OPEN ACCESS

University of BRISTOL

Halal stunning and slaughter

Criteria for the assessment of dead animals

Author(s):
Fuseini, Awal; Knowles, Toby G.; Hadley, Phil J.; Wotton, Stephen

Published in:
Meat Science

DOI:
10.1016/j.meatsci.2016.04.033

Link to publication record on the Bristol Research Portal:
Access record including PDF (if available)

Document version
Peer reviewed version

Licence (if available)
CC BY-NC-ND

This is the author accepted manuscript (AAM). The final published version (version of record) is available online via Elsevier at http://www.sciencedirect.com/science/article/pii/S0309174016301267. Please refer to any applicable terms of use of the publisher.

Citation for published version (Version of Record):
Fuseini, A., Knowles, T. G., Hadley, P. J., & Wotton, S. (2016). Halal stunning and slaughter: Criteria for the assessment of dead animals. *Meat Science*, *119*, 132-137. https://doi.org/10.1016/j.meatsci.2016.04.033

University of Bristol – Bristol Research Portal

Citing this paper
Guidance on citing material from the Bristol Research Portal is available under 'Manuscripts and Citations' in the Terms of Use (linked below).

Terms of Use
Full Terms of Use for the Bristol Research Portal are available online: https://www.bristol.ac.uk/research-enterprise-innovation/research-policy/pure/brp-terms/

Has this research benefited you?

Let us know how being able to access and read this research through the Bristol Research Portal has been meaningful to you by sharing your story at https://forms.office.com/e/ffL5CZ0fGT

Bristol Research Portal Coversheet last updated 16-Oct-2026

Download date: 05-Nov-2026

Halal stunning and slaughter: Criteria for the assessment of dead animals.

Awal Fuseini[a], Toby G Knowles[a], Phil J Hadley[b], Steve B Wotton[a]

[a]University of Bristol, School of Veterinary Science, Langford, Bristol. BS40 5DU. UK

[b]AHDB, Creech Castle, Taunton , Somerset. TA1 2DX. UK

Correspondence: awalfus@yahoo.com

Abstract

The debate surrounding the acceptability of stunning for Halal slaughter is one that is likely to linger. Compared to a couple of decades or so ago, one may argue that pre-slaughter stunning is becoming a popular practice during Halal slaughter due to the increasing number of Muslim-majority countries who continue to issue religious rulings (*Fatwa*) to approve the practice. Concerns have often, however been raised about the likelihood of some animals dying as a result of stunning and whether there are mechanisms in place to identify and remove dead animals stunned with irreversible techniques before their necks are cut. This paper reviews literature about what makes meat Halal, considers the arguments put forward by proponents and opponents of Pre-slaughter stunning for Halal meat production and examines the criteria used by Halal Certification Bodies to identify and reject animals that may die as a result of irreversible stunning and considers the specific risks of waterbath stunning (for poultry) from a Halal viewpoint.

Highlights

- Halal meat consumption is important to Muslims
- The market for Halal meat is growing at an exponential rate
- Halal animals must not be dead at the time of slaughter

- We looked at the arguments for and against pre-slaughter stunning for Halal production
- We examined the measures used to remove dead animals after stunning

Keywords

Halal slaughter; Stunning; Brain death; Bleed-out; Animal welfare; Ventricular fibrillation

1. Introduction

The slaughter of animals for followers of the Islamic faith is both ethically and economically important due to the huge demand for animals slaughtered in this manner, and the insistence by some Muslim groups that animals be slaughtered whilst they are fully conscious. The global demand for meat slaughtered for Muslim consumption is significant and it is projected to grow even stronger (Agriculture and Agri-Food Canada, 2011, Sunkar, 2008, Mintel, 2009, The Economist, 2009). A study commissioned by Thomson Reuters in conjunction with Dinar Standard, dubbed The State of the Global Islamic Economy Report (Thomson Reuters and Dinar Standard, 2013) indicated that the amount of money spent by Muslim consumers on Halal food and drinks represents 16.6% of the global expenditure on food and drinks. This equates to approximately $1.1 trillion and it is estimated that by the year 2018, the value could reach $1.6 trillion. Due to the apparent economic benefits of the Halal market, many food businesses in the West have entered into the trade of Halal food products. Nestle, one of the world's major food manufacturers now holds Halal certification for an estimated 150 manufacturing sites globally (Thomson Reuters and Dinar Standard, 2013).

