

Which Alternative to Electrical Stunning Provides the Most Humane Stun for Poultry at Slaughter?

In the majority of poultry slaughter houses in the United States, birds are hung on shackles and then not touched by human hands until the carcass is processed and packaged. As a result, a reliable method of slaughter that can be automated must be available. Stunning addresses the welfare needs of the bird by providing a humane death. In addition, it helps ensure that the birds will be killed properly in order to prevent live birds from entering the scald tank which would result in a breach of animal welfare and condemned carcasses. This paper will examine electrical stunning as well as current alternative poultry stunning methods and determine which method is the most humane in a commercial setting.

Death by exsanguination or “bleeding out” is the standard method used for poultry slaughter in the U.S. (NACMPI, 2008). The American Veterinary Medical Association (AVMA) considers exsanguination to be a humane form of euthanasia only when the bird is stunned before bleed out begins (AVMA, 2007). It can take up to one minute for a bird to completely bleed out and die so it is important that the bird be unconscious for the whole time period (Hindle, 2010). Slaughterhouses in the United States have never been required by law to stun poultry before slaughter (Thaler, 1999). The Humane Slaughter Act passed in 1958, ensured that livestock would be stunned before slaughter. However, poultry were not covered in the legislation because poultry slaughterhouses had been stunning birds prior to slaughter before the legislation was introduced (Thaler, 1999).

Stunning and slaughter are very closely linked as stunning exists to ensure that the birds are killed in a manner that guarantees they experience the least amount of distress and pain possible according to the AVMA definition of euthanasia (AVMA, 2007). A successful stun is

essentially measured by brain death (Erasmus, et al., 2010) where the cortex of the brain (the portion that controls consciousness) is not able to receive or interpret any signals. If, in theory, the last thing the bird will feel or experience is the stunning, the ideal method of stunning must also be pain free and cause as little distress to the bird as possible. In addition, the bird must not be able to recover from the stun and regain consciousness at any point during slaughter. This means that the stun must either last long enough for exsanguination to occur after cutting of the blood vessels, or the stun must be irreversible because it results in brain death. However, finding a method of stunning birds that provides the least possible discomfort while still being consistent enough to produce uniform, complete stunning of all birds on the line is not as easy as it would first appear.

The most reliable outward sign that a bird has been properly stunned is the absence of the corneal reflex (blinking). In birds that have their eyes closed, the absence of movement of the nictitating membrane can be used instead (Raj, 1998). The best measure of unconsciousness in research is an electroencephalogram (EEG) that has no activity because it indicates brain death (Erasmus, et al., 2010). EEG readouts have been used to understand at what point (either by time or by outward physiological signs) the bird is unconscious. They have also been used to determine if certain bird behaviors and physiological responses are occurring while the bird is conscious in order to judge the humaneness of certain stunning methods.

Currently, the major form of stunning performed in poultry slaughterhouses in the United States is low voltage electrical water bath stunning (Raj, 2010; Heath et al., 1994). Stunning is achieved by a water bath stunner (Raj, 1998) where birds are hung on shackles and their heads are passed through an electrically charged water bath. The shackles are charged at the point in

the line where the bird's head enters the water. The bird works as a bridge to complete the circuit between the charged water bath and the charged shackles resulting in electric current passing through the bird from head to foot (Sheilds and Raj, 2010). The intended result is that the bird is stunned and no longer able to sense pain.

Electric water bath stunning operates on the principle of stunning to induce an epileptic state equal to a grand mal seizure (Raj, 1998). A grand mal epileptic seizure in humans is considered a state of complete unconsciousness (Raj, 1998). However, a grand mal epileptic state is rarely achieved when using water bath stunners (Raj, 2010). Most birds that are considered properly stunned enter a state where their EEG is acutely suppressed which has been interpreted as representing unconsciousness in poultry by researchers (Raj, 2010). As a result, birds who are properly stunned using an electric water bath stunning system should be completely insensible to pain.

