Effect of current frequency during water-bath stunning on turkey meat quality

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Background and objectives

The concerns of French companies, at the stage of electrical stunning, are animal welfare as well as carcass downgrading and meat quality. Most French abattoirs use electrical water-bath stunners (Santé et al., 1996). Besides the intensity recommended to be fixed at 150mA for an efficient stunning (Gregory and Wilkins, 1989), the effects of other electrical parameters such as waveform and frequency of the stunning current have not been elucidated.

An intensity of 150mA reduces the incidence of convulsions and haemorrhages in birds (Gregory and Wilkins, 1989). But such an intensity combined with a frequency of 50Hz, which is the frequency delivered by the stunners used in France, causes very often the cardiac arrest instead of stunning only. It was shown that the efficiency of bleeding was dramatically reduced by cardiac arrest (Mouchonière et al., 1998). The rate and extent of blood loss were lower in birds killed in the water-bath. The incidence of cardiac arrest could be reduced by increasing the frequency of the stunning current. In the other hand, according to Mouchonière et al. (1998), birds stunned with an electrical current of 150mA-600Hz struggled during bleeding and flapped their wings, which is the not the case after stunning at 50Hz. This could have a detrimental effect on meat quality by increasing the speed of pH decline while carcass temperature is higher than 41-42°C.

This experiment was carried out to evaluate the incidence of the frequency of stunning current on turkey meat quality such as the onset of rigor mortis, colour, water holding capacity and cooking yield.

Methods

Animals- Fifty turkey hens from the BUT 9 line, 12 weeks old, were electrically stunned with a current of 150mA intensity per bird and at one of 4 different frequencies : 50Hz (n=12), 300Hz (n=14), 480Hz (n=12) and 600Hz (n=12). Turkeys were plunged in the electrical water-bath for 4 seconds. Unilateral neck cutting was manually performed 10 s after the end of the stun and bleeding lasted for 3 min. Carcasses were cooled 20 min after slaughter in a cold room at 2°C for 24h. Breast meat was cut the day after.

Carcass defects At 24 h post mortem, the following carcass appearance defects were noted: engorged wing veins, haemorrhagic wing veins, red wingtips, haemorrhage in shoulders. Each defect was scored on a three point scale : score 0, absence of the defect; score 0.5, slight presence of the defect; score 1, presence of the defect.

Meat quality

Measurements of pH and temperature Two g of breast muscle were taken and homogenised in 18 ml of 5mM iodoacetate buffer at different times post mortem: 3 min, 20 min, 1h, 2h, 5h and 24h. Temperature was monitored at the same times.

Glycogen and Lactate assessment: Two g of breast muscle were taken and cooled in liquid nitrogen at 3 min, 20 min, 1h, 2h, 5h and 24h and later on freeze-dried. About 200 mg of freeze-dried muscle tissue were homogenised in 10 ml of 0.5 M perchloric acid. Glycogen, glucose and glucose-6-phosphate were simultaneously determined on the homogenate according to Dalrymple and Hamm (1973), after hydrolysis of glycogen with amyloglucosidase. Lactate was determined in the supernatant resulting from the centrifugation of the homogenate (20 min at 2500 g), according to Bergmeyer (1974). Concentrations were expressed as µmol per gram of fresh tissue, assuming a moisture content of 75%.

Colour: Trichromatic coordinates (L*, a* & b*) were measured at 24h at 96h with a Minolta chromameter CR 300.

Water holding capacity: Raw breast meat was weighed at 24h, 48h and 96h. Drip loss was evaluated as the lost of weight during this time, relative to initial weight.

Cooking loss: Breast meat was vacuum packed and cooked at 85°C for 15 minutes. Breast meat was weighed before and after cooking. Cooking loss were expressed as percentage of weight before cooking.

Tenderness: After cooking, the breast meat was cut in pieces (3 x 1 x 1 cm) parallel to the fibre axis. Rheological measurements of myofibrillar strength were performed at room temperature using a Instron. The strength of myofibres was determined according to Lepetit et al. (1986). Meat samples were compressed up to compression ratios of 0.2 and 0.8 . The maximum stress during such tests was shown to give information on the mechanical strength of the myofibres.

Cooking yield: Hundred g of trimmed breast meat was cut in cube pieces of 1cm side. 20g of 136g/l nitrited salt were added according to Naveau et al. (1985). Cured meat was cooked for 10 minutes in boiled water. Dripping lasted 2h30 and cooking yield was expressed as the difference of weight before and after cooking, relative to initial weight.

Results and discussion

Carcass defects were not influenced by the stunning frequency. Neither haemorrhage nor red wing tips were found. The main carcass defect noted was the presence of engorged veins, which is shown on Figure 1.

The pH decline according to the stunning frequency is shown on figure 2. During the first three minutes, the rate of pH decline was higher after stunning at 480 or 600Hz, than at 50 or 300 Hz. Two types of pH decline could be distinguished : a slow pH fall group after stunning at 50 or 300 Hz and a fast pH fall one after stunning at 480 or 600 Hz. After 5 h post mortem the differences in pH were no longer significant. One hour post mortem, temperature was around 34-35°C in all carcasses. No significant difference in temperature was recorded. Glycogen depletion occurred very rapidly in breast muscle (figure 3). After bleeding, the glycogen stores were reduced to 40-50% (480-600 Hz) and to 25% (50-300 Hz). At the same time, lactate accumulated in breast muscles : 60 µmoles and 30 µmoles, respectively (figure 4).

