E47

EFFECT OF DURATION OF FEED WITHDRAWAL AND OF TRANSPORT ON THE SENSORY QUALITIES OF VEAL

X. FERNANDEZ, G. MONIN, J. CULIOLI, I. LEGRAND* AND Y. QUILICHINI*
INRA, Station de Recherches sur la Viande, Theix, 63122 Saint-Genès Champanelle, France
* Institut de l'Elevage, Route d'Epinay, 14310 Villers Bocage, France

OBJECTIVES

Veal often shows excessive losses during cooking and associated defects in juiciness and tenderness (Monin, 1993). The causes of such defects are partly identified. They include too fast chilling, the use of beta-agonists and insufficient ageing (Monin, 1993). Little is known, however, on the influence of preslaughter conditions which are likely to have significant incidence on the eating qualities of veal through their effects on the rate and extent of *post mortem* pH fall. Recently, Guignot *et al.* (1994) found strong positive correlations between ultimate pH, manipulated by preslaughter injection of epinephrine, and sensory qualities of veal. The present experiment was designed to assess the possibility of manipulating ultimate pH, and subsequently sensory qualities, by varying preslaughter conditions in calves.

MATERIAL AND METHODS

The animals were 48 Friesan-Holstein calves coming from the same farm, and slaughtered at 18 weeks of age. They were fed skimmed milk powder and maize. The experiment was carried out in two replicates of 6 x 4 animals each, allocated according to liveweight and hematocrite at 110 days of age, and following a 2 x 2 factorial design including the following treatments: time between last feeding and loading for transport (11 or 1 h) and transport duration (11 or 1 h). Resting time at the abattoir was fixed at 1 h.

At 45 min *post mortem*, samples of muscle *longissimus* (LL) were taken for the determination of the glycolytic potential (GP), an estimator of preslaughter muscle glycogen level, according to Monin and Sellier (1985). The pH was measured in samples of LL and *semimembranosus* (SM) muscles obtained at 4 h *post mortem*. The pH was determined after homogenization of 2 g of muscle in 18 ml of 5mM iodoacetate, using a combined electrode. The LL and SM muscles were taken at 48 h *post mortem* and used for the following analyses: determination of pH directly in the muscle using a combined electrode, and drip loss according to Honikel *et al.* (1986). The samples were vacuum packed and allowed to age for 3 more days at 4°C. Sarcomere length was determined on raw samples of both muscles by diffraction of a laser beam as described by Cross *et al.* (1980-81). Rheological measurements of myofibrillar strength were carried out as described by Lepetit *et al.* (1986). The samples were cooked up to core temperature of 70°C in a microwave and 30 min in a water-bath at 75°C. Cooked samples were submitted to one sinusoidal compression cycle (at compression ratios of 20 and 80 %) and the maximum stresses (K_{20} and K_{80}) were recorded. Before sensory analysis, the samples were cooked in an oven at a core temperature of 70°C. Samples were taken before and after cooking for the determination of dry matter (referred to as raw dry matter and cooked dry matter, respectively). Tenderness, juiciness and flavour were estimated by a trained panel of 12 members during comparative tests, using a 100-point scale (0: very bad, 100: very good).

TABLE 1- EFFECT OF PRESLAUGHTER CONDITIONS ON VARIOUS TRAITS IN *SEMIMEMBRANOSUS* AND *LONGISSIMUS* MUSCLES (mean ± SEM)

