...TIONSHIPS BETWEEN ULTIMATE PH AND MEAT QUALITY IN VEAL

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...MARY

The aim of this study was to evaluate the relationships between the ultimate pH and the colour, the cooking loss and the sensorial ...es in veal meat. Variations in ultimate pH were induced by adrenalin administration (0.1 to 0.4 mg/kg liveweight). Animals were ...ed 2 by 2 to the slaughterhouse. The control animal of each pair was killed just after arriving. The other animal was injected with ...in and killed the day after. Measurements were made on the *Longissimus dorsi* muscle. Sarcomere length, pigment content and pH were ...ed at 29 hours after slaughter, and colour was measured at 2 days and 9 days after slaughter. Sensorial qualities (tenderness, juiciness, ...) and cooking loss were measured at 9 days after slaughter. Sensorial qualities were estimated by a trained panel.

Meat from adrenalin-injected animals had a higher ultimate pH than meat from controls (mean values were respectively 6.25 and 5.59), ...in one case (pH = 5.65 with 0.2 mg/kg of adrenalin). The ultimate pH and the sensorial qualities were linearly correlated (respectively r = ...for tenderness, 0.81 for juiciness and 0.71 for flavour). Tenderness, juiciness and flavour increased when ultimate pH increased. ...ver, sarcomere length and cooking loss decreased when ultimate pH increased (respectively r = - 0.77 and - 0.87). However, colour of ...as darker ($P < 0.01$) and it cleared less during the days after slaughter when the ultimate pH increased.

...ODUCTION

...sides colour, which is one of the most important factors determining the value of veal carcasses, tenderness, juiciness and cooking loss ...ry important criteria of veal meat quality. Much is known about tenderness, juiciness and cooking loss in beef, pork and mutton meat, but ...owledge about these traits in veal meat is reduced.

...All of these traits are affected by many parameters. Colour depends on the muscle pigment content, the chemical state of the pigment, the ...ructure of muscle and the rate of the pH fall. Tenderness and juiciness are influenced by the degree of meat ageing, the degree of muscle ...ing and the collagen content. All of these traits are also affected by the extent of the pH fall. At similar pigment concentration, the colour ...ter when the ultimate pH is lower. Water holding capacity and cooking losses are more important when the ultimate pH is low (Lawrie, ...). Increasing ultimate pH increases juiciness (Dransfield, 1980) and tenderness (Penny *et al.*, 1963 ; Bouton *et al.*, 1973a ; Yu & Lee, ...). Positive linear relations (Dransfield, 1980 ; Bouton *et al.*, 1982) as well as curvilinear relations (Bouton *et al.*, 1957 ; Bouton *et al.*, ...; Purchas, 1990) have been reported between ultimate pH and tenderness in adult bovine muscle.

...The aim of the present study was to assess the influence of the extent of the *post mortem* pH fall on colour, cooking loss and sensorial ...ies in veal muscle. As high ultimate pH are not frequently obtained in the usual slaughter conditions (Guignot *et al.*, 1992), variations in ...ate pH were induced by adrenalin administration (0.1 to 0.4 mg/kg liveweight).

...ERIAL AND METHODS

...als and sampling

...Twelve Friesan-Holstein calves, from a same fattening batch, were used. They were fed skimmed milk powder and maize and slaughtered ...18 weeks old. The animals were transported by pairs (1 pair per day) to the Meat Research Laboratory in Theix (100 km far from the ...). The control animal of each pair was killed just after arriving. The other animal was injected with adrenalin around 3 h after arriving and ...6 h later, and killed 21 h after the first injection. The amounts of adrenalin were varied between animals in order to obtain some variation ...at ultimate pH. Slaughter was made by stunning and exsanguination.

One hour after slaughter, carcasses were put in a cold room at 4 °C. Twenty nine hours after slaughter, samples were taken from the ...ssimus dorsi muscle to measure the pH, the sarcomere length and the pigment content. Other samples were taken to measure the colour at ...d 9 days after slaughter. They were put on plastic form trays, wrapped in oxygen-permeable polyvinylchloride film and stored in a ...erator at 4 °C. Finally, roasts were made to measure the cooking loss and to evaluate the sensorial qualities at 9 days after slaughter.

- *Analytical techniques*

pH measurement : pH was measured directly in the muscle using a glass electrode.

Sarcomere length : sarcomere length was measured by the laser diffraction method described by Cross *et al.* (1980/81).

