DOCUMENTATION OF ANIMAL WELFARE OF PIGS ON THE DAY OF SLAUGHTER

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Abstract – Documentation of animal welfare on the day of slaughter is an increasing demand from both the authorities and the market. Through two different experiments, this study investigates the possibility of using on-line measurements of physiological response variables post-mortem to document the animal welfare pre-mortem. The study shows that temperature early post-mortem (PM) and 45 min PM and blood concentration of lactate, glucose and albumin at sticking combined with skin damage are suitable candidates for on-line documentation.

Key Words – Animal behaviour, Blood temperature, Early post mortem muscle temperature, Lactate, Skin damage

I. INTRODUCTION

Animal welfare on the day of slaughter has become an important factor caused by demands from authorities and NGO's as well as the retail market. If claiming a high level of animal welfare, it is necessary to document that this has actually been fulfilled. Today, description of animal welfare is often based on observations of the animals combined with demands for equipment such as water nipples, as in the EU project Welfare Quality® [1]. A continuous monitoring of a few well-chosen indicators of animal welfare would therefore be of interest for the slaughterhouses, if they are cost effective and can be implemented without altering slaughter speed. The challenges can differ between the large slaughterhouses, slaughtering with a speed of 800 - 1100 pigs per hour, and the medium size slaughterhouses, slaughtering with a lower speed of e.g. 100 - 200 pigs per hour. The aim of this study was to evaluate different indicators for animal welfare in two commercial settings to pin point possible measures that might be possible to implement as on-line measurements of animal welfare.

II. MATERIALS AND METHODS

Two independent experiments were performed. The first experiment took place at a medium size slaughterhouse, slaughtering approximately 110 pigs per hour (CO_2 stunning). No automatic handling of the live pigs was used except in the last part of the driveway just before the stunner. Four batches, a total of 60 pigs from four different producers, delivered during the two experimental days were included in this experiment. The 60 pigs were divided into two groups of 30 pigs and placed in two pens. During off-loading, lairage and moving towards the stunner, animal behaviour was observed by direct observations while behaviour when moving into the stunner was recorded on video and evaluated later. Immediately after slaughter, the temperature of the blood and in the *longissimus dorsi* muscle (LD) was measured as well as the pH in LD. Forty-five minutes later, pH and temperature were measured in LD again, and the amount of skin damage was assessed on a four point scale: 1 (no kind of slap-marks, bite-marks or marks from claws), 2 (superficial marks), 3 quality reducing damage from bites, slaps or claws, 4 strongly reducing quality damage from bites, slaps or claws (the DMRI-scale) [2]. The day after slaughter, pH and temperature was measured in LD, and the drip loss was measured in LD using the EZ-drip loss method [3].

The second experiment was at a large scale slaughterhouse slaughtering approximately 824 pigs per hour per stunner (CO_2 stunning in groups). Driving the pigs towards the stunner was performed using automatic gates. In this experiment, the pigs were observed all the way from the producer to slaughter. Forty pigs from two producers (twenty from each) were delivered together. This was repeated twice on two successive days resulting in a total of 80 pigs in the experiment. Animal behaviour was observed by direct observation

during loading and lairage, and by video recordings evaluated later of the off-loading and moving towards the stunner. During lairage, scan samplings of the behaviour was performed. At the beginning of each period of 2½ minutes the posture of the pigs was recorded and during the period the frequency of aggressive behaviour was recorded.

Immediately after slaughter the temperature in the sticking blood and in LD was measured, and a blood sample was taken for analysis of lactate, albumin, glucose, and creatine kinase (CK). The temperature and pH was measured in LD after 45 min and at the day after slaughter. The amount of skin damage was assessed as in experiment one.

A regression analysis was carried out to investigate the effect of a combined index of the behaviour before slaughter on the post mortem temperature, pH and blood parameters. To investigate the general data structure, a PLSR was performed using the behaviour data as X-axis and the post mortem data as Y-axis.

III. RESULTS AND DISCUSSION

Pre-stunning behaviour

In experiment 1, the time before all pigs were lying down was noted. However, in half of the groups this did not happen during the 60 min of lairage time. It took between 17 and 28 minutes before all pigs were lying down in the rest of the groups. Pigs, not lying down, were either standing or sitting. Furthermore, even if all pigs lay down, they changed position and the situation therefore lasted for a maximum of 12 minutes. Also aggressions were present during lairage. In the four batches 2, 4, 12 and 14 pigs, respectively, were involved in aggressions.

