EFFECT OF SOUS-VIDE COOKING ON MUSCLE FIBER AND COLOR CHANGES OF SIRLOIN LOCAL THAI BEEF

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Abstract – The benefit of local Thai beef to produce many kinds of food was its lower price compared with imported beef and Thai beef cattle. However, its texture was tough and induced spending long time for cooking. Texture of meat related its structure. This research studied effect of cooking under controlled temperature and time in vacuum condition, called sous-vide, on muscle fiber and color changes of local Thai beef. Sirloin part was used as material and sous-vide cooking was designed using temperatures of 60, 70 and 80°C for 0, 6, 12, 18, 24, 30 and 36 h, respectively. Images structure and color changes of sirloin beef undergoing processing were observed. It was found that using of higher temperature and longer time tended to change structure of sirloin beef. Image structure changes of sirloin beef in the first period was found that muscle fiber was clear and firm. After that, muscle fiber shrinkage was observed and layer of muscle fiber was presented. In addition, sous-vide conditions affected lightness, redness and yellowness with significantly different (P≤0.05). Samples after cooking were generally lighter and more yellowness, whereas less redness than that of raw meat.

Key Words – Color, Local Thai beef, Muscle fiber, Sous-vide.

I. INTRODUCTION

Sous-vide cooking was defined as cooking of raw materials under controlled conditions of temperature and time inside heatstable vacuumized pouches or containers. After heating, the products were rapidly cooled down to 0-3°C [1,2,3]. This technique was used to improve qualities of meat, fish and vegetables and hence it was developed for food industry. Sous-vide cooking was widely used in restaurants and catering because of its comfortable to manage food preparation. This provided the manipulation of ready to cook food after thermal treatment with no risk of microbial contamination [1,3] and prolonged shelf-life of foods [3]. Researchers studied effect of sous-vide cooking treatments on color, texture, moisture content, cooking loss, enhanced organoleptic qualities of difference kinds of meat [4,5,6]. They found that sous-vide cooking succeeded for qualities improvement of foods. Kongpeam et al. [7] applied sous-vide process to improve quality of flank steak from local Thai beef. They found that sous-vide process affected physical properties of flank steak and reduced toughness of flank steak after processing. In addition, thermal processing was found to have a large effect on the eating quality of meat [3] as a result of heat changes properties into meat such as, denaturation of proteins [8], fiber shrinkage or collagen solubilization [3,9]. Therefore this was strongly affected texture of meat [6,9].

Texture of meat related its structure, however. Factors affected structure of meat were types of meat, foods, feeding, surrounding, varieties, for example. Studying effect of sous-vide cooking on structural changes of local Thai beef could have advantage to improve its texture. This would be useful for more application to use this material with high valuated. Effect of sous-vide conditions with controlled temperatures and times on image structure of muscle fiber and color changes of sirloin from local Thai beef were observed.

II. MATERIALS AND METHODS

Beef preparation

Sirloin of beef muscle from local Thai beef (*Bos indious*) was purchased from Huatakhe market, Bangkok province, Thailand. Samples were retained blood before trimming fat and connective tissue and sliced into 7×7×7 cm^3. Then samples were wrapped and kept at 4°C. Period after purchasing until experiment was not over than 12 h.

Effect of sous-vide conditions on structure and color changes of sirloin beef

Sirloin beef were vacuum packed in LLDPE bag and then sous-vide cooked using temperatures of 60, 70 and 80°C and times of 0, 6, 12, 18, 24, 30 and 36 h. All samples were determined image structure and color.

Image structure

Samples after sous-vide cooking were cut in parallel to the muscle fibers. Then image structure from each side was acquired using a Fujifilm camera (XT-10, Japan) with image analysis set up applied from [10]. Sample was placed in a black box (61×61×61 cm^3). The height of the camera tripod was 18 cm and distance between camera and beef was 15 cm. Two light-emitting diode (LED) lamps with a 5 watt bulb size of 70×116 mm^2 were placed approximately 20.5 cm in front of this adaptor as a light source. Images were captured and kept in bmp with image size of 4,896×3,264 pixels. Experiments were done in 2 replicates.

