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THE PROBLEM OF DARK-CUTTING IN VEAL

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SUMMARY

During recent years we have performed investigations with the object of studying the effect of handling procedures for calves (carcass weight 100-110 kg) at the abattoir. Effects on ultimate pH of group size, lairage time and a low ceiling in the lairage to prevent mounting have been studied. The ultimate pH was measured in several muscles.

- Ultimate pH was influenced by group size and lairage time. When calves were placed in medium or large groups for longer periods, a dramatic increase in pH resulted. For the animals in small groups, the pH value did not differ significantly with varying lairage time.
- Bull calves had higher ultimate pH than female calves.
- Ultimate pH varied between and within muscles. **M. longissimus dorsi** and **M. semitendinosus** had the highest mean values.
- The use of a low ceiling in the lairage to prevent mounting reduced the ultimate pH.

INTRODUCTION

The problem of dark-cutting in beef has recently been studied in detail (Poulanne & Aalto, 1981; Malmfors et al., 1983; McVeigh & Tarrant, 1983; Warris et al., 1984), but there are few published investigations concerning DFD in veal (Buchter, 1981; Fabiansson et al., 1982; Fabiansson & Bjärstorp, 1983).

In Sweden the DFD frequency for young bulls has decreased over the last 3-4 years, thanks to the application of special handling recommendations at slaughter. Unfortunately, such recommendations regarding calves (carcass weight 100-110 kg) have not yet been in force for more than a couple of years and the DFD frequency is therefore still high, approx. 15%. Since the production of veal in Sweden is quite substantial (9.1 mill. kg in 1986) DFD in veal is responsible for a considerable overall monetary loss for the meat industry.

In the present investigation the effects on ultimate pH of group size, lairage time and a low ceiling in the lairage to prevent mounting have been studied. The purpose of the investigation was to formulate detailed recommendations for slaughter plants and for producers concerning optimal pre-slaughter handling procedures for calves.

The investigation has been presented in more detail by Brendov (1986).

MATERIALS AND METHODS

The investigation was carried out during 1984 and 1985 and comprised about 600 calves delivered from five producers and slaughtered at the producers' cooperative slaughterhouse in Uppsala.

The calves were distributed into groups of three different sizes, viz. 4-5 (small), 8-10 (medium) and 16-20 (large). The groups of each size were lairaged for 1-2 hours, 4-5 hours, and overnight. The low ceiling in the lairage was tested only on the smallest group. The carcasses were electrically stimulated during the bleeding phase (low voltage, 5V and 32 sec.). The ultimate pH was measured in eight different muscles 20-24 hours post mortem. A Knick Portamess 651 pH-meter with an Ingold meat electrode (type Lot 406-M4) was used. Muscles with a $pH_{24} \geq 5.80$ but <6.20 were classified as being moderate DFD and muscles with a $pH_{24} \geq 6.20$ as DFD.

The effects on ultimate pH of producer, group size, lairage time, low ceiling, breed, sex and conformation as well as the interaction between group size and lairage time were tested statistically using the Statistical Analysis System, SAS (SAS Institute Inc., 1985).

RESULTS AND DISCUSSION

The ultimate pH values of the different muscles, expressed as overall means, are presented in Table 1.

Table 1. Overall means and standard deviations (S.D.) for ultimate pH in different muscles

Muscle	Overall mean	S.D.
M. longissimus dorsi (LD)	5.94	0.36
M. psoas major (PM)	5.70	0.19
M. adductor (AD)	5.68	0.27
M. semimembranosus (SM)	5.64	0.29
M. semitendinosus (ST)	5.77	0.36
M. quadriceps femoris (QF)	5.62	0.20
M. biceps femoris (BF)	5.65	0.25
M. pectoralis profundus (PP)	6.13	0.25

LD showed the highest value, 5.94, in the muscles of the hindquarters and LD and ST had the greatest standard deviation. PP in the forequarters had the highest ultimate value, 6.13. The variation between muscles is probably a consequence of i) their function, and ii) their metabolic activity. LD, ST, AD, SM and BF muscles are involved in mounting activity, causing glycogen stores to be reduced.

The overall DFD frequency in the material was 17.4%. This incidence was obtained by distributing the ultimate pH values for LD according to the given limit ($pH_{24} \geq 6.20$).

In Table 2 the effects of group size and lairage time on ultimate pH in different muscles are presented as least-squares means. As the interactions between lairage time and group size were significant for all muscles, except for **M. biceps femoris**, the subgroup means are presented.

For the small group, no significant effects of lairage time were noted. When the shortest lairage time was used, no significant effects of group size were found - except for PP.

