An update on halal slaughtering techniques: current methods and ongoing research on halal meat production techniques and their implication on animal welfare

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Abstract

The ethical and economic significance of slaughtering animals for consumption by people of faith cannot be underestimated. On one hand, there are concerns for the welfare of animals during rearing, transport and slaughter, on the other hand, the market for halal meat products continue to grow at an exponential rate which has attracted the attention of independent and the mainstream retailer multiples. This paper considers the slaughter methods approved for the main species of animals slaughtered for consumption by Muslims; beef, lamb, goats and poultry. It further examines the rationale for approving and rejecting some methods of stunning and the implication this has on the welfare of animals. Areas where further research is needed to improve animal welfare during halal slaughter are also highlighted, and the authors have argued why a dialogue between animal welfare researchers, Islamic scholars and halal certification or accreditation bodies is vital in creating knowledge exchange between key stakeholders with a view to improving animal welfare during halal meat production.

Keywords: Animal Welfare; Halal Slaughter; Meat; Blood loss; Stunning and Slaughter; Slaughter Without Stunning.

1. Introduction

Halal and shechita slaughter are the two main religious rites of economic significance due to the large number of animals slaughtered for consumption, particularly by Muslims. One of the reasons for the continued growth of the halal market is the rapid expansion in the global Muslim population. European Council Regulation, EC1099/2009 makes it an offence to slaughter any animal without stunning, with the exception of those slaughtered in accordance with religious rites, mainly for consumption by followers of the Islamic and Jewish faiths. It must however be noted that EU member states have the right not to exercise the derogation, which has led to a number of member states banning slaughter without stunning. The Wallonia region of Belgium was the latest to ban the practice on perceived animal welfare grounds in 2019. In Finland, simultaneous application of a stun and neck cutting is required, this is arguably practically impossible to do. While the majority of halal slaughter is carried out with stunning, the Jewish authorities do not approve pre-slaughter stunning for kosher meat production. In the UK for instance, data from the Food Standards Agency (FSA) suggests that while no animal is stunned prior to Shechita slaughter, over 80% of halal meat is from animals that have been stunned prior to bleeding (FSA, 2018). A European Commission funded research project (DIALREL) also found that up to 53% of animals were stunned during halal slaughter within the European Union (EU) (DIALREL, 2010). The acceptability of stunning for halal meat production is also prevalent in Muslim-majority countries, including Malaysia, Indonesia, Saudi Arabia, the UAE and other countries in the Middle East. In fact, many countries in the Middle East import the majority of their meat from Australia, Brazil and New Zealand, and all these major exporting countries stun animals prior to slaughter. Member states of the Gulf Cooperation Countries (GCC) have unanimously approved a unified Gulf halal standard, the GSO 993 standard, which all exporting countries to GCC countries (Saudi Arabia, the UAE, Qatar, Bahrain, Kuwait and Oman) must comply with. According to the standard, the following methods of stunning are halal compliant; head-only electrical stunning of small ruminants and

50 percussive stunning of large ruminants. The OIC/SMIIC halal standard (OIC/SMIIC 1:2019)
51 appears to be the widely used halal standard, in fact it has been officially adopted by 45 of the
52 57 OIC countries. The Organisation of Islamic Cooperation (OIC) is a membership
53 organisation made up of mainly Muslim-majority countries formerly founded in May 1971
54 following a 1969 summit by heads of state and government. It is worth noting that the different
55 variants of GCC halal standards originated from the OIC/SMIIC 1 standard. With regard to the
56 stunning of poultry, OIC/SMIIC 1: 2011 made reference to the use of non-lethal stunning but
57 the revised standard, OIC/SMIIC 1: 2019 makes no reference to the stunning of poultry
58 although it permits the use of reversible (electrical) stunning for other species. It is unclear
59 whether electrical water bath stunning is now prohibited.
60 It is important to note that while there are differences in Islamic scholarly opinion on the
61 compatibility of stunning with the halal rules, reversible stunning is widely accepted (Anil,
62 2012). In the UK for instance, the majority of halal certification bodies approve head-only
63 electrical stunning, while controlled atmosphere stunning (CAS) and mechanical stunning
64 methods are the least favoured (see table 1 below). Nonetheless, the first author is aware of the
65 approval of abattoirs that use CAS and mechanical stunning in the UK, Europe and Australia.
66 [INSERT TABLE 1 ABOUT HERE]
67 The welfare aspects of halal slaughter have been widely discussed (Aghwan et al., 2016;
68 Farouk et al., 2016). As highlighted earlier, the majority of halal slaughter is carried out with
69 stunning, but this is not to suggest that stunning is unanimously approved by all Islamic Jurists
70 or accepted by all consumers. The acceptability of stunning depends on the species of animals
71 and the method of stunning, with emphasis on the animal remaining alive (but unconscious)
72 prior to bleeding. To evaluate the perception and level of acceptability of stunning among
73 Islamic scholars, Fuseini et al (2017) carried out a survey of Islamic scholars. They found that
74 while the majority of scholars indicated that they accept reversible stunning, there is a minority

