RELATIONSHIP BETWEEN RATE OF PH-FALL AND TIME OF DEBONING ON VEAL MEAT QUALITY

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Background

In the Netherlands a project has been started with the aim to optimize the processing conditions of veal carcasses in order to further improve meat quality. The rate of postmortem glycolysis is one of the important factors influencing muscle tenderness. Postmortem pH-fall in combination with muscle temperature will influence muscle shortening and proteolysis and thereby meat toughness and water holding capacity (Offer, 1991). Excission of muscle from its attachments in the skeleton, might result in a further contraction of the muscle thereby increasing muscle toughness. Buchter (1972) found in unstimulated beef and veal carcasses a significant increase in toughness of muscle that was removed from the carcass at 24 hours after slaughter compared to meat deboned 48 hours postmortem. However, in another experiment no differences were found between 24 and 48 hours deboned meat from non electrostimulated carcasses (Eikelenboom and Smulders,1987).

Objectives

The aim of this experiment was to study the effect of 24 compared to 48 hours deboning of muscles from non electrostimulated veal carcasses on shear force measurements and water holding capacity of meat. Furthermore, its relation and interaction with the rate of pH-fall was investigated.

Methods

Two hundred male veal calves of the Friesian Holstein (FH-) breed and 28 weeks of age were slaughtered at a commercial slaughterhouse. Carcasses were not electrostimulated and chilled at 0°C. Temperature and pH of the longissimus muscle (LD) were recorded at 40 minutes, 3, 24, and 48 hours after slaughter. Three groups of 10 calves each were selected on the basis of their pH at 3 hours after slaughter: (1) "Fast pH-fall", pH3 < 6.2; (2) "Intermediate pH-fall", pH3= ± 6.6; and (3) "Slow pH-fall", pH3 > 6.7

LD-muscles from either the left or right side of the selected carcasses were randomly assigned to be excised at 24 hours after slaughter and stored at 2 °C. At 48 hours postmortem the contralateral loin muscle was removed from each carcass. Two days after slaughter all muscles were divided into five parts for shear force measurements at 2, 3, 4, 7, and 14 days postmortem. Muscle samples that were analysed at 3, 4, 7, and 14 days after slaughter were vacuum packaged and stored at 4°C. Drip loss during the storage period was determined. Cooking loss of each sample was measured after one hour heating in a waterbath at 80 °C and Warner-Bratzler shear force was measured according to Chrystall et al. (1994). Samples were taken of all loins for the determination of sarcomere lenghth by laser diffraction (Koolmees et al., 1986). Data were analysed with an analysis of variance model (REML-procedure, Genstat 5, 1993). Fixed effects in the model were were main effects and the interactions for factors: pH had not been reached, especially in the medium and slow glycolysing muscles (table 1). Sarcomere lengths were significantly (p=0.05) shorter for loins deboned at 24 hours (1.79 ± 0.11) compaired to 48 hours postmortem deboned muscle from the same carcass (1.84 ± 0.13). The question remains whether sarcomere length is the only determining factor in the shown increase in toughness due to earlier deboning. Ageing improved tenderness for all muscles, but did not completely reduce the difference in toughness between 24 and 48 hours deboned muscles (table 2).

Table 2. Mean values (± s.d.) of relative shear force, cooking- and drip losses during vacuum package (in %) measured in longissimus dorsi muscles of veal carcasses with a different pH-fall (fast, intermediate, and slow), that were deboned at 24 or 48 hours postmortem and aged for 2, 3, 4, 7, 14 days.

	Rate of pH-fall											
Variable	Fast (n=10)				Intermediate (n=10)				Slow (n=10)			
	24 hours		48 hours		24 hours		48 hours		24 hours		48 hours	
Shear force day 2 pm (%)	81^{a}	(16)	65^{b}	(14)	99^{c}	(25)	$79^{a,b}$	(21)	100^{c}	(19)	$66^{a,b}$	(24)
Shear force day 3 pm (%)	68^{a}	(16)	57^{a}	(13)	83^{b}	(25)	62^{a}	(21)	88^{b}	(16)	53^{a}	(18)
Shear force day 4 pm (%)	66^{b}	(13)	54^{a}	(16)	82^{c}	(15)	$58^{a,b}$	(22)	82^{c}	(20)	52^{a}	(12)
Shear force day 7 pm (%)	$57^{a,b}$	(19)	$52^{a,b}$	(12)	79^{c}	(23)	64^{b}	(18)	86^{c}	(12)	46^{a}	(13)
Shear force day 14 pm (%)	49^{b}	(15)	38^{a}	(10)	65^{c}	(18)	54^{b}	(14)	72^{c}	(15)	$41^{a,b}$	(8)
Cooking loss day 2 pm (%)	38.2^{a}	(2.0)	38.1^{a}	(2.0)	$38.2^{a,b}$	(2.6)	$37.3^{a,b}$	(1.9)	$37.0^{a,b}$	(2.3)	35.2^{b}	(1.7)
Cooking loss day 3 pm (%)	37.2^{a}	(2.5)	$35.9^{a,b}$	(2.3)	36.8^{a}	(1.7)	$34.6^{b,c}$	(2.3)	34.8^{b}	(1.1)	33.0^{c}	(2.7)
Cooking loss day 4 pm (%)	37.8^{a}	(1.2)	$36.9^{a,b}$	(2.5)	$36.5^{b,c}$	(1.9)	$36.2^{b,c}$	(1.7)	$35.9^{b,c}$	(1.7)	35.2^{c}	(1.3)
Cooking loss day 7 pm (%)	36.6^{a}	(2.3)	36.5^{a}	(2.2)	36.4^{a}	(1.4)	35.4^{a}	(1.7)	35.9^{a}	(2.0)	32.4^{b}	(1.6)
Cooking loss day 14 pm (%)	36.8^{a}	(2.3)	36.8^{a}	(2.9)	35.8^{a}	(2.2)	$35.5^{a,b}$	(1.7)	35.2^{a}	(1.9)	33.8^{b}	(1.2)
Drip loss day 3 (%)	4.8^{b}	(1.9)	3.6^{a}	(1.5)	5.1^{b}	(2.2)	3.7^{a}	(1.5)	3.8^{a}	(2.2)	3.8^{a}	(2.6)
Drip loss day 4 (%)	4.8	(1.4)	5.3	(2.6)	5.7	(2.6)	4.9	(1.8)	4.9	(2.1)	4.5	(2.1)
Drip loss day 7 (%)	$8.1^{b,c}$	(2.0)	$6.9^{a,b}$	(2.3)	9.1^{c}	(1.5)	$8.4^{b,c}$	(1.6)	$8.5^{b,c}$	(1.7)	6.1^{a}	(2.3)
Drip loss day 14 (%)	11.7^{b}	(2.2)	$10.6^{a,b}$	(2.8)	$10.7^{a,b}$	(2.2)	$9.7^{a,b}$	(1.3)	10.8^{b}	(1.6)	9.1^{a}	(2.4)

