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Blood parameters and electroencephalographic responses of goats to slaughter without stunning

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ABSTRACT

The study compared changes in blood biochemistry, hormonal and electroencephalographic indices associated with possible noxious stimuli following neck cut slaughter in conscious, non-anaesthetized versus minimally-anaesthetized goats. Ten male Boer crossbreed goats were assigned into two groups and subjected to either slaughter conscious without stunning (SWS) or slaughter following minimal anaesthesia (SMA). Hormonal responses and changes in electroencephalographic (EEG) parameters were not influenced by slaughter method. The SWS goats had higher glucose and lactate than did SMA goats. It can be concluded that the noxious stimulus from the neck cut is present in both conscious and minimally anaesthetized goats. The application of slaughter without stunning causes changes in the EEG activities that are consistent with the presence of post slaughter noxious sensory input associated with tissue damage and would be expected to be experienced as pain in goats.

1. Introduction

Goat meat production has been increasing over the last few years from 4.90 million tons in 2008 to 4.99 million tons in 2011 (FAO, 2010). This has been driven by its perceived healthiness compared with other red meat (Argüello, Castro, Capote, & Solomon, 2005; Webb, Casey, & Simela, 2005). The gradual expansion of goat meat industries is as a result of increased consumer demand (Dhanda, Taylor, Murray, Pegg, & Shand, 2003). This development has stimulated researches to improve the availability and quality of goat meat (Adeyemi, Sabow, Shittu, Karim, & Sazili, 2015; Sabow et al., 2016).

The last step of the meat production chain (slaughter) has received much debate as regards to its humaneness (Sabow et al., 2015; Salwani et al., 2015). Fear and pain are important elements of stress that have profound effects on meat quality (Heinz & FAO, 2001). Slaughter procedures are usually regulated by legislation, codes of practice and species-specific recommendations but the suitability of commonly used methods depends as well on availability of facilities, consumer demands and economic considerations (Anil, 2012). Religion is one of the most influential factors determining choice and subsequent selection or purchase of foods. Due to religious requirements, it has become evident that the market for meat from slaughtered animals without stunning is an important proportion of the global production and supply (van der Spiegel et al., 2012). The global value of trade in halal meat is huge with Muslim countries alone consuming meat estimated to be worth USD 57.2 billion in 2008 (Farouk et al., 2014). The value of halal red meat and co-products imported into countries and regions with sizeable population of Muslims (Indonesia, Maghreb, Malaysia, Middle East, Saudi Arabia and United Arab Emirates) in 2011 was USD 28.5 billion (Farouk, 2013). According to the British Veterinary Association (2013), the number of slaughtered sheep and goats by ventral-neck incision without prior stunning in the UK increased 70% between 2003 and 2011. A recent survey on animal welfare carried out in abattoirs across the UK published by the Food Standards Agency (2015) indicated that the number of goats and sheep slaughtered

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without pre-stunning is 15.2% in 2013, which is higher than the 10% of the population that were slaughtered without stunning in 2011.

Slaughtering of animals without stunning prior to ventral neck incision and exsanguination is recognized as the appropriate method for slaughtering animals intended for meat consumption by a number of religious faiths, such as Islam and Judaism (Sabow et al., 2015). This practice is allowed in many countries and recognized by the World Organization for Animal Health (OIE) as a slaughter method used by certain faiths (Farouk et al., 2014; Velarde et al., 2014). Meanwhile the European Union (EU) legislation grants exceptions from stunning for religious groups, but it is extremely controversial with regards to animal welfare. Both sides agree that animal welfare is important in the production of meat. Areas of concern include possible pain and distress during and immediately following the neck cut and the time to onset of insensibility (Grandin, 2010; Gregory, 2005). Pain caused by neck cutting has been the subject of much debate. It has been suggested that the use of an exquisitely sharp knife produces minimal behavioral reactions in animals and as a result, the neck cut is not perceived as painful by the animal (Regenstein, 2012; Rosen, 2004). This in itself is the main perception by advocates of religious slaughter of many faiths, as it is known that both fear and pain affects eventual meat quality (Grandin & Regenstein, 1994). However, there are little neurophysiological and physiological evidences to support this suggestion. Until recently it was not clear whether slaughter of conscious animals by neck cutting causes pain or distress (Gibson et al., 2009; Zulkifli et al., 2014). This was due to the complexities of measuring pain in animals and limitations on the interpretation of behavioral and physiological responses to slaughter by neck cut alone. The phylogenetic similarities in structure and function of the central nervous systems (CNS) between humans and other mammals leave little doubt that farm animals can indeed experience pain (Barnett, 1997). Moreover, there is little doubt that these animals are conscious pre-slaughter, during slaughter, and for a period post-slaughter, without stunning (Gibson, Dadios, & Gregory, 2015). Therefore, it is possible that animals experience nociception/pain during slaughter prior to the onset of insensibility (Gibson et al., 2009; Zulkifli et al., 2014).