who do not approve any form of stunning under any condition. In a separate survey of English halal consumers' preference for meat according to the method of slaughter, Fuseini and Knowles (2020) found that the majority of consumers prefer meat from animals slaughtered without stunning. This is because many consumers are unsure about the compatibility of stunning with the halal rules, so they over cautiously avoid meat from animals stunned prior to slaughter.

The objective of this paper is to consider the main methods of halal slaughter and evaluate the acceptability of stunning based on the species of animals. Ongoing research on the development of new systems of reversible stunning of beef and poultry that are likely to appeal to the Muslim authorities are also explored.

2. Halal Slaughter Methods

Within the European Union and globally, there are three main approved methods of halal slaughter; slaughter without stunning, pre-slaughter stunning and post neck-cut stunning. The choice of a method of slaughter is mainly based on whether any treatment prior to bleeding would cause the death of animals. Table 2 below shows the methods of slaughter currently approved by some countries in Europe. It is important to note that for meat to be halal, the animal must be alive (see Quran 5:3), but not necessarily conscious, at the time it is bled out. Pre-slaughter events that can impact the welfare of animals and may even result in their death include long distance transport, rough pre-slaughter handling (including restraint) and stunning. Halal certification bodies usually focus on the point of slaughter, with no emphasis on pre-slaughter events. For the purpose of this paper, emphasis is on the compatibility of stunning (pre-slaughter and post-slaughter stunning) to the rules of halal meat production.

[INSERT TABLE 2 ABOUT HERE]

2.1.Slaughter without stunning

Slaughter without any form of stunning is the traditional halal method of slaughter. In fact, it was the only method of slaughtering animals for both conventional and religious rites until the mid 1800s when mechanical stunning was first introduced in the form of a poleaxe (Karczewski, 2011). As pointed out earlier, animals need to be alive during halal slaughter, this has meant that, given the choice, the majority of Muslims would choose meat from animals that have been slaughtered without stunning over those from stunned animals (see Fuseini and Knowles, 2020). Others hold a view that meat from animals slaughtered without stunning are of the highest spiritual quality (Farouk et al, 2014), because this was the exclusive method used by the Prophet of Islam, Mohammed (PBUH) (Khalid et al, 2015).

It is also worth noting that some religious authorities hold a view that slaughter without stunning offers better protection to the welfare of animals in comparison to animals stunned prior to slaughter. In written evidence to an All-Party Parliamentary Group (APPG) into religious slaughter of red meat (beef and lamb) in the UK, Shechita-UK rejected the idea of using any form of stunning during shechita slaughter. They explained that, in their view, the shechita cut renders animals irreversibly unconscious, they are therefore content that there is no need to use any form of stunning. This view is consistent with the findings of Grandin and Regenstein (1994) who found that when 3000 formula-fed calves were slaughtered without stunning (in line with shechita guidelines) in the US, the animals did not show any behavioural indicators of pain, with the exception of a ‘slight flinch’ when the knife touched the neck. The majority of animal welfare scientists however hold a different view on the pain associated with slaughter without stunning. Gibson et al (2009) carried out an objective assessment of the pain associated with neck cutting (without stunning) on fourteen Angus steers using Electroencephalogram (EEG) recordings. They concluded that ventral incision is perceived by animals as a noxious stimulus. Gregory et al (2012) identified three complications that may occur during slaughter without stunning of cattle; i) false aneurysms resulting in premature

arrested blood flow, ii) blood escape into the respiratory tract during bleeding, and iii) delay in the time of collapse after neck cutting which can be interpreted to be a delay in the initiation of the loss of consciousness.

2.2.Pre-slaughter stunning

This method of slaughter is the main halal slaughter technique used within the EU and in the top three global lamb exporting countries, that is, Australia, New Zealand and the UK. It must be reiterated that not all methods of stunning are approved for halal slaughter. As a general rule of thumb, the majority of halal certification bodies approve non-lethal (reversible) stunning techniques. In the UK, for instance, approximately 75% of small ruminants are electrically stunned prior to halal slaughter. In New Zealand and Australia, on the other hand, all animals (irrespective of species) are stunned prior to halal slaughter using a range of different stunning techniques. Nonetheless, the proportion of small ruminants stunned prior to halal slaughter in the UK has been decreasing. Data from the UK's FSA indicate that in 2011, 90% of small ruminants were stunned prior to slaughter, this decreased to 85% in 2013 and further dropped to 75% in 2015. To increase halal consumer confidence in meat derived from animals stunned prior to slaughter, New Zealand permits a stun recovery demonstration as an assurance tool (this is described in more detail later in this paper). New Zealand's stun recovery demonstrations and the UK's proposed demonstration of life assurance schemes will be covered later in this paper. Table 1 above shows the UK halal certification bodies that approve stunning as well as the certifiers who do not. The various methods of stunning and their compatibility with the halal rules will be discussed later in this paper.

