooked meat products beforehand. In addition to the cooking time and cooking temperature, the selection of packaging for samples will also be an important issue. On one hand, packaging is a connection point for the meat joints and cooking–cooling environment for exchange of mass and heat during processing. On the other hand, packaging is also important in food safety and processing control. For example, removal of the cooking bag for the meat joints is necessary for vacuum cooling (McDonald & Sun, 2001), because water needs to escape from the cooking bag and produce cooling. Additionally, removal of its cooking bag could cause the microbial contamination during handling.

Therefore, as a preliminary test for cooking and cooling pork ham in water, the aim of the current study was to investigate the effect of packaging materials (netting and cooking bag) on the quality of pork ham, including processing characteristics, chemical components, texture properties, and shrinkage analysis.

2. Materials and methods

2.1. Ham processing

Pork legs with pH 5.7–6.0 were purchased from a local butcher, deboned and the visible fat and connective tissue trimmed. The procedures for ham processing including injection, tumbling and standing were according to Cheng and Sun (2004). Leg meat, 2.2 ± 0.2 kg, was stuffed into single netting or double netting (Red Micro Netting, GB Miller Fispak Ltd., Ireland). For storage, sample was put into a cooking bag (CN300 350 × 500, Sealed Air Ltd., Ireland), and given 5 s heat shrinkage at 95 °C in water bath, then stored at less than −18 °C for two weeks. Before cooking, the sample was thawed at 4 °C for 48 h. For cooking ham with a bag (CB), single netting samples together with the bag, were put in a water bath (heat power 1.4 kW, maximum flow rate 17 L/min, water volume 20 L) (GD120, Grant Instruments Ltd., UK), and cooked at 82 °C until the core temperature reached 72 °C. For cooking hams with single netting (SN) and double netting (DN), the cooking bags were removed before cooking. Then samples without bags were put into 2% salt solution directly at 82 °C using the water bath and cooked from 4 °C to 72 °C core temperature. After cooking, traditional air blast cooling (1 ± 1 °C, relative humidity >90%, air velocity 2.0 ± 0.1 m/s) was used to cool all the samples to 4 °C core temperature. For CB samples, the cooking bag was removed before cooling began. However, samples without a bag, i.e. SN and DN, were put into the air blast chamber directly for cooling immediately after cooking.

The processing characteristics measured for each treatment (CB, SN & DN) consisted of cooking time (time taken for temperature to reach 72 °C from 4 °C at core), cooling time (time taken to reach 4 °C from 72 °C at core), cooking loss (weight lost during cooking/weight before cooking × 100%), cooling loss (weight lost during cooling/weight before cooling × 100%), and yield (weight after cooling/raw weight before injection × 100%).

2.2. Physical analysis

Ten strips (45 mm × 30 mm × 2.0 mm) were cut parallel to the fibre direction from each cooked ham. Each strip was sheared perpendicular to the fibre direction using an Instron Universal testing machine (Model No. 5544, Instron Corporation, UK) fitted with a Warner–Bratzler shear attachment. Shear value (WBS, Newton) was recorded at the peak force of shearing.

For texture profile analysis (TPA), two slices of 20 mm in thickness from the samples were taken. Using a 60 mm circular flat disk attached to a 0.5 kN load cell with a crosshead speed of 50 mm/min, five cores of ham (25 mm in diameter × 20 mm in height) from each slice were compressed to 50% of their original height to represent the whole slice. Quality attributes were calculated as follows: hardness – peak force required for first compression; cohesion – ratio of the positive force area during the second compression over that in the first compression; springiness – ratio of distances that the samples recover after the first compression; chewiness – product of gumminess (hardness × cohesion) and springiness.

The colour of the cooked ham was measured by the CIE $L^*a^*b^*$ (L^* – Lightness, a^* – red/green and b^* – yellow/blue) system using a tristimulus colorimeter (Chromameter CR300, Minolta Ltd., Japan) with a pulsed xenon as light source.

To obtain shrinkages of ham during processing, the volume before and after cooking, and before and after cooling was measured automatically using a computer vision system. The image acquisition system used in this study consisted of a Dell Workstation 400 equipped with an IC-RGB frame grabber (Imaging Technology, US), and a high quality 3-CCD Sony XC-003P camera. The image-processing algorithm developed to measure the volume of ham was implemented by using Visual C ++ combined with Matlab (Mathworks, 1992). The volume of the meat joint obtained was used to calculate the apparent density (kg/m^3) according to the formula as following (Rahman, 1995),

$$\rho = \frac{m}{V}$$

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