The higher extent of pH decline and glycogen depletion occurring during the first three minutes after stunning at 480 or 600 Hz, are most likely due to struggle and wing flapping during bleeding. Indeed, cardiac arrest at stunning occurred at rates of 100 and

50 % after 50 and 300 Hz, respectively. After stunning at 480 and 600 Hz, however, cardiac arrests were not observed and most birds exhibited wing flapping during bleeding.

Trichromatic coordinates were not affected by stunning frequency (figure 5 and 6). A higher a/b ratio was found for the 480 Hz group but no clear relationship between a/b and stunning frequency could be drawn up. Stunning frequency did not affect the time-related changes in colour during the 4 days following slaughter (data not shown).

Myofibrillar strength, drip loss, cooking loss and cooking yield were not affected by stunning frequency (data not shown).

Conclusions

These data show that stunning frequency affects the early rate of post mortem pH fall (during bleeding) and this effect is most likely due to the occurrence of wing flapping during this period. Under the conditions of the present work, the increase in rate of pH fall after stunning at 480 and 600 Hz was not sufficient to induce dramatic defects in meat quality. However, the chilling conditions were particularly efficient since muscle temperature was lowered to 35°C within 1 h. This probably contributes to reduce the negative effects of fast *post mortem* pH decline. The influence of stunning frequency on turkey meat quality needs to be evaluated under industrial conditions.

References

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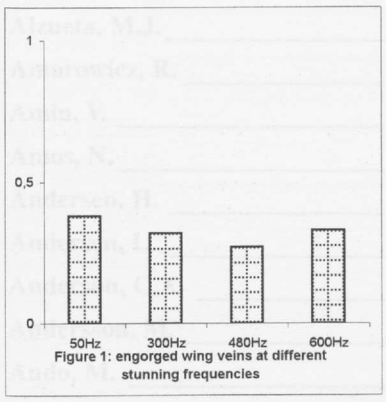

Figure 1: engorged wing veins at different stunning frequencies

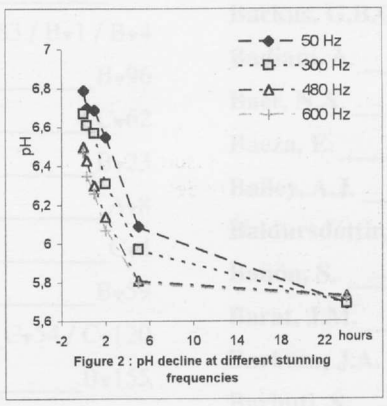

Figure 2 : pH decline at different stunning frequencies

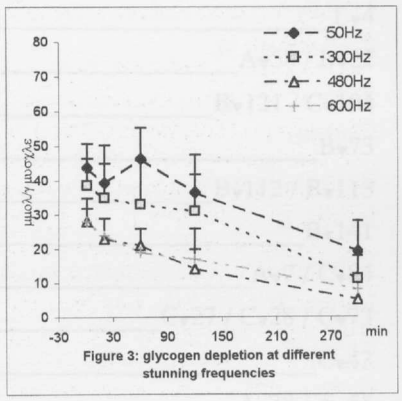

Figure 3: glycogen depletion at different stunning frequencies

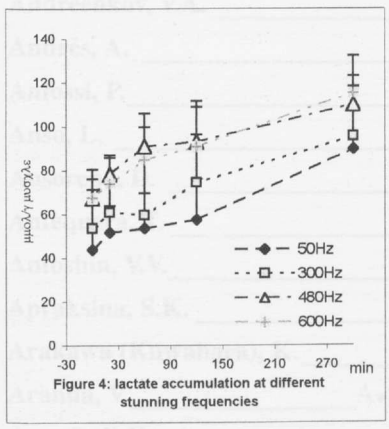

Figure 4: lactate accumulation at different stunning frequencies

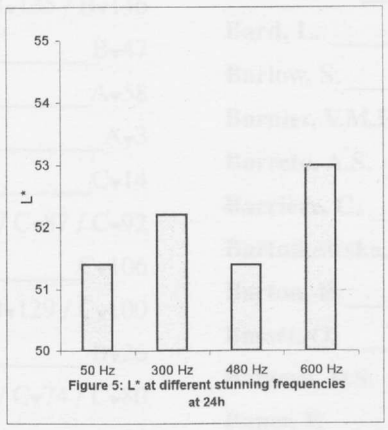

Figure 5: L* at different stunning frequencies at 24h

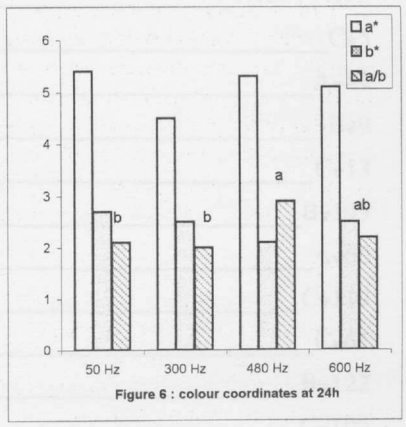

Figure 6 : colour coordinates at 24h

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