THE EFFECT OF DIFFERENT PELVIC HANGING TECHNIQUES ON MEAT QUALITY IN BEEF

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BACKGROUND

Tenderstretch, or pelvic hanging, has been used to underpin a number of carcass quality assurance schemes focused on eating quality (Ferguson et al 1999; MLC 1991). When applied to the carcass pre-rigor, pelvic hanging places tension on the major leg and loin muscles, which either minimises shortening, or stretches the muscles with subsequent improvement in tenderness (Bouton et al, 1972; O'Halloran et al., 1998). Commercially, carcasses can be tenderstretched by suspending either through the aitch bone (obturator foramen) or through the pelvic ligament. As the suspension fulcrum is not the same for these two methods, they may place sufficiently different tension on individual muscles in the leg to differ in their effect on the palatability of these muscles. The magnitude of the tenderstretch effect on palatability depends upon the origin and insertion points for individual muscles and although this effect has been documented for the major muscles in the hindlimb (Bouton et al., 1973; Hostetler et al., 1975; Aberle and Judge, 1979; Ferguson et al 1999), the effect on many of the minor muscles has not been reported, nor the relative effect of different pelvic suspension methods. In addition to between muscle variation in palatability, a number of studies have shown significant variation in palatability within the muscles (eg, the *m. longissimus dorsi* Ludwig et al., 1997 and the *m. biceps femoris* and *semitendinosus,* Shackelford et al., 1997)). It is thus possible that position effects within the muscle may interact with hanging technique.

OBJECTIVES

Sarcomere length, shear force and palatability of selected hindlimb and loin muscles were compared between sides suspended from the aitch bone or pelvic ligament (tenderstretch) and by the achilles tendon (conventional hanging). The impact of pelvic suspension on variation in palatability within muscles was also examined.

MATERIALS AND METHODS

Experimental design, animals, treatment and sample preparation: Carcass sides (224 ± 37 kg, P8 fat thickness 6 ± 3 mm) from 17 steers were randomly allocated to one of three hanging methods (Achilles tendon, AT; tenderstretch by the aitch bone, TS aitch; tenderstretch by the pelvic ligament, TS lig). Sides were high voltage stimulated 40 min after slaughter for 30 seconds (850 RMS Volts, 14 pps) prior to rehanging individual sides according to treatment. Carcasses were chilled (2^{o}C) overnight prior to collecting the rump, tenderloin, striploin, silverside, topside, knuckle and flank cuts from each side. Cuts were vacuum packed and aged for 10 days at 2^{o}C before being separated into individual muscles (*Mm. semitendinosus, rectus femoris, vastus intermedius, vastus lateralis, vastus medialis, biceps femoris, gastrocnemius, gluteus profundus, tensor fascia latae, gluteus medius, longissimus dorsi, psoas major, adductor, gracilis and semimembranosus)*. Adjacent samples (ca. 150 gm each) were taken for sensory and objective (sarcomere length, shear force) analyses. In the larger muscles (eg, *m. biceps femoris*) up to 4 sensory and objective samples were collected, but in many of the smaller muscles (eg, *m. gluteus profundus*) only one sensory and one sarcomere sample was possible. Cranial to caudal, proximal to distal positions within the muscles were coded A,B, C (and D in large muscles).

Sensory measurement and statistical analyses: Sensory samples were prepared using the MSA stir-fry protocol (Gee et al., 1999). Briefly, 20 beef strips (10x10x75mm) from the sensory block were cut along the grain and frozen. Prior to tastings the samples were defrosted, heated in a wok, sealed with neutral glaze, and served warm to untrained consumers who scored them for tenderness, juiciness, flavour and overall liking. These scores were combined into a meat quality score (MQ4, Polkinghorne, 1999). Data on sarcomere length, shear force and MQ4 for individual muscles were analysed using a mixed model including terms for side, hanging treatment, position within the muscle (where relevant) and the interaction between treatment and position. Animal was included as a random effect.

RESULTS AND DISCUSSION

Table 1 shows the predicted means for sarcomere length, shear force and MQ4 scores for 7 muscles of the 15 examined, and the significance of hanging treatment and position on these means. Tenderstretch (by either suspension method) resulted in longer sarcomeres and more tender meat for most positions within the major leg muscles than did conventional hanging. The effect was most marked in the *Mm. semimembranosus, longissimus dorsi, gluteus medius, biceps femoris* and the *vastus* group of muscles, which comprise a large proportion of the muscles in the hindlimb and loin. For the *m. longissimus dorsi* the relationship showed the classic threshold effect where sarcomeres greater than 2.0 microns did not show any further improvement in palatability or decrease in shear force. In some minor muscles of the hindlimb and loin (*Mm. psoas major, iliacus, gluteus profundus, tensor fascia latae, gastronemius,* and *gracilis*) tenderstetch allowed the muscles fibres to shorten. For the *Mm. psoas major, iliacus,* and *gastronemius* the decrease in sarcomere length in the tenderstretched sides was small, and any consequent decrease in palatability was not apparent. In contrast, some muscles appeared not to toughen even at very low sarcomere lengths (*m. gluteus profundus,* data not shown), while others toughened at higher sarcomere lengths (*m. tensor fascia latae*). The relationship between the degree of shortening and palatability thus varied with muscle, suggesting that the threshold length of less than 2.0 microns (Bouton et al., 1973) at which toughness starts may not be applicable to all muscles.