Time since last feeding (TLF) [1]	*11 h*		*1 h*		*Significance levels* [2]		
Transport duration (TD)	*11 h*	*1 h*	*11 h*	*1 h*	*TLF*	*TD*	*TLFxTD*
			Semimembranosus				
pH_{4h}	6.60 ± 0.02	6.56 ± 0.02	6.57 ± 0.02	6.55 ± .04	NS	NS	NS
pH_{48h}	5.46 ± 0.02 [a]	5.42 ± 0.01 [b]	5.45 ± 0.05 [ab]	5.47 ± 0.01 [a]	NS	NS	p<0.05
Drip loss (%)	4.56 ± 0.68	4.60 ± 0.58	5.17 ± 0.57	4.00 ± 0.52	NS	NS	NS
Sarcomere length (µm)	1.71 ± 0.03	1.69 ± 0.03	1.69 ± 0.02	1.75 ± 0.03	NS	NS	NS
Cooking loss (%)	28.6 ± 0.6 [a]	28.5 ± 0.5 [a]	27.5 ± 0.4 [b]	27.4 ± 0.7 [b]	p<0.05	NS	NS
Raw dry matter (%)	24.1 ± 0.1	24.2 ± 0.1	24.6 ± 0.1	24.2 ± 0.2	NS	NS	NS
Cooked dry matter (%)	33.3 ± 0.3	33.4 ± 0.4	34.1 ± 0.3	33.6 ± 0.4	NS	NS	NS
K_{20} (N/cm²) [3]	28.0 ± 1.8	24.7 ± 1.3	28.8 ± 1.8	26.4 ± 1.4	NS	p<0.10	NS
K_{80} (N/cm²) [3]	128 ± 4 [a]	114 ± 3 [bc]	123 ± 3 [ab]	109 ± 3 [c]	NS	p<0.001	NS
			Longissimus				
pH_{4h}	6.59 ± 0.02 [a]	6.52 ± 0.02 [b]	6.58 ± 0.02 [a]	6.51 ± 0.02 [b]	NS	p<0.05	NS
pH_{48h}	5.43 ± 0.01	5.41 ± 0.01	5.45 ± .04	5.41 ± 0.01	NS	NS	NS
Drip loss (%)	4.17 ± 0.59 [ab]	5.41 ± 0.55 [a]	3.54 ± 0.38 [b]	4.11 ± 0.47 [ab]	p<0.10	p<0.10	NS
Sarcomere length (µm)	1.59 ± 0.06	1.72 ± 0.08	1.63 ± .08	1.71 ± 0.04	NS	p<0.10	NS
Cooking loss (%)	27.6 ± 0.6 [a]	27.7 ± 0.5 [a]	26.6 ± 0.9 [b]	26.2 ± 0.6 [b]	p<0.05	NS	NS
Raw dry matter (%)	23.9 ± 0.1	24.2 ± 0.2	23.8 ± 0.4	24.1 ± 0.3	NS	NS	NS
Cooked dry matter (%)	32.5 ± 0.4	32.9 ± 0.3	32.4 ± 0.5	33.0 ± 0.4	NS	NS	NS
GP (µmol/g) [4]	183 ± 6 [a]	206 ± 7 [b]	190 ± 7 [ab]	203 ± 7 [ab]	NS	p<0.01	NS
K_{20} (N/cm²) [3]	21.2 ± 1.7	22.0 ± 1.6	22.9 ± 1.6	21.0 ± 1.8	NS	NS	NS
K_{80} (N/cm²) [3]	111 ± 6	106 ± 7	103 ± 9	95 ± 5.6	NS	NS	NS

n=12 per treatment - [1], time between the last milk feeding and loading for transport to the slaughterhouse - [2], NS, p>0.10
[3], K_{20} and K_{80}, maximum stress during compression of samples at compression ratios of 20 and 80 %, respectively - [4], glycolytic potential, GP= 2([glycogen] + [glucose] + [glucose-6-P]) + [lactate], expressed as µmol lactate/g fresh tissue - [ab], different superscripts indicate significant differences between means (p<0.05).

Analysis of data was carried out using the GLM procedure of the SAS system (SAS, 1989). The model included the following effects: slaughter day (replicate), time of feed withdrawal, transport duration and the interaction between the two last effects. When appropriate, means were further compared using Duncan's test for multiple means comparison.

RESULTS

In the SM muscle, long transport duration was associated with significantly increased ultimate pH only in the group which experienced long time of feed withdrawal (Table 1). However, this effect was of low magnitude (+ 0.04 pH unit). Regardless of transport duration, increasing time since last feeding induced a significant decrease in cooking loss. Transport duration had a highly significant effect on myofibrillar strength at the compression ratio of 80 %: calves which experienced long transport showed increased myofibrillar strength as compared to short-transported animals. In the group which has been fed 1 h before loading, the animals transported for 11 h showed significantly lower sensory evaluated tenderness than those transported for 1 h (Table 2). Short transport was associated with significantly higher overall acceptability. The effect of transport duration on juiciness and flavour was close to significance (p= 0.08).

