EFFECT OF LOW-VOLTAGE ELECTRICAL STIMULATION ON THE TENDERNESS OF SLOWLY REFRIGERATED BEEF

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SUMMARY: The effect of low voltage stimulation of beef carcasses on the onset of rigor mortis and the ageing time in delayed chilling systems was studied. Two voltages were tested: 45 and 85 V. The pH values of the L. dorsi, Semitendinosus and Triceps brachii muscles were measured at 1, 2 and 8 hours post mortem. Instrumental evaluation of texture was carried out with an Instron machine after 3 and 5 days of storage for treated samples and 7 days for controls. Measured pH values showed the effectiveness of the low voltage treatments applied. Statistical analysis of results showed that samples stimulated at 85 V reached a degree of ageing after 3 days equivalent to that reached by samples stimulated at 45 V after 5 days and non-stimulated samples after 7 days of storage.

INTRODUCTION: In Cuba, the refrigeration of beef carcasses is carried out rather slowly in many industrial slaughterhouses. Even though the risk of cold-shortening is practically nil under these circumstances, electrical stimulation remains an interesting alternative as regards the improvement of quality through accelerated ageing.

Meat ageing is perhaps the most widely tenderization method employed in the meat industry. Ageing periods used vary widely, from as little as one week to as much as one month (Sawell, 1981). In some Cuban slaughterhouses, prime beef is aged for 7 days at 0°-2°C.

The process can be accelerated by combining electrical stimulation (ES), hot boning and temperature conditioning, a system now commonly used in the production of tender beef (George, 1980; Will and Reesing, 1987).

Furthermore, the very slow chilling schedules frequently used in some of our older slaughterhouses could be conveniently combined with ES in order to increase the tenderness of the beef produced.

Low voltage ES is a very attractive alternative, since its less stringent safety requirements represent a substantial cut in investment costs (Taylor, 1981). A low voltage electrical stimulator meeting national safety standards has been designed and manufactured jointly by the Food Industry Research Institute and the National Scientific Research Center of Cuba.

The present study was conducted to assess the effectiveness of low voltage ES in improving the tenderness of slowly refrigerated beef, under conditions similar to those encountered in some of our older slaughterhouses.

MATERIALS AND METHODS: A total of 104 first grade bulls were slaughtered in the Meat Pilot Plant of the Food Industry Research Institute. Of them, 52 were electrically stimulated: 26 at 45 V for 90 s and 26 at 85 V for 60 s. The other 52 remained as non-stimulated controls. ES was applied within 3 minutes of sticking.

The nostril-rectal system was selected for positioning the electrodes in this experiment. All carcasses were very slowly cooled in air at 16°C for 8 hours and then transferred to a chamber at 0°- 2°C.

Ageing periods of 3 and 5 days were tried for ES carcasses and up to 7 days for the non-stimulated (NS).

The pH values of L. dorsi muscle (LD), Semitendinosus (ST) and Triceps brachii (TB), were measured at 1, 2 and 8 hours post-mortem.

After the ageing period, carcasses were deboned and LD, ST and TB muscles removed for texture evaluation, using an Instron Texture Machine with a Warner-Braztler shear cell.

For this evaluation each muscle was roasted in a microwave oven to a core temperature of 80°C. Cylindrical core samples 2,54 cm in diameter were obtained from each muscle and tested in an Instron machine with a Warner-Bratzler shear cell.

Cooking losses were also evaluated.

Statistical analysis of data (analysis of variance) was carried out using the SPSS/PC+ system (SPSS, 1987).

RESULTS AND DISCUSSION: Figures 1 - 3 show the post-mortem evolution of the pH of the meat for each treatment.

In all cases the rate of pH fall in the muscles from ES sides was higher than that of NS controls. Differences were more remarkable the higher the voltage used, in agreement with previous reports (Fabiansson, 1984; Taylor 1988).

The biochemical causes of this phenomenon are well known (Dutson, 1981).

Table 1 shows the results of maximum shear force measurements for the three different muscles. The effect of ageing time is very evident.

Shear force values were significantly lower ($P<0,05$) for ES samples than for controls. This has been reported to be due to a number of factors, among others: the acceleration of ageing processes (Sawell, 1981); certain types of enzymic action (Datson, 1980) and changes in the thermal stability of collagen (Judge, 1981).

Table 1 also shows that even though some tenderization occurs between the third and fifth day of ageing for samples ES at 45 V, there is practically no further improvement during the same period for samples treated at 85 V, which reach their ultimate values after only 3 days ageing. The observed increase in the rate of tenderization is in agrement with Smith (1980), Powell (1980) and Fabiansson (1985).

Similar shear force values were obtained for ES-85 V samples after 7-day ageing than for ES-45 V samples after 5-day ageing.

No significant differences in cooking losses were found in any case (Table 2) as previously reported in the literature (Fabianson, 1984; Taylor, 1988).

