STRUCTURAL CHANGES OF LOCAL THAI BEEF DURING SOUS-VIDE COOKING

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I. INTRODUCTION

Local Thai beef, *Bos indicus* had been used since a long time in many kinds of Thai foods because of its price, lower than that of imported beef. However, its texture is generally very tough and suitable processes are essential in order to improve the qualities of these products. Cooking usually results in a contraction of the pieces of meat, which is reflected at the microscopic scale by a lateral and longitudinal contraction of the muscle fibers. The water contained in the muscle fibers is expelled into the extracellular space and then into the cooking juices. This phenomenon is accompanied initially by a hardening of the meat. When the cooking time in wet conditions increases, the collagen solubilizes in gelatin improving meat tenderness. Thai beef is rich in cross-linked collagen and a slow cooking method should be more suitable for its preparation. The objective of the present study was to investigate sous-vide cooking time/temperature parameters on meat histological structure and tenderness of Thai beef, in order characterize the structure changes during cooking process, and to identify the couple time/temperature allowing the best quality of the end product.

II. MATERIAL AND METHODS

Experimental design: 15 round beef muscles from local Thai beef (*Bos indicus*), at 24 hours post mortem, were cut into 7×7×7 cm cubes, vacuum sealed in laminated low-density polyethylene (LLDPE) bag and cooked at 60, 70 and 80°C for 2, 4, 6, 12, 18, 24, 30 and 36 hours (triplicates). ***Shear force:*** Seven pieces (3×1×1 cm) were prepared from each condition. Shear force was measured perpendicularly to the muscle fiber direction using a Warner-Bratzler shear force texture analyzer (TA.XT *plus*, Stable Micro System, England). ***Histology:*** At the end of the cooking process, 0.5×0.5×1 cm blocks taken in the core of the meat piece were cryofixed in cooled isopentane (-160˚C) by liquid nitrogen (-196˚C). 10 µm thick cryosections, transversal to muscle fiber direction (cryostat CM1950, Leica Microsystems, Germany) were stained with hematoxylin eosin safran (HES) and Sirius Red (RS) solution to evidence muscle fibers and connective tissue respectively. Images were acquired using an Olympus BX 61 microscope coupled to high resolution digital camera (Olympus DP 71) using Cell Sens software and morphological changes were determined by image analysis (ImageJ software).

III. RESULTS AND DISCUSSION

Representative histological images of Thai beef are shown in Fig. 1. Cooking temperature and time significantly ($p<0.05$) affected the extracellular space area (ECS) and fiber cross sectional area (CSA) (Fig. 2). Compared to 60 °C samples, 70°C samples did not show significant difference in CSA and ECS data (Fig. 2). Increasing temperature from 60-70°C to 80°C resulted to a significant increase in CSA (2, 4, 6 30 hours of heating) and a significant decrease in ECS (4, 6, 30 hours of heating). Shear force did not vary significantly during the first 4 hours of cooking. From 6 hours of cooking, shear force was significantly lower for 60°C cooked samples than for 70-80°C cooked samples. From 24 hours of cooking, the shear force increased with cooking temperature (Fig. 2C). The lowest shear force was reach after 18 hours cooking at 60°C. "Conventional" cooking generally causes lateral and longitudinal contraction of fibers, which is associated with an increase in meat toughness [1]. The lateral contraction of muscle fibers increases with temperature in the first phase of cooking [1,2] then stabilizes [2]. Our results show, on the opposite: a swelling of the muscle fibers after cooking which increased with cooking temperature. These results are in agreement with those of Wattanachant et al [3] on sous vide cooking of Thai indigenous chicken. Roldan et al [4] also evidenced an increase in muscle fiber size when increasing sous vide cooking temperature. Compared to conventional cooking, this difference in the behavior of muscle fibers change during sous vide cooking could be related to partial solubilization of the collagen that makes up the endomysium. The lateral contraction of muscle fibers during cooking results from the contraction of the myofibrillar material and collagen [1]. Long time cooking results in collagen solubilization to gelatin [5].The slightest compression of the muscle fibers would allow their lateral expansion. This expansion is probably not linked to a water transfer from the extracellular space to the intracellular space of muscle fibers since the cooking loss increased after cooking (results not shown). This increase in muscle fiber volume is not associated with a decrease in shear force (Fig. 2C). This phenomenon can be due to the fact that it is rather the perimysium which is responsible for the hardness of the meat and not the endomysium. Perimysium, denser than the endomysium, is also more difficult to solubilize than the endomysium located around the muscle fibers.