Colour : reflectance spectra were determined on the samples packed and kept at 4 °C in darkness. Reflectance spectra were record between 360 and 760 nm using a Uvikon 860 spectrophotometer, and colour coordinates (lightness, L* ; redness, a*) were calculated in t CIELAB (1976) system.

Pigment : the pigment concentration was determined using the technique of Hornsey (1956) at 3 days *post mortem.*

Sensorial qualities : roasts were cooked at a final temperature of 70 °C. Tenderness, juiciness and flavour were estimated by a trained pa between 0 and 10.

Cooking loss : roasts were weighed before and after cooking. Cooking loss was expressed as lost weight in percentage of weight befo cooking.

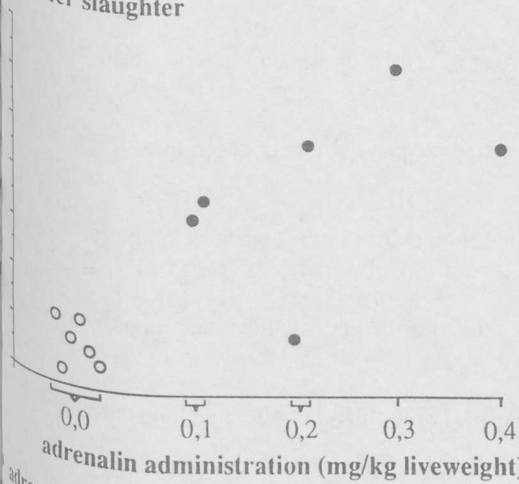
- *Calculations* : linear regressions, means comparisons and variance analysis were used.

RESULTS AND DISCUSSION

A large variation in ultimate pH was obtained in the adrenalin-injected animals (Fig. 1). Extreme values were 5.65 and 6.72 in adrenali injected animals. One of them had normal pH with 0.2 mg/kg of adrenalin. Correlations between ultimate pH and colour parameters are report in table 1. Ultimate pH and colour parameters were highly correlated (P < 0.01 at 2 and 9 days after slaughter). Brightness, redness a reflectance decreased when ultimate pH increased. Moreover, during the days after slaughter, meat colour of all animals cleared (P < 0.01), b colour of meat with high ultimate pH tended to clear less. Sensorial qualities, cooking loss and sarcomere length were highly correlated wi values of ultimate pH (Fig. 2 & 3). Tenderness, juiciness and flavour increased whereas sarcomere length and cooking loss decreased whe ultimate pH increased. All relations were linear, particulary the relation between tenderness and ultimate pH. It can be noticed that the meat fro the adrenalin-injected veal, which had have a ultimate pH value of 5.65, had sensorial qualities similar to those of meat from control animals.

At high ultimate pH, transmittance through the fibers is high and light diffusion is small, so meat colour appears dark (Swatland, 199 The linear relation found here between sarcomere length and ultimate pH agrees with the results of Bouton *et al.* (1972) in ovine muscle a Honikel *et al.* (1986) in porcine and bovine muscles, but not with the results of Purchas (1990) in bovine muscle. The latter author found curvilinear relation between sarcomere length and ultimate pH, with a minimum sarcomere length when pH reached a value around 6.3. M with high ultimate pH is more tender than meat with normal pH according to Penny *et al.* (1963), Bouton *et al.* (1973a), Dransfield (1980) a Yu & Lee (1986). This can be explained by the effect of pH on protease activities. A high pH is favourable to the proteolytic activity of prote (Greaser, 1986 ; Asghar & Bhatti,1987). These authors found that calpain activity was optimal when pH reached a value of 7.0. However, th results desagree with the results of Geesink *et al.* (1991). These latter authors found that the decline in calpain activity measured at 29 h a slaughter in *Rectus abdominis* muscle of adrenalin-treated calves was more important at high ultimate pH. Geesink *et al.* (1991) thought t calpains lose their activity possibly through autolysis of the enzyme, because the calpain activity is more important at high ultimate pH (Grea 1986 ; Asghar & Bhatti, 1987). Meat with high ultimate pH was more tender in the experiment of Geesink *et al.* (1991), so the increase tenderness of meat with high ultimate pH could not be due to calpain activity. The linear relation found here between ultimate pH and tendern desagrees with the curvilinear relation found by Bouton & Shortose (1969) and Purchas (1990), who observed in adult bovine muscle minimum of tenderness for a pH value around 6.0. The meat toughness observed when ultimate pH was normal could be explained by t contraction of the muscle with high ultimate pH. Marsh *et al.* (1974) found that a contraction of the sarcomere length above 40 % increased t tenderness of the meat as a result of myofibrils disruptions. Surely the shortest sarcomere showed only a contraction of the order of 30 % if i considered that sarcomere length at rest is in the order of 2 μm (Honikel *et al.*, 1986), but the measurement of sarcomere length by las diffraction is not very reliable for sarcomere length less than 1,6 μm (Young *et al.*, 1990). So it cannot be excluded that sarcomeres of meat w high ultimate pH have contracted to an extent in the order of the contraction found by Marsh *et al.* (1974). Ultimate pH could also effect th tenderness through its affect on cooking loss and the resulting water content, which increase with pH.