Color

Color was measured across the cut surface of the sous-vide cooked sirloin at room temperature (25°C). Color (L^* a^* and b^*) were measured using a Minolta Colorimeter (CR400, Japan). Means of reading on three locations in each sample were determined. Instrument was calibrated using a white ceramic tile before color measurement [11]. In each condition, sirloin beef was binary and each side of sirloin was measured color for 3 positions. Experiments were done in 2 replicates. Significant difference test at 95% confidence level was applied to identify differences of evaluated color parameters. Using SPSS (version 16.0) statistical software.

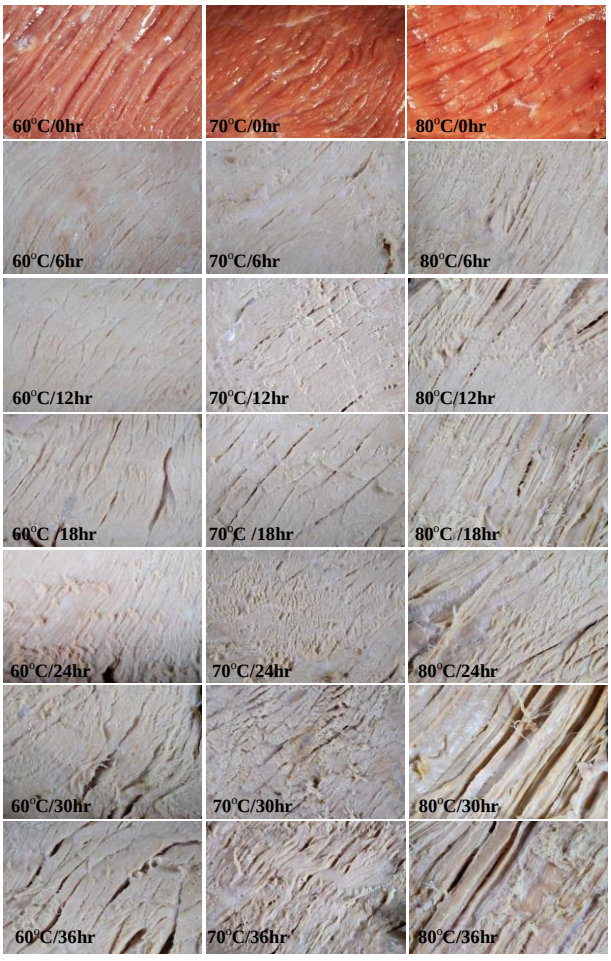
III. RESULTS AND DISCUSSION

Image structure of sirloin beef

Effect of sous-vide temperatures and times on image structure of muscle fiber of sirloin beef was shown in Figure 1. It was found that using of higher temperature and longer time tended to change muscle fiber of sirloin beef. This changes might be divided into 2 periods. In the first period, image structure of muscle fiber was clear and firm. This might be because some of protein was denatured and then it was complex and aggregated [4]. After that, muscle fiber was shrank and presented layer of muscle fiber. This can be indicated very high compression due to collagen was shrunk and water was released from muscle fiber [6].

Palka and Daun [12] suggested that myofibrillar protein was changed in its structure during heating. Then, myosin was denatured and led water retention at the first part of shrinkage. After that, actomyosin complex was denatured and induced dehydration to protein. In addition, the muscle fiber shrank both transversely and longitudinally, then sarcoplasmic protein aggregated and formed gel and finally connective tissue were shrank and solubilized [5,8].

Figure 1.Sirlion beef undergoing at 60, 70 and 80°C for 0-36 h



The granulation of the perimysium and sarcolemma began after meat was cooked to 60°C. Then granulation was observed after meat was cooked to 70°C and sarcolemma was probably denatured. This compression effect might have been due to shrinkage

of the endomysial collagen [5,12] and became gelatin at 80°C [5].

color parameters

L^* (lightness), a^* (redness) and b^* (yellowness) of sirloin samples after sous-vide cooking at different temperatures and times were shown in Figure 2. The cooked samples were generally lighter and more yellowness (higher b^*), whereas less redness than raw meat. Sous-vide cooking conditions affected color of sirloin beef with significant difference ($p \leq 0.05$). Results were in the same trend as obtained by Garcı´a-Segovia et al. and Nikmaram et al. [5,6].

