P-05-10

The longitudinal and transverse heating- induced shrinkage of two bovine muscles (#285)

Rozita Vaskoska[1], Minh Ha[1], Zahra Naqvi[2], Jason D. White[2], Robyn D. Warner[1]

[1] University of Melbourne, Faculty of Veterinary and Agricultural Sciences, Parkville, Australia; [2] Charles Sturt Univeristy, Wagga Wagga, Australia

Introduction

This study aimed to explore the differences in the heating- induced shrinkage of two bovine muscles *biceps femoris* (BF) (high collagen content, short sarcomere length, white muscle) and *psoas major* (PM) (low collagen content, long sarcomere length, red muscle) at four cooking temperatures (50, 60, 70 and 80°) and after two ageing periods (unaged and aged for 14 days).

Methods

10 BF and PM muscles were collected from both sides of 5 beef carcasses at ~ 24 hrs post-slaughter, on 3 collection days, and each muscle within a carcass was allocated to an ageing period of 1 day (unaged) or 14 days ageing. Sarcomere length of the muscles was measured with a laser diffraction unit and collagen by the AOAC hydroxyproline method. The cooking method was based on the study of Purslow at al. (2016) with slight modifications. Each muscle was cut into twenty (BF) or fifteen cuboids (PM) with dimensions: length 50mm x width 30mm x height 30mm. Four (BF) or three cuboids (PM) were randomly assigned to each of the following temperatures: 50, 60, 70 and 80°C within each muscle. The meat cuboids were cooked in individual plastic bags in a water bath (Julabo, Germany) at the designated temperatures. The samples were cooked for 30 min. after reaching the desired internal temperature, cooled on ice for 15 minutes, and wiped dry. The dimensions (length, width, height) of each cuboid were measured with calliper (Kincrome, Australia) before and after cooking. Longitudinal shrinkage was defined as the shrinkage in the direction of the fibres. Transverse shrinkage was the shrinkage perpendicular to the fibre direction, calculated as cross-sectional area (CSA). The CSA of the cuboid was calculated as the product of the width and the height. The longitudinal/transverse shrinkage was calculated as the difference between the length/CSA before and after cooking, divided by the length/CSA before cooking. Data analysis was performed with REML in Genstat (Version 18) with muscle, aging and temperature as fixed effects and collection day and carcass number as random effects.

Results

Average sarcomere length for the muscles was 3.48 ± 0.04 and 1.9 ± 0.02 (mean ± se) for PM and BF respectively, while the average collagen content was 17.45 ± 2.21 and 44.51 ± 2.68 µg/mg freeze dried tissue for the PM and BF, respectively. Longitudinal shrinkage of the cuboids was affected by the muscle, temperature and ageing period (muscle*temperature*ageing period $p<0.01$, sed for the interaction =1.86). The onset of shrinkage in unaged BF and PM occurred already at 50°C, while aged muscles only started shrinking at 60° (PM) and 70° (BF) (Figure 1). A continuous increase in shrinkage occurred between 60 to 70°C and 70 to 80°C in PM, while in BF shrinkage only increased between 70 and 80°C in unaged and between 60 and 70°C in aged muscle (Figure 1).Themaximumlongitudinal shrinkage of the muscle cuboids presented in the following sequence: PM (1 day) > PM (14 days) > BF (1 day) > BF (14 days) (Figure 1).

Transverse shrinkage, unlike longitudinal shrinkage, was only affected by the interaction of the muscle type with, temperature ($p<0.001$, sed=2.62), and with ageing period ($p<0.05$, sed=1.83). Most of the transverse shrinkage of the muscles has already occurred when the cuboids were cooked at 50°C (Figure 2A). BF had greater transverse shrinkage than PM at all temperatures except at 60°C, (Figure 2A). Unexpectedly, shrinkage of PM at 80°C was smaller than shrinkage at the other cooking temperatures (Figure 2A). With respect to ageing, PM showed a consistent transverse shrinkage for both ageing periods, while less transverse shrinkage occurred in aged muscle for BF (Figure 2B).