2.3.Post neck-cut stunning

This method of slaughter involves cutting the neck of a conscious animal and then stunning it immediately to ensure that the period of consciousness is limited to a short duration. Lambooij and Hindle (2012) found that it took veal calves on average of 80 s to lose consciousness when

slaughtered without stunning, however, post neck-cut stunning using captive bolt guns induced loss of consciousness within 4 s (time between neck-cutting and application of the stun). Gregory et al. (2012) recommended post neck-cut stunning as a potential solution to mitigating complications (e.g., arrested blood flow) during slaughter without stunning in cattle. Many researchers would agree this is a compromise on animal welfare, but it arguably provides an improvement over slaughter without stunning. From a halal consumer point of view, post neck-cut stunning guarantees a live animal at the point of neck cutting or bleeding. However, the first author's personal communication with some halal certification bodies revealed that some certifiers have concerns over the use of penetrative captive bolt guns as a post neck-cut stunning device, because they are of the view that the gun is the main cause of death, and not blood loss. Due to these doubts over its compatibility with the halal rules (when mechanical stunning devices are used), post neck-cut stunning is the least favoured method of slaughter for halal meat production.

3. Stunning methods based on species of animals

The species of animal influences the choice of halal method of stunning. It is not uncommon for a halal certification body to accept stunning for one species and not for others. For instance, the UK's Halal Food Authority (HFA) accepts stunning for small ruminants and poultry but not for large ruminants. Even with poultry, not all methods of stunning are approved by the HFA; water bath stunning is acceptable while controlled atmosphere stunning is not. The halal standard approved for Gulf Cooperation Countries (GSO 993) also approves electrical head-only stunning for beef and lamb, percussive stunning of beef but no stunning is approved for poultry. Controlled atmosphere stunning of poultry is generally prohibited by the major halal standards, nonetheless, some halal certification bodies in Europe and Australia approve it.

3.1.**Halal slaughter of small ruminants**

The main methods of conventional and halal slaughter of small ruminants include slaughter without stunning, pre-slaughter stunning with electrical head-only, pre-slaughter stunning with electrical head-to-body as well as pre- and post-slaughter stunning using mechanical (captive bolt) stunning devices. Electrical stunning (head-only) is the commonest method of stunning used for halal meat production globally. All the major halal importing countries, including Saudi Arabia, the UAE, Kuwait, Qatar and others permit the importation of meat from sheep and goats that have been stunned using electrical head-only stunning. This is because animals are unlikely to die when stunned with the electrical head-only technique. To demonstrate this, Orford et al (2016) electrically stunned (head-only) 275 sheep using a Jetco MS10 and Jetco MS105 electrical stunners. Using Electrocardiogram (ECG), they recorded heart function and found that there was no evidence of ventricular fibrillation in any of the sheep. Further, there is sufficient scientific evidence to suggest that electrical head-only stunning of small ruminants, when performed properly, is a humane method of slaughter (Blackmore and Newhook, 1982; Lambooy, 1982).

Electrical head-to-body stunning causes fibrillation of the heart (cardiac arrest) resulting in the death of animals. Anil and McKinstry (1991) stunned sheep using electrical head-to-body stunning and found that in addition to inducing epileptiform activity in the brain, there was cardiac fibrillation resulting in irreversible loss of consciousness. It is for irreversibility of loss of consciousness (and subsequent death) that many halal authorities do not approve the use of electrical head-to-body stunning.

Both penetrative and non-penetrative captive bolt stunning may also be used in small ruminants. Penetrative captive bolt stunning causes gross physical damage to the brain due to the penetrating bolt which penetrates the skull into the brain. As a consequence, animals may die (neurocentric death) prior to neck-cutting. For this reason, the majority of halal authorities do not approve mechanical stunning. The Malaysian halal standard (MS1500/2009) for

instance requires the animal to remain 'intact' after stunning, carcasses are rejected if the skulls are found to have any physical damage after inspection. Skull indentation, fractures and holes created by the bolt are all deemed to be 'damages' to the skull. Due to the uncertainties surrounding the reversibility of some methods of stunning, some halal certification bodies have taken a cautious stance by putting a blanket ban on all methods of stunning. The UK's Halal Monitoring Committee (HMC) and France's A Votre Service (AVS) are the two largest certifiers of meat from animals slaughtered without stunning in continental Europe.