CONCLUSIONS: The pH values measured showed the effectiveness of the low-voltage treatments applied. Statistical analysis of results showed that samples stimulated at 85 V reached a degree of ageing after 3 days equivalent to that of samples stimulated at 45 V after 5 days and non-stimulated samples after seven days storage.

Table 1 Evaluation of hardness of different muscles (kg).

Muscle	aging time	Treatments 45 V	85 V	N.S.	S.E.
L. dorsi	3 days	12.5 am	8.3 an	15.8 ao	± 1.08
	5 days	8.3 bm	8.1 am	14.8abm	
	7 days	-	-	12.0 b	
Semitendinosus	3 days	5.8 am	5.9 am	6.6 an	± 0.22
	5 days	5.8 am	5.5 am	6.7 an	
	7 days	-	-	5.3 b	
T. Brachii	3 days	7.4 am	5.7 an	7.7 am	± 0.33
	5 days	6.5 bm	5.8 an	6.8 bm	
	7 days	-	-	7.1 b	

a,b,cMean values in a column without letter in common differ at P<0,05 (Duncan's multiple range test).

m,n,oMean values in a row without letter in common differ at P<0,05 (Duncan's multiple range test).

Table 2 Average cooking loss values for tested muscles (%).

		Treatments			
Muscle	aging time	45 V	85 V	N.S.	S.E.
L. dorsi	3 days	33.2 am	30.1 an	33.1 am	± 1.53
	5 days	29.0 bm	34.6 bn	31.9 bo	
	7 days	-	-	33.3 a	
Semitendinosus	3 days	28.2	31.7	29.5	± 1.41
	5 days	27.8	31.5	30.6	
	7 days	-	-	30.7	
T. Brachii	3 days	30.0	30.4	30.3	± 1.61
	5 days	32.4	34.0	32.5	
	7 days	-	-	34.1	

a,b,cMean values in a column without letter in common differ at P<0,05 (Duncan's multiple range test).

m,n,oMean values in a row without letter in common differ at P<0,05 (Duncan's multiple range test).