Water bath electrical stunning has been used in commercial poultry slaughterhouses since the 1950's (Fletcher, 1999). Though it produces excellent stun uniformity in the laboratory, its ability to properly and uniformly stun birds in commercial slaughterhouses has been questioned. It has been shown that up to one third of the birds slaughtered in North America may not be completely stunned by the system (Raj, 2010; Boyd, 1994; Griffiths and Purcell, 1984; Heath et al., 1981). This can result in birds not being properly cut by the automated knife system, or not being cut at all. If this happens, the birds may not bleed out correctly, or at all, and have the potential to enter the scald tank while still alive. This presents an animal welfare issue because there is the possibility that the birds are experiencing undue distress during bleeding out because they were improperly stunned or through entering the scald tank alive. The problem of under-

stunning when using electric water bath stunners is caused by many factors according to Boyd (1994). Variations in the birds' body weights will change the amount of electricity needed to properly stun them (Boyd, 1994). This leaves birds that are heavier than average open to the possibility of under-stunning. Though this is not as much of a problem with commercial broiler flocks that have birds of uniform size, it can be a problem for slaughterhouses that process smaller, less uniform flocks. How much condition (fat) a bird is carrying also affects the ability of the system to effectively stun because fat works as an insulator (Boyd, 1994). In a commercial slaughterhouse, one large concern is how dirty the water bath becomes as it will affect the conductivity of the system and as a result, the quality of the stun (Boyd, 1994).

It can be concluded that, though electrical water bath stunning is the most widely used method of stunning, it may not be the most effective at providing for the welfare of the bird. When used in the commercial environment this technique does not produce a uniform, proper stun to all of the birds going through the slaughterhouse. If this technique were capable of supplying the results in a commercial setting that it produces in a controlled environment, then it might still be considered the method of choice. However, since the poultry industry values providing a way to stun birds in order to prevent unnecessary distress at slaughter (NCC, 2010), the system it chooses to use should be capable of accomplishing the expected results.

Alternative Stunning Methods:

The next portion of this paper will describe and compare other methods of humane stunning that are being researched and implemented as alternatives to electrical stunning in commercial slaughter houses. There are three main categories of alternative stunning methods that have been researched and show promise for use in a commercial setting: controlled

atmosphere stunning (CAS), controlled atmosphere killing (CAK), and low atmospheric pressure stunning (LAPS). Of these, CAS and CAK systems have been implemented in slaughterhouses in the United States and abroad (Raj, 2010). LAPS stunning for use in poultry slaughter is new technology that is currently only being used by one plant in the United States (Feedstuffs FoodLink, 2011).

CAS stunning involves use of inert gasses such as carbon dioxide, argon, nitrogen, or a mixture to stun birds (Raj, 2010). Birds can either be stunned by anoxic gas mixtures or with some oxygen added to the mixture. One of the main welfare advantages of this system is that birds do not have to be shackled prior to stunning (Raj, 2010). Crates of birds that come from the battery can be put directly into the CAS system to be stunned. This minimizes the stress of being handled and the pain associated with the shackles (Raj, 2010). In addition, stunning is uniform and none of the birds that are put into the stun box are 'missed' (Sheilds and Raj, 2010). Once the birds are stunned, they are then shackled and killed by exsanguination. In a commercial CAS system, the crate is passed into the system and then lowered into a well where the gas is concentrated. This makes the transition from the atmosphere to the gas more rapid so that the birds have less time to react to the gas before the stun takes effect (Eisele, 2012). Once the birds are in the chamber, it takes about 90 seconds for the birds to be stunned (Buhr, 2009). The reaction the birds have to the gas and the time it takes to stun them varies depending on the gas (Buhr, 2009).

Systems in which oxygen is present at higher than two percent of the gas mixture have been studied in the hope that they would allow for a more gradual transition into the stun and reduce bird distress. However, it has been found that birds exhibit a more adverse reaction to the

gas mixture when it is slowly introduced into a stun box filled with atmospheric air or when the gas mixture contains a large percentage of oxygen (Coenen et al., 2009; Eisele, 2012; McKeegan et al., 2007). This reaction may arise because the oxygen present in the mixture allows the birds to be sensible longer to the physiologic responses that the body is mounting in response to the gas mixture (Eisele, 2012). If they are sensible longer, then they have the chance to react more violently while still conscious which compromises bird welfare.

