PE4.96 Individual electrical stimulation of beef with new equipment: controlled current depending on category, age and body weight 339.00

Marchen Hviid (1) mah@danishmeat.dk, Niels T. Madsen( ), Jesper Blom-Hanssen , Sandie Møller
(1)Danish Meat Research Institute
Department of Food Science, Research Centre Aarslev

***Abstract*- Electrical stimulation (ES) of carcasses accelerates the process of *rigor mortis* by changing the rate of pH fall. The Danish Meat Research Institute has developed new ES equipment allowing individual variation of the voltage, current and other electrical parameters, and also monitoring and documenting the actual stimulation achieved. The new ES equipment makes it possible to control the stimulation profile for the individual carcass, and thereby make the most of the individual carcass potential for tender meat by minimizing (the time for temperature = 20˚C) – (time for pH=6.0).**

M. Hviid is with Danish Meat Research Institute, Maglegaardsvej 2, DK-4000 Roskilde (corresponding author to provide phone: +45 46 30 32 70; fax: +45 46 30 31 32; e-mail: mah@Danishmeat.dk).
N.T. Madsen is with Danish Meat Research Institute, Maglegaardsvej 2, DK-4000 Roskilde (e-mail: ntm@Danishmeat.dk).
J. Blom-Hanssen is with Danish Meat Research Institute, Maglegaardsvej 2, DK-4000 Roskilde (e-mail: jb@Danishmeat.dk).
S.M. Møller is with Department of Food Science, Research Centre Aarslev, DK-5792 Årslev (e-mail Sandie.moeller@agrisci.dk)

***Index Terms*: beef, electrical stimulating, pH decline, tenderness**

I. INTRODUCTION

Electrical stimulation (ES) of carcasses accelerates the process of *rigor mortis*. By changing the rate of pH fall post-mortem glycolysis is accelerated. ES is a process that involves passing an electric current through the carcass hanging on the slaughter line [1]. ES is widely used in commercial cattle, lamb and poultry slaughterhouses to avoid cold shortening and increase the tenderness. [2] showed that the highest tenderness score in LD from sheep carcasses was obtained at temperatures of 15 ˚C - 25 ˚C at pH=6.

There are numerous electrical settings and locations applicable for ES. For beef in the Nordic countries ES is usually applied as low ES, early post mortem, during bleeding or after dehiding, but before splitting.

The ES equipment traditionally used in slaughterhouses in Denmark, Sweden and Norway has standard settings of current, resistance and duration. It is not possible to alter the settings between carcasses or to monitor if the target ES setting was achieved.

The Danish Meat Research Institute has developed new ES equipment allowing individual variation of the voltage, current and other electrical parameters, and also monitoring and documenting the actual stimulation achieved. It is therefore possible to stimulate the individual carcass according to available information on category, carcass size, age, breed or other characteristics that may call for individual ES setting. Furthermore, the new ES equipment logs both the applied ES profile and estimates of achieved stimulation parameters.

The new ES equipment was used to investigate:

- the effect of ES 15 min after sticking (after bleeding) and after 25 min. (after dehiding)

- the effect of accumulated current dependent on category

- the effect on tenderness dependent of current.

II. MATERIALS AND METHODS

The investigation was made in three separate experiments all performed at a commercial slaughter line. The new ES equipment was connected to existing mechanical electrodes during bleeding whereas electrodes were applied manually after dehiding. With the ES equipment it is possible to estimate the energy deposited in the carcasses by simple multiplication of current*voltage*time.

Exp. 1. 65 dairy cows (250 kg CW) were stimulated (15 min. *post mortem*) and 66 cows (262 kg CW) were stimulated after dehiding (25 min. *post mortem*). The settings for the stimulation was identical (pulse width **6** ms – break **78** ms – voltage **78** V – duration **35** s).

Exp. 2. Young bulls and cows were stimulated 25 min *post mortem* with two different profiles (either **160** mA or **280** mA, the rest of the settings were similar pulse width **6** ms – break **78** ms – voltage **100** V – duration **35** s).

Exp. 3. Three groups of calves (15 bull calves < 10 months each) were either not stimulated or stimulated with the profiles from exp. 2; 25 min *post mortem*.

In all three experiments, pH and temperature in *M. Longissimus Dorsi* were measured immediately after stimulation, after 1-1.5 hours, 4, 6 and 24 hours *post mortem*, to calculate the rate of pH and temperature decrease and estimate the time from sticking until pH = 6.0 and temperature = 20˚C. A new parameter DIF-TIME [3] was then calculated as (time for temperature = 20˚C) – (time for pH=6.0). DIF-TIME expresses how close we can get to the optimal combination of pH and temperature development. In Exp. 1 sensory analyses were carried out on 11 randomly selected carcasses from each ES treatment. A trained panel of 8 assessors evaluated 20 mm steaks cut from *M. Longissimus Dorsi,* vacuum packaged and aged 14 days at 2˚C. Steaks were cooked to a core temperature of 62 - 63˚C. In exp. 3, sensory analyses were made on steaks from all carcasses with the same trained panel as exp. 1.

