TENDERNESS IN *M. LONGISSIMUS DORSI* FROM COWS – EFFECT OF PELVIC SUSPENSION AND AGEING TIME

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Background

Tenderness is found to be the most important trait when meat is judged from a sensory point of view (Koohmaraie, *et al*., 1998). Meat from older cows is often rejected because it is considered tough. Madsen (1997) found that the age of the cow (2–9 years) did not substantially affect the tenderness in *M. longissimus dorsi* when it was aged for 14 days. Thus, it is of value to study the quality of meat from cows.

Most studies evaluating meat tenderness are done on meat aged for a standardized time, then frozen until heat treatment. However, in the fresh meat marketing of whole steaks, most meat is aged and sold fresh without freezing. Shanks *et al*. (2002) showed that freezing positively affected tenderness compared with meat stored fresh. This indicates the importance of a correct and consistent treatment when meat tenderness is evaluated and implies that results from studies on frozen meat might not be directly applicably to meat marketed/consumed fresh.

An alternative method to enhance tenderness in beef meat is the use of pelvic suspension, instead of Achilles suspension. Pelvic suspension has been reported to improve tenderness in young bulls (Lundesjö *et al*., 2001; Sørheim *et al*., 2001), steers (Hostetler *et al*., 1972) and heifers (Jeremiah *et al*., 1984; Lundesjö *et al*., 2002, Lundesjö Ahnström *et al.*, 2004). Moreover, pelvic suspension was also found to decrease the variation in tenderness. To our knowledge, no studies evaluate the effect of pelvic suspension on meat from cows and it is therefore of interest to evaluate pelvic suspension and different ageing times in cows.

Objectives

The aim of this study was to evaluate the effect of pelvic suspension and ageing time on shear force in fresh *M. longissimus dorsi* from cows. In addition, the effect of freezing on shear force was also studied for meat aged for 7 days.

Materials and methods

Animals. Twelve cows of the Swedish Red and White breed, selected at a commercial slaughter plant, were used. The background of the animals was unknown but only cows in good condition were included in the study. The average slaughter weight and age at slaughter was 315 kg (range 265 – 375) and 68 months (45 – 80), respectively. *M. longissimus dorsi* (LD) from both sides of the 12 carcasses were used.

Slaughter, cutting and preparation of samples. The animals were slaughtered according to the standard routines at the slaughter plant. All carcasses were electrically stimulated, 20 min *p.m*. Left sides were rehung in the pelvic bone, after splitting (app. 45 min *p.m*.), by attaching a rope in ilium. The right sides were used as control, and were kept hung in the Achilles tendon. The carcasses were chilled 30 min in a chilling tunnel (–2°C, –4°C, –2°C), and thereafter in a chilling room (+2-4°C). After 24 h chilling, the carcasses were divided in fore and hindquarter between the 8th and 9th rib from the cranial part. At 48 h *p.m*. LD from both sides were collected, packed in plastic bags and transported to the laboratory. pH was registered to avoid samples with DFD (pH>5.8) (pH-meter WTW pH 340, Germany; electrode Knick SE 104 Germany).

Length and weight of the muscles were registered and each LD was separated into six 10-cm pieces for texture analyses. The pieces were randomized for ageing at 4°C for 2, 4, 7, 14 or 21 days, and also for 7 days followed by freezing at –20°C. All samples were weighed and packed in vacuum bags. Within each carcass, samples were given the same treatment in both left and right side. The sample aged for 2 days was heat treated immediately at the laboratory. A 1-cm piece for analysis of intramuscular fat content (IMF) was

packed in vacuum and stored in –20°C until analysis. A separate 5-cm sample was also packed in vacuum for measurement of pH during storage and kept at 4°C.

