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Different electric stunning methods and the effect on some meat quality traits in pigs.

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Introduction

Electric stunning can be recommended as being safe, efficient and last but not least relatively inexpensive in comparison with carbon dioxide stunning or using a captive bolt pistol.
Different voltages in electric stunning are legally permitted in the Netherlands, but mostly a low voltage method with about 75 Volts AC was used. For this procedure a time of at least 15 seconds is legally stipulated.
The need for more rapid slaughter methods compel us to pay more attention to high voltage stunning procedures, however.
In the following study a comparison has been made on electric stunning under practical conditions with three different voltages and the influence of each method on meat quality.
This study can be regarded as a follow up of earlier experiments in which attention was focussed upon the effect of pre-stunning conditions and muscle contractions during electrical stunning on meat quality (Sybesma and Groen, 1970).

Material and methods

Three groups of 50 normal slaughter pigs each were used. The animals, weighing about 100 kg live weight, originated from several piggeries located at distances approximately 50 km from the factory. The pigs were slaughtered within two hours after arrival at the slaughterhouse. Each group of animals was submitted to one of three stunning procedures as described below. The whole experiment was repeated three times, in which the sequence of stunning methods was changed.

The stunning procedures used were as follows:

1. Electric stunning 75 Volts AC, during 20 seconds;
2. Electric stunning 190 Volts AC, during 5 seconds;
3. Electric stunning 300 Volts AC, during $1\frac{1}{2}$ seconds.

The stunning apparatus was an experimental one in which voltage as well as time could be fixed.

After stunning and hoisting the animals were exsanguinated in hanging position.

In a second experiment, the experimental apparatus for electric stunning with 190 Volts has been compared with a commercial one. For this study about 50 pigs per group have been measured. The experiment was made during the second and third week of the first experiment. The data obtained in the first experiment with the 190 Volts experimental apparatus were also used in the comparison of the second experiment. The next scheme gives the numbers of animals per group per week of the two experiments:

	experiment 1			experiment 2
voltage	75	190	300	190
week 1	54	42	62	--
week 2	51	55	42	52
week 3	44	44	62	52

Meat quality parameters measured at the slaughter line, 45 minutes post mortem were pH readings (Electrofact, type 36100) taken from the m.semimembranosus and m.longissimus dorsi, development of rigor mortis according to Sybesma (1966) and temperature (Braun, Tastomed P) of the m.semimembranosus.

A meat quality score as well as the Göfo value of the long.dorsi were estimated 24 hours after slaughter.

Results

A very important factor in this study was the gain of time in using high voltage stunning procedures, as has been shown in table 1.

Table 1. Time interval in seconds between stunning and moment of exsanguination.

Method of stunning	n	$\bar{x}$	S_x
75 Volts (20 seconds)	48	44.1	4.6
190 Volts (5 seconds)	49	23.0	3.6
300 Volts ($1\frac{1}{2}$ seconds)	29	22.3	2.7

The times given in this table do include the time course of the real stunning act (given between brackets).

Violent clonic muscle contractions, however, appearing just after stunning with the experimental 190 Volts apparatus gave problems, specially from the labour point of view. In some cases even animals had to be stunned for a second time. The suitability of this very apparatus for stunning became questionable. Meat quality parameters showed none or little differences from week to week. For that reason only average values for the whole experiment and their standard deviations have been given (table 2).

Table 2. Parameters of meat quality at different stunning methods. (mean $\pm$ SD)

Method of stunning	75 Volts	190 Volts	300 Volts
45 min. post mortem			
number of animals	149	141	166
m. semimembranosus			
pH	6.28 $\pm$ 0.35	6.39 $\pm$ 0.30	6.34 $\pm$ 0.32
rigor mortis	6.6 $\pm$ 3.3	6.0 $\pm$ 3.4	7.1 $\pm$ 3.6
temperature (^{0}C)	40.43 $\pm$ 0.69	40.00 $\pm$ 0.71	40.36 $\pm$ 0.62
m. longissimus dorsi			
pH	6.17 $\pm$ 0.30	6.33 $\pm$ 0.28	6.25 $\pm$ 0.30
24 hours post mortem			
number of animals	147	139	163
m. longissimus dorsi			
meat quality score	1.8 $\pm$ 1.0	1.6 $\pm$ 0.8	1.8 $\pm$ 0.9
Göfo value	64.4 $\pm$ 12.1	66.7 $\pm$ 10.4	65.1 $\pm$ 12.8

