Optimum conditions for low voltage electrical stimulation of beef carcasses

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In a previous study we reported on the use of electrical stimulation to avoid cold shortening in beef. The electrical parameters were chosen arbitrarily. The aim of the present work was to find the optimal conditions for low voltage electrical stimulation. As criteria for efficiency we considered

- the time needed for reaching pH 6.0 in the meat
- the speed of the slaughterline and
- possible unwanted side effects

We found that precise definition of the best electrical parameters was rather unimportant. To fullfill most demands on a method useful in practice we recommend the following electrical conditions:

- Voltage 15 V
- Current 0.2 A
- Frequency 0.5 cycles/second
- Time 60 seconds

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Optimale Bedingungen für elektrische Niederspannungsreizung an Rinderkörpern

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In einer früheren Studie berichteten wir von der Verwendung elektrischer Reizung zur Verhinderung vom Schrumpfung in kaltem Fleisch. Die elektrischen Parameter wurden nach Belieben ausgewählt. Das Ziel dieser Arbeit war, optimale Bedingungen für die elektrische Niederspannungsreizung zu finden. Als Wirkungskriterien betrachteten wir:

- die Zeit, um pH 6,0 im Fleisch zu erreichen,
- die Geschwindigkeit des Schlachtbandes,
- mögliche, unerwünschte Nebenwirkungen

Wir kamen zu dem Ergebnis, dass eine genaue Bestimmung des besten Parameters ziemlich unwichtig war.

Um die hauptsächlichen Forderungen einer Methode in der Praxis erfüllen zu können, schlagen wir folgende elektrischen Bedingungen vor:

- Spannung 15 V
- Strom 0,2 A
- Frequenz 0,5 Perioden/Sekunde
- Zeit 60 Sekunden

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2.3

Conditions optimums pour la stimulation des corps bovins par de l'électricité à basse tension

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Nous avons présenté dans une étude antérieure notre rapport sur l'usage de stimulation électrique pour éviter le rétrécissement froid du boeuf. Les paramètres électriques ont été choisis arbitrairement. L'objet du travail présent était de trouver les conditions optimales pour la stimulation électrique à basse tension. Nous avons considéré comme critériums de l'efficacité

- le temps nécessaire pour arriver à pH 6,0 dans la viande
- la vitesse de la voie d'abattage et
- les effets secondaires, eventuels et non souhaités

Nous avons trouvé que la définition precise des meilleurs paramètres electriques n'était pas nécessaire. Pour satisfaire la majorité des ezigences d'une méthode pratiquement utilisable, nous recommandons les conditions électriques suivantes.

-	Tension	15 V
-	Courant	0,2 A
-	Fréquence	0,5 cycles/seconde
-	Temps	60 secondes

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Оптимальные условия воздействия низковольтным электротоком на мясные туши

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В представленном до этого исследовании мы сообщали о применении электрического воздействия для избежания сжимания мясных туш от холода. Электрические параметры выбирались нами произвольно. Целью представленной работы было найти оптимальные условия для воздействия низковольтным электротоком. Мы решили принять следующие критерия эффективности:

- время, нужное для достижения уровня pH 6.0 в мясе
- скорость работы убойной установки и
- возможные нежелательные побочные эффекты

Мы пришли к выводу, что точное определение лучших параметров электровоздействия не является особенно важным. Для удовлетворения большинства требований к методу, который бы успешно применялся на практике мы рекомендуем такие параметры:

-	Напряжение	15 В
-	Ток	0,2 А
-	Частота	0,5 Гц
-	время	60 секунд

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2.3

Optimum conditions for very low voltage electrical stimulation of beef carcasses

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Introduction

Fast depletion of glycogen in pre rigor muscle induced by electrical current through the carcass on the slaughterline can substantially improve meat quality. Several investigations have been published on electrical stimulation of sheep and beef carcasses since the work of New Zealand scientists appeared in the early 1970-ies (Carse, 1973; Davey et al., 1976). Commercial equipment is available for sheep carcasses (3600 V) in New Zealand and beef carcasses (550 V) in USA. Of the 550 V beef carcass stimulator twelve have been ordered in USA and three in Europe (April 1st, 1979). It is our experience that the interest for and practical use of electrical stimulation is rapidly growing.

Most of the work on electrical stimulation has been centered around high voltages (Bendall et al., 1976; Chrystall & Hagyard, 1976; Chrystall, 1978; Savell et al., 1978) and only a limited number of investigations on lower voltages are available (Bouton et al., 1978; Jonsson et al., 1978). Because of the safety regulations in Sweden it is difficult to work with voltages higher than 50 V in the abattoir without extraordinary precautions. In a preliminary investigation we therefore studied the effects of low voltage electrical stimulation on beef carcasses (Jonsson et al., 1978), in which study the electrical parameters were chosen arbitrarily only to fit the Swedish labour safety regulations.

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The aim of the present investigation was to optimize the electrical conditions and to develop a suitable manual stimulation method for early stimulation of beef carcasses.

Materials and Methods

At the Kristianstad-Blekinge abattoir experiments were conducted involving carcasses from 200 young bulls with carcass weights ranging between 200 and 350 kg. The carcasses were divided into eight groups and electrically stimulated immediately after exsanguination with the use of four needle electrodes with a length of 15 cm, one for each back leg and one on each side of the neck. The carcasses were shackled in one back leg during stimulation. The electrical parameters were varied according to table 1. The current used was square wave direct current pulses with controlled peak voltage. No polarity reversal was used. After stimulation the carcasses were kept at ambient temperature in the slaughter room. The pH drop was followed in M. longissimus dorsi at a depth of 2 cm opposite the third lumbar vertebra and the time necessary for pH to reach 6,0 and 5,7 was recorded. The carcasses were then chilled according to normal practice at the abattoir. After chilling the carcasses were cut into retail cuts and the cuts inspected for bleedings and fractures.

