Effect on meat quality of shackling pigs by one or two legs

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INTRODUCTION

The development of less good meat quality in a muscle immediately after exsanguination has a multifactorial background. The stress susceptibility of the pig, together with the environmental factors preceding slaughter, will interact with the conditions caused by temperature and time after bleeding. The forces that the carcass is exposed to due to the weight of the hanging carcass is one factor that we know very little about. Indications of a poorer meat quality in the shackled side have been detected (Fisher & Augustini, 1981; Lundström & Malmfors, 1985). The variation in meat quality found along the longissimus muscle (as reviewed by Lundström & Malmfors, 1985) might also partly depend on a variation in working load along the hanging carcass.

The purpose of the investigation was to study the effect of two-leg shackling compared with the usual one-leg shackling on meat quality in the longissimus dorsi muscle. In addition, we also wanted to examine the variation in light scattering along the muscle and between sides.

MATERIAL AND METHODS

The animals used in this study were 253 pigs brought for slaughter at an abattoir in southeastern Sweden. Shackling by the left leg is the usual routine at this slaughterhouse, but during the present experiment every second pig was shackled by both hind legs. The same type of chain was used for both shackling types. The animals were stunned with carbon dioxide. The carcasses remained shackled throughout the bleeding and scalding procedure (altogether 15-20 min).

Evaluation of meat quality was made with the Fibre Optic Probe (TBL, Leeds, Great Britain) the day after slaughter. The recordings were made at three sites in the Longissimus dorsi muscle, on both left and right halves. The sites were: (i) between the 9th and 10th thoracic vertebrae (shoulder cut), (ii) at the tip of the last rib (mid-loin), and (iii) between the 5th and 6th lumbar vertebrae (lumbar cut). The probe was inserted into the middle of the muscle between the spines on the split carcass. The loins were divided into two quality groups - PSE and normal - depending on the Fibre Optic Probe value (FOP value). The muscles were classified as PSE when the FOP value equalled or exceeded 55 (G. Bjärstorp, pers. comm., 1984).

Statistical analyses

Data were analysed with the Statistical Analysis System (SAS Institute Inc., 1985) using the General Linear Models procedure. The following model was applied:

$$y_{ijklm} = \mu + t_i + a_{ij} + h_k + s_l + (hs)_{kl} + e_{ijklm}$$

where y_{ijklm} = the ijklmth observation; μ = general mean; t_i = effect of the ith type of shackling (i=1,2); a_{ij} = effect of the jth animal within the ith type of shackling (j=1,2,....126); h_k = effect of the kth half (k=1,2); s_l = effect of the lth site of measurement (l=1,2,3); $(hs)_{kl}$ = effect of the interaction between the kth half and the lth site and e_{ijklm} = residual random term with variance σ_e^2.

The effect of animal was regarded as random and the effects of type of shackling, half, site of measuring and the interaction between half and site were regarded as fixed. To further evaluate the effect of type of shackling, the analyses were also run separately for each type. Differences between the same site in the two different halves were tested using linear contrasts including information from all six points of measurement for each animal.

RESULTS

Overall means for the FOP values for both one- and two-leg shackling and from the right and left side measured at the three sites are given in Table 1. The proportions of PSE muscle (FOP values $\geq$55) are also shown. There was no significant difference between one- and two-leg shackling. As the effect of shackling for the three sites in the longissimus dorsi muscle differed somewhat, the data were analysed separately for each shackling type.

Table 1. Overall means of FOP values for the right and left sides of **M. longissimus dorsi** measured at the shoulder, mid-loin and lumbar sites for one- and two-leg shackling. The proportion of PSE muscles with FOP values ≥55 are also given

	Region								
	Shoulder		Level of significance[2]	Mid-loin		Level of significance[2]	Lumbar		Level of significance[2]
	Right side	Left side		Right side	Left side		Right side	Left side	
One-leg shackling[1]									
Mean (SD)	43.1 (14.9)	46.3 (15.4)	**	32.4 (11.7)	33.3 (12.8)	n.s.	48.3 (15.6)	50.2 (16.4)	n.s. (p=0.12)
PSE (%)	20.6	23.8		5.6	6.3		26.2	36.5	
Two-leg shackling									
Mean (SD)	43.4 (16.5)	47.0 (17.2)	**	31.8 (13.0)	32.2 (12.6)	n.s.	49.9 (16.3)	48.8 (17.7)	n.s.
PSE (%)	22.0	21.4		4.7	5.5		30.7	28.3	

[1]Shackling on left side.

