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EFFECT OF PRE-RIGOR STRETCHING OF BEEF *M.LONGISSIMUS THORACIS* MUSCLES ON STRUCTURAL CHANGES AND KEY MEAT QUALITY ATTRIBUTES

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INTRODUCTION

Sarcomere length has an important effect on meat toughness: the increase in overlap between thick and thin filaments as sarcomeres shorten results in higher levels of the rigid, heat denatured actinomyosin complex on cooking (Marsh & Carse, 1974), and thus increased toughness. While shortening induced by temperature extremes can be avoided by control of processing parameters, when muscle approaches the state of rigor some shortening occurs with attendant toughening. In contrast, stretching a muscle before rigor to increase sarcomere length results in a lower initial toughness and a reduced ageing requirement (Davey *et al*, 1967). Therefore, it is likely that as long as this procedure does not have a deleterious effect on the other meat quality attributes, this technique has some potentially important economic benefits.

OBJECTIVES

The aims of this study were to evaluate the effect of pre-rigor stretching and two different pre-rigor holding temperatures on tenderness development of post-rigor muscle, and on other key meat quality attributes.

MATERIALS & METHODS

Nine prime heifers were captive-bolt stunned, and dressed, and the *M.Longissimus thoracis* muscles from both sides of the carcass were removed approximately 45 minutes post-mortem and transported to the laboratory. Each muscle was trimmed of all visible fat and connective tissue and cut into eight strips with the muscle fibres running longitudinally. Each was marked at 1cm intervals at rest length. One strip was maintained at rest length while the others were clamped and stretched to 20, 40 or 60% using a purpose built apparatus. To prevent surface drying, each sample was wrapped in polyelthylene film. The apparatus was then placed at the required temperature until rigor onset. The samples were removed from the apparatus and prepared for meat quality measurements.

The myofibrillar fragmentation index (MFI) preparation was carried out using fresh muscle samples in accordance with Watanabe *et al.*, (1993). The MFI was calculated using an image analysis software package (Image Pro Plus V3) and expressed as a percentage of the myofibrils that were 1-4 sarcomeres long in relation to the total number of fragments within an image. Water binding capacity (WBC) was measured using the filter press method similar to that described by Kauffman *et al,* (1986). Samples were measured in triplicate and the results were expressed as a ratio (M/T) where M is the area covered by the meat ring and T is the total area of fluid absorbed into the filter paper.

Samples for compression analysis were cooked in a boiling waterbath to the required endpoint temperature, and chilled overnight prior to compression analysis. The cook loss was expressed as the % weight loss during cooking. Samples were prepared for compression analysis (1cm x 1cm compressed to 90% with the fibres running longitudinally) and the resulting force deformation curve was digitised and analysed.

RESULTS

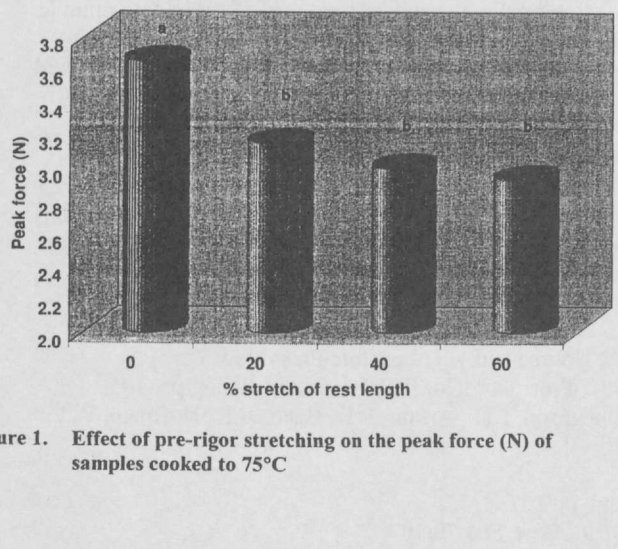

Figure 1. Effect of pre-rigor stretching on the peak force (N) of samples cooked to 75°C

Stretching pre-rigor muscle resulted in a significant reduction in the peak force values of cooked samples averaged for rigor temperature and ageing time (Fig. 1). The greatest reduction in peak force was between 0 and 20% stretch. Further stretching reduced the peak force but these reductions were not statistically significant.

At all degrees of stretching, peak compression forces after 7 days of ageing were lower in samples held at 30°C pre-rigor compared with 4°C pre-rigor ($P<0.001$). However, while ageing reduced the peak force values in the control and 20% stretched samples, ageing did not result in any changes in samples stretched to either 40 or 60%, irrespective of the pre-rigor holding temperature (Fig. 2).