^{a,b,c} Mean values within a row with a different superscript differ significantly between different combination of pH-groups and time after deboning.

Except for the cooking loss of 7 days aged muscle samples, there was no interaction found between 'rate of pH-fall' and 'time of deboning'. There were both a significant pH- and deboning effect on cooking loss, leading to increased cooking losses for faster glycolysing muscles compaired to loins with a slow pH-fall. Deboning at 24 hours also caused higher cooking losses than muscle excission at 2 days after slaughter. Drip loss was only significantly increased by earlier deboning and not by differences in pH-fall in this experiment. It can be concluded that rate of pH-fall (fast, intermediate, and slow) and time of deboning (24 and 48 hours postmortem). Animals were introduced as random effects. Differences between factors or combinations of factors were compaired pairwise with Fisher's method.

Results and discussion

Selection on the basis of pH in the LD at 3 hours after slaughter tended to coincide with a lower carcass weight (table 1). This relationship between carcass weight and temperature is confirmed by a recent survey involving 1800 veal calves that were slaughtered and processed in the same way (Klont et al., 1996). Smaller carcasses are chilled faster, which leads to significant differences in temperature at 3 hours after slaughter. A decrease in temperature will slow down the enzymatic processes involved in postmortem glycolysis and results in a slower rate of pH-fall.

Table 1. Mean (± s.d.) carcass weight (kg) and pH- and temperature (T) values of longissimus dorsi muscles at 40 minutes, 3, 24, and 48 hours postmortem of veal carcasses with a different rate of pH-fall (fast, intermediate, and slow).

	Rate of pH-fall					
Variables	fast (n=10)		intermediate (n=10)		slow (n=10)	
Carcass weight (kg)	149.3	(10.2)	149.1	(14.7)	137.7	(19.2)
pH 45 min pm	6.67	(0.10)	6.74	(0.10)	6.78	(0.15)
pH 3 h pm	6.17^{a}	(0.11)	6.58^{b}	(0.02)	6.83^{c}	(0.07)
pH 24 h pm	5.58	(0.11)	5.67	(0.13)	5.72	(0.15)
pH 48 h pm	5.57^{a}	(0.05)	5.56^{a}	(0.04)	5.63^{b}	(0.06)
T 45 min pm (°C)	38.3	(0.4)	38.6	(0.4)	38.3	(0.7)
T 3 h pm (°C)	23.2^{a}	(1.9)	23.0^{a}	(1.8)	21.0^{b}	(2.4)
T 24 h pm (°C)	2.0	(0.4)	2.3	(0.6)	2.0	(0.4)

^{a,b,c} Mean values within a row with a different superscript differ significantly between different pH-groups.

There was a significant interaction between the factors 'pH-fall' and 'time of deboning'. Faster glycolysing muscles resulted in more tender veal meat, as assessed by Warner-Bratzler shear force measurements (table 2). Similar results were found by O' Halloran et al. (1995) for beef muscles using both shear force and sensory panel analysis. Deboning at 24 hours after slaughter resulted in significantly tougher meat, when compaired to excission of the contralateral LD of the same carcass at 48 hours postmortem. This effect was more pronounced for slower glycolysing muscles.

One reason for this difference in tenderness might be that the end-pH has not yet been reached when muscles are excised. There is still energy left and muscles may further contract because they are no longer restrained by bone attachments. The pH at 24 hours postmortem show that the end-excission of muscle from the carcass before the end-pH has been reached caused a substantial negative effect on tenderness and water holding capacity of veal meat.

Conclusions

Veal carcasses with a faster pH-fall have lower shear force values than carcasses with a slower pH-fall. Deboning at 24 h postmortem leads to tougher meat (higher shear force) in comparison with 48 h deboning. Differences in shear force between 24 and 48 h deboning are bigger in slower glycolysing carcasses. Aging improves tenderness but did not reducee the difference in shear force values between 24 and 48 h deboning. Cooking losses increase with both faster pH-fall and 24 h deboning. Drip losses during vacuum storage increase with 24 h deboning compared to 48 h deboning. Effect of time of deboning on shear force and water holding capacity can at least be partly explained by a shorter sarcomere length. The negative effect of earlier deboning should be taken into account when very fast chilling measurements are to be developed.

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