For meat to be considered fit for Muslim consumption, Islamic law, the *Shariah*, requires that the animal must have been reared under conditions conducive to express

normal behaviour, and that the slaughter of such animals must be performed in a humane manner. The *Shariah* law is derived from the Quran (Islamic Holy Book) and Hadith (traditions of the Prophet of Islam, Mohammed). The following *Hadith* (*Ahadith*-plural) is one of a number of *Ahadith* that emphasise the protection of the welfare of animals during Halal slaughter:

"*Verily Allah has prescribed Ihsan in all things. So if you kill then kill well, and if you slaughter, then slaughter well. Let each one of you sharpen his blade and let him spare suffering to the animal he slaughters*." (Sahih Muslim, 40 Hadith Hawawi 17).

One of the most important conditions that must be met for meat to be considered Halal is that the animal must be alive at the time of slaughter, some Muslims however insist that animals must be conscious at the time of slaughter. This has led to debate among Islamic jurists as to whether modern slaughter technologies such as pre-slaughter and post-slaughter stunning, mechanical slaughter and thoracic sticking can be accepted as part of Halal slaughter. Stunning in particular has attracted a lot of interest from animal welfare proponents due to its proven ability to minimise pain by rendering animals immediately insensible to pain. Opponents of pre-slaughter stunning for Halal production have always maintained that the practice contravenes Islamic *Shariah* law since the Prophet did not use such a technology and that there is the possibility that some animals may die as a consequence of the stun. Proponents of pre-slaughter stunning for Halal production on the other hand have argued that if stunning is proven to minimise the pain associated with the neck-cut, and the method of stunning does not result in the death of animals before slaughter, then stunning may be accepted as a Halal compliant procedure.

This review will consider the arguments surrounding the acceptability of stunning during Halal slaughter and examine the relevant Islamic scriptures to ascertain whether Islamic law explicitly outlaws stunning during Halal slaughter. The paper also looks at the criteria used by Halal Certification Bodies (HCBs) to identify and reject animals that may die as a consequence of the stun and examines whether these criteria provide an accurate diagnosis of death.

2. Halal Slaughter

The word Halal is an Arabic term that means anything or act that is permissible in accordance with *Shariah* law. The slaughter of animals for Muslim consumption, sometimes referred to as *Zabiha/Dhabihah* must meet certain conditions specified in the Quran and *Hadith.* The following verse of the *Quran* commands Muslims to consume only Halal food, many Muslims therefore regard eating Halal meat as a form of worship:

"O you who have believed, eat from the good (i.e. lawful) things which We have provided for you and be grateful to God if it is (indeed) He that you worship" (*Quran*, 2:172).

Not all foods are permissible to Muslims. The following verse outlines what is considered Halal and what is forbidden (*Haram*) for Muslims to consume, it is important to note that at the latter part of the verse, God has made it clear that these dietary laws do not apply in situations of genuine need:

"Prohibited to you are dead animals, blood, the flesh of swine, and that which has been dedicated to other than God, and [those animals] killed by strangling or by a violent blow or by a head-long fall or by the goring of horns, and those from which a

wild animal has eaten, except what you [are able to] slaughter [before its death], and those which are sacrificed on stone altars, and [prohibited is] that you seek decision through divining arrows. That is grave disobedience. This day those who disbelieve have despaired of [defeating] your religion; so fear them not, but fear Me. This day I have perfected for you your religion and completed My favour upon you and have approved for you Islam as religion. But whoever is forced by severe hunger with no inclination to sin then indeed, God is Forgiving and Merciful" (*Quran*, 5:3).

It is important to note that it is contrary to Islamic teachings for a Muslim to declare any food, or in fact anything as *Haram* unless it is explicitly prohibited by God (*Quran*, 16:116). Muslims who act in contrast to the above verse are regarded as idolatry worshippers as seen in the following verses:

"If God had willed, we would not have associated (anything) and neither would our fathers, nor would we have prohibited anything. Likewise, did those before deny until they tasted our punishment. Say, do you have any knowledge that you can produce for us? You follow not except assumption, and you are not but falsifying" (*Quran*, 6:148).

"Say (O Mohammed): Bring forward your witnesses who will testify that God has forbidden this. And if they testify, do not testify with them. And do not follow the desire of those who deny our verses and those who do not believe in the Hereafter, whilst they equate (others) with their Lord" (*Quran*, 6:150).

The slaughter of animals in accordance with *Shariah* law must meet the following conditions:

- The animal must be a Halal acceptable species (MS 1500, 2009, MUI HAS 23103, 2012, HFA, 2014, HMC, 2016).

- The animal must be alive at the point of slaughter (*Quran*, 5:3, 6:118-119, 6:145, 16:115).
- The name of Allah must be pronounced during slaughter (*Quran*, 6:118-119, 22:34, 22:36).
- The person bleeding the animal must have attained the age of discretion and he/she must be mentally stable. It is preferable that the slaughterer be a Muslim, however, the *Quran* permits Muslims to consume meat slaughtered by Christians and Jews (*Quran* 5:5).