TABLE 2- EFFECT OF PRESLAUGHTER CONDITIONS ON THE SENSORY QUALITIES OF *SEMIMEMBRANOSUS* AND *LONGISSIMUS* MUSCLES (mean ± SEM)

Time since last feeding (TLF)[1]	*11 h*		*1 h*		*Significance levels* [2]		
Transport duration(TD)	*11 h*	*1 h*	*11 h*	*1 h*	*TLF*	*TD*	*TLFxTD*
			Semimembranosus				
Tenderness	53 ± 2 ^{a}	58 ± 2 ^{ab}	53 ± 2 ^{a}	60 ± 2 ^{b}	NS	p<0.01	NS
Juiciness	50 ± 2	54 ± 1	50 ± 1	53 ± 2	NS	p<0.10	NS
Flavour	56 ± 1	57 ± 1	56 ± 1	58 ± 1	NS	p<0.10	NS
Overall acceptability	53 ± 2 ^{a}	58 ± 1 ^{b}	53 ± 1 ^{a}	58 ± 1 ^{b}	NS	p<0.001	NS
			Longissimus				
Tenderness	54 ± 2 ^{a}	61 ± 2 ^{b}	57 ± 3 ^{ab}	60 ± 2 ^{ab}	NS	p<0.05	NS
Juiciness	52 ± 1	54 ± 1	53 ± 2	56 ± 2	NS	p<0.10	NS
Flavour	57 ± 1	56 ± 1	56 ± 1	57 ± 1	NS	NS	NS
Overall acceptability	51 ± 1	53 ± 1	52 ± 2	55 ± 2	NS	NS	NS

n= 12 animals per treatment - [1], time between the last milk feeding and loading for transport to the slaughterhouse - [2], NS, p>0.10.
^{ab}, different superscripts indicate significant differences between means (p<0.05).

Animals which have been transported for 1 h showed significantly lower pH at 4 h *post mortem* in the LL muscle than those transported for 11 h, regardless of the time since last feeding (Table 1).Though significant, this effect (- 0.07 pH unit) was of low magnitude. Regardless of transport duration, increasing time since last feeding induced a significant decrease in cooking loss. Glycolytic potential was higher in short-transported animals but this effect was significant only in the group fed 11 h before loading. Calves transported for 11 h showed lower sensory evaluated tenderness of the LL than those transported for 1 h. However, this effect was significant only in the group of animals fed 11 h before loading (Table 2). The effect of transport duration on juiciness score was close to significance (p= 0.08).

CONCLUSIONS

The present results show that long transport is associated with decreased sensory evaluated tenderness in veal. In the SM muscle, this effect was also demonstrated for myofibrillar toughness assessed instrumentally. Long transport duration was expected to induce higher ultimate pH, due to muscle glycogen depletion, and subsequently increased tenderness as the results of Guignot *et al.* (1994) would suggest. The reverse was found and multiple regression analyses (not shown) indicate that this effect could not be explained by pH variation or by other factors assessed in the present study and usually influencing tenderness, such as contraction state (sarcomere length), water-holding capacity and water content of cooked muscle.

REFERENCES

Cross, H. R., West, R. L. & Dutson, T. R. (1980-81). Comparison of methods for measuring sarcomere length in beef semitendinosus muscle. *Meat Sci.*, **5:** 261-266.

Honikel, K. O., Kim, C. J. & Hamm, R. (1986). Sarcomere shortening of prerigor muscle and its influence on drip loss. *Meat Sci.*, **16:** 267-282.

Guignot, F., Touraille, C., Ouali, A., Renerre, M. & Monin, G. (1994). Relationships between post-mortem pH changes and some traits of sensory quality in veal. *Meat Sci.*, **37:** 315-325.

Lepetit, J., Salé, P. & Ouali, A. (1986). Post-mortem evolution of rheological properties of the myofibrillar structure. *Meat Sci.*, **16:** 161-174.

Monin, G. (1993). pH et qualités sensorielles de la viande de veau. *VPC*, **14:** 43-47.

Monin, G. & Sellier, P. (1985). Pork of low technological quality with a normal rate of pH fall in the immediate post-mortem period : the case of the Hampshire breed. *Meat Sci.*, **13:** 49-63.

SAS (1989). *SAS/STAT User's Guide*. SAS Institute Inc., Cary, NC, USA.