Opponents of halal stunning (Muslim authorities who oppose pre-slaughter stunning) believe that stunning reduces the volume of blood loss. This claim has been addressed by Khalid et al (2015) who found that when lambs were stunned using three slaughter treatments (slaughter without stunning, post neck-cut electrical head-only stunning and pre-slaughter head-only electrical stunning), there was no statistical difference in the volume of blood loss between all treatments. Due to the effectiveness of electrical head-only stunning of small ruminants, and the fact that it is widely approved for halal slaughter, there is currently no known ongoing research to find an alternative method of stunning for small ruminants.

3.2.Halal slaughter of large ruminants

The three main animal proteins consumed by Muslims are poultry, sheep meat and beef in descending order of preference. While stunning is generally accepted during halal slaughter of small ruminants, only a handful of halal certification bodies approve stunning of cattle during halal beef production. This has meant that the majority of halal slaughter of cattle is carried out without any form of stunning. Gregory et al. (2012) addressed the welfare aspects of slaughtering cattle without stunning and noted the following concerns:

- The pain and/ or distress associated with restraining cattle by various methods e.g., lateral and dorsal recumbency positions as well as live hoisting by the hindleg (popular in some Muslim-majority countries).

- The pain associated with cutting the necks of conscious animals and
- The pain and/ or distress after the neck-cut

The method of bleeding cattle also presents some challenges. Halal slaughter is generally performed by ventral neck cutting, this implies that even if the cut is performed properly, oxygenated blood can still nourish the brain through the vertebral arteries which run along the back of the neck and are left intact after a ventral neck incision. Gregory et al. (2010) reported that complications during cattle slaughter can extend the time to collapse (an indication of the onset of unconsciousness) to over 60 s in some cattle. Fuseini et al (2016) carried out a review of halal beef slaughter methods in Europe and identified cattle as the least stunned species of animal during halal slaughter, they suggested that further research was needed to identify animal welfare-friendly halal compatible methods of slaughtering cattle. Mechanical stunning (penetrative and non-penetrative captive bolt) is the commonest method of stunning beef, however, this method is not approved by the majority of halal certification bodies. In the UK, the HFA is the largest certifier of meat from animals stunned prior to slaughter, but they do not accept any form of stunning for halal beef. The authors are aware of at least one UK abattoir certified by Halal Monitoring Board that applies penetrative captive bolt stunning, in Europe, Halal Quality Control also certifies penetrative captive bolt stunning. The Gulf halal standard (GSO 993) approves non-penetrative captive bolt stunning, however, this method is contrary to EU legislative requirements when used on ruminants over 10 kg (EC 1099/2009). In an effort to identify a halal compatible method of beef stunning, the Jarvis Beef Stunner (JBS) was developed by researchers in New Zealand. The JBS is an electrical head-only stunning system with an electro-immobilisation phase used to disrupt the electrical activity of the spinal cord in order to minimise post-stun convulsions so that slaughter operatives can bleed animals safely. Wotton et al (2000) reported that the use of electro-immobilisation can mask the recovery of cattle from the stun, it is also contrary to EU legislation to use any immobilisation techniques.

As a consequence, the JBS used in New Zealand cannot be used within the European Union. It is also worth noting that the JBS was adapted for use in the EU by incorporating a cardiac arrest cycle, this makes it incompatible with the rules of halal slaughter. While New Zealand continues to use the JBS with electro-immobilisation, research must continue to develop a beef stunning method that would be suitable for use globally by considering the needs of the Muslim community and ensuring that it complies with animal welfare regulations in all jurisdictions. In an effort to encourage research in this area, the Humane Slaughter Association (HSA) funded the PhD of the first author (AF) in Bristol University which has led to the production of a prototype electrical head-only beef stunner. There is also ongoing research in Australia looking at using microwave energy to stun cattle (see more details on microwave stunning below).

