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Opinion

Poultry Welfare at Slaughter

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Abstract: Billions of poultry are slaughtered globally each year to provide protein for a rapidly expanding human population. The large number of birds produced in conventional systems presents animal welfare issues during production, transport, and at the time of slaughter. While we recognise the significance of welfare issues during rearing and transport, this paper highlights the welfare of poultry at the time of slaughter. The impacts of manual handling, inversion and shackling, use of inappropriate electrical stunning parameters, and the use of aversive gas mixtures during controlled atmosphere stunning are some of the evident welfare lapses; if the entrance to the water bath is wet and not isolated, bird welfare can also be compromised during water bath stunning because of pre-stun shocks. We also highlight the use of aversive stunning methods such as carbon dioxide gas at high concentrations, which has been shown to compromise bird welfare. In conclusion, we offer some reflections on ways to improve the welfare of birds during pre-slaughter handling, stunning, and neck cutting.

Keywords: pre-slaughter handling; shackling; slaughter; water bath stunning; animal welfare

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1. Introduction

The USA, China, and Brazil are the top three global producers of poultry meat, accounting for a combined share of 45% of the total volume produced [1]. In 2021, this figure was estimated to be approximately 140 m tonnes, which was valued at US $322.5 billion with a compound annual growth rate of 3.8% [2]. A recent report [3] on the growth of chicken production worldwide indicated that by 2050, poultry production is expected to reach 180 million tonnes. This would equal a 1200% increase since 1960, which is three times the growth rate of pork and ten times that of beef. The report argues further that chicken is on track to account for more than 40% of all meat eaten globally by 2030.

Poultry appears to be the most consumed animal protein because it is comparatively cheap, convenient (easy to cook), perceived as healthier (low fat) than other types of meat, and more versatile (easy to use in variety of dishes) [4–6]. However, despite the economic significance and potential for continued growth of the market, there are concerns over the welfare aspects of poultry rearing, catching, transport, and slaughter [7–9]. Poultry production is also a labour-intensive venture, and as more people move out of rural areas, labour shortages [10] pose a threat to effective animal welfare management that could impact growth [11]. The industry is also at risk of disease outbreaks [12] and food safety lapses [13,14]. Furthermore, there are environmental sustainability concerns regarding soil acidification [15], emissions of harmful gases such as ammonia from poultry waste [16], phosphorus pollution [17], the spread of pathogens, and nutrient leaking [18].

There are also issues with inappropriate stocking densities during rearing and transport, lapses in environmental enrichment during husbandry, and challenges related to potential bone breakages during the catching and collection of birds for transport from farms to abattoirs [19–21]. The current EU animal welfare legislation is in the process of being revised and several NGOs (e.g., Eurogroup for Animals) argue that this is a critical

time for Europe to take a stronger position against cruelty, improve meat chicken welfare standards, and acknowledge the requirements indicated in the European Chicken Commitment: i.e., the use of breeds that demonstrate higher welfare outcomes, lower maximum stocking densities without derogations, and the provision of natural light, perches, and pecking substrates in barns [22].

The incidence of birds being dead on arrival (DoA), described as the number of birds that die in transit between farms and abattoirs, is arguably the biggest animal welfare challenge facing the global poultry industry. Over a 4-year period (2001–2015), Petracci and colleagues [23] conducted a survey involving 70% of Italian abattoirs to estimate the incidence of DoA. During the period of the study, 1266 million broilers, 118 million turkeys, and 54 million spent hens were transported to the abattoirs surveyed. Spent hens are layer birds that have come to the end of their productive life. In total, 0.47% of broilers, 0.38 of turkeys, and 1.22% of spent hens were found to be DoAs. While these figures may seem insignificant, the number of birds involved is high. For instance, the figure of 0.47% of broilers being dead on arrival at abattoirs equates to 5.9 million individual birds out of a total of 1266 million. Park et al. [11] suggested a radical solution for reducing or preventing DoAs. They argued that on-farm poultry slaughter and the use of mobile processing units could potentially minimise handling and transit times. While this approach may be well suited for low-throughput processors, it may not be practical to implement in companies processing millions of birds.

While we recognise the welfare issues associated with events prior to the arrival of birds at abattoirs, this paper focuses on identifying poultry welfare issues that occur after their arrival: that is, pre-slaughter handling, stunning, and bleeding. It must be reiterated that within the UK and EU, there are humane slaughter regulations that stipulate how birds must be handled, stunned, and bled out to protect welfare (see WATOK, 2015; EC 1099/2009). Despite the existence of these regulations, however, welfare lapses still occur [8,24], and it is these lapses that this paper discusses. More specifically, we examine the welfare issues associated with the following procedures: inversion and shackling during water bath stunning and slaughter without stunning, pre-stun shocks during water bath stunning, aversion to gases during controlled atmosphere stunning, and ineffective stunning.

