

ASCERTAINING DEATH IN PIG SLAUGHTER USING HOT WATER

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Abstract – Sometimes slaughter pigs recover consciousness during the slaughter process although modern stunning and bleeding methods are implemented in today's slaughter houses. Therefore, a total of 29,627 finishing pigs after CO₂ or electrical stunning were examined shortly before further processing (e.g. scalding) begins. In this study, exposure with 60 °C hot water was used as a method for provoking detectable movements in pigs. As a reference to the observations during the hot water stimulation, tests to evaluate brain stem function were carried out on each animal. The method worked satisfactory. Sensitivity was calculated between 99 % and 100 % and specificity between 98 % and 100 %. Results showed that reactions to hot water as well as positive brain stem results were present as well after electrical stunning and bleeding as after carbon-dioxide stunning and bleeding. Every reacting pig that had positive brain stem results had also shown spontaneous movements before the hot water test. Therefore, a combination of sorting out pigs with specific spontaneous movements along the bleeding line, and implementing a hot water test as a “last check”, can ascertain death before further processing.

I. INTRODUCTION

Despite modern slaughter techniques, in German slaughter houses approximately 1 % of slaughter pigs recover consciousness or sensibility after sticking. (Schütte et al. [3], Troeger et al. [6], [7]). Reasons for this serious animal welfare problem involve inefficient stunning and / or lack of complete and fast exsanguination. The affected animals usually show signs that indicate their recovery. These movements may be detected by observing the slaughter pigs along the bleeding line. Consequently an immediate and efficient restun is necessary. However, under routine conditions after pigs have left the bleeding position the reliable detection of such animals is often associated with several difficulties. Primarily a secure monitoring of each pig cannot be performed because of high conveyor speeds.

The bleeding lines are sometimes not entirely accessible and the workers are only able to perform restunning within the first minutes after stunning. In addition it can happen that slaughter pigs do not always show typical and recognizable signs of recovery but start moving only once they reach scalding. Developing an automated system to doubtlessly proof absence of signs of life for each slaughter pig right before further processing would greatly improve animal welfare at slaughter houses. To proof unconsciousness in pigs Anil [2] worked with a hypodermic needle applied to the noses of animals. Initial trials of Troeger et al. [7] successfully used a hot water jet for this purpose in a small-scale study. Furthermore, the European government implemented in 2009 the Council Regulations (EC) No 1099/2009 on the protection of animals at the time of killing [11]. Here it says that the stunning effect must last until the death of the slaughtered animal has irreversibly occurred. Further dressing or scalding shall only be performed once the absence of signs of life of the animal has been verified. Therefore no conscious or sensitive pig may reach further processing. Based on this regulation the German Federal Office for Agriculture and Food has funded a project, partly demonstrated in this paper, for developing a method for ascertaining death in pig slaughter.

II. MATERIALS AND METHODS

The study took place at 6 abattoirs in Germany using either CO₂ or electrical head-to-body stunning methods. In total 29,627 finishing pigs were examined. Data of 24,390 pigs of 3 abattoirs using CO₂ stunning systems and data of 5,237 animals of 3 abattoirs using electrical stunning systems (head-to-body) were used. As a stimulus to check absence of signs of life right before further processing, hot water, at 60 °C, was utilized. The duration of the stimulus lasted between 5 and 15 seconds. An automated

construction, built by the company BANSS GmbH (Biedenkopf/Germany), induced the stimulus within the faces, necks and front legs of the pigs. The time between stunning and the hot water test was 3 to 6 minutes. As a reference to the observations of movements during the application of the stimulus, brain stem reflexes (corneal and palpebral) and reactions to a nasal septum pinch were manually examined. Pigs that either reacted positively to the hot water stimulus or the test of brain stem function were restunned using captive bolt device. The entire bleeding line was videotaped. Additionally to the hot water test spontaneous movements of the pigs, 3 to 5 minutes after stunning, were analyzed. For statistical analysis the software JMP[®] 11 (SAS Institute Inc. 2013, Cary, NC, USA) and Microsoft Excel 2010 (Microsoft Corporation, Redmond, WA, USA) were used. To proof independency of nominal data the fisher exact test was utilized.

III. RESULTS AND DISCUSSION

To prove the effectiveness of the hot water test, relevant parameters were determined. After CO₂ stunning the sensitivity of the hot water test was 100 %. Every pig out of 32, that exhibited positive brain stem results, had also reacted to the hot water test. The sensitivity after electrical stunning was slightly lower, at 99 %. One animal out of 75 had positive corneal- and palpebral-reflexes but had not reacted to the hot water stimulation. However, this pig showed obvious spontaneous movements beforehand. The specificity of the hot water test was determined at 100 % following CO₂ and 98 % following electric stunning. Two more parameters to evaluate the functionality of a test system are the positive and negative predictive value. A weak result of the test device with hot water was the fact that only 37 % of the electrically and 80 % of the CO₂ stunned pigs, that had reacted to the hot water test, also exhibited positive brain stem reflexes or reacted to the nose pinch. However, in terms of animal welfare the high sensitivity and specificity were satisfactory (Table 1).