Conclusion

At higher cooking temperatures (70 and 80°C), which are common in meat cooking and processing, PM has a greater longitudinal shrinkage, while BF has a greater transverse shrinkage. These results are probably a consequence of the differences in sarcomere length and/or collagen content. Previous research has shown that stretched bovine *semitendinosus* had a greater longitudinal and smaller transverse shrinkage in comparison to cold-shortened muscle (Bouton et al., 1976). Greater longitudinal shrinkage was also found in a comparison of bovine *longissimus dorsi* (LD) to PM, where PM also had twice longer sarcomeres. Instead of the expected greater longitudinal shrinkage of BF due to greater collagen content (Mohr & Bendall, 1969), we instead found greater transverse shrinkage in comparison to PM. The potential explanation for this could be the assumed relationship between sarcomere length and collagen by Lepetit et al. (2000), where shorter sarcomere length in a muscle results in less collagen shrinkage at 60°C.

The greater longitudinal (BF, PM) and transverse shrinkage (BF) of unaged versus aged muscle implies a potential role of proteins prone to post- mortem proteolysis (titin, desmin) in the shrinkage of muscle cuboids.

The results of this study provide a better understanding of the shrinkage of bovine muscles of different characteristics during heating, that ultimately results in an effect on their water- holding capacity and eating quality.

Notes

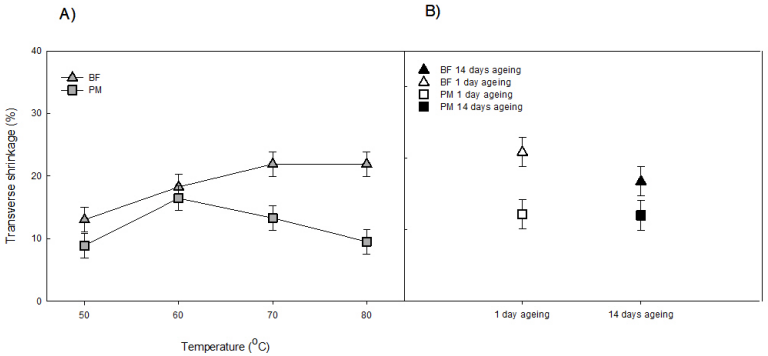

Figure 2.
Transverse shrinkage of BF and PMcuboids. A) heated to 50, 60, 70 and 80°C B) aged for 1 and 14 days.Each point is a least square mean and the sed is shown as a vertical line above and below each point.

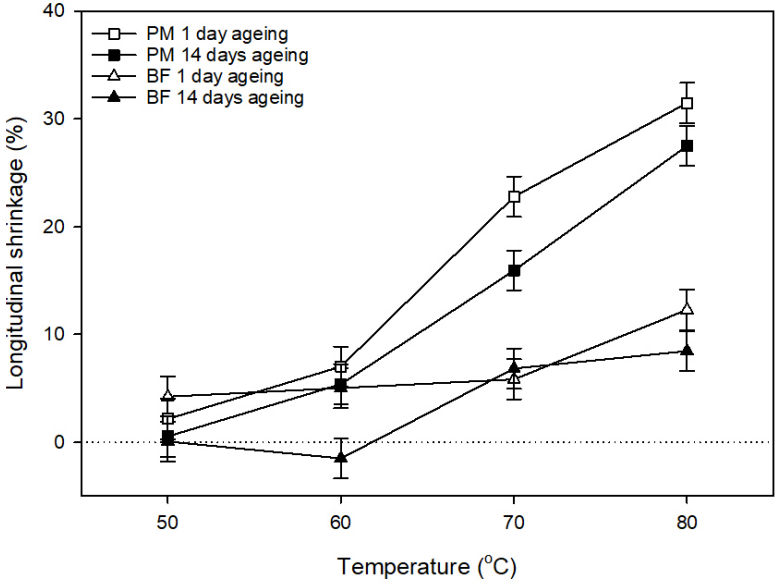

Figure 1.
Longitudinal shrinkage of BF and PM cuboids heated to 50, 60, 70 and 80°C and aged for 1 or 14 days. Each point is a least square mean and the sed is shown as a vertical line above and below each point.

Notes