A study on the effects of conditioning on shear force values and water holding capacity of different skeletal muscles in Malaysian indigenous (MALIN) sheep

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Introduction

In Malaysia, tenderness and water holding capacity are among the most important meat quality traits in meat production. In most parts of the world, it has been well accepted that carcass conditioning improves meat tenderisation through proteolysis during the muscle to meat conversion. Additionally, beside tenderness, carcass conditioning has also been implicated with enhanced water holding capacity in different porcine muscles (Melody et al., 2004). In relation to that, published findings on the effects of conditioning on sheep meat quality particularly tenderness and water holding capacity are still limited. The rate and extent of post mortem biochemical changes particularly proteolysis during conditioning also depend on muscle metabolic and contractile characteristics, which in turn would directly influence the variability of meat eating quality of different muscles. Thus, the present study was carried out to determine the effects of post mortem conditioning on tenderness and water holding capacity of nine major skeletal muscles in sheep.

Materials and methods

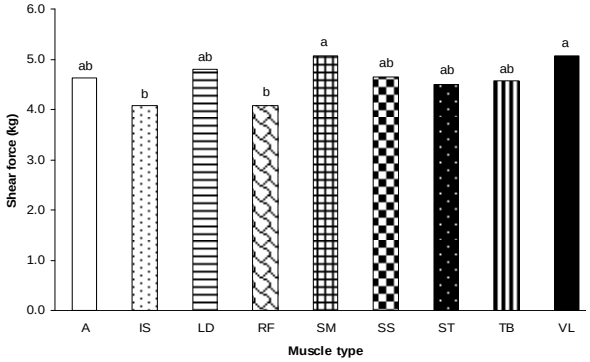
A total number of eighteen 1 year old male Malaysian indigenous (MALIN) sheep were slaughtered according to the slaughter procedure outlined in the MS 1500: 2004 (Department of Standard Malaysia, 2004). Immediately after evisceration, the carcasses were subjected to conditioning at 4°C and subsequent samplings. The accessibility, size and economic importance are the criteria which led to the selection of *Supraspinatus (SS), Infraspinatus (IS) and Triceps brachii (TB)* muscles of the forequarter *and Longissimus dorsi (LD), Adductor (A), Rectus femoris (RF), Semimembranosus (SM), Semitendinosus (ST),* and *Vastus lateralis (VL)* muscles of the hindquarter in this study. Muscle chops of approximately 3 cm thick were dissected from each specific muscle and assigned for the textural assessment while sub samples of each (approximately 30g) were subjected to water holding capacity determination. The unconditioned (*pre rigor)* steaks were collected, vacuum packaged and labelled accordingly. After 24 hrs of carcass conditioning (1 day *p.m.),* the second set of muscle chops of similar thickness were also removed, trimmed off of any visible fat and connective tissue, labelled, vacuum packaged and assigned as 1 day *p.m.* samples. The remaining carcasses were subjected to 6 days of further conditioning before the third sub samples were taken, prepared and stored as described earlier. All samples were blast frozen and stored at -80°C until subsequent shear force, drip loss and cooking loss determination.

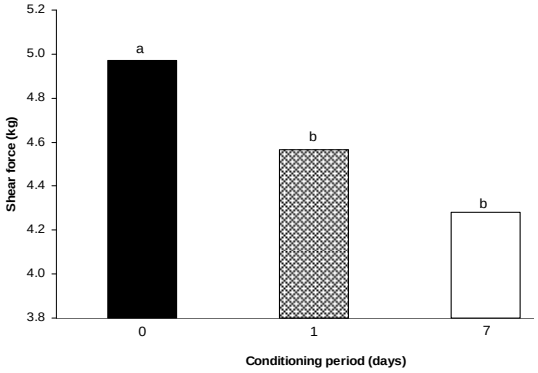
The textural assessment of cooked meat tenderness was carried out using the TA.HD plus® texture analyser (Stable Micro System, Surrey, UK) equipped with a Warner-Bratzler blade set. The samples preparation and shear force analysis were carried out according to the procedures described previously (Sazili et al., 2005). Meanwhile, the other frozen sub samples (triplicates of each sample) were removed from the freezer, individually weighed and recorded as initial weight (W1). Following to that, the sample was placed within a container on a supporting mesh and sealed. After a 24 hrs of storage at 4°C, the thawed samples were immediately taken from the containers, gently blotted dry, weighed and recorded as W2. The drip loss was calculated and expressed as percentage of the initial weight. Once the drip loss percentage was determined, similar sub samples were placed in water–impermeable and sealed plastic bags and cooked in a continuously boiling water-bath set at 80°C. The cooked samples were removed from the water bath, equilibrated to ambient temperature and removed from the bag, blotted dry, weighed and recorded as final weight (W3). The cooking loss is expressed as percentage of the raw sample weight (W2).The percentages of drip loss and cooking loss were calculated using the following equations: (a) Drip loss (%) = [(W1 – W2) ÷W1] x 100; (b) Cooking loss (%) = [(W2 – W3) ÷W2] x 100.

The data generated in the present study were analysed by General Linear Models Procedure using the Statistical Analysis System (SAS version 8, 2000). The differences between means were analysed by Duncan's Multiple Range test. Where there is no interaction between conditioning and muscle type, the means of each individual muscle were pooled and analysed.