2. Primary Processing of Poultry

There are some key processes which birds must go through on arrival at abattoirs before they are bled out. These legislated processes are in place to protect the welfare of the birds and ensure that the resulting meat is fit for human consumption. Indeed, it is also worth noting that as well as the potential negative impact on bird welfare, rough pre-slaughter handling can affect the quality of the resulting carcass and meat [25]. For instance, rough handling of birds in the abattoir can impede their welfare by causing acute stress, which then leads to the production of meat of inferior quality known commonly as pale soft exudative (PSE) meat. PSE meats are characterised by an abnormal meat colour with high drip loss, conditions that affect the saleability of meat. Ali and colleagues [25] outlined the main welfare issues before stunning and slaughter as heat stress, feed and water withdrawal, crating and transport, and inversion and live bird shackling. Figure 1 below outlines the mandatory processes for birds (in the UK and within the EU) during primary processing in abattoirs that use water bath stunning [26]. Where animals are stunned using controlled atmosphere (gas) stunning, several steps in Figure 1 are not required, including the removal of birds from transport containers, and inversion and shackling. Non-stun abattoirs follow the same procedures as water bath stunning, except for the stunning stage, which is not performed.

On arrival at abattoirs using water bath stunning, birds are usually rested in a lairage. They are first unloaded from transport modules and antemortem inspected for notifiable

diseases. In addition to inspection for diseased birds, DoAs can also be identified during this antemortem inspection. Jacobs et al. [20] and Caffrey et al. [27] identified the incidence of DoAs as an important indicator of the compromise of birds' welfare from farm to abattoir. While still in their transport containers or crates, birds may spend some time in the lairage until they are removed from the containers to be inverted and shackled. The shackled birds are then conveyed through an electrified water bath to be stunned before they are bled out; we should note that the removal of individual birds from containers is not needed during controlled atmosphere stunning. The welfare aspects of pre-slaughter handling, water bath stunning, controlled atmosphere stunning, and slaughter without stunning are discussed below. To efficiently assess the welfare consequences of pre-slaughter procedures, the European Food Safety Authority (EFSA) recommends the use of animal-based measures (ABMs), some of which include death, deep breathing, injuries, flight, muscle jerk, panting, vocalisation, and wing flapping [24]. Table 1 is a list of ABMs related to events prior to and following stunning and neck cutting, including their definitions and welfare consequences. The accurate identification of welfare hazards and impending consequences through the use of ABMs can be used to identify the structures, equipment, or personnel responsible for the welfare compromise incident. The EFSA (AHAW Panel) [24] defines a welfare consequence as a change in the welfare of an animal that results from the effect of one or more factors. These factors may be structural (facilities) or related to equipment (transport, shackling, and stunning equipment) or personnel (bird handlers and slaughterers).

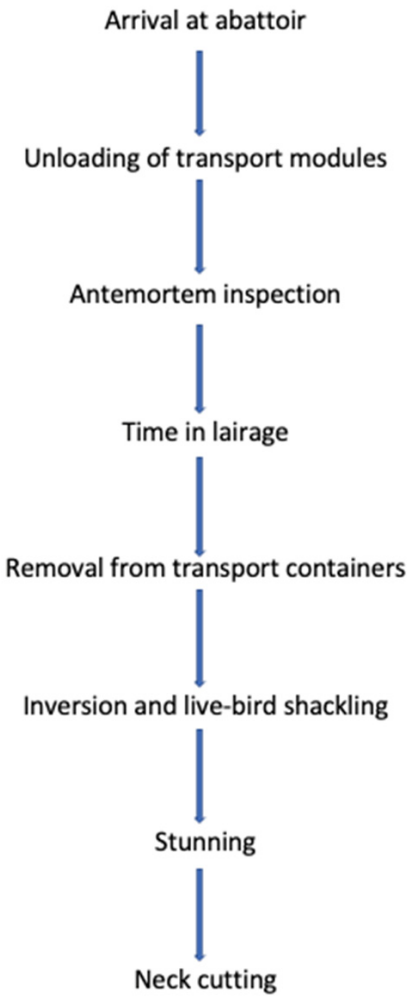

Figure 1. Primary processing operations during poultry slaughter with water bath stunning (adapted from Fuseini et al. [26], permission obtained).

Table 1. List of ABMs, their definitions, and welfare consequences (adapted from EFSA [24]).