[2]Levels of significance: n.s. = non-significant (**P**>0.05); * = **P**≤0.05; ** = **P**≤0.01; *** = **P**≤0.001. The difference between right and left side within region and type of shackling is tested (see **Statistical analyses**)

The lowest light scattering values (indicating the best meat quality) were found at the site of the last rib, and higher light scattering in the anterior and posterior parts of the muscle, with average differences vs. the middle part of 12 and 17 FOP units, respectively. With both one- and two-leg shackling, the left side (e.g. shackling side with one-leg shackling) was less good (**p**<0.01) in the anterior part. Irrespective of type of shackling, there was no difference between sides in the mid-part of the muscle. In the posterior part of the longissimus muscle, shackling by two legs yielded no difference between sides. When shackling by one leg, however, the shackled leg showed a tendency towards poorer meat quality (**p**=0.12). When using a threshold value to indicate PSE/non-PSE of FOP≥55, however, the difference between sides was greater in the posterior part when shackled by one leg only, by 10 percentage-units less PSE in the non-shackled leg.

DISCUSSION

The overall effect of type of shackling was not great enough in this experiment to recommend a change in the shackling procedure from one-leg to two-leg shackling. With one-leg shackling, the shackled left side had higher light scattering values in the shoulder (**P**<0.01) and lumbar regions (**P**=0.12), compared with the non-shackled side. In an earlier investigation with a larger number of animals studied (Lundström & Malmfors, 1985), the differences between sides were highly significant at both shoulder and lumbar sites. With two-leg shackling, the meat quality in the same site of the two sides of longissimus dorsi was more uniform. One unaccountable exception was the less good meat quality also in the left lumbar region of the two-leg shackled pigs. A possible explanation might be that the two sides were exposed to an unequal force irrespective of type of shackling. Some carcasses rotate for example when being shackled after stunning, and collide violently with a metal guide. Whether this is detrimental to the final meat quality, and if it occurs in a systematic way affecting the left side of the carcass more than the right side, remains to be studied.

The method of hanging scalding as used in this slaughterhouse was originally developed for hygienic reasons (Ekstam, 1963). The scalding water in a tank leads to an increased risk of microbial contamination. Even though only limited increases in bacterial counts have been shown (Nickels et al., 1976), radioactively labelled scalding water from tank scalding has been found in all tissues and organs (Jones et al., 1979, 1984).

To achieve the same depiliatory effect with hanging scalding, compared with ordinary tank scalding, a slightly higher water temperature is used. The scalding time is also somewhat longer (7 min compared with 6 min on average). The greatest difference, however, is the increased shackling time (15-20 min compared with approx. 8 min). With ordinary tank scalding, the water in the scalding tank bears up the weight of the carcass. Even so, Fischer & Augustini (1981) found an increased glycolysis rate in the shackled side, even after tank scalding. In a Dutch experiment, van der Wal (1984) found a rather inconsistent effect of shackling. The pH of the right **M. semimembranosus** showed a decrease as a consequence of shackling, whereas there was no effect in the left semimembranosus. Irrespective of the side of shackling, no effect could be found on the development of rigor mortis.

In conclusion, too little is known about how the ultimate meat quality is affected by the technical equipment in the abattoir. The muscle is still alive for some time after stunning and exsanguination, and some solutions that are good from a technical point of view may be detrimental to the final meat quality. The effect of the forces at work upon the pig carcass during shackling is, for example, a matter of great interest calling for further evaluation.

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