Carbon dioxide is one of the common gasses used in anoxic stunning. Birds show signs of discomfort when forced to breath it (Raj, 2010), but when inhaled it stimulates deeper and faster breathing. As a result, birds stunned with carbon dioxide often show behaviors that are consistent with respiratory distress such as gasping, head shaking, sneezing, and vocalizations (Raj, 2010; Gregory et al., 1990). The fact that birds show signs of distress before the stunning has taken effect can be considered a drawback to CAS stunning with carbon dioxide as the ultimate goal would be to develop a stunning method that is pain free.

Argon or nitrogen gas can be used instead of carbon dioxide as another means of anoxic stunning. Birds stunned with argon or nitrogen gas do not exhibit signs of respiratory distress or discomfort during the stunning process. However, they do exhibit convulsions and wing flapping. These convulsions are thought by researchers to signify loss of consciousness because the EEG at the time of onset of the convulsions shows significant depression that is consistent with, or very close to EEG's of birds that are known to be unconscious (Raj, 2010; Raj et al., 2008). Some researchers have questioned this theory because they believe that the EEG is not depressed enough to be completely certain that there is loss of consciousness (McKeegan et al., 2007). Stunning through this method has the potential to wear off quickly when the birds are

reintroduced to atmospheric conditions (Raj and Gregory, 1990). As a result, it is recommended that nitrogen and argon be used to kill the bird before the rest of processing occurs (Raj and Gregory, 1990; HMSO, 1995).

At this point that we can draw the distinction between CAS and CAK systems. CAS systems only stun birds so that they have no perception of pain and death is brought about by exsanguination. CAK systems expose birds to the gas for a longer period of time resulting in 'brain dead' birds because there is no way for them to regain consciousness. However, their heart may still be beating (Sheilds and Raj, 2010). Exsanguination will be responsible for stopping the heart and completing the process of death (Eisele, 2012).

LAPS stunning is a very new method of stunning that reduces the pressure inside the stun box, and in the process removes oxygen to produce a state of hypoxia which causes the bird to lose consciousness (Vizzier-Thaxton et al., 2010). The AVMA has objected to the use of decompression as a method of euthanasia in animals because conventional decompression chambers are often designed to proceed too quickly which can result in pain from gasses expanding that are trapped inside the animal's abdomen. Other objections from the AVMA include concerns about the animal's physiological responses to decompression such as vomiting, defecation, convulsions, and bleeding; accidental re-compression which would result in regaining of consciousness, and the high tolerance that immature animals have to hypoxic conditions (AVMA, 2007). Since chickens have lungs that do not expand during respiration, and air is moved in and out at the same time through a complex of air sacs it is unlikely that gasses would be trapped inside the abdomen of the bird unless the trachea was blocked (Vizzier-Thaxton et al., 2010).

A LAPS system has been developed by collaboration between Dr. Yvonne Vizzier-Thaxton at Mississippi State University and TechnoCatch LLC. This system reduces the atmospheric pressure from 14.7psi (pounds per square inch) to 5psi in four minutes and 40 seconds which produces an irreversible stun (Higgins, 2011). McKeegan and Gerritzen tested bird responses and the welfare of birds stunned by the system using EEG and electrocardiogram (ECG) (Feedstuffs FoodLink, 2011). Though wing flapping occurs during the process of decompression, researchers concluded that it happens after consciousness is lost. They also concluded that this system does not cause distress to the birds because the birds did not exhibit elevated heart rates or behavior showing avoidance or attempts at escape (Feedstuffs FoodLink, 2011).