In experiment 2, 58 % of the pigs were lying down within the first 15 minutes on day 1; however, only 48 % were lying down during the subsequent observation period (15 minutes). On day 2, 68 % of the pigs were lying down within the first 15 minutes, 93 % within 30 minutes and 95 % within 45 minutes. There was an effect of pen as it took longer time for the pigs placed in the pen closest to the automatic push gates in the driveway to settle down, and they were disturbed during the periods of observation. In total, 10 pigs were recorded sitting, and four pigs were involved in aggressions during the experimental period.

Animal behaviour on the way into the stunner was described for the first two batches (Table 1).

Table 1 Behaviour and handling on the way into the stunner.

Observations	Frequency (%)	
	Exp. 1 (n=240)	Exp. 2 (n=80)
Hard driven[1]	35	0
Touched by automatic push gate[2]	No aut. gates	54
Turn around	19	Not measured
Falls	Not measured	13
Disturbed	39	Not measured
Lifted by the other pigs[3]	3	11
Pushed into the stunner	5[4]	Not measured
Backwards into the stunner	15	Not measured
Caught under the hoist gate	13	0

[1] Physical contact with the pig e.g. with a board
[2] By at least one out of three push gates
[3] At least one leg without contact with the floor
[4] By the personal or the other pigs

As can be seen in Table 1, the coincidence of negative behavioural and handling patterns are 0 - 54 %. More than a third of the pigs in experiment 1 were driven hard by the personal while this was not the case in experiment 2 using the automatic push gates. In this system, the pigs were often touched by the push gate driving them into the stunner. The two systems were very different and this is reflected in the amount of pressure the pigs are experiencing and the resulting behaviour of the pigs.

Physiological response

To be a candidate for a parameter to be measured continuously to document animal welfare, three factors must be fulfilled:

- The parameter must be correlated to traits relating to animal welfare e.g. animal behaviour
- The parameter must show a variation

- The parameter must be realistic to measure continuously

Temperature and lactate concentration in the sticking blood are candidates which after a development phase are possible to implement on-line, especially if the blood is collected by tubes such as rota stick. Temperature and pH in LD, especially 5 min after sticking, are not realistic to use as on-line measurements as they are destructive methods, but they are still interesting to investigate if they show correlations to animal welfare, it might be possible to find indirectly and correlated traits which can be measured.

Table 2 shows the variation in the measured traits.

Table 2 General variation in temperature and pH measured post mortem

Parameter	Average	Std.dev.	Min	Max	Exp.
Blood T	39.6	0.47	37.2	41.8	1
	39.0	0.47	37.3	39.9	2
$T_{5\ min}$	39.3	0.46	37.4	40.9	1
	38.7	0.76	35.3	39.7	2
$T_{45\ min}$	38.7	1.03	35.3	41.4	1
	39.3	0.43	38.2	40.1	2
$T_{22\ hr}$	3.3	0.75	1.9	4.7	1
	4.8	0.24	4.2	5.4	2
$pH_{5\ min}$	6.7	0.19	6.1	7.1	1
$pH_{45\ min}$	6.6	0.19	5.9	7.1	1
	6.8	0.17	6.5	7.1	2
$pH_{22\ hr}$	5.64	0.13	5.30	6.31	1
	5.52	0.10	5.38	5.94	2
Glucose	16.8	4.6	6.8	28.2	2
Albumin	40.6	3.2	30.0	47.9	2
CK	7864	9885	920	43540	2
Lactate	7.2	1.9	2.9	11.8	2

As can be seen in Table 2, the three temperature parameters on the day of slaughter showed a large variation within each experiment and also between the two experiments. The temperature is correlated to the animals' energy metabolism as the energy metabolism results in heat production. Also the pH shows a considerable variation within each experiment but not so much between the two experiments. The pH of the meat is also related to the energy metabolism and production of lactate in the muscles and might therefore reflect the same physical status of the animals as the temperature.

Also the blood parameters show a high variability. Blood samples were only included in the second experiment and reflect both the energy metabolism (lactate and creatine kinase), and the thirst and hunger status of the animal (glucose and albumin).

Skin damage

Skin damage was assessed after slaughter and it is not known if the damage reflects handling at the slaughterhouse or if it was already present at arrival perhaps because the pigs have been mixed before loading onto the truck. However, skin damage is still interesting to evaluate as it represents reduced animal welfare no matter when it was inflicted. Table 3 shows the frequency of skin damage in the two experiments.