III. RESULTS AND DISCUSSION

Experiment 1 showed a significant difference in current depending on the stimulation taking place before or after dehiding, even with the same voltage. The consequence was a slow pH decrease and a low tenderness score (table 1).

Experiment 2 was a comparison between the two levels of currents found in experiment 1, but now applied 25 min. after sticking (after dehiding) to young bulls and cows. The same level of current resulted in a difference in voltage due to differences in carcass resistance between the two categories. The consequence was that the level of energy differed and influenced the DIF-TIME (table 2). In this experiment, the stimulation profile with 280 mA current was close to the optimal pH decline in *M. Longissimus Dorsi*, and lead to the lowest DIF-TIME for both categories. Calculations based on carcass weight, same chilling condition and DIF-TIME = 0 showed that the current was dependent on weight and that heavy carcasses need less current. Thus, the optimal ES level should be set according to category.

Experiment 3 focused on the need for ES on veal which is usually considered tender. Again, the carcasses were stimulated after dehiding with three levels of current either 0, 160 or 280 mA. The results showed that calves stimulated with 280 mA 25 min. *post mortem* had a faster and more uniform pH decline [3] and more tender meat (table 3). The DIF-TIME was also closer to 0.

The new ES equipment makes it possible to control the stimulation profile for the individual carcass, and thereby make the most of the individual carcass potential for tender meat by minimizing the DIF-TIME. This is useful, especially in situations where large variations in categories and animal size apply, and an optimal standard setting of ES is difficult to make. Further research and industrial experience with the new ES equipment will show how many different settings of ES will be applied given the difference in production set up and variation in slaughtered animals.

IV. CONCLUSION

ES of beef carcasses accelerates the pH decline and results in more tender meat from *M. Longissimus Dorsi* provided the DIF-TIME is minimized.

ES low voltage can be applied after dehiding with similar or even better effect than before dehiding.

The energy deposited in the carcass depends on the stimulation applied, and the differences in resistance of categories/weight groups. That is why an individualized carcass ES seems to minimize DIF-TIME and maximize the tenderness potential.

The new ES equipment developed by DMRI helped to estimate and monitor the current, voltage and energy deposited in the carcass.

ACKNOWLEDGEMENT

M. Hviid thanks the Danish Meat Board, Nortura AB and HK-Scan for financial support to the project.

REFERENCES

[1] Lawrie R.A., 2002. Lawrie's Meat Science, 6. ed., *Woodhead Publishing Limited,* Abington Hall, Abington, Cambridge, England

[2] Thompson J.M., Hopkins D.L., D´Souza D.N., Walker P.J., Baud S., and Pethick D.W., 2005, The impact of processing on sensory and objective measurements of sheep meat eating quality, *Australian Journal of Experimental Agriculture*, Vol. 45, Page 561-573

[3] S.M. Moeller 2007. Effect of electrical stimulation on pH decline and quality of Bovine *Longissimus Dorsi* and *Semimembranosis*. Master thesis from University of Copenhagen, Faculty of life science.

Table 1. Results from experiment 1 - Current and tenderness

Time from sticking	15 min. (before dehiding)	25 min (after dehiding)
Received current (mA)	160 ± 27	280 ± 50
DIF-TIME, hours*	+ 4[a]	- 2.2[b]
Tenderness**	6.7[a]	8.4[b]
Juiciness**	9.0[a]	8.8[a]

a-b values within a row are significantly different at ($p<0.05$) level.

* DIF-TIME,(hour)= (time for temperature = 20 ˚C) – (time for pH=6.0)

**intensity scale (0-15), where 15 is most intensive

Table 2. Results from experiment 2. Accumulated energy and DIF-time dependent on category and current.

	160 mA		280 mA	
	Young Bulls	Dairy Cows	Young Bulls	Dairy Cows
N	45	32	39	36
Carcass Weight (kg)	216	297	220	288
Energy (mJ)	13.3[a]	18.0[b]	37.2[c]	54.2[d]
DIF-TIME (hours)	2.0[a]	4.5[b]	-1.0[c]	-0.3[c]

a-d values within a row are significantly different at ($p<0.05$) level.

Table 3. Results from experiment 3. Calves stimulated with 3 different profiles

Current	0	160 mA	280 mA
N	15	15	15
Rate of pH decline	0.5[a]	0.5[a]	0.7[b]
DIF-TIME (hour)	3.0[a]	2.7[a]	-0.7[b]
Tenderness	9.0[a]	9.0[a]	10.4[b]

a-b values within a row are significantly different at ($p<0.05$) level.