EFFECT OF PELVIC SUSPENSION ON SENSORY AND INSTRUMENTAL EVALUATION ON FOUR BEEF MUSCLES IN HEIFERS AND YOUNG BULLS

Lundesjö Ahnström, M[1]. , Enfält, L[1]., Johansson, J[1]., Virhammar, K[2]., Hansson, I[1]., Johansson, L[2]., Lundström, K[1]

[1]Dept. of Food Science, Swedish University of Agricultural Sciences, P.O. Box 7051, SE-75007 Uppsala, Sweden
[2]Dept. of Domestic Sciences, Uppsala University, Dag Hammarskjölds väg 21, SE-75237 Uppsala , Sweden

Background

The three main factors that determine beef palatability are tenderness, juiciness and flavour. The most important factor for the consumer is tenderness and it is also the most desired attribute when eating a steak regardless of if it is eaten at home or in a restaurant (Huffman, *et al.*, 1996). Koohmaraie (1996) showed that an unacceptable variation in tenderness was the biggest reason for consumer dissatisfaction of beef. Many factors influence the tenderness of meat and therefore it is a challenge for the beef meat industry to reduce the inconsistency in meat quality and especially in tenderness. The four general characteristics that are considered most important for the tenderness are post mortem proteolysis, intramuscular fat content, connective tissue and the contractile state of the muscle. These factors are also responsible for the differences in tenderness between muscles within the same carcass (Belew et al. 2003). There is an individual variation among animals and there are also quality differences between sexes, heifers being generally more tender than bulls (Jeremiah, 1991). It is known that the conditions during rigor development are the most important factor controlling tenderisation (Dransfield, 1994). It is therefore of interest to study the influence of pre-rigor suspension methods on carcasses. Suspension from the achilles tendon is used in general but to get a stretching effect on the hindquarter muscles and to prevent muscle shortening, pelvic suspension is more effective (Hostetler et al., 1970).

Objective

The objective of this investigation was to study the combined effect of gender and pelvic suspension on tenderness and sensory perception of beef from four different muscles.

Methods

Carcasses from Swedish red and white cattle were selected on the slaughter line; 7 heifers (age 24-28 months and weight 248.5-301.4 kg) and 7 young bulls, (age 22-28 months and weight 234.8-309.7 kg). All carcasses were electrically stimulated (low voltage, 30 sec) within 30 minutes after bleeding. The left side from each carcass was re-hanged by the pelvic bone approximately 60 minutes after exsanguination while the right side was left hanging in the Achilles tendon. The carcasses were chilled during 50 minutes in a chilling tunnel, starting with −2°C, passing a zone with –4°C and then back again to –2°C. The carcasses were stored in a chilling room at 2-4°C until cutting 2 days after slaughter. pH was measured at cutting in the centre of the *M. longissimus dorsi* at the 11th rib, to avoid DFD carcasses. The whole muscles, *M. longissimus dorsi*, *M. psoas major*, *M. gluteus medius* and *M. adductor*, were vacuum-packed and aged for 7 days at 4°C. Samples for Warner-Bratzler measurements were then taken out and frozen at –20°C. *M. gluteus medius* was cut up in two pieces along the thick connective tissue band in the central part of the muscle and only the smaller piece was used for analyses.

The Warner-Bratzler (WB) shear force method (Honikel, 1998) was used for measurement of instrumental tenderness. The WB samples were thawed at 4°C over night and then placed in a water bath (20°C) for 1 hour. The samples were heated vacuum-packed in a water bath for 2 h at 70°C. The weight of the meat samples were recorded before freezing, after thawing and after cooking. The cooked meat samples were stored at 4°C until the measurement of shear force was performed the next day. From each sample, strips (40 x 10 x 10 mm) were cut out following the muscle fibre structure. A minimum of 8 strips from each sample were analysed using a Stable Micro System Texture Analyser HD 100 (Godalning, UK) equipped with a Warner-Bratzler shear force blade with a rectangular hole (Honikel, 1998). A selected and trained panel of 7 judges performed the sensory analysis. The samples, strips from the Warner-Bratzler measurement (20 x 10 x 10 mm), were served room-tempered to the judges in replicates and the attributes bite resistance, tenderness and juiciness were judged on a scale from 0-100. Statistical evaluation was performed using the Procedure Mixed in SAS (Version 8e, SAS Institute Inc., Cary, NC, USA). The statistical analyses were made separately for each muscle. The model contained the fixed effects of sex and suspension method and the interaction between these, and the random effect of animal. For the sensory evaluation the random effect of panel member was also included.

Results and discussion

The results from the Warner-Bratzler shear force measurements (Figure 1 a) from the four muscles show that tenderness is improved in muscles from pelvic suspended carcasses. This confirms earlier results from Hostetler et al. (1970), Bouton and Harris (1972), Fisher (1994) and Lundesjö et al. (2002). The effect of suspension method is greater in young bulls than in heifers. This agrees with the results by Fisher (1994), where the biggest tenderising effects of pelvic suspension were observed in the bull group. In the present study *M. psoas major* was least affected by the suspension method and no significant differences were recognised within gender, but there was a significant difference between genders where the young bulls had a shear force value 27% higher than the heifers ($p=0.005$). A large effect of suspension method was found in *M. longissimus dorsi* from young bulls, where pelvic suspension improved the quality by lowering the shear force value 22% compared to Achilles suspension ($p=0.006$). There was no significant difference between the heifers for *M. longissimus dorsi* and the value for pelvic suspended young bull was not significantly separated from the values for the heifers. The same trend was valid for *M. gluteus medius* and *M. adductor* , where the values for *M. gluteus medius* in the pelvic suspended young bulls were at the same level as the heifers in shear force values, while muscles from Achilles suspended young bulls had shear force values 30% higher then the pelvic suspended ($p<0.0001$). For *M. adductor* there was no significant difference between the heifers and the difference in muscles from young bulls was smaller than in *M. longissimus dorsi* and *M. gluteus medius*. The Achilles suspended muscles had shear force values 9% higher than those from pelvic suspended muscles ($p=0.039$). The method of pelvic suspension reduced the shear force values for *M. gluteus medius* from young bulls down to the level of *M. psoas major* for young bulls. It should be noted that all the muscles from the heifers reached the shear force level of *M. psoas major* from young bulls.