Group[x]	Pulse frequency (Hz)	Peak voltage (V)	Time (minutes)
1			
2	50	50	4
3	10	50	4
4	0.5	50	4
5	0.5	20	4
6	0.5	15	4
7	0.5	5	4
8	0.5	15	2
	0.5	15	1

x) 25 animals in each group

Table 1. Different electrical conditions used.

The statistical method used to evaluate the data was Student's paired t-test.

Results

The results are compiled in table 2.

	Time to reach pH 6,0 (hours)		Time to reach pH 5,7 (hours)		Frequency (Hz)	Voltage (V)	Time (minutes)
	$\bar{X}$	S.D.	$\bar{X}$	S.D.			
1	1.97	0.47	2.64	0.59	50	50	4
2	2.04	0.43	2.79	0.62	10	50	4
3	1.58	0.36	2.24	0.58	0.5	50	4
3	1.58	0.36	2.24	0.58	0.5	50	4
4	1.44	0.25	1.95	0.36	0.5	20	4
5	1.74	0.36	2.36	0.51	0.5	15	4
6	2.81	0.58	3.68	0.74	0.5	5	4
5	1.74	0.36	2.36	0.51	0.5	15	4
7	1.83	0.26	2.52	0.43	0.5	15	2
8	1.99	0.27	2.60	0.38	0.5	15	1

Table 2. Time for the musculature to reach pH 6.0 and 5.7 after different electrical treatments.

The effect of varying the electrical parameters was measured as the times needed to reach pH 6.0 and pH 5.7 respectively. The lowest frequency tested was found to be the most effective. The difference was highly significant between 0.5 and 10 Hz and significant between 0.5 and 50 Hz. We therefore used 0.5 Hz in the following experiments.

The differences in effect between the four voltages tested was small except for 5 V. With 50 and 20 V fractures in the tibia of the shackled leg occasionally occurred and small diffuse bleedings could sometimes be detected in the musculature. With 15 V no side effects could be detected and so this voltage was preferred.

Stimulation times of 1, 2 and 4 minutes were compared. The longer the stimulation time the better the results, but the difference was rather unimportant from a practical point of view. The difference between 1 and 4 minutes was only 0.25 hours for reaching pH 6.0 and 0.24 hours for reaching pH 5.7. To best fit the speed of the slaughterline 60 seconds of stimulation was preferred.

Discussion

Earlier investigations have been somewhat difficult to evaluate in terms of what minimum voltage can be used (Harsham & Deatherage, 1951; Shaw & Walker, 1977; Bouton et al, 1978). The general view, however, seems to be that voltages below several hundred volts will not give the desired effect. Our results clearly indicate that, provided low contact resistance is achieved through the use of needle electrodes and stimulation is performed immediately after exsanguination, voltages in the range of 10-20 V will produce a fast pH drop, pH 5.7 beaing reached within 2-3 h at room temperature.

Because of the small differences in pH fall between the different sets of electrical parameters tested, we conclude that the precise electrical conditions may be chosen rather from a practical point of view than from the effects on energy metabolism. However, depending on the type of electrodes used and the way the carcass is suspended during stimulation, care should be taken not to cause fractures and bleedings by using too high voltage.

We believe that the following conditions will fulfil most demands on a method usedful in practice.

Voltage	15 V
Frequency	0.5 Hz
Time	1 min

The current flow will be 0.2 A (peak) with the needle electrodes used.

The resulting meat quality has been tested in a separate study (Nilsson et al, 1979).

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References

BENDALL, J.R., KETTERIDGE, C.C. and GEORGE, A.R., 1976. The electrical stimulation of beef carcasses. J. Sci. Fd Agric. 27, 1123-1131.

BOUTON, P.E., FORD, A.L., HARRIS, P.V. and SHAW, F.D., 1978. Effect of low voltage stimulation of beef carcasses on muscle tenderness and pH. J. Food Sci. 43, 1392-1396.

CARSE, W.A., 1973. Meat quality and the acceleration of post-mortem glycolysis by electrical stimulation. J. Fd Technol. 8, 163-166.

CHRYSTALL, B.B., 1978. Electrical stimulation, refrigeration and subsequent meat quality. 24:th European Meat Research Congress, Kulmbach, pp. E 7:1-6.

CHRYSTALL, B.B. and HAGYARD, C.J., 1976. Electrical stimulation and lamb tenderness. N.Z. Journal of Agricultural Research 19, 7-11.

DAVEY, C.L., GILBERT, K.V. and CARSE, W.A., 1976. Carcass electrical stimulation to prevent cold shortening toughness in beef. N.Z. Journal of Agricultural Research 19, 13-18.

HARSHAM, A. and DEATHERAGE, F.E., 1951. U.S. Patent No. 2544681.

JONSSON, G., FABIANSSON, S. and NILSSON, H., 1978. Experiments to avoid cold shortening in beef. 24:th European Meat Research Congress, Kulmbach, pp E 10:1-6.

NILSSON, H., RUDERUS, H. and FABIANSSON, S., 1979. Meat quality characteristics of very low voltage stimulated beef carcasses. Submitted to the 25:th European Meeting of Meat Research Workers, Budapest.

SAVELL, J.W., SMITH, G.C. and CARPENTER, Z.L., 1978. J. Animal Sci. 46, 1221-1228.

SHAW, F.D. and WALKER, D.J., 1977. Effect of low voltage stimulation of beef carcasses on muscle pH. J. Food Sci. 42, 1140-1141.