Statistical analysis of the parameters, mentioned in table 2, gave some significant differences between the three stunning methods, as has been shown in table 3.

Table 3. Analysis of variance applied to the data of table 2.

45 min. post mortem

m.semimembranosus		
pH	$F^2_{453} = \frac{0.44053}{0.10511} = 4.19$	$0.01 < P < 0.05$
rigor mortis	$F^2_{453} = \frac{46.12719}{11.85103} = 3.89$	$0.01 < P < 0.05$
temperature (^{0}C)	$F^2_{453} = \frac{7.71840}{0.45135} = 17.10$	$P < 0.001$
m.longissimus dorsi		
pH	$F^2_{453} = \frac{0.92755}{0.08641} = 10.73$	$P < 0.001$

24 hours post mortem

m.longissimus dorsi		
meat quality score	$F^2_{446} = \frac{1.91938}{0.81959} = 2.34$	N.S.
Göfo value	$F^2_{446} = \frac{198.0327}{140.9058} = 1.41$	N.S.

Remarkable was that only measurements taken at the slaughterline differed significantly for the three methods of stunning, while differences in meat quality scores and Göfo values were not significant.
For a good insight into the different electrically stunning procedures, also a commercial stunning apparatus with 190 Volts AC was compared with the experimental instrument with the same voltage. In this study measurements were made of pH, rigor and temperature of the m.semimembranosus and the pH-value of the m.longissimus dorsi (table 4.).

Table 4. Meat quality parameters at 45 min. after stunning with different 190 Volts AC equipment.

Stunning apparatus	Experimental	Commercial
number of animals	99	104
m.semimembranosus	$\bar{x}$ S_x	$\bar{x}$ S_x
pH	6.36 ± 0.29	6.19 ± 0.37***
rigor mortis	6.0 ± 3.2	7.5 ± 3.3 **
temperature (^{0}C)	39.78 ± 0.63	40.42 ± 0.63***
m.longissimus dorsi		
pH	6.30 ± 0.27	6.14 ± 0.33***

t-test according Student ** $0.001 < P < 0.005$; *** $P < 0.001$.

The two methods differed significantly for all parameters tested by means of the t-test of Student, in such a way that the experimental apparatus gave the best results as to the meat quality parameters. In contrast to the experimental apparatus, muscular contractions were not observed at the animals when using the commercial stunning device.

Discussion

The speed of the processes of stunning and sticking was significantly increased by using high voltage stunning methods. This improvement could be considered as a consequence of the decreased stunning times. A problem, however, were the violent clonic muscle contractions appearing just after the stunning act with 190 Volts when using the experimental stunning apparatus. This trouble from the labour point of view was not observed when a commercial stunning apparatus was used with the same voltage. It was supposed that the reduced electric capacity of the experimental apparatus could be responsible for this undesirable phenomenon.
A comparison of the three different voltages, administered with the experimental stunning apparatus was significantly better for the 190 Volts group, while stunning with 300 Volts took in an intermediate position. Experiments made in the past gave better meat quality results for 300 Volts compared with 75 Volts (Van der Wal et al, 1972), and this holds true for this series of experiments. Measurements made 24 hours after slaughter did not show significant differences.

