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19th MEETING OF EUROPEAN MEAT RESEARCH WORKERS

Title: "Some Observations on Electrical Stunning Techniques  
in Relation to Biochemical & Quality Factors in Pork"

Authors: M. Hatton & P.W. Ratcliff\*

Theme: A

SUMMARY

Batches of 100 Large White pigs were divided into two experimental groups, and stunned electrically (95 - 110 volts, 550 - 750 m. amps) either with low frequency current (50 cycles) or with high frequency current (1300 cycles). After sticking and processing on a conventional slaughter line, the carcasses were chilled, and the meat was examined for haemorrhages in the shoulder joints. Water binding capacity, colour and pH were observed in the meat.

Frequency at 50 cycles, applied for 6 - 9 seconds, gave a high incidence of haemorrhage (60 - 80%) which was unaffected by deliberately stressing the pigs before slaughter. This incidence was reduced to the 40% level by reducing the time of application to 3 sec. Use of current at 1300 cycles drastically reduced the incidence of haemorrhage, to 20% with 9 seconds' application of the tongs, and to < 10% with 3 seconds' application.

The type and duration of stunning had no observable effect on colour or water binding of the meat, and pH ult. was also unaffected.

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**Titel:** "Einige Betrachtungen über elektrische Betäubungsverfahren  
im Hinblick auf biochemische und Qualitätsfaktoren bei  
Schweinefleisch."

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**Thema:** A

#### Zusammenfassung

Gruppen von 100 Schweinen der Rasse Large White wurden in zwei Versuchsgruppen aufgeteilt und elektrisch betäubt (95-110 Volt; 550-750 mAmp.), und zwar entweder mit Niederfrequenzstrom (50 Hz) oder mit Hochfrequenzstrom (1300 Hz). Nach dem Abstechen und der Verarbeitung auf einem normalen Schlachtförderband wurden die Tierkörper abgekühlt und das Fleisch auf Blutungen in den Schultergelenken untersucht. Wasserbindungsvermögen, Farbe und pH-Wert des Fleisches wurden geprüft.

Eine Frequenz von 50 Hz (Einwirkung: 6-9 Sekunden) ergab ein hohes Vorkommen von Blutungen (60-80%), das durch eine vorsätzliche Stress-Belastung der Schweine vor dem Schlachten unbeeinflusst blieb. Dieses Vorkommen wurde auf 40% gesenkt, wenn die Stromeinwirkungszeit auf 3 Sekunden verkürzt wurde. Hochfrequenzstrom (1300 Hz) reduzierte das Blutungsvorkommen drastisch, und zwar auf 20% bei einer Stromeinwirkung von 9 Sekunden, und auf <10% bei einer solchen von 3 Sekunden.

Art und Dauer der Betäubung hatten keine merkliche Wirkung auf die Farbe oder das Wasserbindungsvermögen des Fleisches, und der endgültige pH-Wert blieb ebenfalls unbeeinflusst.

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19-е СОВЕЩАНИЕ ЕВРОПЕЙСКИХ ИССЛЕДОВАТЕЛЬСКИХ  
РАБОТНИКОВ МЯСНОЙ ПРОМЫШЛЕННОСТИ

Доклад: "Наблюдения по приемам электроударного глушения  
в связи с биохимическими свойствами и качественными  
показателями свинины"

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Тема: А

АННОТАЦИЯ

Партии 100 свиней породы "большая белая" разделялись на две экспериментальные группы и подвергались глушению электроударом (95-110 в, 550-750 ма) низкочастотным током (50 гц) или высокочастотным (1300 гц). После закалывания и обработки на обыкновенной убойной линии туши подмораживались, после чего мясо осматривалось на кровотечения в районе плечевого сустава. Определялись водосвязующая способность, цвет и рН мяса.

Ток низкой частоты 50 гц, подаваемый в течение 6-9 сек, соответствовал высокой встречаемости кровотечений (в 60-80% туш), причем зависимости встречаемости кровотечений от намеренного возбуждения животных перед убоем не наблюдалось. С другой стороны, при сокращении продолжительности электроудара до 3 сек встречаемость кровотечений снижалась до 40% от общего числа туш. Применение тока частотой 1300 гц приводило к значительному снижению встречаемости кровотечений, а именно до 20% от общего числа туш при 9-секундном ударе и <10% при 3-секундном.

Зависимости цвета, водосвязующей способности и конечного рН мяса от параметров и продолжительности глушительного электроудара не наблюдалось.

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TITRE : "Quelques observations sur les techniques assommant au moyen de  
l'électricité et leur effet sur la qualité et les facteurs  
biochimiques du Porc

Auteurs : M. Hatton & P.W.Ratcliff.

