PE4.02 DSC analysis of heat-induced changes of thermal shrinkage temperatures for perimysium and endomysium collagen from beef semitendinosus muscle 15.00

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***Abstract*—Changes of thermal shrinkage temperatures of perimysium and endomysium collagen for beef *Semitendinosus* (ST) muscle during heating were analyzed by Differential Scanning Calorimeter (DSC). Beef ST muscle was heated to internal endpoint temperature of 40, 50, 60, 70, 80, and 90℃ by water-bath and microwave oven respectively. The results indicated that thermal shrinkage temperatures of perimysium and endomysium collagen, including onset (T_o), peak (T_p) and end (T_e) temperatures were all shown significant differences at different endpoint temperature during water-bath and microwave heating. And internal endpoint temperature of 60℃ was critical heating temperature which affects thermal shrinkage temperatures of perimysium and endomysium collagen for both water-bath and microwave heated meat.**

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***Index Terms*—beef *Semitendinosus* muscle, collagen, DSC, thermal shrinkage temperatures**

I. INTRODUCTION

Changes of meat tenderness and texture during heating are partly result from the changes of collagen characteristics, including collagen contents and solubility and thermal stability. Meat collagen characteristics have been analyzed to obtain information on beef tenderness, especially for collagen contents and solubility. In addition to, the thermal stability of connective tissue has been analyzed by measuring the onset (T_o) and peak (T_p) temperatures and enthalpy (ΔH) of thermal shrinkage of intramuscular connective tissue (IMCT) when the role of connective tissue in meat tenderness has been studied [1]. However, few literatures have been reported on the comparative study of thermal characteristics changes of perimysium and endomysium collagen for Chinese yellow bulls during water- bath and microwave heating. Therefore, the objective of the study was to comparative characterize the changes of thermal shrinkage temperatures of perimysium and endomysium collagen in beef ST muscle from Chinese yellow bulls during water-bath and microwave heating.

II. MATERIALS AND METHODS

A. Meat Samples and Heating Treatments

Beef ST samples were collected from 15 Simmental × Nanyang crossbreed bulls (age: 24-30 months; live weight: 500±30 kg) (LvQi Meat Co.Ltd, Henan, China). The visible subcutaneous fat and connective tissue were trimmed off and samples were sliced into cubes 2.54 cm thick, perpendicular to the direction of the fiber.

ST steaks (2.5×5.0×5.0 cm) were heated in a 95° water-bath (HH-42, Guohua, Changzhou, China) and a domestic microwave oven (600W, 2450MHz) (EM-2008MS1, Shanghai, China) to internal core temperature of 40, 50, 60, 70, 80 and 90° respectively. The internal temperature was measured using digital needle-tipped thermometer (HI145, HANNA Instruments, Italy), by a temperature probe was inserted into the geometric center of steaks. After heating, the steaks were then chilled with cold running water to about room temperature (20℃). Raw meat (unheated) was used as the control group at room temperature (20℃).

B. Perimysium and Endomysium Preparation and DSC Analysis

The perimysial and endomysial portions of raw and heated meat samples were prepared and extracted according to the procedures of [2]. DSC analysis of perimysium and endomysium were conducted as described by [3] with slight modifications. The purified perimysial and endomysial portions were concentrated by freeze-dried (Alpha 2-1.2, Christ, Germany), and then the thermal shrinkage temperatures of perimysial and endomysial collagen were measured using DSC (Pyris 1, Perkin Elmer instruments, USA). The samples (10mg) were accurately weighed into aluminum pans and hermetically sealed. The samples were heated from 20 to 100° at heating rate of 10°/min, and nitrogen was used as purge gas at flowing rate of 20 ml/min. An empty sample pan was used as the reference. Thermal shrinkage temperatures of perimysium and

endomysium collagen were estimated from the thermogram using the software of Pyris Manager Series (Pyris 1, Perkin Elmer, USA).

C. Statistical Analysis

Statistical analyses were carried out using SPSS 16.0 (SPSS Inc., Chicago, IL). One-way analysis of variance (ANOVA) and Duncan's multiple-range test were carried out to determine significant differences of thermal shrinkage temperatures between water-bath and microwave heating, and effects were considered significant at $P<0.05$ (*) and $P<0.01$ (**).

III. RESULTS AND DISCUSSION

Thermal shrinkage temperatures, including onset (T_o), peak (T_p) and end (T_e) temperature of perimysium collagen were shown in Fig.1 A, B and C respectively. Significant differences of T_o were manifested at 40℃, 60℃ ($P<0.05$) and 50℃, 90℃ ($P<0.01$) respectively between water-bath and microwave heated meat. T_p manifested significant differences at 40℃, 50℃ and 60℃ ($P<0.05$). And significant differences of T_e were at 50℃ and 60℃ ($P<0.05$). As in Fig.2 showed, T_o, T_p and T_e of endomysium collagen were shown significant differences at 40℃ (Fig.2A), 70℃ (Fig.2B), 60℃ and 70℃ (Fig.2C) ($P<0.05$) respectively during water-bath and microwave heating. From the tendency of Fig.1 and Fig.2, we can get conclusion that internal endpoint temperature of 60℃ was critical heating temperature which affects thermal shrinkage temperatures of perimysial and endomysial collagen for both water-bath and microwave heated meat.

