71st ICoMST
GIRONA - CATALONIA - SPAIN
3rd-8th August - 2025

LAIRAGE ACTIVITY LEVEL DOES NOT INFLUENCE LATENCY TO LOSS OF POSTURE DURING STUNNING IN A MINIMAL-HANDLING HIGH-CONCENTRATION CO_2 STUNNER

Robert J. E. Hewitt[1*], Kate J. Plush[1], Alan J. Tilbrook[2], Darryl N. D'Souza[1]

[1] SunPork Group, Eagle Farm, Australia.

[2] The School of Veterinary Science, The University of Queensland, Gatton, Australia

*Corresponding author email: robert.hewitt@sunporkfarms.com.au

I. INTRODUCTION

There is much focus on current stunning practices of pigs and their impact on animal welfare. Pigs are aversive to carbon dioxide (CO_2) and exposure does not result in instantaneous insensibility therefore the potential for pain and distress occurs whilst consciousness remains [1,2]. The actual stunning event is part of a larger stunning process, with variation in response to stunning and meat quality relating to handling, inherent animal factors, lairage conditions, facility design and management [1,3]. Inherent animal factors, such as activity level and aggression, are outside the control of abattoirs, but must be managed to reduce their impact on ultimate meat quality. Minimal-handling lairage and stunning systems have been developed that reduce human-animal interactions and work with the natural social behaviour of pigs to maintain stunning effectiveness and meat quality. The objective of this work was to determine if a minimal-handling high CO_2 concentration stunning system would reduce the variation in response to stunning of pigs with different activity within the lairage. We hypothesized that the latency to loss of posture in a minimal-handling high concentration CO_2 stunner would not be influenced by lairage activity level.

II. MATERIALS AND METHODS

This research was undertaken in a commercial pig abattoir, utilizing a manual lairage operation, a raceway equipped with automatic gates, and a seven gondola backloader CO_2 stunner (Frontmatec ML7, Frontmatec Group, Kolding, Denmark) processing approximately 700 pigs per hour.

Sixty-seven lairage pens were recruited to the study, with recruitment reflective of pigs being presented to slaughter whilst allowing researchers suitable time to track pigs through the raceway, stunning and slaughter process. Activity levels of pigs within pens was assessed using a 3-point scale during a one-minute observation period, 1.5 to 2 hours prior to stunning: 1 - > 50% of pigs lying or inactive, 2 - > 50% of pigs active, 3 – > 50% of pigs active with aggression or mounting observed [1]. Data from the PigPass national vendor declaration was used to determine time of delivery to the abattoir and transport duration (https://pigpass.australianpork.com.au/FAQ). Five focal pigs per lairage pen were randomly selected, identified with marking spray and the timing of their movement from lairage pen to the stunner and the stun cycle duration (entry to exit) were recorded.

Response of pigs within the CO_2 stunner was recorded using a single fixed camera focused on the first-stop position, offering a view of the entire width of the gondola. During the gondola's descent pigs entered the field of view prior to them detecting CO_2 and allowed viewing for six seconds after descent from the first-stop before the next gondola obscured more than 50% of the prior gondola. The following measures were recorded from video footage: latency from gondola movement to CO_2 exposure (detection of CO_2 was determined from behaviour change; pigs sniffing, opening their mouths, increased movement), latency to loss of posture, latency to the cessation of convulsions.

Duplicate blood samples were collected at exsanguination from each focal pig immediately post-sticking, centrifuged and the serum fraction analysed for cortisol (commercial radioimmunoassay kit), haptoglobin (pig haptoglobin ELISA kit) and L-lactate (enzymatic assay kit). Statistical analysis was conducted with pen as the replicate, average of the five focal pigs, with $P < 0.05$ deemed significant and $P < 0.10$ a tendency. Comparisons between activity scores were analysed using ANOVA (Minitab® Statistical Software, Minitab, LLC, State College, PA, USA), and due to uneven sample sizes (activity score 1, n=51; 2, n=13; 3, n=3) were checked with the Kruskal-Wallis H test.

III. RESULTS AND DISCUSSION

Higher activity levels, with active bouts of aggression or mounting, were associated with transport durations of less than two hours ($P < 0.05$, Table 1), in line with previous findings that longer transport duration may reduce subsequent fighting as pigs become familiar with one another under conditions that do not allow fighting to occur [4]. When more than half the pigs in a lairage pen were active the time taken to move the pigs from their lairage pens to the stunner was also extended compared to pens where the majority of pigs were lying or inactive ($P < 0.05$). The stunning cycle

duration, which reflects the time it takes to load each gondola, also tended to be longer in pens with more activity ($P < 0.10$). Activity level of pigs within the lairage did not influence the response of pigs to CO_2 exposure, with no statistical difference observed in the latency to loss of posture (LOP), the duration between exposure to CO_2 and LOP, or the latency to when convulsions ceased. Jongman et al. [1] had previously shown that gasping behaviour was greater in moderately active (score 2) pigs, however, gasping is associated with a shorter duration to LOP [5] which was not observed in this study. Faster and deeper respiration patterns were observed when pigs were exposed to high CO_2 concentrations, reducing the induction period and time to loss of consciousness [2]. Modern CO_2 paternoster stunners expose pigs to high-concentrations rapidly, reducing variation in their response to CO_2 exposure, including blood biomarkers of stress (Cortisol, L-lactate, Haptoglobin) where no significant differences were observed between pigs with different lairage activity levels.