Thème : A

RÉSUMÉ

Des groupes de cent gros cochons de race LARGE WHITE ont été divisés en deux groupes expérimentaux, et assommés par choc électrique (95-110 volts, 550-750m.amps) de courant de basse fréquence (50 cycles) ou de haute fréquence (1.300 cycles). Après qu'ils aient été égorgés et traités sur une chaîne d'abattage conventionnelle, les carcasses ont été réfrigérées, et on a examiné la viande pour voir les traces d'hémorragie dans l'articulation de l'épaule. La capacité de rétention d'eau, la couleur et le pH de la viande ont été étudiés.

Une fréquence de 50 cycles, appliquée de 6 à 9 secondes, causait une forte incidence d'hémorragies (60 à 80%), même si les porcs étaient délibérément tendus avant l'abattage. En diminuant la période d'application à 3 secondes, cette incidence en était réduite jusqu'à un niveau de 40%. En se servant d'un courant de 1.300 cycles, l'incidence d'hémorragie était diminuée de façon spectaculaire jusqu'à 20%. Les pinces étant appliquées pendant 9 secondes et jusqu'à moins de 10% avec une application de seulement 3 secondes.

Le type et la durée de l'assomage n'avaient aucun effet qu'on puisse observer sur la couleur et la rétention d'eau de la viande; le pH ult. n'en était pas modifié non plus.

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## SOME OBSERVATIONS ON ELECTRICAL STUNNING TECHNIQUES

### IN RELATION TO BIOCHEMICAL & QUALITY FACTORS IN PORK

#### INTRODUCTION

Stunning of pigs by electrical means is more common in abattoirs in the U.K., than the alternative methods using CO<sub>2</sub> or a captive bolt pistol. The relative merits of these stunning methods, in respect to subsequent meat quality, are controversial.<sup>(1,2)</sup> In commercial practice, at one abattoir the use of low frequency current (50 c/s) applied to the pigs over a period of 8 - 9 sec. was found to result in severe haemorrhaging of the shoulder joints, - a defect which was conspicuous in the pork and bacon obtained from the carcasses. The present work was undertaken in order to ascertain, and rectify, the factors responsible for this problem at the abattoir.

#### EXPERIMENTAL

In each of 6 experiments 100 pigs (Large White, with admixture of Landrace) of approximately 200 lbs live weight, were randomly taken from the normal delivery at a commercial abattoir, and divided into two groups of fifty. The animals were electrically stunned by a procedure in which one variable, (a) the frequency of the current applied, or (b) the time of application of the stunning current, was varied between the two groups of pigs in each experiment. The current, either low frequency, 50 c/sec. or high, 1300 c/sec. was applied through Iwel tongs of the standard type. The tongs were routinely dipped in brine to improve electrical contact at the electrodes when placed across the animal's head, through which current was passed for either ~ 3 seconds ('short' stun) or 7 - 9 sec. ('long' stun).

For the measurement of stunning times, and the current used during stunning, an "Avometer" was connected into the secondary circuit, and the dial reading during the stunning of each pig was observed and timed with a stopwatch. Frequency of current was checked by oscilloscope. Electrode potential was standardised at 95 v. for low frequency current or 100 v. for high frequency current; the amount of current used amounting to 550 ± 250 ma. and 750 ± 250 ma. respectively. The pigs were 'stuck' and bled 15 sec. after removal of the tongs and the carcasses were dehaired, eviscerated, dressed and chilled according to normal practice at this abattoir. At subsequent butchery (48 hours post-mortem) the shoulder joints were examined visually for haemorrhage of the medium-sized blood vessels in the muscle and connective tissue membranes in the region of the 'ball joint' (the articulation of the humerus and scapula). The incidence of shoulder haemorrhage was recorded for each group of pigs.

In three additional experiments the pigs were divided into two groups which were similarly subjected to two contrasting procedures of stunning. In one of these experiments (No.7), one group of pigs was deliberately stressed and excited by use of electrical goads over a period of 60 seconds immediately before stunning, while the corresponding group remained quiet and calm throughout. The chump joints were prepared as for retail, from the chilled carcasses, and the *M. longissimus dorsi* was removed from the loin region for determination of pH ult. and colour.

The amount of watery exudate from the chump joints was determined, after 1 - 4 days' storage in polythene film at  $1 \pm 1^\circ\text{C}$ . Brightness of colour of a freshly cut surface of the *M. longissimus dorsi* was determined in terms of reflectance or 'Y Values', using a 'J 40' Colourmeter (Hilger and Watts Ltd.,) (3) pH ult. was determined in a homogenate of the long. dorsi (1.0g) in 10 ml 0.005M iodoacetate, (Pye 'dynacap' pH meter).

### RESULTS

The incidence of haemorrhage observed in the shoulder joints in six experiments using controlled stunning times, and low or high frequency stunning current, is recorded in Table I.