The three methods of stunning discussed in this section provide significant improvements over electrical water bath stunning simply by increasing the accuracy in the number of birds successfully stunned. In addition, they allow shackling to occur after consciousness is lost which can greatly decrease pain especially in broilers who are prone to painful, arthritic hock joints (Eisele, 2012). The CAK and LAPS systems are the most accurate because they leave no room for recovery from the stun. Though there is debate about the point when unconsciousness is reached, the research seems to indicate that the convulsions observed in the CAS, CAK, and LAPS systems happen after loss of consciousness. As a result, the most humane method is the one that provides the least discomfort up until the point when unconsciousness is lost. Of the systems discussed, the anoxic CAK systems using nitrogen or argon and the LAPS system appear to produce the least distress in the birds prior to loss of consciousness. The LAPS system is still very new and has little peer reviewed research covering its affects on the birds when

compared with the CAK systems. However, it is possible that the LAPS technology will prove to be more economical in the long-run because it does not require the purchase of compressed gas (Higgins, 2011). As a result, it is recommended that anoxic nitrogen or argon CAK systems be adopted as the major poultry stunning method and that more research on the relatively new LAPS technology be conducted.

A stunning system for poultry at slaughter should be one that induces as little pain and distress on the bird as possible while achieving high stun accuracy and maintaining the efficiency needed in a commercial poultry slaughterhouse. Anoxic nitrogen or argon CAK systems provide increased stun accuracy while reducing the distress experience by birds during stunning when compared to the conventional electrical water bath stunner. In addition, they eliminate the pain experienced during shackling. At this time, anoxic nitrogen or argon CAK systems provide the best humane stun to birds before slaughter. However, through further research, the LAPS technology may prove to be more economical or perhaps even better for bird welfare and may be the preferred stunning system in the future over CAK systems.

Literature Cited

- AVMA. 2007. AVMA Guidelines on Euthanasia (Formerly Report of the AVMA Panel on Euthanasia). Accessed Jan. 22, 2012. http://www.avma.org/issues/animal_welfare/euthanasia.pdf
- Boyd, F. 1994. Humane Slaughter of Poultry: The Case Against the Use of Electrical Stunning Devices. *Journal of Agricultural and Environmental Ethics*. 7(2) 221-236. Accessed Jan. 21, 2012.
- Buhr., R.J. 2009. Why poultry should be stunned at slaughter and the welfare advantages and challenges of electrical and gas stunning. USDA. Accessed Jan. 21, 2012. http://www.ars.usda.gov/research/publications/publications.htm?seq_no_115=237782
- Coenen, A.M.L., J. Lankhaar, J.C. Lowe, and D.E.F. McKeegan. 2009. Remote monitoring of electroencephalogram, electrocardiogram, and behavior during controlled atmosphere stunning in broilers: Implications for welfare. *Poultry Science*. 88:10-19. Accessed Jan. 21, 2012.
- Eisele, M. 2012. Commercial CAS stunning of broilers at Dayton Natural Meats. Observation at Dayton Natural Meats. Dayton Natural Meats. Feb. 9, 2012.
- Erasmus, M.A., P.V. Turner, and T.M. Widowski. 2010. Measures of insensibility used to determine effective stunning and killing of poultry. *Journal of Applied Poultry Research*. 19:288–298. Accessed Jan. 21, 2012.
- Feedstuffs FoodLink. 2011. New research supports LAPS stunning method. Accessed Feb. 21, 2012. <http://www.feedstuffsfoodlink.com/ME2/dirmod.asp?sid=&nm=&type...5ABC72CB5F516B4C10&tier=3&nid=EEC61A7CE10449769F12210193764D0E>
- Fletcher, D.L. 1999. Slaughter Technology. *Poultry Science*. 78:277-281. Accessed Feb. 8, 2011.
- Gregory, N.G., A.B.M. Raj, A.R.S. Audsley, and C.C. Daly. 1990. Effects of carbon dioxide on man. In: *The Use of Carbon Dioxide for the Stunning of Slaughter Pigs*. Report of a meeting of experts held in Heeze, The Netherlands, 26-27th January 1990. *Flieschwirtschaft*, 70: 1173-1174.
- Griffiths, G.L. and D.A. Purcell. 1984. A survey of slaughter procedures used in chicken processing plants. *Australian Veterinary Journal*. 61:399-401. Accessed Feb. 8, 2011.
- Heath, G.B.S., D.J. Watt, P.R. Waite, and J.M. Ormand. 1981. Observation on poultry slaughter. *Veterinary Record*. 108: 97-99. Accessed Feb. 14, 2012.
- Heath, G.E., A.M. Thaler, and W.O. James. 1994. A Survey of Stunning Methods Currently Used During Slaughter of Poultry in Commercial Poultry Plants. *Journal of Applied Poultry Research*. 3:297-302. Accessed Jan. 21, 2012.
- Hindle, V.A., E. Lambooi, H. G. M. Reimert, L. D. Workel, and M. A. Gerritzen. 2010. Animal welfare concerns during the use of the water bath for stunning broilers, hens, and ducks. *Poultry Science*. 89:401–412. Accessed Jan. 21, 2012.
- Higgins, K.T. 2011. Engineering R and D: New solution for slaughter. *Food Engineering Magazine*. Accessed Feb. 22, 2012. <http://www.foodengineeringmag.com/articles/print/88503>

