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

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9 **Abstract**

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

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

24 **1. Introduction**

25 Halal and shechita slaughter are the two main religious rites of economic significance due to
26 the large number of animals slaughtered for consumption, particularly by Muslims. One of the
27 reasons for the continued growth of the halal market is the rapid expansion in the global Muslim
28 population. European Council Regulation, EC1099/2009 makes it an offence to slaughter any
29 animal without stunning, with the exception of those slaughtered in accordance with religious
30 rites, mainly for consumption by followers of the Islamic and Jewish faiths. It must however
31 be noted that EU member states have the right not to exercise the derogation, which has led to
32 a number of member states banning slaughter without stunning. The Wallonia region of
33 Belgium was the latest to ban the practice on perceived animal welfare grounds in 2019. In
34 Finland, simultaneous application of a stun and neck cutting is required, this is arguably
35 practically impossible to do. While the majority of halal slaughter is carried out with stunning,
36 the Jewish authorities do not approve pre-slaughter stunning for kosher meat production. In the
37 UK for instance, data from the Food Standards Agency (FSA) suggests that while no animal is
38 stunned prior to Shechita slaughter, over 80% of halal meat is from animals that have been
39 stunned prior to bleeding (FSA, 2018). A European Commission funded research project
40 (DIALREL) also found that up to 53% of animals were stunned during halal slaughter within
41 the European Union (EU) (DIALREL, 2010). The acceptability of stunning for halal meat
42 production is also prevalent in Muslim-majority countries, including Malaysia, Indonesia,
43 Saudi Arabia, the UAE and other countries in the Middle East. In fact, many countries in the
44 Middle East import the majority of their meat from Australia, Brazil and New Zealand, and all
45 these major exporting countries stun animals prior to slaughter. Member states of the Gulf
46 Cooperation Countries (GCC) have unanimously approved a unified Gulf halal standard, the
47 GSO 993 standard, which all exporting countries to GCC countries (Saudi Arabia, the UAE,
48 Qatar, Bahrain, Kuwait and Oman) must comply with. According to the standard, the following
49 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

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

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

85 **2. Halal Slaughter Methods**

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

97 [INSERT TABLE 2 ABOUT HERE]

98 **2.1.Slaughter without stunning**

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

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

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

127 **2.2.Pre-slaughter stunning**

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

145 **2.3.Post neck-cut stunning**

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

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

162 **3. Stunning methods based on species of animals**

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

172 **3.1. Halal slaughter of small ruminants**

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

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

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

198 instance requires the animal to remain ‘intact’ after stunning, carcasses are rejected if the skulls
199 are found to have any physical damage after inspection. Skull indentation, fractures and holes
200 created by the bolt are all deemed to be ‘damages’ to the skull. Due to the uncertainties
201 surrounding the reversibility of some methods of stunning, some halal certification bodies have
202 taken a cautious stance by putting a blanket ban on all methods of stunning. The UK’s Halal
203 Monitoring Committee (HMC) and France’s A Votre Service (AVS) are the two largest
204 certifiers of meat from animals slaughtered without stunning in continental Europe.
205 Opponents of halal stunning (Muslim authorities who oppose pre-slaughter stunning) believe
206 that stunning reduces the volume of blood loss. This claim has been addressed by Khalid et al
207 (2015) who found that when lambs were stunned using three slaughter treatments (slaughter
208 without stunning, post neck-cut electrical head-only stunning and pre-slaughter head-only
209 electrical stunning), there was no statistical difference in the volume of blood loss between all
210 treatments. Due to the effectiveness of electrical head-only stunning of small ruminants, and
211 the fact that it is widely approved for halal slaughter, there is currently no known ongoing
212 research to find an alternative method of stunning for small ruminants.

213 **3.2.Halal slaughter of large ruminants**

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

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

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

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

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

259 **3.3.Halal slaughter of poultry**

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

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

291 A minority of halal certification bodies in the EU (particularly Germany and Holland) and
292 Australia approve controlled atmosphere stunning (CAS). This is a controversial method of
293 stunning for halal meat production because CAS is currently not approved by any of the highly
294 regarded international halal standards (SMIIC 1: 2019; GSO 993; MS1500:2009). Opponents
295 of this method insist that it is not reversible, in fact in the UK, the law requires birds to be killed
296 before they exit the gas compartment. This is contrary to the halal rules and, as a consequence,
297 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

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

327 **4.2.Single Pulse Ultra-High Current Stunning**

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

336 **4.3.Electrical head-only stunning of poultry**

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

347 **4.4.Dutch Vision Head-Only Electrical stunning of poultry**

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

360 **5. Assurance of stun compatibility**

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

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

377 **6. Encouraging dialogue**

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

391 **7. Labelling meat according to the method of production**

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

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

411 **7. Animal welfare implication and conclusion**

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

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

427

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