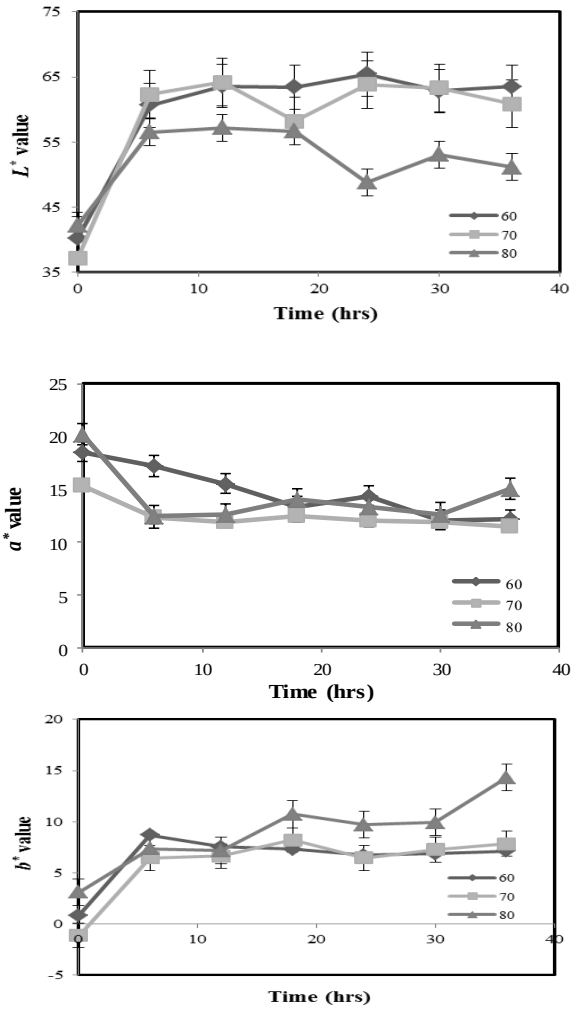
A higher of L^* values indicated a lighter color, which is desirable in order to ensure that the meat products will be accepted [3,5,6]. A higher of L^* values when increasing temperature due to higher moisture content in meat cooked at lower temperature led deeper penetration of light in tissue and thus producing darker meat appearance [3]. In addition, increasing cooking temperature would lead to higher denaturation and aggregation of sarcoplasmic and myofibrillar proteins, which would increase light scattering [3,8,13].

However, samples cooked at 60°C represented slightly higher L^* values than those cooked at 70°C and 80°C, which was attributed of free water. At lower temperature condition, muscle fiber consisted of more free water both at surface and inside. This would increase light scattering during color measurement [3].

Sirloin beef under cooking at lower temperature had higher a^* value compared with those of higher temperatures. However, a^* value of samples tended decreased undergoing cooking time at all temperature conditions. This indicated that higher myoglobin degradation as cooking temperature increased. The compound largely responsible for the brown-gray color is globin hemochrome (Fe^{3+}), as result of the globin (the protein part of myoglobin) was denatured due to heat [13]. This loss of redness with increasing cooking temperature was in accordance with the results obtained by Garcı´a-Segovia et al. [4], who cooked beef samples at 60-80°C for 15-60 min, and Roldán et al. [3], who cooked lamp lions at 60-80°C for 6-24 h.

A higher of b^* values as a consequence of both cooking temperature and time. This was most likely due to the formation of metmyoglobin and further heat denaturation of this protein, giving rise to a brownish color [3]. Higher of b^* values with increasing cooking temperature was in accordance with the results obtained by other authors [3,5,8,13].

Figure 2. Color parameter of sous-vide cooked sirloin beef



IV. CONCLUSION

Cooking temperature and cooking time affected the characteristics of sous-vide cooked sirloin beef. The image structure of muscle fiber after sous-vide cooking was affected by cooking temperature and cooking time. Increased cooking temperature and time resulted cooked sirloin beef with lightness and yellowness increased, while redness decreased.

ACKNOWLEDGEMENT

The authors express their sincere appreciation to King Mongkut's Institute of Technology Ladkrabang (KMITL), Thailand for supporting the study financially.

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