A SHORT OVERVIEW OF THE WELFARE IMPLICATIONS OF PRE-SLAUGHTER STUNNING IN POULTRY

X. Fernandez
ENSAT, Laboratoire de Zootechnie et Qualités des Produits Animaux (EA 3014- USC INRA), Castanet-Tolosan, France
INRA, Département PHASE, Rennes, France

Introduction

In poultry, as in any other animal species, it is a legal requirement that the animals must be rendered unconscious, *i.e.* insensible to pain, before cutting the neck vessels and remain so until death supervenes from blood loss. From an ethical point of view, the following conditions are required : i) the induction of insensibility must be effective in all the animals, ii) the induction of insensibility must be painless and iii) the duration of insensibility must be long enough to allow the birds dying from bleeding without recovering consciousness.
Appropriate neurophysiological measurements, *i.e.* electroencephalogram (EEG) recordings, must be used for an objective and unequivocal assessment of stunning efficiency. In red meat species, the induction of 'grand mal epilepsy' in the brain, is recognised as a sign of stunning-induced unconsciousness (for a review see Raj, 2003). In poultry however, the changes in EEG following the application of a stunning current differ from those observed in mammals. Abolition of evoked potentials in the brain has been therefore used as an unequivocal indicator of unconsciousness (loss of brain function) in poultry (Raj & O'Callaghan, 2001; Raj et al., 1992). We recently showed that the power spectra of the EEG, obtained by Fast Fourier Transformation could be used as an indicator of stunning efficiency in ducks (Beyssen *et al.*, 2004).
From a technological point of view, stunning aims to reduce birds movements in order to facilitate bleeding, especially on automatic slaughter lines. In addition, the reduction of birds movements during bleeding, including wing flapping, reduces the incidence of carcass appearance defects.
Electrical stunning and Controlled Atmosphere Stunning (CAS) are the two main methods used in poultry slaughter plants. In the following, the ethical implications of both methods will be shortly discussed.

Stunning or stunning/killing?

The interest of killing the animals by the stunning method is still a matter of debate. From the point of view of animal protection, killing the animal at this point is the best way to ensure that it will not recover consciousness during bleeding. This aspect is particularly relevant to gas stunning since Raj & Gregory (1990) stated that the return of consciousness after a non-lethal gas stunning was by far to quick to ensure that birds would die from bleeding while being still unconscious.

Electrical stunning

Electrical stunning in a water-bath is the most common method in Europe and was until recently, in France, the only technique encountered in commercial slaughter plants. This method is based on the application of a current flow through the body of the birds which are hanged head-downwards on a moving shackle. The systems are designed to flow from the live water electrode to earth trough the bird. Research works carried out under controlled laboratory conditions and based on EEG recordings have allowed to determine the minimum current intensity required to induce an efficient stun in various poultry species (table 1).

Table 1- Minimum currents required to induce an efficient stun in the water-bath stunning system

Species	Minimum current (mA)
Turkey	150
Chicken	100
Goose	130
Duck	130
Quail	50

It is important to note that these recommendations correspond to the values which must be applied to individual birds. Under practical situations, several birds are present simultaneously in the water-bath and generate a parallel resistances pathway. A very rough estimation would lead to the fact that the intensity of the current delivered on the circuit must be at least equal to the minimum current required/bird x number of birds present simultaneously in the water-bath. This is however not sufficient to ensure that each bird receives the accurate amount of current (Wotton & Gregory, 1991). The recommendations are actually based on the most common current waveform commercially available : a sinusoidal alternating current (AC) at 50 Hz. In turkey, we demonstrated that the application of a 50 Hz, 150 mA AC induced cardiac arrest in 100 % of the birds. Increasing the current frequency from 50 to 600 Hz decreased both the incidence of cardiac arrest (0 % at 600 Hz) and the duration of stunning-induced unconsciousness (Mouchonière *et al.*, 2000). Therefore, the minimum current required to stun the birds need to be re-evaluated for each current frequency. Apart from the difficulty to ensure under practical situations that all the birds receive an adequate current, electrical stunning in a water-bath poses some other welfare problems:

- this method implies the shackling of conscious birds head downwards, and this may last several minutes in poorly designed slaughter plants,
- when turkeys are shackled head downwards, their wings hang lower than the head and may therefore touch the water-bath first, thus leading to a painful electric shock. Because of anatomical differences, this problem is much less important in broiler chickens,
- some birds may lift up their head and thus avoid the water-bath. In that case, they may be fully conscious at time of neck cutting.