The water holding capacity for the genders and suspension methods is illustrated in Figure 2, where the purge, thaw loss and cooking losses are presented for *M. longissimus dorsi*. The other muscles have a similar pattern. Pelvic suspension lowered the losses compared to Achilles suspension and young bulls had a poorer water holding capacity than the heifers.

The correlations between shear force measurements and the sensory analysis of bite resistance were high for all muscles (Table 1). The correlations for shear force measurements and tenderness were similar, ranging from 0.77 to 0.94. There was no correlation between

tenderness and juiciness; this can be due to difficulties for the panellists to judge juiciness in such a small sample. In the sensory analysis of bite resistance the differences between suspension methods for heifers were magnified compared to the shear force values (Figure 1 b), which resulted in significantly lower values for pelvic suspended compared to Achilles suspended heifers in the muscles *M. longissimus dorsi* and *M. adductor*. In *M. gluteus medius* the result was the opposite, as the strips from the pelvic suspended muscles were considered to have a higher bite resistance compared to the Achilles suspended.

Conclusion

Pelvic suspension lowered the shear force in all muscles from young bulls. Thereby they reached the same low levels in shear force as the heifers had, independent of suspension method. The same pattern was seen for sensory evaluation of bite resistance. All muscles from the heifers (both suspension methods) reached the shear force level of *M.psoas major* from young bulls.

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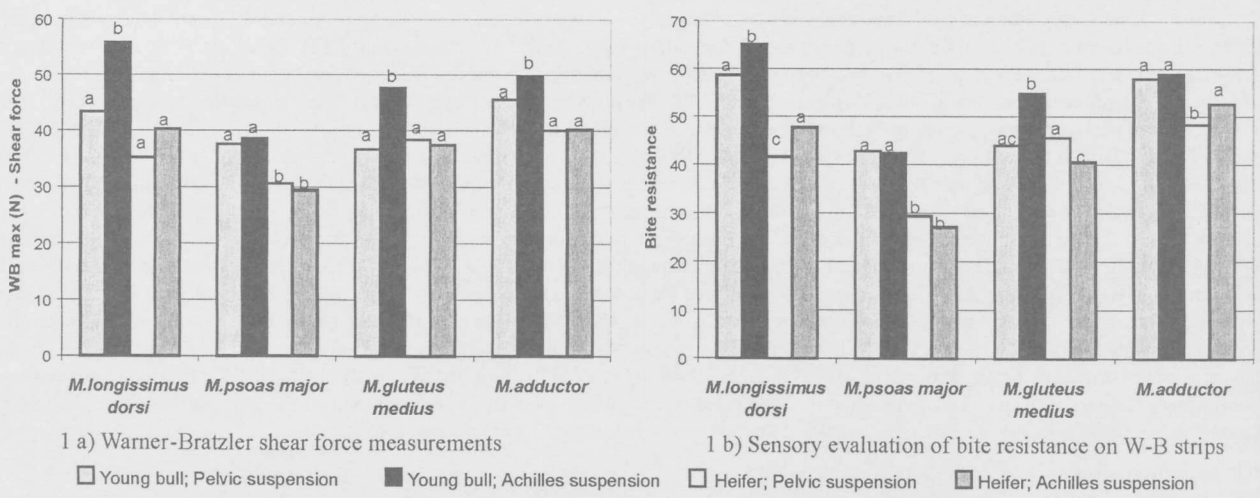

Figure 1 a and b: The effect of Pelvic and Achilles suspension in young bulls and heifers on shear force and bite resistance in four muscles. Bars within muscle with no superscript in common differ significantly ($p<0.05$).

Table 1. Correlations between shear force and bite resistance in four muscles

Muscle	Achilles suspension	Pelvic suspension
M. Longissimus dorsi	0,92***	0,90***
M. Psoas major	0,95***	0,89***
M.Gluteus medius	0,89***	0,80***
M.Adductor	0,72**	0,79***

Levels of significance: ** = $p \leq 0.01$; *** = $p \leq 0.001$.

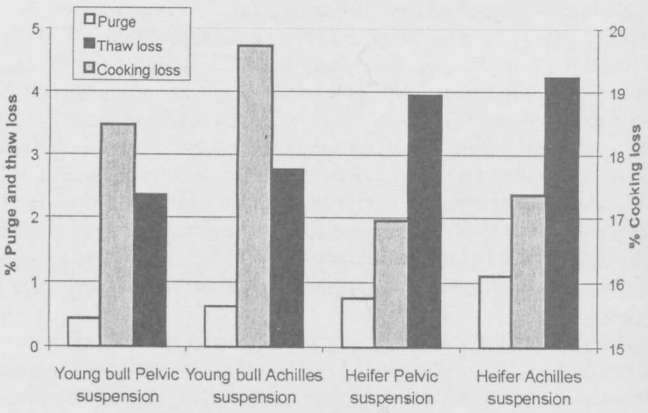

Figure 2: Purge, thaw loss and cooking loss from *M.longissimus dorsi.*