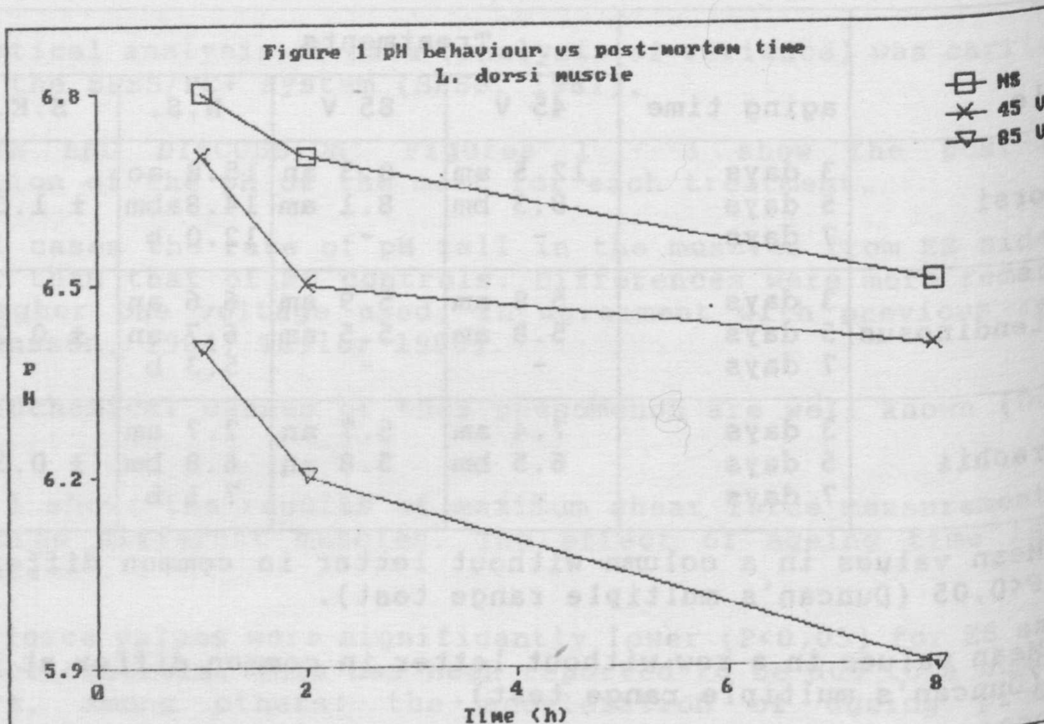

Figure 1 pH behaviour vs post-mortem time
L. dorsi muscle

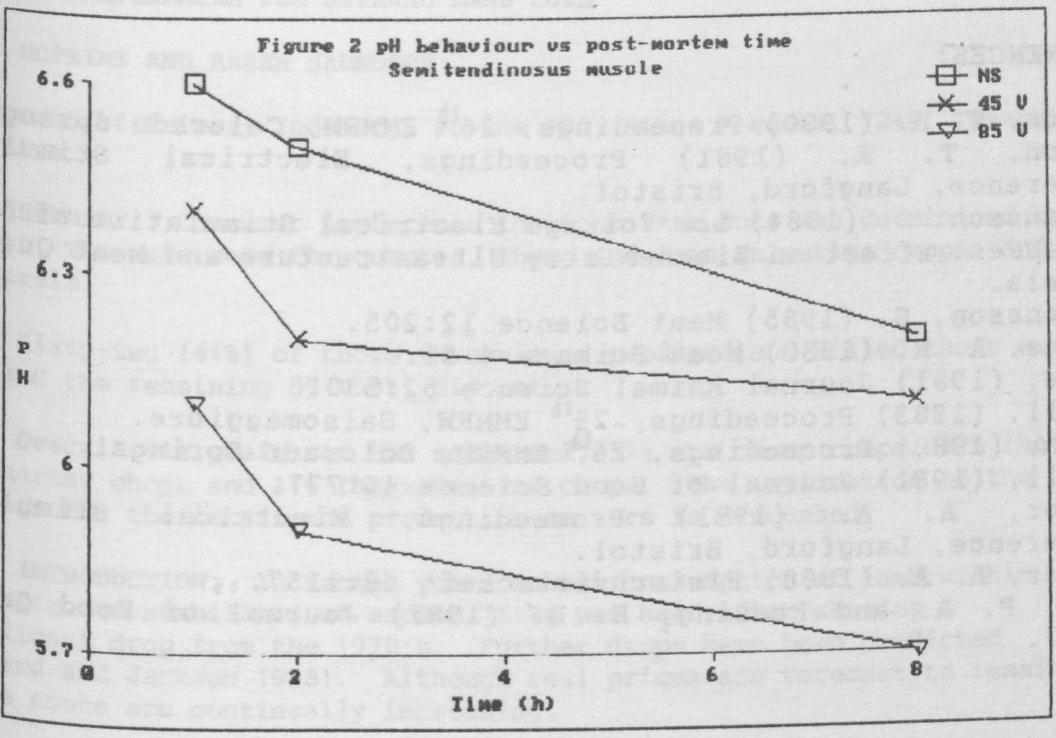

Figure 2 pH behaviour vs post-mortem time
Semitendinosus muscle

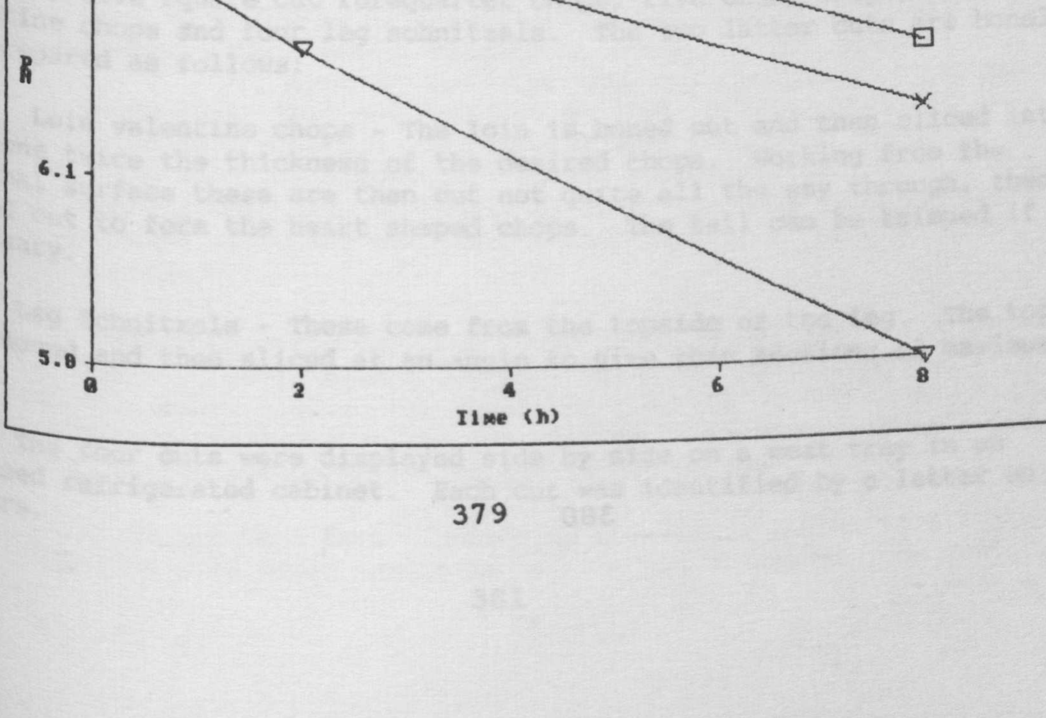

Figure 3 pH behaviour vs post-mortem time
Triceps Brachii muscle

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