The electroencephalogram (EEG) is the recording of electrical activity from electrodes placed in various positions on the scalp (Kaka et al., 2015). Electroencephalogram spectrum changes have been used as an indicator of the experience of pain in red deer (Johnson, Wilson, Woodbury, & Caulkett, 2005), sheep (Otto & Gerich, 2001), pigs (Haga & Ranheim, 2005), cattle (Zulkifli et al., 2014; Gibson, Johnson, Stafford, Mitchinson, & Mellor, 2007) and horses (Murrell et al., 2003). In addition to that, plasma levels of adrenaline and noradrenaline are commonly used to measure stress or distress before and during slaughter in animals (Bórnez, Linares, & Vergara, 2010; Ndlovu, Chimonyo, Okoh, & Muchenje, 2008). It is well known that animals exposed to stressful situations respond through activation of both the sympathetic and hypothalamic-pituitary-adrenal axes. The activation of the first axis determines the release of adrenaline (epinephrine) and noradrenaline (norepinephrine) into the blood stream as a preparatory event in which the animal perceives a problem and prepares its immediate reactions (Micera, Dimatteo, Grimaldi, Marsico, & Zarrilli, 2010).

Slaughter procedures need to maintain product quality as well as protect animal welfare. Although there has been some research in this area, most information originates from work in conventional slaughter methods with limited comparison to religious slaughter. This was due to the limited access to religious slaughter without stunning in most developed countries because of legal and welfare reasons. Animals subjected to minimal anaesthesia have been accepted as a humane model to study noxious stimuli associated with the neck cut slaughter in cattle and sheep (Johnson, Mellor, Hemsworth, & Fisher, 2015), but has not been reported in goats, particularly in countries where pre-slaughter stunning is mandatory. The minimal anaesthesia model is a proven model to evaluate the presence of noxious stimuli, especially when used in conjunction with electroencephalography (Gibson et al., 2009; Mellor, Gibson, & Johnson, 2009). Under the minimal anaesthesia model, animals have been shown to be able to demonstrate EEG responses from the cerebral cortex, as well as normal physiological cardiovascular responses to nociceptive stimulation, that are consistent with that of fully awake animals (Johnson, Murrell, Gibson, & Mellor, 2007). However, as emotion and conscious awareness also contributes significantly to the perception of pain in animals, there could be differences in response between awake and minimally anaesthetized animals, particularly on parameters that are under the influence of the autonomic nervous system. As a consequence, there is a need to study and compare electroencephalographic response and changes in blood parameters following the neck cut in minimally anaesthetized versus fully awake animals. Apart from offering scientific insights into stress and noxious stimuli, responses which have not been conducted until now in goats, this study strives to evaluate the utility of the minimally anaesthetized model in animal slaughter research. In particular its use in studying the controversial topic associated with religious slaughter. Therefore, the objective of the present study was to compare the changes in blood biochemistry, hormonal and electroencephalographic changes associated with possible noxious stimuli following neck cut slaughter in conscious, non-anaesthetized halal-slaughtered goats (SWS) versus minimally-anaesthetized goats (SMA).

2. Materials and methods

2.1. Ethical note

This study was conducted following the animal ethics guidelines of the Research Policy of Universiti Putra Malaysia.

2.2. Animals and slaughtering procedure

A total of 10 male Boer crossbreed goats weighing 23.15 ± 1.42 kg were obtained from the same farm and of the same age (approximately 7 months old). The goats were allotted into two groups consisting of 5 animals each and subjected to either conscious slaughter without stunning (SWS) or slaughter following minimal anaesthesia (SMA). Slaughtering was carried out at the Department of Animal Science Research Abattoir, Faculty of Agriculture, Universiti Putra Malaysia. In the first group (SWS), the goats were slaughtered according to halal slaughtering procedure as outlined in the MS1500: 2009 (Department of Standards Malaysia, 2009). The process involved severing the carotid arteries, jugular veins, trachea and esophagus. The neck cut position was performed at the level of first cervical vertebra (C1) based on the requirements of OIE (2007). Another group of goats (SMA) were allocated to a similar slaughter designed to mimic the action of the neck cut under minimal anaesthesia.

2.3. Anaesthesia

The protocol for minimal anaesthesia induction was performed as per the methods of Johnson et al. (2009) and Kaka et al. (2015). Under the minimal anaesthesia model, animals are maintained at end-tidal halothane (ET_{Hal}) of 0.85–0.95%, while under conventional general anaesthesia animals are maintained at ET_{Hal} higher than 1.5%. Anaesthesia was induced using 5 mg/kg propofol administered through rapid injection into cephalic vein and maintained with halothane in 100% oxygen. Vaporizer was adjusted to maintain ET_{Hal} between 0.9% and 1.0%. A blood pressure cuff of 40–60% circumference of the ante-brachium was used to measure blood pressure noninvasively. Mean blood pressure was maintained above 60 mm Hg throughout the anaesthetic period. The temperature was monitored by using an esophageal thermistor probe and was maintained between 37 and 38 °C by a heating pad and a warm blanket. All parameters were monitored using Datex-Ohmeda monitor (GE healthcare, Helsinki, Finland).