Accelerated tenderness of sheep topsides using a meat stretching device

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Abstract

The challenge with increasing processing efficiency is to maintain or enhance eating quality. The aim of this study was to evaluate the effect of both stretching using a pre-production prototype device and ageing on meat tenderness of warm boned sheep topsides. To test this effect, 40 sheep from 3 consignments were assessed. Left and right topsides were collected pre-rigor and randomly allocated to one of four treatments; 0 days ageing + stretch, 0 days ageing + no stretch, 5 days ageing + stretch and 5 days ageing + no stretch. There were differences in shear force due to stretch ($P < 0.001$), ageing ($P < 0.001$) and an interaction between stretch and ageing ($P < 0.001$). Meat from the 0 days aged + no stretch treatment was the least tender and the 5 days ageing + stretch treatment was the most tender. Meat stretched using the prototype device had a lower cooking loss percentage ($P < 0.001$) and longer sarcomeres ($P < 0.001$). There was no effect of stretching on myofibrillar degradation measured using particle size analysis (PSA), but there was an ageing effect ($P < 0.001$). Meat stretching showed significant improvement in the tenderness of topside meat.

Introduction

The adoption of hot or warm boning in the Australian sheep meat processing industry has been limited to the use of adult sheep meat. This process has in some cases been integrated with electrical stimulation with the intent of reducing muscle contraction subsequent to removal from the skeleton. The only published data on the eating quality of sheep meat processed through this system shows a low level (~14%) of consumer compliance (Toohey & Hopkins 2006). In contrast, when adult sheep were processed at the same abattoir, but conventionally chilled and cold boned, product aged for 7 days achieved a high level (86%) of consumer compliance (Hopkins & Toohey 2006). In follow up work where hot boned loin meat was wrapped and aged for 7 days, there was a 14% and 24% improvement respectively in the overall liking and tenderness scores compared to product unwrapped and frozen at 1 day (Toohey *et al.*, 2008a). The aim of this study was to evaluate the effect of both stretching and ageing on meat tenderness of warm boned sheep topsides (m. *semimembranosus* & m. *gracilis*) using a pre-production stretching prototype device.

Materials and methods

Forty sheep from 3 different consignments were assessed. The sheep were of varying backgrounds, typical of the animals processed at the abattoir. All carcases were exposed to a full suite of electrical stimulation as outlined by Toohey *et al.* (2008b). Both the left and right topsides were collected and two treatments were applied: stretching device (stretch/no stretch) and ageing (0/5) days. The treatment combinations were thus; ageing 0 days + stretch, ageing 0 days + no stretch, ageing 5 days + stretch and ageing 5 days + no stretch.

The carcases were hot boned under the normal commercial procedures of the abattoir. Within 2h of slaughter, topsides (*n=80*) were removed and allocated into the treatment groups. The 5 day aged samples were chilled at 4°C. The 0 and 5 day aged samples were frozen (-22ºC) and stored until sampling. Some descriptive measurements were taken on each of the topsides including initial length and initial circumference. Topsides that underwent the stretch treatment were re-measured after being stretched. The pH and temperature were measured in both the left and right topsides approximately 1.5h post death using the method described by Toohey & Hopkins (2006). Frozen topsides were tempered for approximately 2h after which time sarcomere, particle size and shear force samples were cut whilst the meat was still predominantly frozen. Sarcomere length was measured using laser diffraction (Bouton *et al.*, 1978) on samples aged for 0 and 5 days. The shear force samples were tested for peak shear force (N) adapted from the method described by Thompson *et al.* (2005). Samples taken for Warner Braztler shear force testing were used to measure the amount of cooking loss. An initial weight was recorded to two decimal places (this weight was close to 65 g) then the samples were cooked for 35 minutes at 71ºC. Once the samples were

cooled to room temperature they were blotted dry using paper towelling and re-weighed; cooking loss percentage was calculated using the difference. Particle size analysis as described by Karumendu *et al.* (2008) was conducted on 2g samples. A linear mixed model using restricted maximum likelihood (REML) within ASReml (Gilmour *et al.*, 2002) was used to analyse all data. The model contained fixed effects for stretch treatment (no stretch or stretch), ageing time (0 or 5 days) and interactions between these. Random terms used in the model were consignment, replicate and animal.

Results and discussion

Initial pH and temperature of the topside muscles was measured and on average the muscles were still in the *pre-rigor* phase with a mean pH of 6.22 at 33.5°C. Topside muscle length increased on average by 24% (s.e.± 8%) with a 27% (s.e.± 6%) decrease in circumference after stretching treatment was applied.