TABLE I  
HAEMORRHAGE IN RELATION TO STUNNING CONDITIONS

Experiment No.	Stun Current Frequency (cycles/sec)	Time of Stun (sec)	Incidence of Shoulder Haemorrhage (% of Joints Examined)
1	50	Short: 3.5 (0.3)	33
	1300	Short: 3.5 (0.3)	2
2	50	Short: 3.4 (1.0)	40
	1300	Short: 2.8 (0.8)	10
3	50	Long: 6.8 (1.1)	80
	50	Short: 2.7 (0.8)	61
4	1300	Long: 8.9 (1.7)	21
	1300	Short: 3.5 (0.8)	5
5	50	Long: 9.2 (1.5)	60
	50	Short: 2.8 (0.6)	40
6	50	Long: 9.1 (1.9)	62
	50	Long: 7.5 (1.6)	74

S.D. is given in brackets

Table II summarises the results for the additional experiments, in which the watery exudation from the chump joints was measured during 1 - 4 days' storage, and pH ult. and brightness of colour (Y values) were determined in the *M. longissimus dorsi*.



TABLE II

## MEAT QUALITY PARAMETERS IN RELATION TO STUNNING CONDITIONS

Experiment No.	Stun Current Frequency (cycles/sec)	Time of Stun (sec)	Meat Quality				
			Drip from Chump Joints, % by weight.		Y Value, % (L.dorsi)	pH ult. in L.dorsi.	Shoulder Haemorrhage, % Incidence
			1 Day	3-4 days			
7 A	50	Long: 8.7 (1.2)	0.7 (0.3)	1.2 (0.4)	21.0 (1.4)	5.5 (0.1)	80
	B *	Long: 9.4 (1.6)	0.7 (0.3)	1.2 (0.6)	20.0 (3.5)	5.5 (0.2)	75
8	50	Short: 5.0 (0.9)	0.7 (0.3)	1.1 (0.5)	26.3 (2.6)	5.6 (0.1)	45
	1300	Short: 3.5 (0.3)	0.7 (0.4)	1.0 (0.5)	26.3 (2.9)	5.6 (0.1)	5
9	50	Long: 9.1 (1.0)	0.5 (0.2)	0.7 (0.3)	21.3 (2.2)	5.8 (0.1)	-
	1300	Short: 2.8 (1.3)	0.4 (0.1)	0.6 (0.2)	23.0 (4.0)	5.8 (0.2)	-

S.D. is given in brackets

\* Pigs of group (B) stressed during 1 minute prior to stunning. Group (A) pigs quiet.

By examination of Tables I and II it is seen that with low frequency current, a long stun (6 - 9 sec) was associated with the highest incidence of shoulder haemorrhage, 60 - 80% of the joints being affected. With reduction of the stun time to  $3.0 \pm 0.5$  sec. this incidence was significantly reduced ( $p < 0.01$ ) but remained at the high level of 33 - 60%.

Drastic reduction of this form of haemorrhage occurred when high frequency current was used: with a long stun time, 9 sec, the observed incidence was 21%, falling to 2 - 10% when the stun time was reduced to  $3.0 \pm 0.5$  sec.

Observed differences in wetness of the individual joints, and in colour and pH of the *M. longissimus dorsi*, as recorded in Table II, were not significantly related to the different methods of stunning used. It is also remarkable that the stressing treatment given to one group of pigs in experiment No. 7 - these animals being in a highly excited and frightened state following the deliberate use of electrical goads during a period of 60 sec. immediately prior to stunning - was without effect on pH ult. or the meat quality factors examined.

#### DISCUSSION

The data indicate that the incidence of haemorrhage in the shoulder joints may be largely controlled by (a) use of high frequency current of sinusoidal wave form (1300 c/s), together with (b) a short time of stun ( $3.0 \pm 0.5$  sec).

These results support, and extend, the conclusions of Koledin<sup>(4)</sup>, who reported a decrease in tissue rupture and haemorrhaging as the frequency of the stun current was raised, and a significant deterioration in meat quality when the time of stun was increased. This worker however preferred the use of current at 2,400 c/s, and a stunning time of 6 - 10 sec, a considerably longer time than is desirable for use with current at 1300 c/s.

The underlying causes of the haemorrhaging are little understood. The passage of the current through the brain stimulates the vagus nerve with consequent stoppage of the action of the heart, and exerts a vasoconstriction effect. Rupture of blood vessels has been attributed to the substantial rise in blood pressure which follows the resumption of activity by the heart, as soon as the current is switched off<sup>(4)</sup>. There is however, evidence which is in conflict with this view<sup>(5)</sup>. Adrinergetic stimulation leading to fibrinolytic activity which increases the fragility of the blood vessels, has more recently been implicated<sup>(6)</sup>.

As the haemorrhaging is symptomatic of complex physiological responses of the animal to the passage of electric current, it is clear that a study of the physiological effects of electrical stunning is required. Meanwhile it is tentatively suggested that electrical stunning of the pig administers a major shock to the system, the effects of which are seen not only in haemorrhaging of the blood vessels, but in terms of other meat quality factors, wetness and colour. With respect to the latter parameters, which are known to be pH dependant, this work provides an indication that the influence of preslaughter stress may be of minor significance in comparison with that due to shock sustained at electrical stunning. The post-mortem effects of electrical stunning on carbohydrate metabolism and nucleotide breakdown are under investigation.



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