Table 3. Frequency of skin damage. Grade 1 corresponds to no damage and grade 4 corresponds to major damage

		Frequency (%)			
		1	2	3	4
Fore-end					
	Exp. 1	32	53	13	2
	Exp. 2	6	59	31	4
Middle					
	Exp. 1	62	35	3	0
	Exp. 2	43	49	8	
Ham					
	Exp. 1	78	18	3	1
	Exp. 2	80	16	4	

Only a few pigs had the highest score in skin damage, especially at the fore-end, which is the most exposed part during fighting. The frequency of grade 3 was quite high. Skin damage in the middle part of the carcass is often related to injuries due to equipment in the stable, the truck, from fighting or hoof marks. The frequencies of this damage were rather low, especially in experiment 1. Also the frequency on the ham is rather low. As skin damage reflects an incidence of low animal welfare (pain), a high frequency must represent bad animal welfare even though it cannot be said to be directly correlated to the day of slaughter.

To investigate the structures in the dataset, a PLSR analysis was performed (Figure 1 and 2).

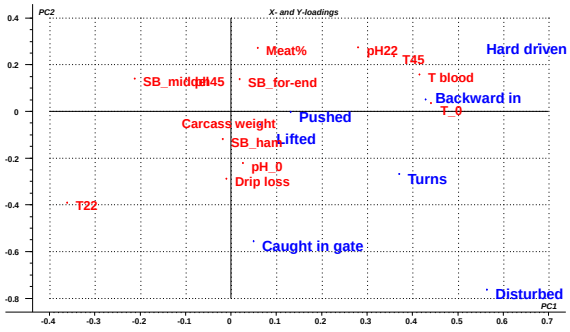

Figure 1. PLSR loading plot from experiment 1 of measures post mortem (X-axis) and behaviour pre mortem (Y-axis)

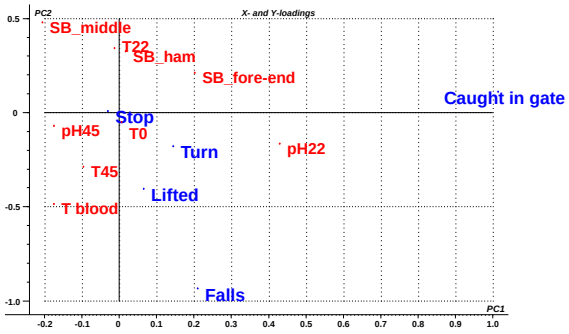

Figure 2. PLSR loading plot from experiment 2 of measures post mortem (X-axis) and behaviour and handling pre mortem (Y-axis)

In both experiments, the animal behaviour is situated in the same half of the plot, indicating that the negative behaviour patterns are more or less correlated. The behaviour is correlated with the early post mortem temperatures (Tblood, T0 and T45) and pH22 in both experiments, indicating that a high score on the behavioural patterns, indicating a negative animal welfare just before stunning, results in a high temperature early post mortem and a high ultimate pH.

Indicators of animal welfare on the day of slaughter

To investigate the correlation between animal behaviour and handling before slaughter and the physiological response and skin damage, a stress index was calculated combining the stressful incidents and subtracting the positive incidence (time to all pigs were lying down during lairage). An analysis of variance was performed to investigate which of the measured response variables that had a significant regression on the stress index.

In experiment 1, a significant effect of the stress index was seen on temperature immediately after sticking in the LD (P=0.007) and a tendency in the blood (P=0.010) and also of pH_{45} (P=0.08).

In experiment 2, a tendency was seen between the behaviour during lairage and T_{45} (P=0.06), but no regressions were seen between the behaviour just before the stunner and the measured physiological responses. This might be caused by the low incidence of negative behaviour, other than being caught by the gate to the stunner. However, there was an effect of behaviour close to the stunner on the concentration of glucose (P=0.02) and a tendency to an effect on the concentration of lactate of both behaviour close to the stunner (P= 0.10) and during lairage (P=0.08). Furthermore, a statistical effect of behaviour during loading at the farm was seen in the concentration of albumin (P=0.02).

IV. CONCLUSION

The two experiments have indicated that temperature immediately after sticking and the concentration of lactate, glucose and albumin in the blood combined with skin damage might be relevant parameters for documenting animal welfare on the day of slaughtering. This has to be further investigated in future studies.

ACKNOWLEDGEMENTS

Maiken Baltzer, Peter Vorup and Helle D. Larsen are thanked for technical assistance during the studies. The Pig Levy fund and the Danish Agency for Science, Technology and Innovation are thanked for financial support.

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