3.3.Halal slaughter of poultry

Water bath stunning is the main method used for halal poultry meat production. However, the welfare aspects of this method of stunning and its compatibility with the rules of halal meat production have been widely reported (Hindle et al 2010; Shields and Raj, 2010; Gentle, 2011; Shahdan et al, 2016; Fuseini et al, 2018). Prior to immersion into the electrified water bath, birds are inverted and shackled, this procedure has been shown to be stressful (Sparrey and Kettlewell, 1994), leading to broken bones in end-of-laying hens (spent hens) (Gregory and Wilkins, 1989) as well as exposing birds to pre-stun electric shocks (Rao et al, 2013). A pre-stun shock is a painful electric shock that a bird may be exposed to if the entry to the water bath is wet and electrified. To prevent this, the entry to the bath must be designed with a material that does not conduct electricity. The majority of halal certification bodies prefer high frequency stunning because stunning with high frequency water bath is unlikely to kill birds, but birds are more likely to recover quickly from the stun. The UK's HFA recommends of use of 1000 Hz in line with UK and EU legislative requirements. It is important to note that during

water bath stunning current flows through the whole body (from the head through the body to the feet) (Raj et al, 2006). This presents a concern from a halal perspective in that the heart can be fibrillated, which can cause the death of birds (Fuseini et al, 2018). Due to the reported animal welfare and halal compatibility issues with water bath stunning, some halal standards do not recognise it as a halal compatible slaughter method. The GSO 993 halal standard, which has been widely adopted by countries in the Middle East does not recognise water bath stunning as halal compliant, although it is the main stunning technique used within the EU. The reluctance of some certifiers to recognise water bath stunning has meant that millions of birds are slaughtered without any form of stunning. As a result of the shortfalls of water bath stunning, over 200 global leading food processing companies have committed to ending water bath stunning by 2026 at the latest under the 'Better Chicken Commitment' (Peacock and Mendez, 2020). The Better Chicken Commitment is a set of improved broiler welfare standards initiated by the major animal welfare organisations around the globe including the Humane Society of the United States, Compassion in World Farming, World Animal Protection, Mercy for Animals, Animal Equality and others. From halal certifiers' point of view, this presents a challenge in that water bath stunning is the only approved stunning method. Unless an alternative for water bath stunning is found before 2026, many certifiers could revert to slaughter without stunning.

A minority of halal certification bodies in the EU (particularly Germany and Holland) and Australia approve controlled atmosphere stunning (CAS). This is a controversial method of stunning for halal meat production because CAS is currently not approved by any of the highly regarded international halal standards (SMIIC 1: 2019; GSO 993; MS1500:2009). Opponents of this method insist that it is not reversible, in fact in the UK, the law requires birds to be killed before they exit the gas compartment. This is contrary to the halal rules and, as a consequence, the majority of halal certification bodies in the UK do not approve CAS for halal chicken

298 slaughter. For CAS to appeal to halal certification bodies, research or demonstrations are
299 needed to show that some gases or gaseous mixtures do not cause instantaneous death of birds,
300 this is the only way researchers can provide some assurance to the halal authorities and
301 consumers.

302 **4. Ongoing research on halal compatible stunning**

303 The quest to find animal welfare-friendly and halal compatible methods of stunning for some
304 species of animals, particularly poultry and cattle continues. Electrical head-only stunning of
305 small ruminants appears to be effective and widely accepted for halal slaughter, so there is no
306 urgent need to develop new stunning systems for sheep and goats. The situation with cattle and
307 poultry is however different, mechanical stunning is the commonest method used for beef
308 slaughter while water bath stunning and CAS are the main methods for poultry. Although
309 mechanical stunning is an effective method from animal welfare standpoint, it is not approved
310 for halal by the major certification bodies. CAS is also deemed a killing method, hence not
311 approved for halal, whilst water bath stunning on the other hand has well documented animal
312 welfare and halal compatibility issues. The following are ongoing research aimed at producing
313 new stunning systems for beef and poultry that are likely to be accepted by the Muslim
314 community for halal slaughter.

315 **4.1.Microwave energy stunning (cattle)**

316 This system uses focused microwave energy to increase the temperature of the animal's brain
317 by a few degrees to a point where they lose sensibility (Small et al., 2013; Rault et al., 2014;
318 Small et al., 2019). Small et al (2019) suggested that with optimal energy application, there
319 were signs of animals recovering from the stun, approximately 100 s after application, this is
320 likely to appeal to halal certification bodies. Another promising feature of this novel technique
321 is that there is sustained duration of unconsciousness lasting between 80 s and 4 minutes post
322 treatment. This provides sufficient time for animals to be bled without any risk of recovery

during bleeding. Animals showed the following behavioural characteristics post application (Small et al., 2019); loss of posture, absence of eye reflexes (e.g., loss of corneal reflex), loss of response to pinprick, loss of coordinated movements and eye staring. It is unclear whether this research is nearing the production of commercial units.

4.2.Single Pulse Ultra-High Current Stunning

As pointed out earlier, the HSA funded a PhD project in Bristol University looking at the development of a new system of high voltage head-only stunning for adult cattle. It is an electrical head-only system which utilises high voltage application through two routes: neck and nose plate electrodes. An initial trial with this system has shown promising signs of cattle recovering consciousness, and the researchers involved have engaged the Muslim community by presenting updates on the progress of the project in several halal conferences. A prototype Single Pulse Ultra-high Current (SPUC) stunner has been produced, but it currently undergoing fine-tuning with a view to producing commercial units in the near future.