- HMSO. 1995. The Welfare of Animals (Slaughter or Killing) Regulations, 1995, No. 731. Her Majesty's Stationary Office, London, UK. Accessed Feb. 19, 2012. <http://www.legislation.gov.uk/ukxi/1995/731/part/IV/made>
- McKeegan, D.E.F., J.A. McIntyre, T.G.M. Demmers, J.C. Lowe, C.M. Wathes, P.L.C. van den Broek, A.M.L. Coenen, and M.J. Gentle. 2007. Physiological and behavioural responses of broilers to controlled atmosphere stunning: Implications for welfare. *Animal Welfare*. 16:409-426. Accessed Feb. 18, 2012.
- NACMPI. 2008. Improvements for Poultry Slaughter Inspection, Appendix C-Literature Review of the Poultry Slaughter Process. In: Poultry Slaughter Technical Report. Accessed March 1, 2012. http://www.fsis.usda.gov/OPPDE/NACMPI/Feb2008/Slaughter_Appendix_C.pdf
- NCC. 2010. National Chicken Council Animal Welfare Guidelines and Audit Checklist for Broilers. Accessed March 1, 2012. <http://www.nationalchickencouncil.org/wp-content/uploads/2012/01/NCC-Animal-Welfare-Guidelines-2010-Revision-BROILERS.pdf>
- Raj, A.B.M. 2010. Stunning and Slaughter. Page 259-277 in *The Welfare of Domestic Fowl and Other Captive Birds*. I.J.H. Duncan and P. Hawkins eds. Springer, New York, NY.
- Raj, A.B.M., M.C. O'Callaghan, K. Thompson, D. Becket, I. Morrish, A. Love, G. Hickman, and S. Howson. 2008. Large-scale killing of poultry species on farm during outbreaks of diseases: Evaluation and development of a humane containerised gas killing system. *World's Poultry Science Journal*. 64:227-243. Accessed Feb. 9, 2011.
- Raj, A.B.M. 1998. Welfare During Stunning and Slaughter of Poultry. *Poultry Science*. 77:1815-1819. Accessed Jan. 24, 2012.
- Raj, A.B.M., and N.G. Gregory. 1990. Investigation into the batch stunning/killing of chickens using carbon dioxide or argon-induced hypoxia. *Research in Veterinary Science*. 49:364-366. Accessed Feb. 19, 2010.
- Sheilds, S.J., A.B.M. Raj. 2010. A Critical Review of Electrical Water-Bath Stun Systems for Poultry Slaughter and Recent Developments in Alternative Technologies. *Journal of Applied animal Welfare Science*. 13:281-299. Accessed Jan. 21, 2012.
- Thaler, A.M. 1999. The United States Perspective Towards Poultry Slaughter. *Poultry Science*. 78:298-301. Accessed Jan. 24, 2012.
- Vizzier-Thaxton, Y., K.D. Christensen, M.W. Schilling, R.J. Buhr, and J.P. Thaxton. 2010. A new humane method of stunning broilers using low atmospheric pressure. *Journal of Applied Poultry Research*. 19:341-248. Accessed Jan. 21, 2012.