



Stunning of Pigs with Carbon Dioxide

SUBMISSION TO THE OIE BY THE INTERNATIONAL COALITION FOR ANIMAL WELFARE

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ICFAW welcomes the recognition in the OIE *Terrestrial Animal Health Code* (Article 7.5.7.4) that “Inhalation of high concentration of carbon dioxide is aversive and can be distressing to animals. Therefore, the use of non-aversive gas mixtures is being developed.” We also note that the section on gas stunning is stated to be “under study”. We believe that this is an appropriate time for the OIE to review the use of different gas mixtures in the stunning of pigs.

ICFAW members are deeply concerned about the welfare of pigs at slaughter when high concentrations of CO₂ are used to induce unconsciousness. The welfare disadvantages of the use of CO₂ for stunning pigs are widely acknowledged.^{1,2,3,4} Pigs are not rendered unconscious immediately following exposure to CO₂.⁵ When they are lowered into a well containing 80-90% CO₂, as occurs commercially, it may take 30-60 seconds after the start of inhalation for them to lose consciousness.⁶

CO₂ is known to be highly aversive to pigs.^{7,8,9,10} Inhalation of CO₂ causes acute respiratory distress through irritation of the mucus membranes.^{11,12} Respiratory distress causes hyperventilation, a sense of breathlessness, gasping,¹³ and suffocation.¹⁴ Pigs also display muscular excitation and vocalization when exposed to CO₂, and all of this occurs prior to the loss of consciousness.^{15,16} Collaborating researchers in Denmark and Spain concluded that “[t]he fact that these behaviours occur when the animal is conscious is evidence that induction to CO₂ anaesthesia is not immediate and pigs suffer from fear, pain and/or stress during immersion into gas.”¹⁷

Behavioural studies have shown that the majority of pigs avoid or quickly withdraw from high atmospheric concentrations of CO₂¹⁸ and that almost 90% of pigs preferred to go without water for 72 hours rather than experience exposure to CO₂.¹⁹ Further, a German study found that a concentration of 80% CO₂ over 70 seconds is not sufficient to stun pigs properly.²⁰

Genetic variation appears to have an effect on how pigs react to CO₂. Pigs possessing the ‘halothane’ gene can have stronger reactions to CO₂²¹ and may therefore be even more sensitive to changes in CO₂ concentration.²² If CO₂ mixtures are used, the potential to use selective breeding to eliminate the halothane gene should be investigated. Regardless of the presence of the halothane gene, there can be variation in responses between pigs to stunning with CO₂,²³ which presents a further issue regarding consistency in the procedure. Variation in loss of consciousness during stunning can have major animal welfare implications.²⁴

A European Food Safety Authority (EFSA) report (2004)²⁵ explained that stunning is intended to induce insensibility and unconsciousness in animals so that slaughter may occur without avoidable fear, anxiety, pain, suffering, and distress. Gas stunning has a high potential to be more humane, but

only if non-aversive gases are used.²⁶ However, there is overwhelming scientific evidence demonstrating that CO₂ stunning does not guarantee an absence of avoidable pain, suffering, and distress in pigs.^{27,28} EFSA has concluded that at concentrations above 30%, CO₂ “is known to be aversive and cause[s] hyperventilation and irritation of the mucous membranes that can be painful, and elicits hyperventilation and gasping before loss of consciousness”. EFSA recommended that “the gas used to induce unconsciousness should be non-aversive” and stressed that the development of alternative humane gas mixtures was a high research priority.²⁹ The UK Farm Animal Welfare Council (2003)³⁰ concluded that the use of high concentrations of CO₂ to stun pigs is not acceptable, and should be phased out.

