Institution: University of Bristol

Unit of Assessment: UoA6 – Agriculture, Veterinary and Food Science

Title of case study: Animal welfare policy and practice improved internationally as a result of research into poultry-stunning prior to slaughter

1. Summary of the impact (indicative maximum 100 words)

Defra-funded research at the University of Bristol showed that the water bath stunning protocols commonly used in commercial processing plants resulted in paralysis rather than unconsciousness in chickens during slaughter. This finding led directly to the modification of stunning protocols in a European Union Regulation (1099/2009). Their practical application within slaughter plants has been promoted to the poultry industry in Europe and worldwide via Animal Welfare Officer (AWO) training courses that were developed in Bristol. This has ensured that since 1st January 2013 billions of birds in Europe are now adequately stunned, and therefore unconscious, before they are slaughtered.

2. Underpinning research (indicative maximum 500 words)

Dr Mohan Raj (Bristol University Research Associate 1990 – Reader 2010) and colleagues, sought to determine the conditions necessary to effectively stun poultry using an electrical water bath [1,2,3]. They proposed that the electroencephalogram (EEG) should be recorded in birds before and after electrical water bath stunning to evaluate whether birds had been effectively stunned.

By identifying and objectively measuring the total power content of the pre-stun and post-polyspike EEG, they demonstrated that an effective stun occurs if the magnitude of post-polyspike is ≤10% of the pre-stun value. These criteria reliably indicate the induction of unconsciousness because when polyspike activity, which in birds is symptomatic of epileptiform activity, is followed by EEG suppression, the ability of the brain to function normally, and associated consciousness, is lost. These criteria developed by Raj and colleagues are also now used by other researchers to determine the effectiveness of stunning methods in poultry.

Using this approach, Raj et al. [2] demonstrated that the electrical stunning parameters used in the poultry industry (typically 600 Hz Pulsed DC current at 80mA rms per bird) did not necessarily result in immediate unconsciousness for all birds. Specifically, they showed that AC sinusoidal frequencies above 800 Hz (see Table 1) [1] and DC waveforms above 200 Hz [2] did not lead to an immediate state of unconsciousness, and that increasing the AC sinusoidal frequency progressively from 50 Hz to 800 Hz required increasing levels of applied current to produce an effective stun [1, 2, 3].

Table 1. Minimum current to achieve an effective stun (sinewave AC)

Frequency (Hz)	Recommended minimum current (mA per bird)
Up to 200	100
201 to 600	150
601 to 800	200
801 or more	Not recommended

In addition, the research did not support the use of the absence of eye and brain stem reflexes as criteria for determining effective water-bath stunning in a commercial processing plant because the absence of these reflexes, which are consistently used with mammals, were not indicative of loss of consciousness with birds. Raj and colleagues' approach therefore provided new and important knowledge concerning the detection of unconsciousness in bird species.

Raj published a review of these and other recent developments in stunning and slaughter of

poultry, detailing the efficacy of electrical variables used in the water baths and the relative merits of different gas mixtures used for stunning or killing broilers, concluding that the rationalisation of electrical variables was urgently needed [4].

3. References to the research (indicative maximum of six references)

[1] Raj, A.B.M., O'Callaghan, M. and Knowles, T.G. (2006a) The effects of amount and frequency of alternating current used in water bath stunning and of slaughter methods on electroencephalograms in broilers. Animal Welfare. 15: 7-18.
URL: http://www.ingentaconnect.com/content/ufaw/aw/2006/00000015/00000001/art00002
[2] Raj, A.B.M., O'Callaghan, M. and Hughes, S.I. (2006b) The effects of amount and frequency of pulsed direct current used in water bath stunning and of slaughter methods on electroencephalograms in broilers. Animal Welfare. 15: 19-24.
URL: http://www.ingentaconnect.com/content/ufaw/aw/2006/00000015/00000001/art00003
[3] Raj, A.B.M., O'Callaghan, M. and Hughes, S.I. (2006c) The effects of pulse width of a direct current used in water bath stunning and of slaughter methods on spontaneous electroencephalograms in broilers. Animal Welfare. 15: 25-30.
URL: http://www.ingentaconnect.com/content/ufaw/aw/2006/00000015/00000001/art00004
[4] Raj, A.B.M. (2006) Recent developments in stunning and slaughter of poultry. World Poultry Science Journal. 62: 467-484. DOI: 10.1079/WPS2005109

Grant : 2000-2004 DEFRA. £610,435. Raj, M. Evaluation of the neurophysiological basis for electrical stunning in broilers and the determination of the effective electrical stunning and slaughter parameters.