4.3.Electrical head-only stunning of poultry

The Royal Veterinary College in the UK is currently conducting research on dry electrical stunning of poultry, which is likely to eliminate some of the welfare issues associated with water bath stunning as well as comply with the halal rules. The system eliminates pre-stun electric shocks, inversion and shackling of live birds and likely to improve the effectiveness of the stun, in comparison with water bath stunning. Birds are restrained in a conveyor belt and stunned with the application of current through steel-wire electrodes to the head. This development is still in its infancy with further research needed before commercialisation. Due to its mode of application, it is likely to be reversible and will undoubtedly appeal to proponents of halal stunning and animal welfare organisations. The researchers have engaged the Muslim community with periodic meetings to update them on the progress of the research.

4.4.Dutch Vision Head-Only Electrical stunning of poultry

The Dutch Vision system was developed to address the shortfalls of water bath stunning and appeal to halal certification bodies. The system delivers a constant current of 275 mA per bird applied for 1 s followed by a lower immobilising current. It is automated to detect birds that receive no current or those that receive less than 240 mA of current. Such birds are redirected to a secondary line to be effectively stunned. While this system addresses the issue of insufficient current application synonymous with water bath stunning, it has failed to eliminate inversion and live shackling of birds. Research has shown that 95% of birds recover from the stun (Gerritzen et al., 2015), while this may appeal to some Muslims, the majority of halal certifiers would require 100% recovery before they approve the system. Due to the highlighted animal welfare (inversion and shackling) and halal-compatibility constraints, the Dutch Vision system cannot be regarded as a panacea for halal poultry stunning, and the quest for a halal compatible system should therefore continue.

5. Assurance of stun compatibility

As pointed out earlier, proponents of halal stunning insist that animals must not die from the stun, death must occur through blood loss. Some halal certifiers insist on conducting reversibility/recovery demonstrations to ensure that any approved method of stunning does not result in instantaneous death. Recovery demonstrations are however contrary to EU animal welfare regulations, they are only permitted under a licence for animal experimentation. In New Zealand (NZ), recovery trials on a handful of animals are permitted in abattoirs that participate in their 'halal programme'. The trials are used as assurance tools to demonstrate to importing countries and domestic halal consumers that the methods of stunning used in NZ abattoirs are non-lethal. A similar system was launched in the UK on the 22nd of April 2021 by the animal welfare minister at the Department for Environment, Food and Rural Affairs (DEFRA), Lord Goldsmith. The difference between the NZ and the UK protocols is that whilst the NZ protocol demonstrates full recovery of animals, the UK protocol only demonstrate signs

of life post-stun (e.g., return to rhythmic breathing), it is commonly referred to as the 'Demonstration of Life' protocol. The Food Standards Agency (FSA) supervises the delivery of the protocol in the presence of the plant's animal welfare officer and the participating halal certifier.

6. Encouraging dialogue

There is a disconnect between animal welfare research scientists and religious authorities. One of the objectives of the Dialrel project was to encourage dialogue between key stakeholders within the scientific, Muslim and Jewish communities (Dialrel, 2010). Islamic jurists are key stakeholders in halal meat production because they issue religious rulings (Fatwa) on the acceptability of new or emerging meat production technologies. Encouraging a dialogue between scientists and Islamic jurists would ensure that future research on stunning and other slaughter techniques could be tailored to cater for the needs of the halal sector. Islamic jurists would improve their knowledge in the science of slaughter and begin to appreciate the significance of certain slaughter techniques from animal welfare standpoint. Rather than engaging individual Islamic scholars, animal science and welfare researchers should dialogue credible Fatwa issuing authorities such as the International Islamic Fiqh Academy (IIFA), the Fatwa Committee of the National Council for Religious Affairs (as part of JAKIM in Malaysia) and the European Fatwa Council for Halal Transactions.