There are other recommendations, the omission of which does not necessarily render meat *Haram*. It must also be noted that some of these secondary requirements are almost impossible to achieve under commercial conditions, these include:

- Orientating the animal to face *Qibla* (The Grand Mosque in Mecca).
- Sharpening the blade or knife out of sight of the animal.
- Slaughtering animals out of sight of other animals and shielding animals from the sight of blood.
- Slaughtering in one single movement of the knife. This requirement is particularly difficult to achieve in cattle.

As stated above, the *Quran* forbids Muslims from declaring food as *Haram* unless it is clearly commanded by God. On the contrary, some Islamic jurists have declared some new slaughter technologies such as stunning, as *Haram* despite the fact that this is not mentioned in any of the scriptures. It must be noted that stunning is a relatively new technique which was discovered several centuries after the *Quran* was revealed, it is therefore not surprising that it is not mentioned in the scriptures. In a situation where a technology cannot be found in the scriptures, Islamic jurists must pass a

judgement (*Fatwa*) as to whether that technology can be accepted as Halal or not. However, these jurists widely interpret the *Shariah* law differently (Fuseini, Knowles, Lines, Hadley, & Wotton, 2016).

It is an undeniable fact that several verses in the *Quran* and a number of narrations in the *Hadith* emphasise the protection of animal welfare throughout the animal's life. One may therefore argue that if stunning is objectively shown to induce immediate loss of sensibility and does not cause the death of animals prior to slaughter, then such a technique may meet the Halal slaughter guidelines since the scriptures does not declare such a practice as *Haram*. In most Muslim-minority countries, Halal consumers often rely on the approval marks or certificates issued by HCBs to verify the Halal status of food. However, these unregulated HCBs widely operate according to different procedures and the level of expertise of some of these organisations has often been questioned.

3. The Halal stunning debate

Traditionally, Halal slaughter has been performed without any form of stunning. The *Quran* and *Hadith* per se do not specifically forbid the use of stunning during Halal slaughter. However, reference is made in the *Quran* commanding Muslims to avoid the consumption of meat from animals killed by a blow (*Quran*, 5:3). Some Muslim authorities have interpreted this verse to imply that the *Quran* prohibits the use of all forms of mechanical stunning. Opponents of pre-slaughter stunning for Halal production insist that there is an element of doubt as to whether all animals stunned would remain alive at the time their necks are cut. It is due to these perceived doubts surrounding the possible death of animals before slaughter that many Halal consumers prefer meat slaughtered without stunning (EBLEX, 2010).

From an animal welfare standpoint, animals slaughtered without any form of stunning remains a contentious issue (Grandin, 2010) because the procedure is likely to cause pain (Ferguson and Warner, 2008, Gibson et al, 2009, Mellor, Gibson & Johnson, 2009, Grandin, 2010). It is against this backdrop that the Humane Slaughter Act (1958) and the European Council Regulation, EC1099/2009 require the stunning of all animals before slaughter, except where slaughter is done on religious grounds. It is worth noting that some researchers have suggested that the slaughter of animals without stunning is equally a humane slaughter method (Bager et al, 1992, Grandin & Regenstein, 1994). But the majority of researchers would consider slaughter without stunning as causing unnecessary pain and suffering to animals. Despite the exemption of religious slaughter from stunning, many Muslim authorities have accepted stunning as a Halal compliant procedure (MS1500, 2009, MUI HAS 23103, 2012, HFA, 2014 & OIC, 2009), this has led to the stunning of large numbers of animals destined for the Halal market in the developed world. In the UK for instance, the proportion of animals stunned during Halal slaughter is: sheep and goats (63%), cattle (75%) and poultry (84%) (FSA, 2015).

Opponents of pre-slaughter stunning for Halal production have often cited a number of reasons for the rejection of stunning during Halal slaughter i.e. the possibility of animals dying before slaughter, difficulty in identifying and removing dead animals before neck incision, adverse effect on bleed-out rate and volume, poor carcass and meat quality and the belief that stunning causes more pain than slaughter without stunning. Critical among these concerns is how to accurately detect dead animals that may possibly be dead before their necks are cut. The majority of the concerns raised have been addressed through research. It has been demonstrated that the total blood loss at slaughter is not significantly different whether animals are pre-stunned, post-

stunned or slaughtered without stunning (Anil et al, 2004, 2006, Gomes Neves et al, 2009, Khalid et al, 2015). On the issue of product quality, Önenç and Kaya (2004) showed that percussive captive bolt stunning of young bulls offered improved meat quality characteristics in comparison with animals slaughtered using head-only electrical stunning or those slaughtered without stunning.