According to [4], T_p of collagen from mammals is around 65℃ but it is different for different muscles and animal species. They reported that T_o is considered to describe the least stable collagen and the T_p is a measure of the average stability of collagen during heating. [5] reported a T_p of 65.3℃ (heating rate 10℃/min) in isolated IMCT of chickens and [6] found a T_p of 69.2℃ (heating rate 5℃/min) in that of old cows. [7] reported that T_o and T_p of connective tissue from porcine M.*semimembranosus* were around 60℃ and 65℃ respectively (heating rate 5℃/min). Although the DSC samples were not pure collagen in our study, the thermal shrinkage temperatures of collagen were similar to that reported on whole meat, nevertheless, minor difference were also existed because of the different muscles, animal species and collagen kinds for testing.

IV. CONCLUSION

According to the results of the study, the thermal stabilities (manifested in the form of thermal shrinkage temperatures) of connective tissues collagen in beef ST muscle were changed during water-bath and microwave heating. Significant differences of T_o, T_p and T_e for perimysium and endomysium collagen were presented at different internal endpoint temperature during heating.

ACKNOWLEDGEMENT

This work was funded by the project grant 2006CB708212 from the 973 Program of China Ministry of Science and Technology.

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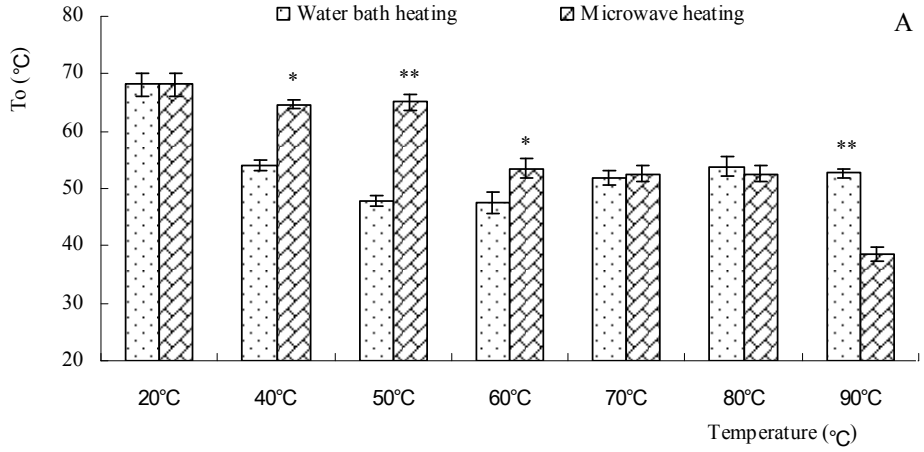
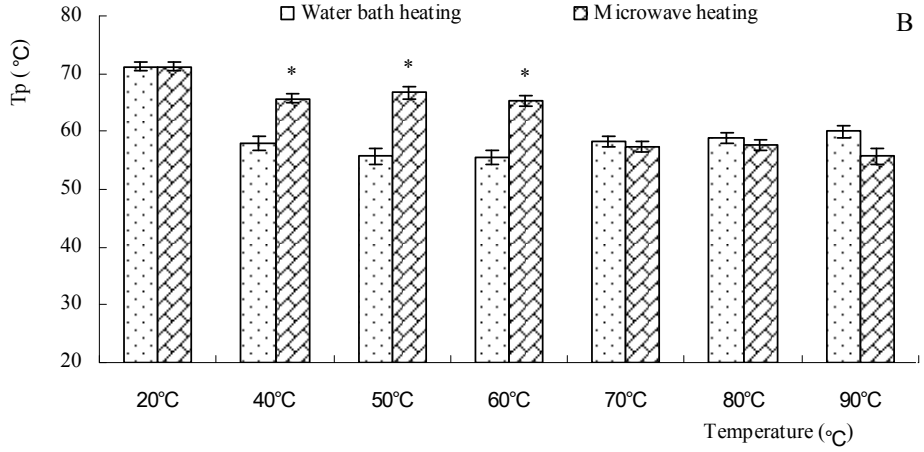
Figure 1. Variation in thermal shrinkage temperatures of perimysium collagen of beef ST muscle during water-bath and microwave heating. A: T_o (Onset temperature); B: T_p (Peak temperature); C: T_e (End temperature). * P<0.05; ** P<0.01. Significant difference between two different heating methods.





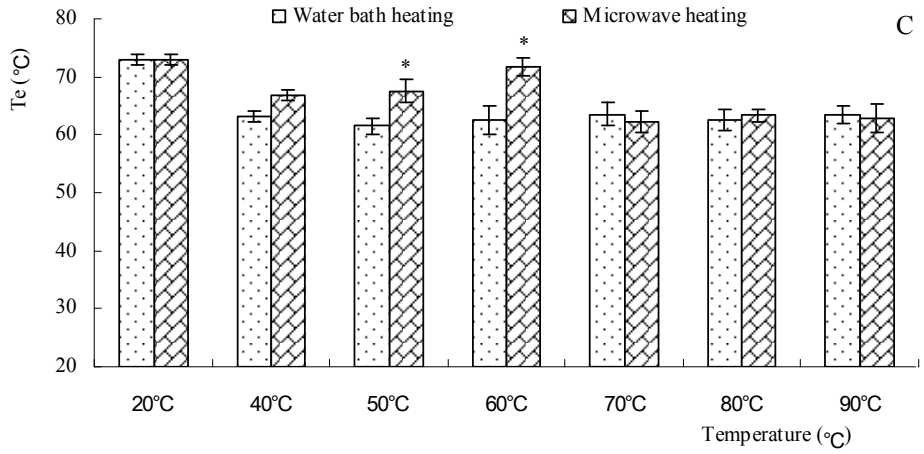


Figure 2. Variation in thermal shrinkage temperatures of endomysium collagen of beef ST muscle during water-bath and microwave heating. A: T_o (Onset temperature); B: T_p (Peak temperature); C: T_e (End temperature). * P<0.05. Significant difference between two different heating methods.