4. Details of the impact (indicative maximum 750 words)

In 2010, a Defra survey of approved processing plants in the UK showed that 78% of plants were using electrical water bath stunners insufficient to induce unconsciousness in chickens [a]. These stunning protocols were also widely used in commercial poultry plants in Europe. This was exposing millions of birds to a potentially painful death. Considering the very large number of animals (minimum 9,350,000 birds per week), this was a major animal welfare concern. However, since 1st January 2013, a new European regulation [b] requires that all abattoirs in Europe must now stun chickens using protocols shown to be effective by Bristol research. The new regulation ensures that billions of birds in Europe are adequately stunned prior to slaughter; a major positive impact on poultry welfare.

The Bristol research into the optimum use of water bath electrical stunner parameters has been widely disseminated to the industry by two main routes; i) **inclusion within European legislation** and, ii) **training Animal Welfare Officers** in abattoirs by University of Bristol staff.

i) Impact on Legislation: The Bristol findings on electric water bath stunning parameters were of sufficient welfare significance to be directly incorporated into **European legislation** [b]. Implementation of these findings into legislation was rapid. On 4th April 2007, The Humane Slaughter Association (HSA) held a workshop to discuss electrical water bath stunning parameters where the results from Raj and colleagues [1, 2, and 3] were presented. The workshop brought together representatives from the poultry industry, retailers and scientists from across Europe. The potential welfare significance of the findings were highlighted and a recommendation for the research work to be urgently corroborated was subsequently undertaken by Prinz et al in Germany [c, d and e].

In the light of the new Bristol research, the European Commission received information and requests from the UK authorities to amend the electrical requirements specified in the previous opinions [f]. The UK authority requested that the high-range frequency band should cover 600 to 800 Hz and that it should not extend to 1500 Hz, due to the concerns that frequencies above 800 Hz lead to electro-immobilisation and do not produce an effective stun. The new frequencies were incorporated into the EFSA Scientific Opinion on the electrical requirements for water-bath stunning equipment applicable to poultry [g]. EFSA stated that when insufficient current passes

through a bird only certain areas of the brain are affected. Consequently it is possible to induce partial epilepsy that leaves a bird conscious and sensible even though it shows seizures and convulsions that are indistinguishable from those shown after an effective stun [1]. Therefore, the occurrence of seizures and convulsions is not a reliable indicator of unconsciousness and insensibility. Fifteen out of 21 studies used to present data for the EFSA document [g] were conducted by members of the University of Bristol, and 14 out of 30 references that were used for the relevant report section had authors from the University. In 2009, the research findings were adopted in the new EC Council regulation No 1099/2009 of 24 September 2009 (1/1/2013) on the protection of animals at the time of killing.

ii) **Impact on training and function of industry personnel:** In recognition of the need for complex technical requirements such as stunning parameters to be well understood by those actually operating slaughter equipment, the European Commission has also enshrined the role of the **Animal Welfare Officer** (AWO) into the EC regulation. The crucial knowledge transfer role of the AWO has been described in the Council Regulation [b] as follows: *"The appointment of a specifically qualified person as an animal welfare officer to coordinate and follow up the implementation of animal welfare operating procedures in slaughterhouses has provided positive welfare benefits. This measure should therefore be applied throughout the Community. The animal welfare officer should have sufficient authority and technical competence (provided by the course) to provide relevant guidance to line personnel."* This technical competence includes a need to understand the welfare significance of the stunning protocols previously developed by the Bristol research team [1, 2, 3]. AWO training courses, initiated and run by the University of Bristol, are now available in Europe, and have ensured that these important research findings have been disseminated to those directly responsible for controlling stunning parameters. Bristol played a pivotal role in embedding this robust knowledge transfer mechanism within the poultry industry in Europe, thus providing a long-term sustainable route for translation of future welfare science into practice.

Direct involvement of Bristol in delivering impact

Active involvement of Bristol researchers in policy and dissemination activities has made an important contribution to the impact in this area. Bristol researchers gave evidence for and assistance with the Farm Animal Welfare Council (FAWC) report on welfare of farmed animals at killing [h]. Raj is a member of the working group that contributed to the scientific opinion on the electrical requirements for water bath stunning equipment applicable to poultry, and leads the Scientific and Technical Advisory Board of the farm assurance scheme "Animal Welfare Approved". In July 2012, members of the Bristol stunning and slaughter group (Knowles, Lines, O'Callaghan, Raj, Wilkins and Wotton) received an award from the Humane Slaughter Association for "Major contributions to the science underpinning humane livestock slaughter".

In particular, Bristol has actively promoted dissemination of science by developing the Animal Welfare Officer concept. This was acknowledged by FAWC when it commented that "The Animal Welfare Officer Course developed by the University of Bristol Department of Animal Science has attained a high level of recognition" [h]. Steve Wotton, who developed the concept, was awarded an MBE for services to animal welfare in 2007. This influence is not limited to Europe. Largely driven by the technical specifications of UK retailers, major exporters of poultry in the Asia and Central and South America now also insist upon Animal Welfare Officer training for managers within plants. Since 2008, Bristol researchers have run 61 courses which have trained over 800 delegates working in abattoirs in UK and internationally.