Proponents of pre-slaughter stunning for Halal production on the other hand have insisted that since the Qur'an does not explicitly prohibit the use of stunning, its application during Halal slaughter is dependent on whether the animal is alive at the time of slaughter, this is in line with commandments in the Quran directing Muslims to avoid the consumption of dead animals (Quran, 2:173, 5:3). As a result of this assertion by some Islamic jurists, stunning is widely accepted by a number of Muslim-majority countries, including Saudi Arabia, the United Arab Emirates (UAE), Indonesia, Malaysia, Singapore, Egypt, Kuwait, Yemen and a host of others. Notable among some of the *Fatwas* issued by Islamic jurists to accept stunning include the following:

- *Fatwa* issued in 1978 by the Egyptian Fatwa Council at Al Azhar University. This *Fatwa* was made specifically to confirm the suitability of electronarcosis for Halal slaughter.
- *Fatwa* issued in 1987 by the Fiqh Council in Makkah, Saudi Arabia. This *Fatwa* was issued regarding reversible electrical stunning during the 10th session of the Islamic Fiqh Council at the Muslim World League held from 24th October to 28th of October 1987 in Saudi Arabia.

- *Fatwa* issued in 2006 by the Council for Legal Verdicts in Yemen. This *Fatwa* was made with reference to reversible electrical stunning (A type of stunning that supports full recovery of animals).

It is clear from all the *Fatwas* issued in support of pre-slaughter stunning of animals prior to Halal slaughter that there is emphasis on the reversibility of stunning. Anil *et. al*., (2006) observed that head-only electrical stunning is generally accepted as Halal by the Muslim community. Despite the clear guidelines issued by Islamic scholars on the need for the stunning method to be reversible, it has been reported by Berg and Jakobsson (2007) that some Muslims in Sweden, in addition to using reversible electrical stunning, also employ stunning methods such as captive bolt stunning that result in the death of majority of animals. Many HCBs have expressed their displeasure at slaughter plants that use irreversible stunning for Halal slaughter due to fears that animals could be dead before slaughter (Saqib Mohammed, Personal communication, 2016). For this reason, it is critical for HCBs who employ irreversible stunning to institute accurate diagnostic measures to detect dead animals or birds before they are slaughtered for Muslim consumption. Some researchers have however suggested that although captive bolt stunning may be irreversible, it may not result in immediate brain death (Zulkifli et al, 2014). Zulkifli and others (2014) recorded EEG readings of cattle during different stunning and slaughter treatments (including penetrative and non-penetrative captive bolt stunning), they suggested that the correct application of the captive bolt gun did not result in, or promote death. They retorted: "cessation of vital life functions such as heart beat and subsequent brain death are attributable to the act of the throat cut and exsanguination". It must however be noted that the penetrative captive bolt gun does not solely depend on the throat cut and exsanguination to cause death. The impact of the bolt and the physical

destruction of the brain (caused by the penetrating bolt) can cause immediate and irreversible brain death. Using somatosensory and visually evoked responses to evaluate the effect of captive bolt on brain function, Daly and his colleagues (1986) pointed out that there was immediate and profound brain failure (a situation that can result in brain death) when sheep were stunned with captive bolt.

4. Identifying and removing dead animals before slaughter

Opponents of stunning have always maintained that stunning may result in the death of some animals before slaughter. This risk is however eliminated when electrical head-only systems are used to stun ruminants. In the case of poultry, electrical waterbath stunning is commonly used, this method of stunning poses animal welfare, product quality and Halal compliance concerns. From an animal welfare perspective, the inversion and shackling of birds, pre-stun shocks and failure to apply sufficient current to effectively stun some birds are some of the shortfalls of this system of stunning. From a Halal viewpoint, birds with low resistance are likely to receive too much electric current which can in some birds result in a significant effect on heart function, which can result in the death of birds before the ritual cut is made. This is because electric current flows through the whole bird not just the head. Unless there is an effective method of identifying and removing dead birds from the line, these products, which fall short of the Halal requirements may be passed fit for Muslim consumption. Waterbath stunning is also associated with carcass downgrading when birds are stunned at low frequency. The use of controlled atmosphere (gas) stunning systems for Halal poultry has been practiced in England, the Netherlands and Germany. Although this method of stunning/killing provides an improvement in terms of animal welfare, by eliminating issues described above, the majority of HCBs avoid

it because it may lead to the death of birds before slaughter. Raj (2010) reported that stunning methods involving the use of some gas mixtures are meant to induce death rather than unconsciousness and the UK legislation WATOK 2015 specifically requires that animals and birds must be killed in the gas mixture

Halal Certification Bodies (HCBs) do not have a generally accepted procedure for identifying and removing animals or birds that may die as a consequent of the stun. Nonetheless, some HCBs use one or a combination of the following features as a confirmation live animals (MS1500, 2009, HFA, 2014, HFSAA, 2016).