Cooking to both 55°C and 85°C end-point temperatures produced similar effects: At all cooking temperatures, the control samples had higher peak force values compared to the stretched treatments ($p<0.001$) and as the end-point cooking temperature increased the peak force of the samples also increased irrespective of treatment ($p<0.001$) (data not shown).

The effect of stretching on other key meat quality attributes is shown in Table 1. Proteolytic activity measured by MFI was unaffected by stretching. The water binding capacity was also unaffected. Cook loss increased as the endpoint cooking temperature was raised. However, at all temperatures, cook loss in the control samples was greater than from the stretched samples but the different levels of stretch did not affect these losses. In colour, the lightness component (L*) was unaffected by stretching, but the redness (a*) and the yellowness (b*) for the stretched samples was lower than the control, and these effects become more marked as the level of stretch increased.

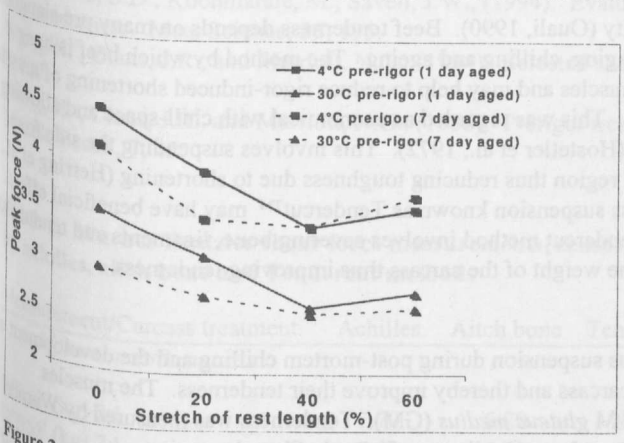

Figure 2. Effect of pre-rigor temperature and subsequent ageing on the peak force (N) of stretched samples

Table 1. Effect of pre-rigor stretching on the MFI and meat quality measurements

	Stretch of rest length (%)				
Measurement	**0**	**20**	**40**	**60**	**Sig.**
MFI	58.7	57.7	59.2	63.4	ns
WHC	89	77	78	77	ns
Cook loss (55°C)	19.1^{a}	16.8^{b}	15.7^{bc}	15.1^{c}	***
Cook loss (75°C)	24.8^{a}	21.9^{b}	22.1^{b}	21.9^{b}	***
Cook loss (85°C)	29.2^{a}	27.4^{b}	26.8^{b}	26.1^{b}	***
L*	40.4	40.9	39.8	39.9	ns
a*	14.3^{a}	13.8^{b}	13.3^{b}	12.4^{b}	***
b*	5.4^{a}	5.5^{a}	5.0^{b}	4.6^{b}	*

Values with different superscripts are significantly different. *** $p<0.001$, * $p<0.05$

DISCUSSION

These results clearly demonstrate the improvement in cooked meat tenderness conferred by pre-rigor muscle stretching. However, reductions in toughness are affected by pre-rigor temperature and the degree of stretch. One explanation for the enhanced tenderness in the stretched samples is a reduction in the amount of actomyosin gel complex formed during cooking. The lack of any change in tenderness after seven days of ageing in the 40 and 60% stretch treatments cannot be explained by changes in proteolytic activity since there were no effects on MFIs. Therefore, stretching appears to improve tenderness, by reducing the initial toughness that develops from heat denaturation of the actinomysin complex during cooking. The peak force of stretched muscle held at 30°C pre-rigor was lower than when held at 4°C, suggesting that pre-rigor temperatures may affect subsequent cook-induced toughening.

Therefore, taken collectively, these findings suggest that the toughness reduction conferred by stretching are due to structural alterations rather than modifications to the proteolytic activity although these differences are dependent upon the level of stretching. However, irrespective of the mechanism of tenderisation, the requirement for proteolytic activity is reduced or at best eliminated.

Lower cook losses probably reflect the more longitudinal arrangement of the connective tissue net around the stretched muscle fibre, resulting in less compressive force as the collagen shrinks during cooking and thus a reduction in the water expulsion. The reduced a*values in stretched samples is difficult to explain, but may reflect changes in the oxygen diffusion rate into meat during the blooming process.

CONCLUSION

Stretching pre-rigor muscles reduces toughness at early post-mortem periods and does not adversely affect other meat quality attributes. However the continuation of these improvements during prolonged ageing, relative to the degree of stretching, has yet to be examined.

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