Evidence suggests that anoxia induced with inert gas mixtures of argon and nitrogen may offer a higher welfare option for stunning pigs.³¹ Behavioural evidence suggests that pigs do not find argon aversive, even at a concentration of 90%,³² and physiological evidence indicates that exposure to 90% argon results in minimal respiratory distress.³³ Inert gases are used commercially in poultry abattoirs in the United Kingdom, and it has been estimated that more than 75% of turkeys and 25% of broiler chickens slaughtered for human consumption are killed using inert mixtures.³⁴ Studies have examined the commercial feasibility of using inert gas mixtures to stun pigs. Dalmau et al. (2010) found that gas uniformity was higher in 90% argon, argon and CO₂ mixtures, and nitrogen and CO₂ mixtures than in 90% CO₂. This finding suggests that these mixtures may have a higher stability and uniformity than CO₂.³⁵ The AVMA (2013) approves the use of argon and nitrogen gases, and states that the advantages of these gases include being non-aversive, nonflammable, nonexplosive, readily available as compressed gases, that hazards to personnel are minimal when used with appropriate equipment, and that they are heavier than air and can be contained within equipment in which animals can be lowered.³⁶

While nitrogen, argon, or mixtures of the two, have welfare advantages over the use of CO₂,^{37,38,39,40} the stun-to-stick interval needs to be carefully monitored following the use of these hypoxic gas mixtures. Combinations of argon with CO₂ have been proposed, with the various concentrations and exposure times requiring different stun-to-stick intervals.^{41,42} Important considerations when using hypoxic gas mixtures include not only the short stun-to-stick interval, but also longer exposure times to cause death. Research has examined the possibility of using a combination of hypoxic gas mixtures to induce unconsciousness in a humane manner, followed by electrical cardiac fibrillation.⁴³ Another potential method to improve welfare involves a two-step procedure, by which pigs are initially anaesthetised using an anoxic gas mixture such as nitrous oxide, followed by death from immersion in CO₂.⁴⁴

Mixtures of low concentrations of CO₂ with argon or nitrogen (e.g. 30 and 60% CO₂ and argon, respectively) have been suggested.⁴⁵ However, this is very much the least preferred option compared to using inert gases alone. EFSA opinion has stated that “Hypoxic stunning induced with 90% argon in air is less aversive than hypercapnic hypoxia induced with 30% CO₂ in argon or nitrogen or stunning with 80-90% CO₂ in air.”⁴⁶

The science is very clear that CO₂ gassing does not meet an acceptable standard of animal welfare. ICAEW recommends that stunning/killing pigs with high concentrations of CO₂ should be phased out, quickly. The development of more humane gas mixtures and suitable equipment should be urgently prioritized, and this can be facilitated by a strongly worded recommendation in the *Terrestrial Animal Health Code*, chapter 7.5 on slaughter of animals.

ICFAW Members:

Animal Welfare Institute
Compassion in World Farming
Eurogroup for Animals
Humane Society International
International Fund for Animal Welfare
National Council of SPCAs
Japanese Farm Animal Welfare Initiative
Pan African Animal Welfare Alliance
Royal Society for the Prevention of Cruelty to Animals
RSPCA Australia
World Animal Net
World Animal Protection
World Horse Welfare

¹ Raj ABM and Gregory NG. 1995. Welfare implications of the gas stunning of pigs 1. Determination of aversion to the initial inhalation of carbon dioxide or argon. *Animal Welfare* 44:273-280.

² Opinion of the Scientific Panel on Animal Health and Welfare on a request from the Commission related to welfare aspects of the main systems of stunning and killing the main commercial species of animals. 2004. *The EFSA Journal* 45:1-29

³ Scientific Report of the Scientific Panel for Animal Health and Welfare on a request from the Commission related to welfare aspects of animal stunning and killing methods. 2004. Welfare aspects of animal stunning and killing methods. *The EFSA Journal* 1-241.

⁴ Velarde A, Cruz J, Gispert M, Carrión D, Torre RJ, Diestre A, and Manteca X. 2007. Aversion to carbon dioxide stunning in pigs: effect of carbon dioxide concentration and halothane genotype, *Animal Welfare* 164:513–522.

