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EFFECTS OF STUNNING METHOD ON SOME INSTRUMENTAL AND SENSORY QUALITIES OF RABBIT MEAT[1]

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ABSTRACT

Different voltage and frequency (T-1=49V, 179Hz; T-2=130V, 161 Hz; T-3=22V, 833Hz) applications of electrical stunning were compared with cervical dislocation in commercial slaughter rabbits. Blood loss, hematine content in muscle, color CIELAB system, shear force and sensory characteritics (tenderness, juiciness, aroma and global acceptability) were measured. The electrical treatments provided lower initial pH-values on Biceps femoris and Longissimus dorsi muscles ($P<0.05$) and higher ultimate pH-values on Biceps femoris muscle (6.18, 6.12 and 6.16) than cervical dislocation (6.01, $P<0.05$). Furthermore meat from animal stunned with electrical methods had more redness (1.24, 1.30 and 1.17 vs 0.66, $P<0.01$), although their blood loss percentage tends to be greater ($P=0.06$). Shear force did not change by the stunning methods, but the members of experimented panel found tougher (43.96) and less juicier (43.18) the meat coming from electrical stunning with intermediate voltages and frequencies (T-1) in relation to obtained from the other electrical applications (53.72 and 48.15 , T-2; 51.90 and 48.53 , T-3) or from cervical dislocation (51.13 tenderness and 49.14 juiciness).

INTRODUCTION

The traditional method of stunning before slaughtering in rabbits is the cervical dislocation. The progressive production in great-scale of this species and the legal requirements on the subject of animal welfare in the European countries, are generalising the use of electrical current to stun the rabbits in the abattoirs. However, some slaughteres still have a low opinion of this procedure, because they think that the bleeding is not enough, which could bring about the refuse from those consumers who do not prefer red meats much. Also it could damage the meat quality and decrease their storage period.

Ouhayoun (1988) and Ouhayoun and Poujardieu (1990) showed that stunning methods modified the kinetics of muscle acidification and also the course of the *rigor mortis* due to alterations in the contraction of the sarcomeres. Civera *et al*. (1989) and Dal Bosco *et al*. (1997) indicated that the effect of stunning on the instrumental meat qualities of rabbits is not very important.

The aim of this work is to know the effect of mechanical or electrical stunning applied in a commercial plant conditions on some quality characteristics of meat, with a special reference to sensory properties.

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MATERIAL AND METHODS

A total of 101 rabbits crossbreeding New Zealand and Californian from a commercial slaughterhouse were used for this study.

The rabbits came from the same farm and they had identical management and feeding conditions. The distance (150 km) and transportation time to the slaughterhouse were also the same. Following 2-3 hours rest after the trip, the experimental rabbits were chosen per random between those weighing 1.8-2.0 kg, because these are the weights for slaugtering in Spain.

The study was performed in nine working days. Four lots of 3 rabbits each were sacrificed each day (total=108 rabbits, but 7 rabbits were removed due to different reasons). A different stunning treatment was applied to each lot, as follows:

T-1. Voltage and frequency normally used at the slaughterhouse (electrical values of 49V and 179Hz) (n=24).

T-2. Maximum tension (130V) and minimum frequency (161Hz) (n=24).

T-3. Minimum tension (22V) and maximum frequency (833Hz) (n=27).

T-4. Cervical dislocation (n=26).

A V electrode was applied on the rabbit's frontal sinus by a specialised person. The contact time with the electrodes was never more than 2 seconds. The rabbits were killed by exsanguination from the severed blood vessels of the neck before they recovered sensitivity. (López et al., 1998).

Before the stunning was determined the individual weight of the rabbits, and their carcasses were weighed 3 minutes after the bleeding. The difference between weights indicates the blood losses.

After evisceration the carcasses were aired for 15 minutes, then they were placed in standard storage crates protected by polyethylene sheets, and put in a cold storage room (1-4ºC), following the regular handling procedure in the commercial plant. The pH was measured on the *Longissimus dorsi* and *Biceps femoris* muscles about 1 hour, 2 hours and 24 hours after slaughtering.

After 24 hours of chilling, the carcasses were carried to the laboratory. Some muscles from the dorsal-lateral area of the leg were dissected: *Biceps femoris*, *Semitendinosus, Semimembranosus, Abductor cruris, Gluteus and Tensor fasciae latae.* On these muscles the colour was determined by the physical-chemical procedure of Hornsey (1957). The results are expressed in hematine content.

The *Longissimus dorsi* muscle from both sides of the carcass was separated also. It was divided in two craneal and caudal portions. The colour was immediately evaluated on the cutting surface according to the CIELAB system (CIE, 1976), using a Minolta colorimeter. Afterwards the four portions were individual vacuum packed.

