Transcranial magnetic stunning of broilers: a preliminary trial to induce unconsciousness

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Abstract

This study was performed to identify whether non-focal transcranial magnetic stimulation (TMS) with an adapted coil for broilers has the potential for use as a non-invasive stunning method for broilers. Application of the TMS probe resulted in dominance of theta and delta waves and appearance of spikes in the electroencephalogram (EEG) after stimulation. Correlation dimension (CD) analyses of the EEG signals recorded prior to and following the application of TMS suggested that the birds might be unconscious for approximately 15 to 20 s assuming that a reduction in CD to 60% of the baseline value indicates unconsciousness. Other observations included loss of behavioural arousal or muscle tone (muscle flaccidity), and irregular heart rate after TMS. It can be suggested that TMS has the potential to be developed as a stunning method in the future. The technique, evaluated using small number of broilers in this study, requires further improvement and the use of a power supply optimised in future research. Transcranial magnetic stimulation of the brain has potential for application as a non-invasive stunning method for broilers, which could be acceptable to some religious groups opposed to the use of established or conventional stunning methods.

Keywords: animal welfare, behaviour, brain and heart activity, broilers, single and double coil, transcranial magnetic stunning

Introduction

A basic requirement for humane slaughter of animals, including poultry, is that they should be stunned, rendered unconscious and insensible, prior to slaughter by exsanguination. Under commercial conditions, poultry species are mostly stunned using an electrified water bath. The water-bath method is based on application of an electric current through the body of the bird which is hung head-down by the legs in moving shackles. Thereafter, the birds pass through the bath in line. Depending on the dimensions of the bath, several birds are submerged (up to their shoulders) simultaneously in water. In conventional use, a metal strip at the base of the water bath acts as one electrode whilst the earthed shackles form the negative electrode. In this way, the electric current is passed through the bird, from head-to-legs. The water bath is electrically live so that each bird is stunned the moment it makes contact with water (Bilgili 1999; Raj 2003).

Scientists have long been searching for alternatives to electro-narcosis (ie electrical stunning). Transcranial magnetic stimulation (TMS) is a recently developed non-invasive technique used in the field of human psychiatry to treat depression with slowly repeated pulses to the frontal lobe (George 2003) or to induce seizures (Lisbany 2002). However, its greater use is in the measurement of conduction time in the motor pathways of the central nervous system (CNS) (Mills 1999). Electromagnetic induction was first described by Michael Faraday in 1831. He wound two coils on an iron ring and showed that when the coil was connected on one side an electrical current passed through the coil on the other side. With non-invasive magnetic stimulation, the stimulating coil acts as the first coil, air as the medium for the flow of the magnetic field and the electrical conductivity of the brain tissue as the second coil. A magnetic field is the means by which an electrical current is generated within the tissue that causes depolarisation of the cell membrane. (Fitzgerald et al 2006). In practice, a single (circular) or double TMS probe containing a copper coil is placed on the skull and an electric current charged by a TMS generator induces the magnetic stimulus within the surface cortex of the brain. TMS fields extend only a few centimetres to the surface of the cortex, although a double probe allows further penetration into the brain (George 2003).

Several measurements were performed under controlled laboratory conditions on individual broilers used in the present study. These investigations were performed in co-