⁵ Llonch P, Dalmau A, Rodríguez P, Manteca X, and Velarde A. 2012. Aversion to nitrogen and carbon dioxide mixtures for stunning pigs, *Animal welfare*. 21:33-39.

⁶ Rodríguez P, Dalmau A, Ruiz-de-la-Torre JL, Manteca X, Jensen EW, Rodríguez B, Litvan H, and Velarde A. 2008. Assessment of unconsciousness during carbon dioxide stunning in pigs. *Animal Welfare* 17:341-349.

⁷ Raj ABM and Gregory NG. 1995. Welfare implications of the gas stunning of pigs 1. Determination of aversion to the initial inhalation of carbon dioxide or argon. *Animal Welfare* 44:273-280.

⁸ Opinion of the Scientific Panel on Animal Health and Welfare on a request from the Commission related to welfare aspects of the main systems of stunning and killing the main commercial species of animals. 2004. *The EFSA Journal* 45:1-29

⁹ Scientific Report of the Scientific Panel for Animal Health and Welfare on a request from the Commission related to welfare aspects of animal stunning and killing methods. 2004. Welfare aspects of animal stunning and killing methods. *The EFSA Journal* 1-241.

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¹¹ Raj ABM and Gregory NG. 1996. Welfare implications of the gas stunning of pigs 2. Stress of induction of anaesthesia. *Animal Welfare* 5:71-78.

¹² Peppel P and Anton F. 1993. Responses of rat medullary dorsal horn neurons following intranasal noxious chemical stimulation: effects of stimulus, intensity, duration, and interstimulus interval. *Journal of neurophysiology* 70:2260-2274.

¹³ Opinion of the Scientific Panel on Animal Health and Welfare on a request from the Commission related to welfare aspects of the main systems of stunning and killing the main commercial species of animals. 2004. *The EFSA Journal* 45:1-29.

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¹⁵ Opinion of the Scientific Panel on Animal Health and Welfare on a request from the Commission related to welfare aspects of the main systems of stunning and killing the main commercial species of animals. 2004. *The EFSA Journal* 45:1-29

¹⁶ Rodríguez P, Dalmau A, Ruiz-de-la-Torre JL, et al. 2008. Assessment of unconsciousness during carbon dioxide stunning in pigs. *Animal Welfare* 17:341-9.

¹⁷ Rodríguez P, Dalmau A, Ruiz-de-la-Torre JL, et al. 2008. Assessment of unconsciousness during carbon dioxide stunning in pigs. *Animal Welfare* 17:341-9.

¹⁸ Raj ABM and Gregory NG. 1995. Welfare implications of the gas stunning of pigs 1. Determination of aversion to the initial inhalation of carbon dioxide or argon. *Animal Welfare* 44:273-280.

¹⁹ Scientific Report of the Scientific Panel for Animal Health and Welfare on a request from the Commission related to welfare aspects of animal stunning and killing methods. 2004. Welfare aspects of animal stunning and killing methods. *The EFSA Journal* 1-241.

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²¹ Troeger K and Woltersdorf W. 1991. Gas anesthesia of slaughter pigs .1. Stunning experiments under laboratory conditions with fat pigs of known halothane reaction type: meat quality, animal protection. *Fleischwirtschaft* 71:1063-1068.

²² Velarde A, Cruz J, Gispert M, Carrión D, Torre RJ, Diestre A, Manteca X. 2007. Aversion to carbon dioxide stunning in pigs: effect of carbon dioxide concentration and halothane genotype, *Animal Welfare*. 164:513–522.

²³ Atkinson S, Velarde A, Llonch P, Algers B. 2012. Assessing pig welfare at stunning in Swedish commercial abattoirs using CO₂ group-stun methods. *Animal Welfare* 21:487-495.

²⁴ Fiedler KJ, Parsons RL, Sadler LJ and Millman ST. 2016. Effects of stocking rate on measures of efficacy and welfare during argon gas euthanasia of weaned pigs. *Animal Welfare* 25: 83-89.

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