For the medium group, overnight lairage resulted in significantly higher pH values, compared with the two shorter lairage periods. Placing calves in the large group resulted in significantly higher pH values after only 4-5 hours. However, the ultimate pH did not increase significantly when the calves in the large group were laired overnight. In the medium group - and especially in the large group - the calves tended to crowd together, which allowed a certain amount of free space, which resulted in greater physical activity, such as mounting and butting. The high pH values obtained for the medium and the large groups, in combination with the two longer lairage periods, were most likely caused by the high physical activity. The number of animals per unit area was the same in the three groups. Unfortunately, no comparable literature concerning calves is available. Buchter (1981) obtained a considerably higher DFD incidence for calves laired overnight compared with calves slaughtered on the day of delivery. However, these calves were tethered throughout the handling procedure.

Table 2. Effects of group size and lairage time on ultimate pH in various muscles. Least-squares means

Muscle and group size	Lairage time			Interaction lairage time · group size[2]
	1-2 hours	4-5 hours	Overnight	
M. longissimus dorsi				
small	5.76^{ab}[1]	5.76^{ab}	5.80^{abc}	
medium	5.66^{a}	5.73^{a}	6.06^{d}	**
large	5.71^{a}	5.87^{bc}	5.95^{cd}	
M. semimembranosus				
small	5.51^{ab}	5.46^{ab}	5.55^{abc}	
medium	5.458^{a}	5.47^{a}	5.74^{d}	*
large	5.47^{a}	5.58^{bc}	5.65^{cd}	
M. semitendinosus				
small	5.53^{a}	5.53^{a}	5.60^{ab}	
medium	5.52^{a}	5.58^{a}	5.85^{c}	*
large	5.55^{a}	5.72^{bc}	5.75^{bc}	
M. biceps femoris				
small	5.51^{a}	5.52^{a}	5.57^{ab}	
medium	5.54^{a}	5.54^{a}	5.72^{c}	N.S.
large	5.53^{a}	5.64^{bc}	5.66^{bc}	
M. pectoralis profundus				
small	6.20^{c}	6.12^{ac}	6.13^{ac}	
medium	6.05^{a}	6.05^{a}	6.24^{c}	**
large	6.01^{a}	6.18^{c}	6.15^{bc}	

[1]Mean values with the same superscript letters do not differ significantly (P>0.05) when tested across all subgroups within muscle.
[2]Levels of significance: $P \leq 0.01$ = **; $P \leq 0.05$ = *; P>0.05 = N.S;

The influence of handling system on meat quality of beef was studied by Malmfors et al. (1983). An optimal lairage period of 3-4 hours was found irrespective of the lairage design used. In that study which comprised 1800 young bulls, individual pens, large free-range pens and tethering were compared. A long lairage period (e.g. overnight) in comparison with a short period in individual pens caused a minor increase in DFD incidence. A corresponding comparison for large pens demonstrated a very substantial increase in DFD.

Table 3 presents the effect of sex on ultimate pH in different muscles.

Table 3. Effect of sex on ultimate pH in different muscles. Least-squares means

Muscle	Sex		Levels of significance[1]
	Bull	Female	
M. longissimus dorsi	5.95	5.67	***
M. psoas major	5.70	5.62	***
M. adductor	5.69	5.49	***
M. semimembranosus	5.64	5.45	***
M. semitendinosus	5.76	5.49	***
M. quadriceps femoris	5.63	5.56	**
M. biceps femoris	5.68	5.49	***
M. pectoralis profundus	6.13	6.12	N.S.

[1]Levels of significance: $P \leq 0.001$ = ***; $P \leq 0.01$ = **; P>0.05 = N.S;

The muscles of the bull calves had significantly higher pH values than female calves except for **M. pectoralis profundus.**

The effect of sex on ultimate pH found in our study is consistent with several other investigations (Augustini & Fischer, 1979; Puolanne & Aalto, 1981; Fabiansson et al., 1982). In the present investigation, the bull calves were much far more active than the female calves. Mounting was the predominant activity. To prevent this, and its deleterious effect on meat quality, a low ceiling in the lairage was tried out, but only on the small group laired overnight. The ceiling was vertically adjustable and in our study the height was fixed at 1.35 m. The results are presented in Table 4.

Table 4. Effect of a low ceiling to prevent mounting on ultimate pH in **M. longissimus dorsi** (LD). Least-squares means

Muscle	Low ceiling		Level of significance[1]
	Used	Not used	
LD	5.64	5.81	*

[1]Level of significance: P<0.05 = *;

For practical reasons, the low ceiling could unfortunately only be tested on the small group. The positive effect of a low ceiling on larger groups would probably be even more pronounced. The ceiling must be vertically adjustable so that the staff easily can empty and clean out the pen.

CONCLUSIONS

- The holding period in the lairage should be kept as short as possible for calves.
- No more than 4-5 calves should be housed in a pen, especially if they have to be laired overnight.
- The ultimate pH can be reduced by lowering the ceiling in the lairage to prevent mounting.

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