- The presence of movement after stunning and/or slaughter
- The presence of a beating heart after stunning
- The ability of animals to bleed-out after stunning

Unfortunately, the presence of any of the above characteristics in a stunned animal or bird does not conclusively confirm a live animal. This is because human 'patients' confirmed as brain dead have been found to express some or all of the above features (Orban, Ferret, Jambou, & Ichai, 2015). Another criterion used by HCBs to reject carcasses is if there is damage to the skull after mechanical stunning (MS1500, 2009).

4.1. The presence of movement after stunning

Prior to the advent of technology, death was simply defined by immobility. The American Academy of Neurology (AAN, 1995) defined brain death as the irreversible cessation of cerebral activity including loss of function of the brain stem. The Royal College of Physicians (1995) explained that brain stem death is a confirmation of the death of an individual whether it is caused by anoxia or extracranial activity. It is well established that even after brain death, several functions including spinal reflexes,

hypothalamic-pituitary-adrenal axis function and thermo regulation may be sustained for several minutes or hours depending on the species (Conference of Medical Royal Colleges and their Faculties in the UK, 1976a, 1976b, 1979a, 1979b, Saposnik et al, 2009). The presence of spinal reflexes in brain dead human subjects has been reported to cause significant distress to family members and caregivers since they sometimes disagree with the diagnosis due to limb movement (Orban et al, 2015). Terlouw and others (2015) observed that movement could be seen in stunned cattle up to 180 s after the start of bleeding, the time around which there would have been sufficient blood loss to ensure brain death. They also observed that when the spinal cord was severed (disconnecting the brain from the spinal cord), cattle continued to exhibit both paddling and neck movement. Some authors have suggested that the term 'movements' in brain dead nomenclature be clearly defined, 'brain dead reflexes' has been suggested as a possible name for stimulus-provoked movements whilst spontaneous movements be referred to as 'brain dead associated automatisms' (Jain and DeGeorgia, 2005). The use of movement to predict life in animals or birds after being stunned may not therefore be an accurate assessment and confirmation of live animals due to the presence of similar spontaneous or reflex movements in dead animals.

It is also impractical (under commercial conditions) for each and every animal or bird to be inspected for signs of life after stunning. Due to the uncertainty surrounding the confirmation and removal of dead animals or birds prior to slaughter, many HCBs are now insisting on scientifically validated recovery trials to be conducted to find optimal electrical parameters that may not result in immediate brain death.

4.2. The presence of a beating heart after stunning

Some HCBs use the presence of a heartbeat to determine whether animals are alive or not (Grandin, 2015). Shortly after brain stem death, it is possible to have a beating heart until such time that oxygen supply to the heart is exhausted. Orban et al (2015) suggested that this may be the result of "prolonged circulatory arrest" which leads to hypoxia. The Conference of Medical Royal Colleges and their Faculties (1976, 1979) reported that after the diagnosis of brain stem death, a ventilated heart may remain beating for up to a few weeks in very exceptional circumstances. In Canada, the term heart-beating cadaver (HBC) is used to refer to brain stem dead 'patients' because the use of the term 'patient' is inappropriate to describe the dead (Saposnik et al, 2009). HCBs generally agree that irreversible stunning is inconsistent with Halal slaughter (HFA, 2014, MS1500, 2009 & HFSAA, 2016) due to the possibility of causing death before slaughter, the practice is however prevalent in Europe (Berg & Jakobsson, 2007, FSA, 2012, 2015) and other parts of the world. Irreversible stunning may induce ventricular fibrillation, this stops normal heart function and eventually causes brain stem death, or, there may be gross physical damage to the skull and the brain if animals are stunned with a mechanical device. In the latter technique, the physical damage to the brain may lead to immediate brain stem death although the heart may keep beating for 8 to 10 minutes (Vimini et al, 1983 & Grandin, 2015). Delays between stunning and the ritual cut, due to the violent convulsions associated with the clonic phase of epilepsy may result in death of animals before slaughter. It must be reiterated that the presence of a beating heart does not therefore guarantee a live animal. An animal welfare survey conducted by the UK's Food Standards Agency (FSA) of one week production between September 16 and 22, 2013 revealed that captive bolt guns and the Jarvis Beef Stunner (with a cardiac arrest function) were used to stun 75% of Halal slaughtered cattle. The widespread use of irreversible

stunning for Halal slaughter is of grave concern to Halal consumers. Reversible head-only electrical stunning may resolve the issue of slaughtering dead animals for Muslim consumption since there is some level of assurance that unconsciousness is induced through temporary disruption of brain function and there is no evidence to suggest that head-only electrical stunning induces ventricular fibrillation or other significant dysrhythmias that result in death before slaughter (Khalid et al, 2015).

