Electrical stunning of pigs: minimum current flow time required to induce epilepsy at various frequencies

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Background:

Electrical stunning is the most widely used method of pre-slaughter stunning of pigs, in Germany too. Most existing equipment currently is based on the 50 Hz sinusoidal voltage available from mains power. Recently, producers of electrical stunning equipment offer apparatus with higher stunning frequencies up to about 800 Hz. Thus carcass quality problems such as blood splash and broken bones should be reduced. But with priority, the effects of high stunning frequencies on animal welfare require evaluation. Each stunning method should induce unconsciousness instantaneously. The presence of an epileptic state is considered to be a guarantee of an effective electrical stun (HOENDERKEN, 1978). Experiments of SIMMONS (1995) showed, that the minimum current required to induce epilepsy depends on the stunning frequency. The threshold was raised as the frequency increased. Dates concerning a correlation between the minimum current flow time for an effective stun and the frequency are not available. In the German regulations for the slaughter of animals (Tierschutz-Schlachtverordnung, 1997) the minimum current flow time is 4 sec for frequencies between 50 and 100 Hz. If the animals are not restrained, the minimal current flow time is as twice as high. Regulations for higher frequencies are not existing.

Objectives:

The objective was to evaluate animal welfare implications of higher frequency electrical stunning in comparison with „normal" 50 - 60 Hz stunning. Therefore, the minimum current flow times (by using constant current) to induce epilepsy at a range of frequencies should be determined. Also the duration of the tonic and clonic phases of epilepsy and time to recovery should be registrated at various frequencies.

Methods:

45 pigs (live weight 95 - 140 kg) were stunned with a stunning equipment delivering constant current (1.3 ampere); frequency and current flow time were variable (Fa. Fuhrmann Elektrotechnik, Heidelberg). The following stunning frequencies were tested: 50, 500 and 800 Hz. The current flow times were decreased in steps of 0.1 resp. 0.2 sec from 0.6 sec (50 Hz), 0.5 sec(500 Hz) and 1.0 sec (800 Hz) to 0.2 resp. 0.3 sec (800 Hz) (Tab. 1). The pigs were restrained in a box and lifted lying with the breast on a bar, so that there was no contact between feet and floor (Fig. 1). After a rest of 5 min the pneumatic tongues were placed on both sides on the base of the ear (Fig. 2) and the defined current flow was started. The experiments are part of investigations within the scope of the thesis „Stunning of pigs: Influence of frequencies on minimum current flow time and meat quality parameters" (Free University, Berlin).

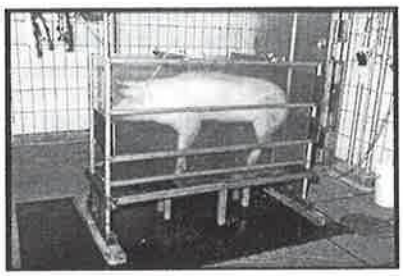

Figure 1: Stunning box

Figure 2: Placing of the pneumatic tongues

The following symptoms were evaluated visually:

- epileptic fit: yes / no
- duration of tonic phase
- duration of clonic phase
- recovery of breathing
- recovery of eyelid reflex

Results and discussion:

The experiments with decreasing current flow times showed, that 0.2 sec was not sufficient in all cases to induce an effective stun. 1 of 2 pigs treated with 50 Hz and 0.2 sec current flow time was not stunned. Therefore, for the experiments with 800 Hz a lower limit of 0.3 sec current flow time was layed down.
With a minimum current flow time of 0.3 sec (1.3 ampere constant) all animals (10 per frequency) showed an epileptic fit as sign of an effective stun. There were no differences between the frequencies (50, 500, 800 Hz).
The use of higher stunning frequencies did not result in a reduction of time of unconsciousness under laboratory conditions as mentioned in literature (ANIL & McKINSTRY, 1992). On the contrary, the duration of the tonic phase was longer with 800 Hz stunning frequency compared to 50 Hz and the recovery of breathing was delayed after 500 Hz stunning compared to 50 Hz (Tab. 2).

Conclusions:

- All stunning frequencies tested (50, 500, 800 Hz) caused an effective stun (epileptic fit) within a minimum current flow time (1.3 ampere constant) of 0.3 sec
- The minimum electrical charge (ampere x seconds) to induce epilepsy under laboratory conditions can be calculated with 0.4 Coulomb; this is less than 1/10 of the amount, resulting after usual stunning operations (current flow time 4 sec). A higher electrical charge during stunning deteriorates meat quality parameters (TROEGER &. WOLTERSDORF, 1989).
- All stunning frequencies tested are in agreement with animal welfare demands.

Pertinent literature:

ANIL, M.H. & McKINSTRY, J.L. (1992): The effectiveness of high frequency electrical stunning in pigs. Meat Sci. **31**, 481 - 491
HOENDERKEN, R. (1978): Elektrische bedwelmen van slachtvarkens. Thesis, University of Utrecht
SIMMONS, N.J. (1995): The use of high frequency currents for the electrical stunning of pig. Thesis, University of Bristol
TROEGER, K. & W. WOLTERSDORF (1989): Elektrobetäubung und Fleischbeschaffenheit beim Schwein. Fleischw. **69**, 1210 - 1218

Data:

frequency	current flow time [sec]	n
50 Hz	variable: 0.6 - 0.2	6
50 Hz	0.3	10
500 Hz	variable: 0.5 - 0.2	5
500 Hz	0.3	10
800 Hz	variable: 1.0 - 0.4	4
800 Hz	0.3	10
		45

Tab. 1: Stunning frequencies and current flow times

Time	50 Hz	500 Hz	800 Hz
tonic phase	7.5 sec (± 1.7) n = 9	8.1 sec (± 2.4) n = 9	9.5 sec (± 1.7)* n = 10
clonic phase	31.9 sec (± 10.7) n = 9	34.1 sec (± 6.9) n = 9	31.7 sec (± 4.7) n = 10
recovery breathing	35.0 sec (± 4.0) n = 6	47.0 sec (± 11.5)* n = 7	45.8 sec (± 16.5) n = 10
recovery eyelid reflex	43.8 sec (± 11.8) n = 4	46.9 sec (± 14.3) n = 7	40,3 sec (± 16.3) n = 8

* $p < 0.05$

Tab. 2: Duration of epileptic states and time to recovery