Other implications for industry arising from Bristol research

Despite the significant welfare benefits of the modified stunning parameters, further research carried out at Bristol University [i and j] indicated that the new current/frequency requirements would significantly adversely affect meat quality. As a result, it has been suggested that slaughter plants might make a move towards CO_2 stunning. As discussed by FAWC [h], gas stunning has further welfare advantages since, unlike electrical stunning, it does not require shackling, which is a significant aversive experience for birds. Two out of four UK poultry-processing plants contacted for a survey of stunning practices had switched to biphasic CO_2 in January 2013.

An alternative method of dealing with the potential conflict between using the newly stipulated electrical parameters and the need to control carcass and meat quality, is a new 'head-only' water bath stunning technique developed in a collaboration between the University of Bristol, Silsoe Livestock Systems Ltd, Cargill Meats and the Humane Slaughter Association (HAS) [k]. The project was funded by Defra and the Scottish Government under the Sustainable Livestock Production LINK Programme. The new technique involves the use of two currents – one across the head to cause immediate insensibility and a smaller one through the body to suppress involuntary wing flapping. The results of two studies [j, k] carried out at Bristol indicate that head-only stunning is an effective method of stunning birds using the criteria developed by Raj and others and may represent a very significant improvement in carcass quality compared with conventional water bath stunning. The application of head-only stunning current to birds will encourage processors to apply sufficient current that will guarantee good welfare, without significant effect on carcass and meat quality. Head-only electric stunning therefore has the potential to meet the commercial requirements of the processing industry for high quality meat and a high standard of animal welfare at slaughter. The LINK Programme Management Committee considered the collaborative project *"...an outstanding project*", awarding a score of 9 out of 10 for scientific content and 10 out of 10 for relevance to the industry.

5. Sources to corroborate the impact (indicative maximum of 10 references)

[a] Rebeca Garcia Pinillos. April 2010. Analysis of results from a questionnaire sent to the poultry industry to estimate the most common stunning and slaughter practices and summary of literature in electrical water bath parameters. Animal Welfare Team, DEFRA *(Information on the effect of the January 2013 legislation change)*

[b] COUNCIL REGULATION (EC) No 1099/2009 of 24 September 2009 on the protection of animals at the time of killing. Official Journal of the European Union L 303/1 *(Corroborates change in EC law and importance of AWO)*

[c] Prinz, S., Van Oijen, G., Ehinger, F., Coenen, A. and Bessei, W. (2010) Electroencephalograms and physical reflexes of broilers after electrical waterbath stunning using an alternating current. Poultry Science. 89: 1265-1274.

[d] Prinz, S. Van Oijen, G. Ehinger, F., Bessei, W. and Coenen, A. (2010) Effects of waterbath stunning on the electroencephalograms and physical reflexes in broilers using a pulsed direct current. Poultry Science. 89: 1275-1284.

[e] Prinz, S., Van Oijen, G., Bessei, W., Ehinger, F. and Coenen, A. (2009) The electroencephalogram of broilers before and after DC and AC electrical stunning. Archiv fur Geflugelkunde. 73: 67-70.

([c-e] These publications corroborate Bristol research)

[f] UK request to EU *(Corroborates UK request to amend EC 1099/2009, based on Bristol research*)

[g] EFSA (European Food Safety Authority), 2004. Opinion of the Scientific Panel on Animal Health and Welfare (AHAW) on a request from the Commission related to welfare aspects of the main systems of stunning and killing the main commercial species of animals. The EFSA Journal. 45: 1-29. *(Corroborates Bristol's contribution to EFSA report describing the need for more research which preceded legislation change)*

[h] FAWC Report on the Welfare of Farmed Animals at Slaughter or Killing. Part II White Meat Animals. May 2009. www.fawc.org.uk *(Evidence that Bristol contributed to Farm Animal Welfare Council report to UK Government)*

[i] Barker, R. (2006) The Effect of Waterbath Stunning Current, Frequency and Waveform on Carcass and Meat Quality in Broilers. MSc Dissertation. University of Bristol.

[j] Lines, J.A., Wotton, S.B., Barker, R., Spence, J., Wilkins, L. and Knowles, T.G. (2011a) Broiler carcass quality using head-only electrical stunning in a waterbath. British Poultry Science. 52:4, 439-445.

[k] Lines, J.A., Raj, A.B.M., Wotton, S.B., O'Callaghan, M. and Knowles, T.G. (2011b) Head-only stunning of poultry using a waterbath: a feasibility study. British Poultry Science. 52: 432–438.

([i-k] Further research leading to improved stunning methods benefitting both poultry welfare and the consumer, improving the nature of the original impact).