Instrumental tenderness. Frozen samples (aged 7 days) were thawed overnight at 4°C. The samples were weighed before further preparation. All samples were kept in a room-tempered water bath for 120 min, before weighing, repacking and heat treatment in a water bath (70°C) during 120 min, until an internal temperature of 69.5°C was reached. Thereafter, the samples were chilled in cold running tap water for 20 min. The samples were stored at 4°C until shear force measurements were performed. Heat-treated samples were room tempered in a water bath for at least 2 h before shear force analysis. Maximal shear force values (WB_{max} in N) was registered on strips (10*10*40 mm) cut parallel with the fiber direction, using a Stable Micro Systems Texture Analyzer HD 100 (Godalning, UK), equipped with a Warner-Bratzler metal blade (1 mm thick; speed 0.83 mm/s) (Honikel, 1998).

IMF, pH and water losses. IMF was analyzed after hydrolysis, using petroleumether for extraction (Soxtec System H^+ equipment, Tecator AB, Höganäs). pH measurement at 2 days *p.m.* was performed when the LD were divided into the different treatments (pH-meter WTW pH 340, Germany; electrode Knick SE 104 Germany). The following pH registrations after 4, 7, 14 and 21 days of ageing were made on the same sample. Water loss was expressed in percentage of initial weight and was calculated as *purge* [(initial weight – weight before heat treatment)/initial weight *100] and *total loss* [(initial weight – weight after cooking)/initial weight *100]. Freezing loss for the frozen samples was calculated as [(initial weight – weight after freezing)/initial weight *100].

Statistical analysis. Data were analyzed with the MIXED procedure in Statistical Analysis System (Version 8e, SAS Institute Inc., Gary, NC, USA). The model used included the fixed effects of ageing time, suspension method, their interaction, and the random effect of animal.

Results and discussion

Pelvic suspension changed the shape of the cuts because loins from the pelvic suspended carcasses were 3.6 cm longer that those from carcasses suspended by the Achilles tendon (p=0.001), which equals to a 5.0% increase. This was also found by Lundesjö *et al*. (2001) in *M. semimembranosus* from young bulls. Both suspension method (p=0.039; least square means 47.9 and 50.9 for pelvic and Achilles, respectively) and ageing time (p<0.001) significantly affected meat tenderness measured as WB_{max}. The overall effect of pelvic suspension independent of aging time was 5.9%, which is lower than previous findings for heifers (12.5%) (Lundesjö *et al*., 2002). Young bulls of the same breed as the cows in this study had as much as 21% decrease in shear force in *M. semimembranosus* after pelvic suspension and 7 days of ageing (Lundesjö *et al*., 2001; 2002).

Suspension method did not significantly interact with ageing time (p=0.818). It was, however still interesting to evaluate the combined effect of the two treatments, and therefore, each subgroup is presented in Table 1. Despite the overall effect of suspension method, with a higher tenderness for pelvic vis-á-vis Achilles suspension, no obvious differences could be found between suspension methods within each ageing time. With 2 days of ageing, shear force values tended to be lower for the pelvic suspended group (p=0.083). This difference was reduced by ageing time, giving equal values between suspension methods after 14 and 21 days of ageing. A lowering of the shear force values as an effect of pelvic suspension tallies with earlier results in other sexes (Hostetler *et al*., 1972; Jeremiah *et al*., 1984; Sørheim *et al*., 2001; Lundesjö *et al*., 2001; Lundesjö *et al*., 2002; Lundesjö Ahnström *et al*., 2004).

Shear force values declined over time, indicating a higher tenderness with longer ageing time, independent of suspension method (Table 1). This is in agreement with the findings by Sañudo *et al.* (2004). In the present study, both suspension methods had significant lower WB_{max} values at 4 days than at 2 days, but no difference between 4 and 7 days of ageing. However, the difference between 4 and 14 days was significant, but not between 14 and 21 days. With Achilles suspension there are larger differences between 7 and 14 and 21 days compared with the pelvic suspension. It can thus be concluded that with pelvic suspension, tenderness after 21 days ageing is already reached within 7 days even though there is a slight, but not

significant increase in tenderness with time. On the other hand, with normal suspension, it takes 14 days of ageing to reach the same value as with 21 days of ageing.