7. Labelling meat according to the method of production

In March 2021, UK Farming Minister, Victoria Prentis announced that the Department for Environment, Food and Rural Affairs (Defra) is launching a consultation on method of production labelling. She hinted that the consultation would include religious slaughter. While this is likely to be welcomed by consumers and animal welfare organisations, it is worth noting that labelling meat according to the method of slaughter, that is, stun and non-stun is likely to increase throughput for non-stun slaughter because many Muslims will consciously look for

meat from animals slaughtered without stunning. Conversely, if you consider this from the standpoint of the conventional (non-religious) consumer, it will assist them in making informed purchasing decisions about meat from animals stunned and those that have not been stunned (Lever and Fischer, 2018). There is also the issue of the hindquarters from shechita slaughtered meat, this is considered non-kosher unless it is adequately 'porged' by a trained Rabi to remove the forbidden fat and other tissues considered treif according to Jewish dietary laws. 'Porging' of the hindquarters is a laborious process which requires skill and expertise to perform, it is rarely carried out outside of Israel due to a shortage of skilled 'porgers' globally. Most Rabis are trained to 'porge' in Israel so it is easier to find Rabis with that expertise in Israel (Personal Communication, Felipe Kleiman, 2021). Anil (2012) reported that due to the lack of 'porging' within the EU, the hindquarters of kosher meat is passed to the conventional food chain. This may not be the case if legislation is introduced requiring meat to be labelled according to the method of slaughter.

7. Animal welfare implication and conclusion

The demand for halal meat products continues to grow due to the rapid expansion in the global Muslim population. While some Muslims insist on the slaughter of conscious animals in line with traditional religious values, there is an increasing number of halal certification bodies who approve pre-slaughter stunning on condition that animals do not die as a result of the stun. There is an effective and widely accepted stunning method for sheep and goats, but not for large ruminants and poultry. This has led to the slaughter of millions of cattle and birds without any form of stunning. To avert this, there is ongoing scientific research to develop animal welfare-friendly and halal compliant stunning systems for poultry and large ruminants, some of the systems have shown promising signs of success. There needs to be a dialogue between religious authorities and the scientific community to ensure that the religious authorities comprehend the science of slaughter and the rationale for stunning and other aspects of

slaughter. Interaction with the religious authorities would also ensure that scientists understand the religious dietary rules so that future research could be designed while taken the religious requirement into consideration to produce slaughter technologies that benefit animal welfare and complies with the requirements of religious rites.

Reference

Aghwan ZA, Bello AU, Abubakar AA, Imlan JC, and Sazili AQ. (2016). Efficient halal bleeding, animal handling, and welfare: A holistic approach for meat quality. *Meat Science* 121: 420-428.

Anil H. (2012). Effects of slaughter method on carcass and meat characteristics in the meat of cattle and sheep. AHDB Report. https://projectblue.blob.core.windows.net/media/Default/Research%20Papers/Beef%20&%20Lamb/slaughter_and_meat_quality_feb_2012-final-report.pdf (Accessed, 3/4/2021).

Anil MH and McKinstry JL. (1991). Reflexes and loss of sensibilityfollowing head-to-body electrical stunning in sheep. *The Veterinary Record* 128: 106-107.

Blackmore DK and Newhook JC. (1982). Electroencephalographic studies of stunning and slaughter of sheep and calves-Part 3: The duration of sensibility induced by electrical stunning in sheep and calves. Meat Science 7:19-28.

Dialrel (2010). Report on good and adverse practices-Animal welfare concerns in relation to slaughter practices from the viewpoint of veterinary sciences. http://www.dialrel.eu/images/veterinary-concerns.pdf (Accessed, 01/04/2021)

Farouk MM, Al-Mazeedi HM, Sabow AB, Bekhit AED, Adeyemi KD and Sazili AQ. (2014). Halal and Kosher slaughter methods and meat quality: A review. *Meat Science* 98: 505-519.

Farouk MM, Pufpaff KM, and Amir M. (2016). Industrial halal meat production and animal welfare: a review. *Meat Science* 120: 60-70.

448 Fuseini A, Knowles TG, Lines JA, Hadley PJ and Wotton SB. (2016). The stunning and
449 slaughter of cattle within the EU: a review of the current situation with regard to the halal
450 market. *Animal Welfare* 25: 365-376.
451 Fuseini A, Teye M, Wotton SB, Lines JA and Knowles TG. (2018). Electrical water bath
452 stunning for halal poultry meat production: animal welfare issues and compatibility with the
453 halal rules. CAB Reviews 13: 016.
454 Fuseini A, Wotton SB, Hadley PJ and Knowles TG. (2017). The perception and acceptability
455 of pre-slaughter and post-slaughter stunning for halal production: The views of UK Islamic
456 scholars and halal consumers. *Meat Science* 123: 143-150.
457 Fuseini A and Knowles TG. (2020). The ethics of halal meat consumption: preferences of
458 consumers in England according to the method of slaughter. Veterinary Record:1-6
459 Fuseini A, Knowles TJ and Hadley PJ. (2020). Halal food marketing: An evaluation of UK
460 *halal standards. Journal of Islamic Marketing*. https://doi.org/10.1108/JIMA-02-2020-0037.
461 Gentle MJ. (2011). Pain issues in poultry. *Applied Animal Behaviour Science* 135: 252-258.
462 Gerritzen MA, van Hattum T and Reimert H. (2015). Efficacy of the Dutch Vision high-low
463 electrical head-only poultry stunner. *Livestock Research Report* 442: 23.
464 Gibson TJ, Johnson CB, Murrell JC, Hulls CM, Mitchinson SL, Stafford KJ, Johnstone AC
465 and Mellor DJ. (2009). Electroencephalograhic responses of halothane-anaesthetised calves to
466 slaughter by ventral neck incision without prior stunning. *New Zealand Veterinary Journal* 57:
467 77-83.
468 Grandin T and Regenstein JM. (1994). Religious slaughter and animal welfare: A discussion
469 for meat scientists. *Meat Focus International* 3: 115-123.
470 Gregory NG and Wilkins LJ. (1989). Broken bones in domestic birds: handling and processing
471 damage in end of lay hens. *British Poultry Science* 30: 555-562.