Table 1: Functionality of a hot water test to prove absence of signs of life in slaughter pigs

Stunning method	Electric	CO ₂
Sensitivity	99 %	100 %
Specificity	98 %	100 %
Positive Predictive Value	37 %	80 %
Negative Predictive Value	100 %	100 %

As an additional result, the authors found that after electrical stunning and bleeding as implemented in the plants visited more pigs showed movements during the hot water test as in the plants using CO₂ stunning and bleeding ($P < 0,001$). In the plants using electrical stunning 3.8 % ($n = 199$) of the pigs showed some kind of reaction to the stimulation compared to 0.2 % ($n = 40$) in the plants using CO₂ stunning, however huge differences between plants have been found. Besides inefficient bleeding one possible reason for this result is reversibility of stunning. In modern CO₂ stunning devices some pigs are irreversibly stunned (Hartung et al [4]), electrical stunning however is reversible, unless effective cardiac arrest is caused (Hoenderken et al. [1], Vogel et al. [8]). It may be assumed that after head-to-body electrical stunning used by the abattoirs displayed in this study cardiac arrest was not always achieved. Furthermore the consequences on the muscle function following the induced epileptic seizure during electrical stunning might have had an effect on the higher percentage of reacting pigs after electrical stunning than after CO₂ stunning.

In the following paragraphs only the results of electrically (head-to-body) stunned pigs are demonstrated. By correlating the observations during the hot water test with the results of the examination of the brain stem, movements during the test can be evaluated. The authors found, that five different types of movements could be differentiated, often shown in combination with each other. Especially the movements head shaking and righting reflex were the ones that mostly correlated with positive brain stem results. 92 % of pigs that shook their heads and 78 % that showed a righting reflex during the hot water test exhibited at least one positive brain stem result. Noticeable front leg activity (moving or tonic stretched front legs = “suspicious front legs”) or opening of the mouth often correlated with positive brain stem results, too (59 % / 50 %).

Hind leg movement was less often associated with positive brain stem results (21 %). By excluding animals that showed combinations of movements, it turned out that all pigs (n = 59) that reacted exclusively with hind leg movement were always brain stem negative. Figure 1 shows the defined movements of electrically stunned pigs during the hot water test correlated with their brain stem results.

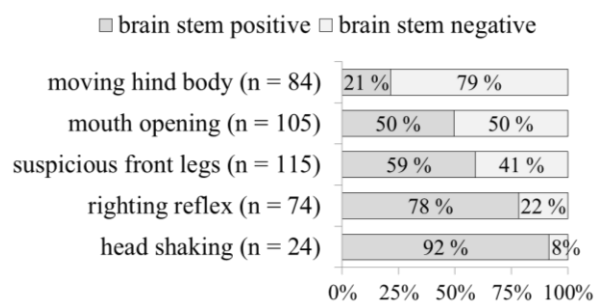


Figure 1: Movements in hot water correlated with brain stem results, electrical stunning

During the study spontaneous movements of the slaughter pigs, from sticking to the hot water device, were monitored and analyzed. Every animal that eventually showed a reaction to the hot water stimulation and exhibited at least one positive brain stem result had moved spontaneously between shackling and the hot water test. These animals could be detected and restunned beforehand, as long as the slaughterhouse staff knows which movements need to be considered. During the study the authors realized that in terms of this, there is still a lack of knowledge among the workers. Combining available expertise (Anil [2], Atkinson et al. [9], EFSA [10]) and making it more practicable for the slaughter house staff, simply understandable working instructions were designed (Figure 2).

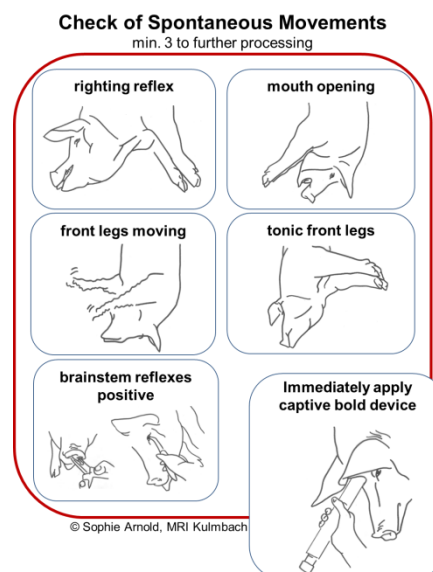


Figure 2: working instructions for detecting spontaneous movements of at risk conscious slaughter pigs

As a suitable solution for ascertaining death in pig slaughter, the idea of paying attention to slaughter pigs that obviously show signs of recovery and implementing a “last check” by using a hot water test right before further processing seems reasonable. To restun suspicious pigs, the use of captive bolt device is recommended by the European Food Safety Authority [5] and the authors.

IV. CONCLUSION

Hot water spray is a suitable test stimulus to prove absence of signs of life right before further processing. Animal welfare issues in terms of recovery of consciousness along the slaughter line are present as well after CO₂ stunning as after electrical stunning requiring action to ensure the enforcement of the legal postulation to verify the absence of signs of life of the animal before further dressing or scalding [11]. Movements during hot water stimulation can be classified into degrees of severity. Head shaking and righting reflex were mostly associated with positive brainstem results. A combination of reacting to specific spontaneous movements later than 2 minutes after stunning combined with a “final check” by a hot water test is recommended by the authors.

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