By freezing the samples after 7 days of ageing, shear force values were significantly reduced (see Table 1). The same effect was found for both suspension methods. This reduction gives meat with the same tenderness as for the meat aged for 14 or 21 days. It is, however, not clear if the improved tenderness as a consequence of freezing is accompanied by a lower juiciness. This could be assumed, as a consequence of the finding of higher freezing loss compared with purge from fresh meat stored for the same time. Shanks *et al*. (2002) also found a significant effect of freezing on tenderness and concluded that results for frozen samples might not be transferable to meat stored fresh. This needs to be further investigated.

pH increased in the samples during ageing, from 5.39 at day 2 to 5.50 at day 21 ($p<0.001$). This might be explained by a degradation of proteins during storage, giving a buffering effect in the meat. The overall water loss increased significantly with ageing time ($p<0.001$) (Table 2), but was not influenced by suspension method ($p=0.436$). Purge also increased with ageing time ($p<0.001$) and was lower for pelvic suspension than Achilles suspension ($p=0.030$). Within subgroups, the only difference was found at 14 days of ageing, with a lower loss as a result of pelvic suspension ($p=0.015$). The small effects found on water loss by suspension method in cows found here are in contrast to a larger effect reported earlier in young bulls and heifers (Eikelenboom *et al*., 1998; Lundesjö *et al*., 2001; Lundesjö *et al*., 2002). The frozen samples had higher water loss compared with those stored fresh, both with pelvic ($p=0.011$) and Achilles suspension ($p=0.001$). Higher water loss as a result of freezing was also found by Shanks *et al.* (2002).

Conclusions

In conclusion pelvic suspension gave a more tender meat, measured as lower shear force values, at 2 days of ageing, compared with normal hanging (Achilles). This difference was not found at longer ageing times and thus, pelvic suspension, does not seem to have a great influence on meat tenderness in LD from cows. The tenderness increased during ageing, from 2 to 21 days, in the same way with both pelvic suspension and Achilles suspension. Freezing the meat after 7 days of ageing gave higher tenderness, compared to fresh stored, and gave the same tenderness as meat aged for 14 and 21 days.

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Tables

Table 1. Shear force values (WB_{max}) (least square means) at different ageing times and suspension methods

Ageing (days)	WB_{max}[1] Pelvic	Achilles	P-value[2] Suspension
2	61.6[a]	67.7[A]	0.083
4	51.6[b]	54.8[B]	0.359
7	47.4[bc]	51.2[BC]	0.280
7 (frozen)	39.4[d]	43.4[D]	0.249
14	43.4[cd]	44.7[CD]	0.712
21	43.9[cd]	43.4[D]	0.872

[1] Least square means with same letter within column do not differ significantly (p>0.05).
[2] Comparison of WBmax for Achilles and pelvic suspension within each ageing time.

Table 2. Water loss (least square means) in *M. longissimus dorsi* with Pelvic or Achilles suspension and different ageing times

Ageing (days)	Purge[1] Pelvic	Achilles	P-value[2] suspension	Total loss[1] Pelvic	Achilles	P-value[2] suspension
2	-	-	-	14.0a	13.9a	0.912
4	1.1[a]	1.3[A]	0.684	15.9ab	15.6a	0.830
7	2.6[b]	2.8[B]	0.725	16.7bc	18.1b	0.241
7 (frozen)	4.2[d]	4.9[C]	0.268	20.9d	21.3c	0.738
14	3.0[bd]	4.7[C]	**0.015**	18.9cd	18.6b	0.785
21	5.9[c]	6.3[D]	0.456	21.0d	22.1c	0.320

[1] Least square means with same letter within column do not differ significantly (p>0.05).
[2] Comparison WBmax for Achilles and pelvic suspension within each ageing time.