4.3. Using bleed-out as a diagnosis of live animals

The first author has years of experience as a Halal auditor, his interaction with Muslim slaughtermen revealed that some slaughtermen use the ability of animals to bleed-out as an indication of live animals. This assertion is echoed by the widely recognised Halal standard issued by the Department of Islamic Development, Malaysia (MS1500, 2009). Also, The Halal Food Standards Alliance of America (HFSAA, 2016) identifies the inability of carcasses to bleed-out at exsanguination as an indicator of dead animals. Conversely, research has shown that the induction of ventricular fibrillation through head-to-back electrical stunning of lambs (which usually leads to the death of lambs) did not prevent bleed-out (Kirton et al, 1981) because bleeding-out does not depend on the pumping action of the heart. Gregory et al (1988) stunned cattle with a captive bolt gun followed after 66 s with the induction of ventricular fibrillation (confirmed after 2 minutes with an ECG recording). They delayed bleeding-out for 6 h and held carcasses at ambient temperature before sticking and evisceration. They observed that even when bleeding-out was delayed for 6 h after the induction of ventricular fibrillation, the carcasses still bled, albeit slower and in reduced volume than cattle which were bled immediately after stunning. This was consistent with an earlier experiment carried out by (Williams et al, 1983), they

delayed the exsanguination of heifers stunned with a captive bolt gun for up to 30 minutes. They observed that the rate and volume of blood loss at exsanguination was lower when bleeding-out was delayed compared to animals that were bled-out immediately after stunning. This implies that the ability of carcasses to bleed-out at exsanguination cannot be used to exclusively confirm that the animals were alive at the point of sticking.

5. Conclusion

Followers of the Islamic faith regard the consumption of Halal meat as a form of worship, this is because it is a commandment from God. The *Quran* and other Islamic scriptures detail some important requirements that must be met during Halal slaughter for meat to be deemed fit for consumption by Muslims. The most important of these requirements is that the animal must be alive at the time of slaughter. This requirement has sparked a debate within the Muslim community as to whether pre-slaughter stunning can be accepted as part of Halal slaughter, this is due to fears among Halal consumers, that, animals may die as a result of the stun. In efforts to assure Halal consumers that some forms of stunning are consistent with Halal slaughter, HCBs generally accept simple or reversible stunning, and they often have guidelines on how to detect dead animals or birds after stunning. However, questions have been raised about the accuracy of the mechanisms used to confirm death, this is because dead animals or birds may sometimes exhibit some of the features used in confirming live animals before slaughter. Waterbath stunning of poultry and the use of irreversible stunning in red meat species during Halal slaughter may increase the risk of death of animals and birds before slaughter. In the case of waterbath stunning, low resistant birds may receive too much current, which may affect their hearts and cause death before slaughter. Irreversible stunning of red meat species may involve

fibrillation of the heart or there may be significant damage to the brain in the case of mechanical stunning, which again, will cause death before slaughter, particularly where there is a delay between stunning and sticking.

Acknowledgement

AF is working on a Halal stunning and slaughter project kindly funded by a HSA Animal Welfare Research Training (PhD) Scholarship from the Humane Slaughter Association (HSA) and the AHDB Beef and Lamb.

References

Agriculture and Agri-Food Canada (2011). Global Halal food market. http://www.agr.gc.ca/eng/industry-markets-and-trade/statistics-and-market-information/by-region/global/global-halal-food-market/?id=1410083148808 (Accessed, 22/02/2016).

American Academy of Neurology (1995). Practice parameters for determining brain death in adults (summary statement). The Quality Standards Subcommittee of the American Academy of Neurology. *Neurology*, 45, 1012–1014

Anil, M. H., Yesildere, T., Aksu, H., Matur, E., McKinstry, J. L., Erdogan, O., Hughes, S. & Mason, C. (2004). Comparison of religious slaughter of sheep with methods that include pre-slaughter stunning and the lack of differences in exsanguination, packed cell volume and quality parameters. *Animal Welfare*, 13(4), 387-392.

Anil, M. H., Yesildere, T., Aksu, H., Matur, E., McKinstry, J. L., Weaver, H. R., Erdogan, O., Hughes, S. & Mason, C. (2006). Comparison of Halal slaughter with captive bolt stunning and neck cutting in cattle: exsanguination and quality parameters. *Animal Welfare*, 15, 325-330.

Bager, F., Braggins, T. J., Devine, C. E., Graafhuis, A. E., Mellor, D. J., Tavener, A. & Upsdell, M. P. (1992). Onset of insensibility at slaughter in calves: effects of electroplectic seizure and exsanguination on spontaneous electrocortical activity and indices of cerebral metabolism. *Research in Veterinary Science*, 52, 162-173.