There was a significant effect on shear force for the stretch treatment ($P < 0.001$), ageing treatment ($P < 0.001$) and an interaction between both of these treatments ($P < 0.001$) as shown in Table 1. This was such that the percentage of samples with a shear force above 49 N dropped from 100% (control) to 5% (stretch) after 0 days of ageing and from 70% (control) to 0% (stretch) after 5 days of ageing. The significant interaction ($P < 0.001$) between stretch treatment and ageing period showed that the 0 days aged control group (no stretch) meat was the toughest and topsides from the stretch and 5 days ageing treatment were the tenderest. The stretch showed a 46% reduction in shear force at 0 days ageing highlighting that the stretching device accelerates the tenderisation process resulting in a better quality product in this time period, potentially eliminating the need to age product. Even after 5 days of ageing there were still large benefits evident, with a reduction in shear force of 38%. These improvements in shear force caused by stretch are comparable to a report by Hopkins *et al.* (2000) on super tenderstretching of the loin and given the low eating quality of the topside (Pethick *et al.* 2006) the current results are an important finding. Due to the notable improvement in shear force, it would be of value to examine the benefits of the stretching approach in terms of eating quality.

Table 1. Predicted means Ave. s.e.d. for topside shear force (Newtons) and cooking loss (%), according to treatment groups

	Shear force		Cooking loss	
Treatments	Stretch	Control	Stretch	Control
0 days aged	40.8ax	74.9bx	20.6ax	24.2bx
5 days aged	33.8ay	53.9by	19.8ax	23.7bx
Ave s.e.d.		*2.5*		*0.87*

Means followed by a different letter in a row (a, b) or column (x, y) are significantly different ($P = 0.05$) within a trait.

There was a significant difference between stretch treatment and control ($P < 0.001$) for cooking loss, but this trait was unaffected ($P > 0.05$) by ageing period and there was no interaction between the stretch and ageing treatments as shown in Table 1. Although there is a significant difference between the stretch treatment and control for cooking loss at, 0 and 5 days ageing, this result may be attributed to the varying amount of initial purge that is lost when samples were tempered. This was observed during the current experiment, but has not been quantified and needs to be considered in future work.

The results in Table 2 show that there was a significant difference ($P < 0.001$) between stretch treatment and control for sarcomere length, but there was no significant difference ($P > 0.05$) between ageing periods or an interaction between ageing and stretch treatment. These results support findings by Devine *et al.* (2002) where meat was wrapped and this reduced sarcomere shortening. This wrapping method is a similar concept to the stretch as the aim is to restrain and hence potentially stretch the de-boned muscle to prevent the muscle fibres contracting or shortening.

Table 2. Predicted means Ave. s.e.d. of topside sarcomere length (µm)

	Sarcomere length	
Treatments	Stretch	Control
0 days aged	2.19ax	1.54bx
5 days aged	2.22ax	1.60bx
Ave s.e.d.		*0.72*

Means followed by a different letter in a row (a, b) or column (x, y) are significantly different $P = 0.05$.

Particle size (PS) analysis showed that there was no significant difference ($P > 0.001$) between stretch treatment and control or interaction between ageing and stretch treatment, but there was a significant difference ($P < 0.001$) between ageing periods. As such 5 day aged samples had a lower PS than 1 day aged samples158 µm and 185 µm respectfully with Ave s.e.d. 9.22 µm. This indicates the fibres had degraded more during ageing and outcome supported by the results of Karumendu *et al.* (2008).

Conclusions

Meat tenderness of the topside was improved significantly by applying the stretch treatment, such that after 0 days of ageing the stretch caused a 46% reduction in shear force. The benefits of the stretch were still evident even after 5 days of ageing, with a reduction in shear force of 38%. This accelerated tenderisation achieved by the pre-rigor stretching device could remove the need for aged chiller storage to achieve acceptable tenderness levels. The magnitude of the reduction in topside shear force demonstrates significant potential for the stretching device and it appears the benefits come from an increase in sarcomere length. The decreased cooking loss from stretched meat suggests further work is needed to determine if the loss results from an increased amount of purge in stretched meat. Overall, the results from this study have highlighted significant potential from using the stretching device to improve sheep meat quality and consumer satisfaction. However, it would be of value to examine the benefits for eating quality of using the stretching approach.

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