The craneal portion was cooked a water bath to 75ºC for 20 minutes. From this, prismas (1 x 1 cm section) were separated in the direction of muscle fibers. The shear force was determined by cutting perpendicularly to the fiber using a model INSTRON equipped with a Warner-Bratzler device.

72 h after slaughtering the two caudal portions from the *Longissimus dorsi* were cooked to grill without additives until the temperature reached 65ºC in the center of the piece. The sensory characteristics (tenderness, juiciness, aroma and global acceptability) were evaluated by a panel with 11 experimented members. The sensory test was based on a structured scale of 1 to 100 points where 1 means a meat which is very tough, not very juicy, without aroma and not very pleasant to eat, and 100 means a meat which is very tender, very juicy, with a lot of aroma and very pleasant to eat.

A GLM procedure from the statistical package SAS (Sas, 1985) was used to evaluate the fixed effects to stunning methods. Means were compared using Duncan's multiple range test with a signification level of P<0.05.

RESULTS

Stunning methods significantly affected the acidification process of both muscles *Biceps femoris* and *Longissimus dorsi* (Table 1 and 2). The pH values obtained from the electrical stunning were lower than the pH corresponding to the mechanical stunning during 2 hours after slaughtering. On the contrary, the ultimate pH value was higher after electrical stunning than mechanical on muscle *Biceps femoris (P<0.05)*; the same tendency was observed on the *Longissimus dorsi*.

Table 1. Effect of stunning on pH values of *Biceps femoris* muscle (x±sd).

VARIABLE	T-1	T-2	T-3	T-4	F
pH-1	6.54 ± 0.29 **b**	6.62 ± 0.31 **b**	6.57 ± 0.29 **b**	6.82 ± 0.25 **a**	**
pH-2	6.47 ± 0.23 **b**	6.40 ± 0.19 **b**	6.46 ± 0.24 **b**	6.68 ± 0.24 **a**	***
pH-24	6.18 ± 0.18 **b**	6.12 ± 0.21 **ab**	6.16 ± 0.25 **b**	6.01 ± 0.17 **a**	*

Table 2. Effect of stunning on pH values of *Longissimus dorsi* muscle (x±sd).

VARIABLE	T-1	T-2	T-3	T-4	F
pH-1	6.79 ± 0.26 **b**	6.84 ± 0.24 **b**	6.83 ± 0.31 **b**	7.06 ± 0.22 **a**	**
pH-2	6.56 ± 0.23 **b**	6.56 ± 0.22 **b**	6.61 ± 0.26 **b**	6.74 ± 0.18 **a**	*
pH-24	6.00 ± 0.17	5.99 ± 0.20	5.98 ± 0.26	5.90 ± 0.12	NS

- *P<0.05, ** P<0.01, *** P<0.001, t =P<0.10; a, b: P<0.05

No differences on blood quantity removed from animals were observed, but their relative proportion seems higher from the electrical methods (Table 3). Neither the hematine concentration showed significant differences (Table 4).

Table 3. Effect of stunning on blood losses (x±sd).

VARIABLE	T-1	T-2	T-3	T-4	F
Blood loss (g)	66.30 ± 0.01	68.89 ± 0.01	67.60 ± 0.01	64.23 ± 0.0.01	NS
Blood loss (% BW)	3.32 ± 0.53 **ab**	3.53 ± 0.36 a	3.44 ± 0.63 **ab**	3.14 ± 0.59 **b**	t

Table 4. Effect of stunning on the hematine content of the muscles (x±sd).

VARIABLE	T-1	T-2	T-3	T-4	F
X_1=640 λ	28.84 ± 22.76	27.76 ± 17.48	27.75 ± 16.06	37.27 ± 25.45	NS
X_2=512 λ	27.11 ± 10.58	28.72 ± 11.46	28.67 ± 13.65	31.49 ± 15.87	NS

The redness values were higher in *Longissimus dorsi* of rabbits submitted to electrical stunning (P<0.01), and the lightness tended to be smaller in these animals, especially in the T-1 group (Table 5).

Table 5. Effect of stunning on colour of *Longissimus dorsi* muscle (x±sd).

VARIABLE	T-1	T-2	T-3	T-4	F
L *	45.56 ± 9.20 **a**	47.67 ± 3.41 **ab**	47.90 ± 2.81 **ab**	48.95 ± 2.22 **b**	NS
a *	1.24 ± 0.65 **a**	1.30 ± 0.69 **a**	1.17 ± 0.91 **a**	0.66 ± 0.70 **b**	**
b *	1.87 ± 1.39	2.35 ± 1.15	2.26 ± 1.79	2.37 ± 1.25	NS

This T-1 treatment was the only different one that the sensory panel perceived: it provided a tougher and less juicier meat (Table 7). The objective tenderness parameters did not show significant differences (Table 6).