With regard to these results it must be noted that correlation coefficients between pH_{45}- and Göfo-values of the m.longissimus dorsi (for respectively 75 V, 190 V and 300 V: r = 0.50; r = 0.26; r = 0.42) were about the same as corresponding coefficients for pH_{45} and meat quality scores (r = -0.50; r = -0.34; r = -0.50). Meat quality scores and Göfo-values, however, correlated better (r = -0.81; r = -0.70; r = -0.79). This may be in agreement with Kallweit (1968) who stated that colour brightness measured 24 hours after slaughter is much more important in meat quality than the same measurement made 30 minutes post mortem. The fact that no significant differences could be observed between the three groups may be a consequence of the fact that the Göfo-values of the three groups are within the normal limits, while this parameter especially gives information about aberrant quality conditions. In this kind of comparative experiments pH-measurements are preferred (Scheper, 1972).
The difficulties with 190 Volts forced us to focus the attention on this type of stunning. A commercial apparatus, however, causing no muscle contractions gave low pH and high rigor values. Both related with a less good meat quality. These less favourable results possibly can be considered as a consequence of a stunning act longer than 5 seconds (about 5 to 8 seconds). A reduction of this time may produce better results for meat quality as has been proved afterwards. This phenomenon points to the importance of the time the muscles and the endocrine system are under influence of the electrical stimulation. A commercial stunning apparatus with 300 Volts gave the impression to produce the best results in a comparative study with different stunning equipment (unpublished, in preparation). As the time of stunning is related to the voltage, stunning methods with high voltages and short stunning times are to be preferred.

Conclusions

High voltage stunning procedures do increase the rapidity of the stunning process.
Meat quality has been proved to be better after short stunning times with high voltages, possibly caused by a shorter electrical stimulation of the musculature and the endocrine system of the animal.
The electroshock stunning method with 300 Volts may be preferable to the 190 Volts procedure.

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Summary

A series of experiments with electrical stunning of pigs was carried out under slaughterhouse conditions. For discriminating the best method of stunning, three different procedures have been used (75 V, 20 sec.; 190 V, 5 sec.; 300 V, $1\frac{1}{2}$ sec.).
Meat quality was rather good after use of 190 Volts with an experimental stunning device, but this method was accompanied with violent clonic muscle contractions. These results were just the opposite of those obtained with a commercial apparatus.
An electroshock method with 300 Volts may have preference for stunning pigs

EFFET de DIFFERENTES METHODES D'ANESTHESIE ELECTRIQUE SUR QUELQUES ASPECTS DE LA VIANDE DES PORCS.

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Résumé :

Une série d'expériences sur l'anesthésie electrique de porcs a été conduite dans les conditions de l'abattoir.

Trois méthodes ont été utilisées (75 volts, 20 secondes, 190 volts 5 secondes, 300 volts 1 1/2 seconde).

La qualité de la viande était assez bonne avec un dispositif expérimental et 190 volts, mais cette méthode était associée à des contractions musculaires violentes.

Ces résultats étaient exactement l'opposé de ceux obtenus avec un appareil commercial.

La méthode d'électrochoc à 300 volts peut être préférée pour l'étourdissement des porcs.

EINFLUSS VERSCHIEDENER METHODEN DER ELEKTRIZITÄTSANÄSTHESIE AUF EINIGE MERKMALE DER FLEISCHBESCHAFFENHEIT BEIM SCHWEIN.

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Zusammenfassung :

Eine Reihe vom Untersuchungen über die Elektrizitätsanästhesie beim Schwein wurde unter den Umweltbedingungen im Schlachthaus durchgeführt. Drei Methoden wurden verwendet (75 V. 20 Sekunden ; 190 V, 5 Sekunden ; 300 V, 1 1/2 Sekunde)

Die Fleischbeschaffenheit war ziemlich gut mit 190 V und einer Versuchsvorrichtung ; mit diesem Verfahren wurden jedoch klonische Muskelzuckungen ermittelt.

Diese Ergebnisse waren genau das Gegenteil derjenigen, die mit einem Handelsgerät ermittelt wurden.

Die Methode der Elektrokrampfbehandlung mit 300 V. kann jedoch für die Anästhesie der Schweine empfohlen werden.