Table 1. Duration of transport, time in lairage, movement of pigs through a minimal-handling high-concentration CO_2 stunning system and blood biomarkers of stress of pigs from lairage pens identified with different activity scores.

	Activity Score†					
Traits	1	2	3	SED	*p* value	Kruskal-Wallis H test
Transport duration, s	14,539[a]	12,576[ab]	6,800[b]	1,665	0.016	$\chi^2(2) = 8.30$, $p = 0.014$
Lairage duration, s	23,605	27,780	26,540	18,876	0.96	$\chi^2(2) = 0.08$, $p = 0.96$
Lairage to stunner duration, s	359[a]	566[b]	525[ab]	58.8	0.046	$\chi^2(2) = 6.14$, $p = 0.046$
Stunner cycle duration, s	251	320	232	35.6	0.056	$\chi^2(2) = 5.76$, $p = 0.056$
Latency to first CO_2 exposure, s	11.8	11.3	11.7	0.41	0.30	$\chi^2(2) = 2.44$, $p = 0.30$
Latency to loss of posture (LOP), s	19.8	19.7	19.4	2.53	0.86	$\chi^2(2) = 0.31$, $p = 0.86$
Duration CO_2 exposure to LOP, s	7.99	8.43	7.66	0.70	0.35	$\chi^2(2) = 2.10$, $p = 0.35$
Latency to convulsions cease, s	39.6	37.3	39.0	0.94	0.18	$\chi^2(2) = 3.41$, $p = 0.18$
Haptoglobin, µg/ml	849	952	864	65.2	0.25	$\chi^2(2) = 2.80$, $p = 0.25$
Cortisol, ng/ml	56.9	49.3	48.0	5.58	0.22	$\chi^2(2) = 3.07$, $p = 0.22$
L-lactate, mmol/l	1.79	1.71	0.91	0.52	0.061	$\chi^2(2) = 5.59$, $p = 0.061$

[a,b]Means in a row with different superscripts differ significantly ($p < 0.05$). †Activity score, level of activity in lairage pen: 1, > 50% lying/inactive; 2, > 50% active; 3, > 50% active and aggression, mounting observed. SED, standard error difference of the means.

IV. CONCLUSION

Lairage activity level lairage did not affect response to exposure to CO_2, with all pigs losing posture within 20 seconds of their descent, approximately 8 seconds after first exposure to detectable concentrations of CO_2. When the majority of pigs within a pen were active, animal behaviour was influenced with it taking longer to move pigs out from their lairage pen to the stunner, however, the design and operation of the CO_2 stunner eliminated any behavioural differences during stunning, supporting our hypothesis. Minimal-handling high CO_2 concentration stunning systems reduce variation in the reaction of pigs to CO_2 stunning.

ACKNOWLEDGEMENTS

The study was approved by the CHM Alliance Pty Ltd Animal Ethics Committee (CHM PP167/23) and conducted in accordance with local legislation and institutional requirements. Financial support was received from the Woolworths Animal Welfare Horizon Fund and Australian Pork Limited (APL 2023/0025). Neither funder had a role in study design, data collection, analysis or interpretation, or the preparation of this short paper.

REFERENCES

1. Jongman, E.C.; Woodhouse, R.; Rice, M.; Rault, J.-L. (2021) Pre-slaughter factors linked to variation in responses to carbon dioxide gas stunning in pig abattoirs. Animal 15: 100134
2. Verhoeven, M.; Gerritzen, M.; Velarde, A.; Hellebrekers, L.; Kemp, B. (2016) Time to loss of consciousness and its relation to behavior in slaughter pigs during stunning with 80 or 95% carbon dioxide. Frontiers in Veterinary Science 3: 38
3. Terlouw, E.M.C.; Arnould, C.; Auperin, B.; Berri, C.; Le Bihan-Duval, E.; Deiss, V.; Lefèvre, F.; Lensink, B.J.; Mounier, L. (2008) Pre-slaughter conditions, animal stress and welfare: current status and possible future research. Animal 2: 1501-1517
4. Warriss, P.D. (1998) The welfare of slaughter pigs during transport. Animal Welfare 7: 365-381
5. Dalmau, A.; Rodriguez, P.; Llonch, P.; Velarde, A. (2010) Stunning pigs with different gas mixtures: aversion in pigs. Animal Welfare 19: 325-333