The effect of tenderstretch method (ie, TS lig *versus* TS aitch) on sarcomere length varied with muscle. For some of the larger muscles (eg. *Mm. semimembraneous, longissimus dorsi, gluteus medius* and *biceps femoris)* there was a trend for TS lig to result in longer sarcomeres than TS aitch, although the increase was generally small. In spite of this trend in sarcomere length, there was a trend for TS aitch to produce more palatable meat than the TS lig method in most muscles, although on an individual muscle basis the advantage was only significant ($P<0.05$) in 4 of the 15 muscles tested. Overall the difference between the two tenderstretch methods was for TS aitch method to produce meat that was 3.2 units more palatable than the TS lig method.

In AT hung sides all portions of the *m. longissimus dorsi* had similar sarcomere lengths but toughness increased from the cranial to caudal position. There was a trend for TS aitch to result in a greater increase in sarcomere length in the cranial portion, with the gradient in tenderness still evident. However TS lig resulted in a sarcomere length of 2.6 microns over the entire loin, which effectively ameliorated the position effect on palatability and shear force. In contrast, within the *m. biceps femoris* the palatability of position A (superficial to the rump muscles) was 15 to 20 points higher than the remainder of the muscle (positions B, C and D), and this difference was independent of the tension applied by the different hanging methods.

CONCLUSIONS

Tenderstretching beef sides, by either aitch bone or ligament methods, generally resulted in increased sarcomere length with associated increased tenderness and palatability for the major muscles in the hindlimb. Differences between the tenderstretch methods showed a small but consistent trend for TS aitch to produce more palatable meat than TS lig. Variation in tenderness within the *m longissimus dorsi* was minimised by tenderstretching using the ligament hanging, whereas palatability differences within the *m. biceps femoris* were independent of sarcomere length.

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Table 1. Predicted sarcomere length (Sarc), peak force (PF) and palatability (MQ4) scores for different positions within selected muscles from normally hung (AT) and tenderstretch sides hung by either the aitch bone (TS aitch), or the ligament (TS lig) after adjustment for side and a random animal effect

		Sarc (µm)			PF (kg)			MQ4 score			Model terms and probability level[Φ]			
	Position	AT	TS aitch	TS lig	AT	TS aitch	TS lig	AT	TS aitch	TS lig	Trait	Treat	Pos	Treat x Pos
LD	A	1.7	2.1	2.6	4.5	3.7	3.6	54.8	60.0	59.2	Sarc	**0.0001**	0.4378	0.0790
	B	1.7	2.0	2.6	4.8	3.6	3.7	54.8	56.8	53.3	PF	**0.0001**	**0.0013**	0.0702
	C	1.7	1.9	2.6	5.2	4.0	3.7	49.6	48.4	56.1	MQ4	**0.0005**	0.3175	**0.0330**
	Av se		0.07			0.14			2.6					
SM	A	1.9	2.4	2.8	4.8	4.7	5.0	43.8	47.6	48.0	Sarc	**0.0001**	**0.0001**	**0.0129**
	B	1.8	2.3	2.5	4.7	5.1	5.1	45.8	48.6	47.9	PF	0.6697	0.0897	0.1042
	C	1.8	2.3	2.4	5.6	4.9	5.1	38.8	54.1	46.7	MQ4	**0.0006**	0.8074	**0.0207**
	Av.se		0.07			0.26			2.3					
BF	A	1.8	2.0	2.2	nd[Ψ]	nd	nd	60.1	69.5	60.2	Sarc	**0.0001**	**0.0001**	**0.0002**
	B	1.9	2.5	2.4	5.2	4.3	4.6	41.0	47.6	45.5	PF	0.1033	**0.0001**	0.1233
	C	1.9	2.4	2.5	5.4	5.7	5.7	39.0	47.7	44.4	MQ4	**0.0001**	**0.0001**	0.6659
	D	1.9	2.3	2.6	4.8	3.9	4.7	40.3	46.7	40.3				
	Av. se		0.07			0.28			2.5					
PM	A	3.4	3.1	2.7	3.5	3.8	4.0	76.0	75.2	64.9	Sarc	**0.0017**	**0.0079**	**0.0357**
	B	3.4	3.2	3.2	3.2	3.1	3.2	75.3	76.3	69.3	PF	0.0985	**0.0001**	0.0641
	Av. se		0.11			0.12			2.4		MQ4	**0.0002**	0.3761	0.5067
Iliacus	A	3.1	2.5	2.5	3.9	4.0	4.1	72.6	69.7	61.6	Sarc	**0.0007**	nd	nd
	Av. se		0.09			0.19			3.5		PF	0.5229	nd	nd
											MQ4	0.0876	nd	nd
TFL	A	2.8	2.1	2.1	Nd	nd	nd	59.9	51.8	47.8	Sarc	**0.0001**	nd	nd
	Av. se		0.08						2.6		MQ4	**0.0187**	nd	nd

LD: *Longissimus dorsi* , SM: *Semimembraneous*, BF: *Biceps femoris*, PM: *Psoas major*, TFL: *Tensor fascia latae.*

Ψ nd: not determined.

Φ Pos: position, Treat: treatment, significant terms ($P < 0.05$) in the mixed model are bolded.