Berg, C. & Jakobsson, T. (2007). Post-cut stunning at religious slaughter. *Svensk Veterinartidning*, 59 (16), 21-28.

Conference of Medical Royal Colleges and their Faculties in the UK (1976). Diagnosis of brain death. *British Medical Journal*, ii, 1187-1188.

Conference of Medical Royal Colleges and their Faculties in the UK (1976). Diagnosis of brain death. *Lancet*, ii, 1069-1070.

Conference of Medical Royal Colleges and their Faculties in the UK (1979). Diagnosis of brain death. *British Medical Journal*, i, 332.

Conference of Medical Royal Colleges and their Faculties in the UK (1979). Diagnosis of brain death. *Lancet, i*, 261-262.

Daly, C. C., Gregory, N. G., Wotton, S. B. & Whittington, P. E. (1986). Concussive methods of pre-slaughter stunning in sheep: Assessment of brain function using cortical evoked responses. *Research in Veterinary Science*, 41, 349-352.

EBLEX (2010). Report on the Halal meat market: Specialist supply chain structures and consumer purchase and consumption profiles in England by the English Beef & Lamb Executive. www.qsmbeefandlamb.co.uk/halal (accessed, 23/02/2016)

Ferguson, D. M. & Warner, R. D. (2008). Have we underestimated the impact of pre-slaughter stress on meat quality in ruminants? *Meat Science*, 80, 12-19.

FSA (2012). Food Standards Agency, results of the 2011 FSA Animal Welfare Survey in Great Britain. Open Board 22 May 2012.

http://www.food.gov.uk/sites/default/files/multimedia/pdfs/board/fsa120508.pdf. (Accessed 16/02/2016).

FSA (2015). Food Standards Agency, results of the 2013 FSA Animal Welfare Survey in Great Britain. http://www.food.gov.uk/sites/default/files/2013-animal-welfare-survey.pdf (Accessed 16/02/2016).

Fuseini, A., Knowles, T.G., Lines, J. A., Hadley, P. J. & Wotton, S. B. (2016) The Stunning and Slaughter of Cattle within the EU: A review of the current situation with regard to the Halal market. *Animal Welfare*, (In press).

Gomes Neves J. E., Paranhos da Costa M. J. R., Roca R., Gregory N. G. & Faucitano, L. (2009). Comparison of slaughter methods with or without previous stunning on animal welfare and bleeding efficiency in bulls. *Journal of Animal Science*, 87, E-Suppl.2, 6-6

Gibson, T., Johnson, C. B., Murrell, J. C., Hulls, C. M., Mitchinson, S. L. & Stafford, K. J. (2009). Electroencephalographic responses of halothane-anaesthesised calves to slaughter by ventral neck incision without prior stunning. *New Zealand Veterinary Journal*, 57(2), 77-83.

Grandin, T. (2010). Auditing animal welfare at slaughter plants. *Meat Science86*: 56-65.

Grandin, T. (2015). Questions about death of the animal when different stunning methods are used before Halal or Kosher slaughter. http://www.grandin.com/ritual/questions.diff.stun.methods.html (Accessed, 28/02/2016)

Grandin, T. & Regenstein, J. M. (1994). Religious slaughter and animal welfare: a discussion for meat scientists. *Meat Focus International*, 115-123.

Gregory, .N. G., Wilkins, L. J. & Gregory, A. M. S. (1988). Studies on blood engorgement in beef carcasses. *J. Sci Food Agric,* 46, 43-51

Gregory, N. G., Fielding, H. R., von Wenzlawowicz, M. & von Hollenben, K. (2010). Time to collapse following slaughter without stunning in cattle. *Meat Science,* 82, 66-69.

Halal Food Authority (2014). Halal Food Authority (HFA) Halal standard, Revised, 2014, 1-50.

Halal Food Standards Alliance of America (HFSAA, 2016). Complete Halal Standard. http://halaladvocates.net/site/hfsaa/our-standards/ (Accessed, 28/02/2015).

Halal Monitoring Committee (HMC, 2016). Definition of Halal. http://www.halalhmc.org/DefintionOfHalal.htm#Halal_Animals. (Accessed, 29/02/2016)

Humane Slaughter Act (1958). United States Statutes at Large, containing concurrent resolutions enacted during the second session of the 85th congress of the United States of America. United States Government Printing Office.

Indonesian Standard MUI HAS 23103 (2012). Guidelines of Halal Assurance System Criteria on Slaughterhouses. Majelis Ulama Indonesia. LPPOM MUI.