...gure 1. Values of ultimate pH obtained on the *Longissimus dorsi* muscle of veal ... 29 h after slaughter



adrenalin-injected animals
control animals

...e 2. Relationships between ultimate pH and sensorial qualities and cooking loss measured at 9 days after slaughter

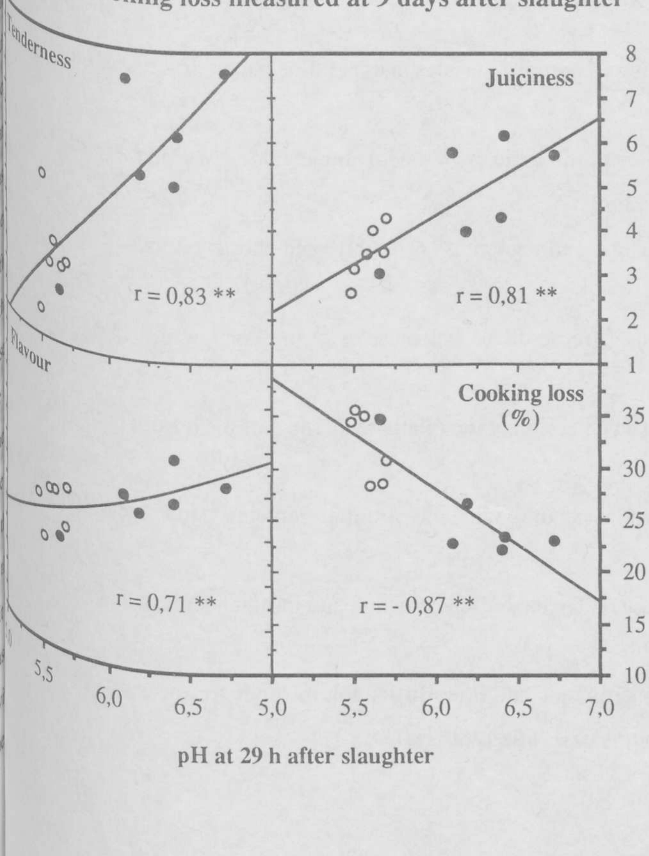
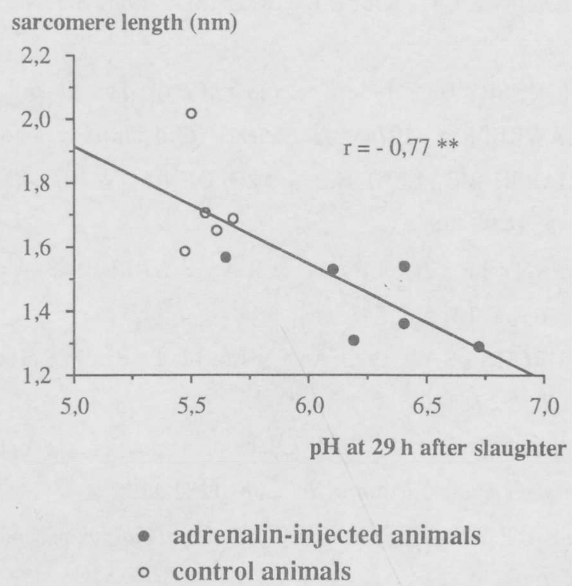


Table 1. Correlations between ultimate pH (measured at 29 h after slaughter) and colour parameters (measured at 2 and 9 days after slaughter) in the *Longissimus dorsi* muscle from veal carcasses

	R_{630}	L*	a*
• 2 days *post mortem*			
ultimate pH	- 0.77 ++	- 0.74 ++	- 0.62 ++
• 9 days *post mortem*			
ultimate pH	- 0.89 ++	- 0.92 ++	- 0.73 ++

R_{630} : reflectance at 630 nm. L* : lightness. a* : redness. ++ : $P < 0.01$.

Figure 3. Relationships between ultimate pH and sarcomere length



• adrenalin-injected animals
○ control animals

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