Gregory NG, Fielding HR, von Wenzlawowicz M and von Hollenben K. (2010). Time to collapse following slaughter without stunning in cattle. *Meat Science* 85: 66-69.

Gregory NG, von Wenzlawowicz M, von Hollenben K, Fielding HR, Gibson TJ, Mirabito L and Kolesar R. (2012). Complications during shechita and halal slaughter without stunning in cattle. *Animal Welfare* 21: 81-86.

Hindle VA, Lambooij E, Reimmert HGM, Workel LD and Gerritzen MA. (2010). Animal welfare concerns during the use of the water bath for stunning broilers, hens and ducks. *Poultry Science* 89: 401-412.

Karzewski J. (2011). Stunning evolution: Technology has refined the process of humane slaughter. Meat and Poultry Magazine, Sosland Publishing, Kansas City, USA

Khalid R, Knowles TG and Wotton SB. (2015). A comparison of blood loss during the 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.

Lambooij E and Hindle VA. (2012). Restraining and neck cutting or stunning and neck cutting of veal calves. *Meat Science* 91: 22-28.

Lambooy E. (1982). Electrical stunning of sheep. *Meat Science* 6: 123-135.

Lever J and Fischer J. (2018). Religion , regulation and consumption: Globalising kosher and halal markets. Manchester University Press, Manchester, UK. 1-183.

Orford F, Ford EA, Brown SN, McKinstry JL, Hadley PJ, Lines J, Knowles TG and Wotton S. (2016). The evaluation of two commercial electric sheep stunning systems: current applied and the effect on heart function. *Animal Welfare* 25: 331-337.

Peacock J and Mendez S. (2020). Measuring Better Chicken Commitment-compliant chicken supply chain: Report E018R01. The Humane League Labs, Rockville, USA. Pp2-5

495 Raj ABM, O'Callaghan M and Knowles TG. (2006). Effects of amount and frequency of
496 alternating current used in water bath stunning and of slaughter methods on
497 electroencephalograms in broilers. *Animal Welfare* 15:7-18.
498 Rao MA, Knowles,TG and Wotton SB. (2013). The effect of pre-stun shocks in electrical water
499 bath stunners on carcase and meat quality in broilers. Animal Welfare 22: 79-84.
500 Rault JL, Hemsworth PH, Cakebread PL, Mellor DJ and Johnson CB. (2014). Evaluation of
501 microwave energy as a humane stunning technique based on electroencephalography (EEG) of
502 anaesthetised cattle. *Animal Welfare* 23: 391-400.
503 Shahdan IA, Regenstein JM, Shahabuddin ASM and Rahman MT. (2016). Developing control
504 points for halal slaughtering of poultry. *Poultry Science* 95: 1680-1692.
505 Shields SJ and Raj ABM. (2010). Critical review of electrical water bath stun systems for
506 poultry slaughter and recent developments in alternative technologies. *Journal of Applied*
507 *Animal Welfare Science* 13: 281-299.
508 Small A, Ralph J, McLean D, Keates H and Owen JS. (2013). Preliminary investigations into
509 the use of microwave energy for reversible stunning of sheep. *Animal Welfare* 22: 291-296.
510 Small A, Lea J, Niemeyer D, Hughes J, McLean D and McLean J. (2019). Development of a
511 microwave stunning system for cattle 2: Preliminary observations on behavioural responses
512 and EEG. *Research in Veterinary Science* 122: 72-80.
513 Sparrey JM and Kettlewell PJ. (1994). Shackling of poultry: is it a welfare problem? *World*
514 *Poultry Science Association* 50: 167-176.
515 Wotton SB, Gregory NG, Whittington PE and Parkman ID. (2000). Electrical stunning of
516 cattle. Veterinary Record 147: 681-684.