Jain S. & DeGeorgia, S. (2005). Brain death-associated reflexes and automatisms. *Neurocritical Care*, 3, 122-6.

Khalid, R., Knowles, T. G. & Wotton, S. B. (2015). A comparison of blood loss during Halal slaughter of lambs following Traditional Religious Slaughter without stunning, Electric Head-Only Stunning and Post-Cut Electric Head-Only Stunning. *Meat Science*, 110, 15-23.

Kirton, A. H., Frazerhurst, L. F., Woods, E. G. & Chrystall, B. B. (1981). The effect

of electrical stunning method and cardiac arrest on bleeding efficiency, residual blood and blood splash in lambs. *Meat Science,* 5, 347-353.

Malaysian Standard MS1500 (2009). Halal Food-Production, preparation, handling and storage-General guidelines. Department of Standards Malaysia, 1-13.

Maqsood, R. (2016). World faiths, Teach yourself. ISBN 0-0340-60901-X, pp168

Mellor, D. J., Gibson, T. J. & Johnson C. B. (2009). A re-evaluation of the need to stun calves prior to slaughter by ventral neck incision: An introductory review. *New Zealand Veterinary Journal*, 57, 74-76.

Mintel (2009). 3 in 5 Kosher food buyers purchase for food quality, not religion. Mintel Oxygen Report. http://www.mintel.com/press-release/321/3-in-5-kosher-food-buyers-purchase-for-food-quality-not-religion. (Accessed 16/02/2016).

Orban, J. C., Ferret, E., Jambou, P. & Ichai, C. (2015). Confirmation of brain death diagnosis: A study on French practice. *Anaesthesia Critical Care & Pain Medicine*, 34, 145–150

Önenç, A. & Kaya, A. (2004). The effects of electrical stunning and percussive captive bolt stunning on meat quality of cattle processed by Turkish slaughter procedures. *Meat Science,* 66, 809-815

Organisation of Islamic Cooperation (OIC, 2009). OIC Standards- General guidelines on Halal food. http://halalworldinstitute.org/download/standard/filegallery/47/OIC%20Standards-General%20Guidelines%20on%20Halal%20Food.pdf. (Accessed, 29/02/2016)

PATOK (2009). Council Regulation (EC) No 1099/2009 on 24 September 2009 on the Protection of Animals at the Time of Killing

Qur'an (2:172, 5:3, 5:5, 6:118-119, 6:145, 6:148, 6:150, 16:115, 16:116, 22:34, 22:36)

Raj, M. (2010). Stunning and slaughter. Ed. Penny Hawkins and Ian J. H. Duncan. The welfare of domestic fowl and other captive birds. *Springer Netherland Publishing*, 9, 259-277

Review by a working group convened by the Royal College of Physicians and endorsed by the Conference of Medical Royal Colleges and their Faculties in the UK (1995). Criteria for the diagnosis of brain stem death. *Journal of the Royal College of Physicians of London*, 29, 381-382

Sahih Muslim, 40 Hadith Nawawi 17.

Saposnik, G., Basile, V.S. & Young, G. B. (2009). Movements in brain death: A systematic review. *The Canadian Journal of Neurological Sciences*, 36, 154-160.

Sunkar, I. (2008). The global Halal trade, trends and issues. *The Halal Journal*, 32-34.

Terlouw, C.E., Bourguet, C., Deiss, V. & Mallet, C. (2015). Origin of movements during stunning and bleeding in cattle. *Meat Science*, 110, 135-144.

The Economist (2009). Cut throat competition: Feeding Europe's Muslims is a growing business. http://www.economist.com/node/14460095 (Accessed, 22/02/2016).

Thomson Reuters & Dinar Standard (2013). State of the Global Economy. http://www.dinarstandard.com/state-global-islamic-economy-report-2013 (Accessed, 24/02/2016)

Vimini, R. J., Field, R. A., Riley, M. L. & Varnell, T. R. (1983). Effect of delayed bleeding after captive bolt stunning on heart activity and blood removal in beef cattle. *Journal of Animal Science*, 57, 628-631.

WATOK (The Welfare of Animals at the Time of Killing (England) Regulations) 2015. Statutory Instruments No. 1782

Williams, J. C., Vimini, R. J., Field, R. A., Riley, M. L. & Kunsman, J. E. (1983). Influence of delayed bleeding on sensory characteristics of beef. *Meat Science*, 9, 181-190.

Zulkifli, I., Goh, Y. M, Norbaiyah, B., Sazili, A. Q, Lotfi, M., Soleimani, A. F. & Small, A. H. (2014). Changes in blood parameters and electroencephalogram of cattle as affected by different stunning and slaughter methods in cattle. *Animal Production Science*, 54, 187-193.