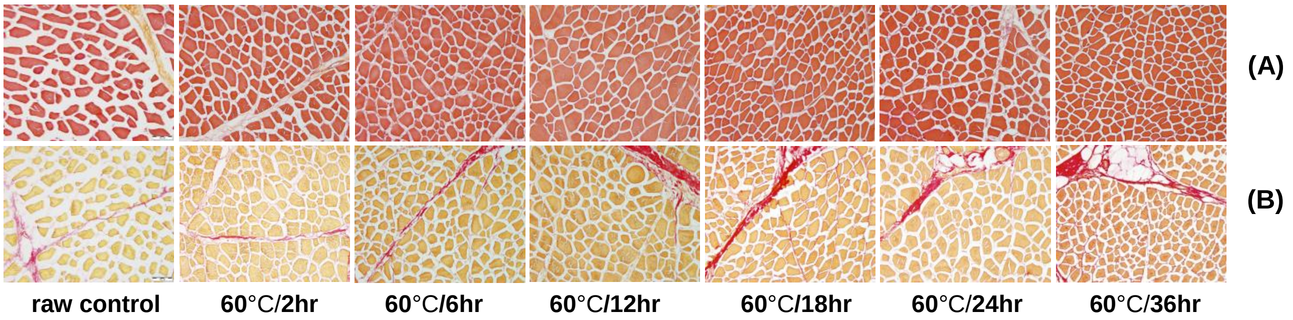
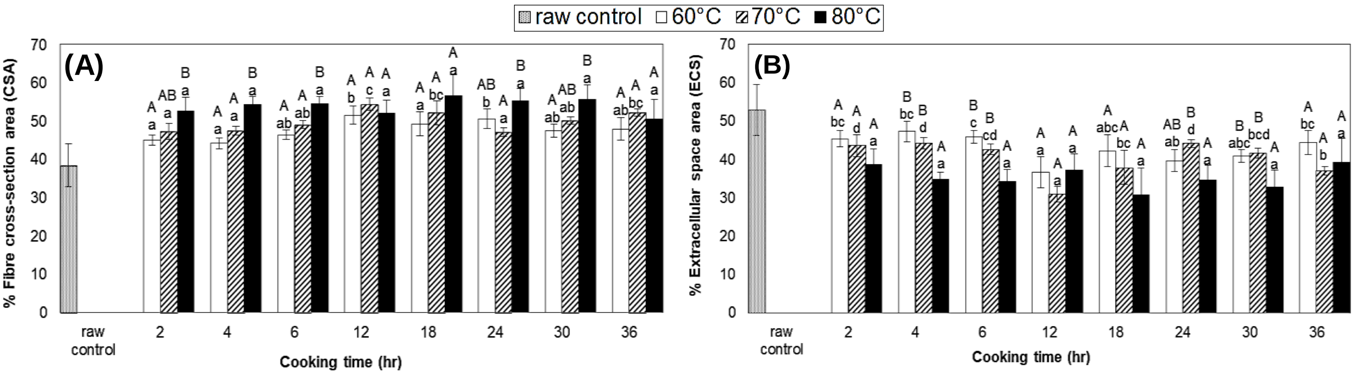


Figure 1. Histological cross-sections stained with haematoxylin eosin safan (A) showing the muscle cells (pink) and sirius red (B) showing the muscle cells (yellow-orange) and connective tissue (pink-red).



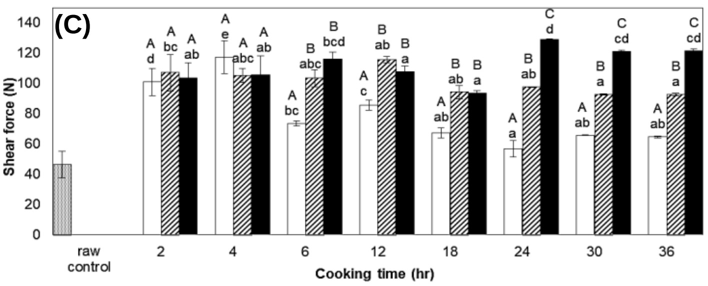


Figure 2. Muscle fiber CSA (% of total image area) (A), ECS (% of total image area) (B) and shear force value (C) of round beef cooked at 60,70 80°C for 0-36 hr. Uppercase indicate significant difference (p<0.05) in cooking temperature (same cooking time) and lowercase indicate significant difference (p<0.05) in cooking time (same cooking temperature).

IV. CONCLUSION

Cooking lead to changes in structural characteristics of round muscle from local Thai beef. 70 and 80°C cooking temperature induced a lower lateral contraction of fiber than 60°C cooking temperature (p<0.05). Up to 6 hours cooking, 60°C cooked meat gave the more tender meat with an optimum after 18 hours of cooking in our experimental conditions. The larger size of muscle fiber cooked at 70-80°C compared to meat cooked at 60°C is still unclear. Electron microscopy analysis should give information that will help the understanding of this phenomenon.

ACKNOWLEDGEMENT

The authors express their sincere acknowledgements to Faculty of Agro-Industry, King Mongkut's Institute of Technology Ladkrabang (KMITL), Thailand and to the INRA QuaPA unit (INRA ARA, France) for funding and supporting this research program.

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