Results and discussion

There were differences ($p<0.05$) in shear force values across the nine different skeletal muscles investigated in this study. In comparison with the RF, ST, TB, A, SS and LD muscles, the highest shear force values ($p<0.05$) were exhibited by the VL and SM muscles while, the lowest shear force values ($p<0.05$) were observed in the RF and IS muscles (Figure 1). In general, this is in agreement with a previous report by Sazili et al. (2005) of significant differences in shear force values between LD, TFL (*Tensor fasciae latae*), ST and SS muscles in growing lambs. In the present study, there was no interaction between conditioning and muscle type and thus, the mean shear force values of all individual muscles were pooled (Figure 2). As expected, the highest shear force values were exhibited by the unconditioned samples (0 day) which have significantly declined after 1 and 7 days of conditioning (Figure 2). The absence of interaction ($p>0.05$) between conditioning and the muscle type indicates that the effects of conditioning on shear force values were not influenced by the muscle type.





The mean shear force values of 9 different skeletal muscles were pooled since there was no interaction between the muscle type and conditioning period. Pooled means with different letter differ significantly ($p<0.05$)

Figure 1. Differences in shear force values of different skeletal muscles in sheep.

Figure 2. Effects of post mortem conditioning on shear force values.

The percentages of drip loss (Figure 3) and cooking loss (Figure 5) differed significantly ($p<0.05$) between the nine different muscles. The highest and lowest percentage of drip loss was indicated by the A and IS muscle, respectively (Figure 3). Meanwhile, compared to the A, LD, SM and TB muscles, the lowest percentage of cooking loss ($p<0.05$) was observed in the IS muscle (Figure 5). Similar to the shear force results, the effects of conditioning on drip loss and cooking loss were also found to be independent of the muscle type and these were statistically evident by the absence of interaction between conditioning and muscle type. In general, the percentage of drip loss declined throughout the 7 days of conditioning. The highest percentage was exhibited by the unconditioned samples and this could be explained by improvement in water holding capacity during the conditioning as reported earlier by Boakye & Mittal (1993). The improved WHC could be due to the proteolytic degradation of cytoskeletal proteins, which has subsequently caused swelling of the myofibrils and allowed the meat to retain water (Kristensen & Purslow, 2001; Huff-Lonergan & Lonergan, 2005). It has been hypothesised that degradation of the cytoskeletal proteins during conditioning would increase WHC of meat by removing inter-myofibrillar and costameric connections and thereby reduce or remove the linkage between the rigor-induced lateral shrinkage of myofibrils and shrinkage of the whole muscle fibre. However, the pooled percentages of cooking loss remained unaffected by the post mortem conditioning (Figure 6).

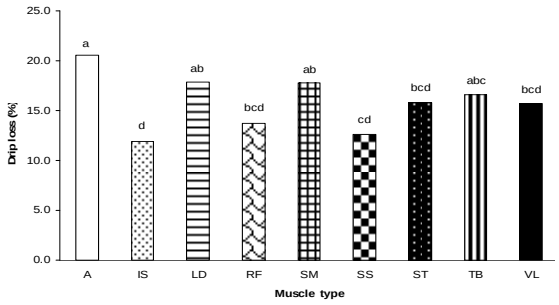


Figure 3. Differences in drip loss of different skeletal muscles in sheep.

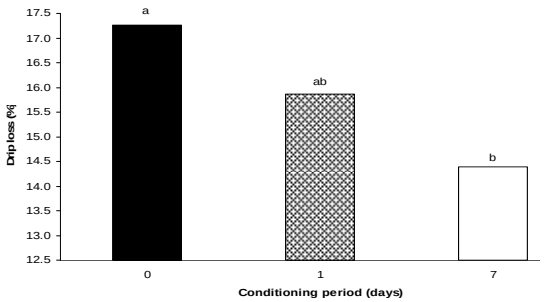


Figure 4. Effects of post mortem conditioning on drip loss.

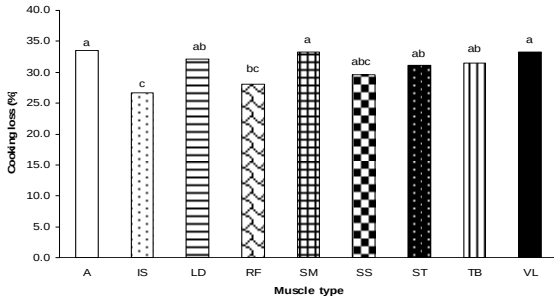


Figure 5. Differences in cooking loss of different skeletal muscles in sheep.

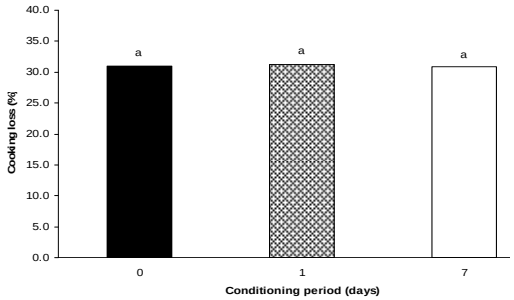


Figure 6. Effects of post mortem conditioning on cooking loss.

The mean drip loss and cooking loss percentages of 9 different skeletal muscles were pooled since there was no interaction between the muscle type and conditioning period. Pooled means with different letter differ significantly ($p<0.05$).

Conclusions

In general, the present study has demonstrated that meat tenderness, drip loss and cooking loss differed among the different skeletal muscles. Besides improving cooked meat tenderness, the carcass conditioning applied in the present study has also improved water holding capacity as indicated by reduced drip loss percentage. However, the effects of post mortem conditioning were found to be independent of the muscle type studied.

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