Gas stunning

The use of modified or controlled atmospheres for stunning birds (CAS) has continually developed since the end of the 1980s. A great deal of laboratory work has been carried out mainly in England and in the Netherlands. CAS is considered as an alternative to electrical stunning since it is thought to eliminate the welfare and meat quality problems encountered with the water-bath method. One of its most important advantage is that it avoids shackling conscious birds, either they are stunned in their transport crates or on a supply conveyor. This is an obvious advantage for bird welfare but also for the welfare of the staff involved in shackling. In practice, only mixtures of gases that occur naturally in air, such as carbon dioxide (CO_2), nitrogen (N_2), oxygen (O_2), and argon (Ar), are used in different combinations and proportions. Different CAS methods can be identified (Barton-Gade *et al.*, 2001) :

- anoxia by displacing air with an inert gas such as Ar,
- combined effects of anoxia (Ar) and anaesthetic effect of CO_2 (hypercapnic anoxia),
- anaesthetic effect of CO_2 at high concentration in air (hypercapnic hypoxia)
- increased concentration of O_2 and CO_2 (hypercapnic hyperoxygenation),
- the bi-phase system use a first exposure to increased O_2 (30 %) and CO_2 (40 %) in air as an induction phase to reduce the aversiveness of CO_2, followed by a stunning/killing phase into high CO_2 concentration after the birds have lost consciousness in the CO_2/O_2 mixture.

Anoxia induces i) a depression of activity in the brain which extend progressively from the telencephalon to the mesencephalon, ii) a suppression of the rostral reticular formation leading to a loss of consciousness and iii), a suppression of the caudal reticular formation triggering the onset of convulsions (Lambooij & Pieterse, 1997). When exposed to high CO_2 concentrations, the saturation of tissues with CO_2 leads to an impairment of cell function which induces on the EEG a decrease in amplitude and frequency and a desynchronisation of activity, preceding an isoelectric state (Bauer, 1982).

Behavioural reactions of the birds when exposed to the various gas mixtures have been used to appreciate the aversiveness of the different atmospheres. When exposed to anoxia, hypercapnic anoxia or hypercapnic hypoxia, the behavioural reactions usually follow the pattern : gasps (light and/or severe), head shaking, wing flapping, convulsions and loss of posture. Based on these observations and on the EEG recordings, the fastest stunning is obtained with Ar/CO_2 mixture (Barton-Gade *et al.*, 2001 for a report of different studies). The behavioural reactions seems to be of lower intensity in the CO_2/O_2 mixture but in the other hand, the time to loss of consciousness is longer. Some of these results are shown in table 2. Whether the severe behavioural reactions seen during gas exposure (wing flapping and convulsions) are unequivocal signs of pain and distress is still not clear. Recently, Coenen *et al.* (2003) demonstrated that the signs of agitation and distress during exposure of chickens to oxygen/carbon dioxide conditions occurred at a time where consciousness could not be fully excluded from the EEG recordings. Under such circumstances, it seems more acceptable to promote a method where the behavioural reactions are the less severe. This is the case in the CO_2/O_2 mixture which induces unconsciousness within 60 s of exposure. Then, the aversive reactions to the following exposure to high CO_2 concentration (the second and 'finishing' step of the stunning/killing) are suppressed.

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Table 2 - Behavioural responses of broiler chickens to different gas mixtures (Barton-Gade et al., 2001)

	Number entering the room	Number with light gasps	Number with head shaking	Number with convulsions	Time to loss of posture (s)
Negative control	17	2	7	0	-
Positive control	18	2	18	0	-
> 90 % Ar	9	0	4	9	21
70% Ar + 30% CO_2	15	14	14	15	12
60 % CO_2	12	12	11	12	17
40% CO_2 + 30% O_2	19	19	19	1	30

Negative control = no air circulation; positive control = air circulated at the same rate as in the other gas mixtures