Table 6. Effect of stunning on the shear force at the level of *Longissimus dorsi* muscle (x±sd).

VARIABLE	T-1	T-2	T-3	T-4	F
LOAD (kg)	2.58 ± 0.67	2.48 ± 0.62	2.45 ± 0.59	2.46 ± 0.74	NS
STRESS (kg/cm)	2.65 ± 0.66	2.65 ± 0.57	2.75 ± 0.59	2.52 ± 0.65	NS
TOUGHNESS (kg/cm)	0.73 ± 0.20	0.70 ± 0.24	0.96 ± 1.08	0.72 ± 0.24	NS

Table 7. Effect of stunning on the sensory characteristics of *Longisimus dorsi* muscle (x±sd).

VARIABLE	T-1	T-2	T-3	T-4	F
Tenderness	45.96 ± 23.12 **b**	53.72 ± 20.82 **a**	51.90 ± 23.79 **a**	51.13 ± 20.60 **ab**	*
Juiciness	43.18 ± 19.44 **b**	48.15 ± 20.31 **a**	48.53 ± 18.07 **a**	49.14 ± 19.90 **a**	t
Aroma	55.45 ± 17.81	55.05 ± 16.02	53.65 ± 14.24	57.05 ± 14.62	NS
Global acceptability	48.60 ± 15.59	49.63 V 14.60	46.69 ± 16.83	47.80 V 15.79	NS

- *P<0.05, ** P<0.01, *** P<0.001, t =P<0.10; a, b: P<0.05

DISCUSSION

Civera *et al.* (1989) studied different electrical (12V for 4 seconds and 14V for 2 seconds) and mechanical (mechanical shock and vertebral dislocation) stunning methods and concluded that the pH-24 h and the concentration of haem pigments in rabbit carcasses are not affected by the stunning method. Neither Dal Bosco *et al.* (1997) found a relevant influence of alternating currents (45 vs 80V and 2.5 vs 8 amperes) or cervical dislocation on some quality meat parameters of this species as pH-u, colour, water holding capacity or tenderness. Both authors pointed that the stunning method modifies the early acidification process. Hulot and Ouhayoun (1999) in an extensive review reported that the stress of electroanaesthesia accelerates the muscular acidification but does not modify ultimate pH in meat.

In effect, the results from this work supports the other investigations with rabbits, in a way that the pH fall after slaughtering is faster in electrical treatments than the mechanical treatments. Because of this the muscles from electronarcosis had an early more acid pH than those from mechanical stunning. However, 24 hours after slaughtering the pH values were higher on the meat from electrical treatments according to our results on Biceps femoris muscle. It seems that the ATP activity that determines the changes in pH fall (Monin, 1988) would be more intense in the rabbits electrically stunned and perhaps due to this that the reserves of glycogen in the muscles are used quicker in these animals. By consequence, the pH-u values after electrical stunning is greater than after mechanical method.

In other species the results are contradictory, although in some experiences it was observed that pork meat obtained after electrical stunning presented 0.1-0.2 pH units higher than meat from non-stunned animals (Warrington, 1974).

On the other hand, all pH-u values on Biceps femoris were slight high. This could be detrimental for carcasses preservation and could decrease their storage period, since it is know that pH values greater than 6 are less effective to inhibition of the pollutant microorganisms.

The bigger pH-u of the muscles from electronarcosis are corresponding with less brightness and more redness meat, in agreement with the classic relation between pH and colour of meat (Charpentier, 1964, Hulot and Ouhayoun, 1999). Furthermore, *a priori* this more intense coloration does not seem to indicate a worse quality of meat steming from a bad bleeding, because the blood loss percentage tends to be bigger after electrical stunning than after mechanical stunning.

According to Dal Bosco *et al.* (1997) the shear force was not affected by the stunning system. However the members of our sensory panel perceived some negative differences in tenderness and juiciness in the meat coming from the stunning system used in the commercial slaughterhouse, which are based in an intermediate voltage and frequency: it would be preferable to use more extreme tensions or frequencies because tenderness and juiciness are considered the main characteristics that the consumer looks for when considering the quality of meat.

In conclusion, this study has showed that the electrical stunning accelarates the early muscular acidification and can provide high pH-u values on some muscles. Likewise this stunning method can be associated to higher redness but not to low exsanguination levels with respect to mechanical stunning.

The different voltages and frequencies of stunning change the meat quality in terms that could be detected by the consumers. Therefore it would be interesting to know the opinion of panels in order to recommend the optimal levels of current to stun of rabbits and their welfare.

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