ABM	Definition	Welfare Consequences
Attempt to regain posture	Head righting (attempt to raise head), head shaking, or wing flapping after stunning.	Consciousness
Bunching	Clustering together on one part of the available floorspace (see "huddling").	Fear
Death	Uncontrolled death of birds. Any bird that is found dead in the container or at the spot is considered a mortality or a DoA.	Heat stress, cold stress
Deep breathing	Deep breathing, often with open beak, can be accompanied by stretching the neck (gasping) [28].	Respiratory distress
Escape attempts	Attempts to move, run, or fly away from the situation [29].	Fear, pain
Flight	Moving, running, or flying away or attempts to do so, often accompanied by vocalisations (see "escape attempts").	Fear
Head shaking	Rapid shaking of the head, usually accompanied by stretching and/or withdrawal movements of the head [28].	Pain, fear, and/or respiratory distress
Huddling	Sitting close together in tight groups or clumps, often with open space in between.	Cold stress
Hyperventilation	Excessive rate and depth of breathing.	Respiratory distress
Injuries	Tissue damage (bruises, scratches, broken bones, dislocations) [30].	Pain
Maintenance of posture	Birds in sitting or standing position capable of keeping their heads lifted and birds regaining posture after loss of balance [31].	Consciousness
Muscle jerks	Muscle contractions similar to spasms, tremors, and pedalling movements of the legs.	Pain
Overcrowding	When the space allowance is insufficient for birds to sit all at the same time without overlapping. It is measurable by counting the birds per m^2.	Restriction of movement, heat stress
Panting	Breathing with short, quick breaths with an open beak.	Heat stress
Piling up	Birds crowding against and on top of each other.	Restriction of movement
Piloerection	Erection, ruffling, or bristling of feathers [32].	Cold stress
Presence of bile	Greenish bile or bile salt on the floor of the containers.	Prolonged hunger
Presence of urates or orange cast on the floor of containers	Crystallised urates on the floor of the container.	Prolonged hunger
Shivering	Shaking slightly and uncontrollably [32].	Cold stress
Vocalisation	Single or repeated short and loud shrieking (screaming) at high frequencies [33].	Fear, pain
Wing flapping	A prolonged bout of continuous, rapid wing-flapping [34].	Fear
Withdrawal reaction	Fast avoiding movement of the stimulated part of the body (i.e., neck, head, wing, or leg) [35].	Pain

3. Animal Welfare Issues Associated with Poultry Slaughter

In this section, we discuss the impact of pre-slaughter handling and slaughter with and without stunning on the welfare of birds. In addition to impacting animal welfare, rough

pre-slaughter handling has a significant impact on product quality and profitability [25] (as highlighted above, in relation to meat quality defects and the production of PSE meat).

3.1. Welfare Issues Associated with Pre-Slaughter Operations

To protect the welfare of birds during slaughter, efforts must be made to minimise manual handling. Minimal handling is possible in abattoirs where controlled atmosphere stunning is used because birds are exposed to gases or gaseous mixtures while they are in containers. Conversely, and as already indicated, birds must be removed from transport containers and individually restrained (inverted and shackled) prior to water bath, captive bolt, percussive blow, or cervical dislocation, and during slaughter without stunning [24]. Park and colleagues [11] suggested a combination of artificial intelligence and robotics to automate primary processing of birds with a view to reducing manual handling. There are several issues with the removal of birds from containers and their inversion and shackling. First, it puts birds in an unnatural position which has been shown to be stressful [36–38]. Secondly, birds lack a diaphragm, which means that when they are inverted, their viscera (internal organs) move to the thoracic cavity (chest area), thereby causing breathing difficulties that can lead to death if inverted for a long period of time [26]. Shackling has also been shown to cause bone breakages and trauma, particularly in spent hens. To estimate the level of damage caused by shackling, Gregory and Wilkins [39] observed the shackling of spent hens by inspecting them for bone breakages before and after shackling. They found a 44% increase in the proportion of birds showing freshly broken bones, which was concluded to be due to shackling. Kannan [37] noted that inversion and shackling induce fear and pain, resulting in 90% of birds flapping their wings immediately after shackling and 66% flapping when they experienced unevenness along the line. EFSA [24] suggest that wing flapping is likely to result in broken bones or dislocated joints. Wing flapping may be reduced by using breast comforters; one way of achieving this is to use a conveyor beneath the shackle line so that birds can rest on it from the start of shackling until they enter the electrified water bath.

During water bath stunning, birds may experience potentially painful electric shocks at the entrance to the water bath. This occurs when the entry to the water bath is wet and not isolated (live), which results in it being electrified. Rao et al. [40] explained that pre-stun shocks occur when any part of the bird touches the electrified water bath before the bird loses consciousness; wing flapping on entry to the water bath results in pre-stun shocks [24]. It is important to note that pre-stun shocks merely shock birds, but do not stun them. Within the European Union, there is a legislative requirement under Annex 1 of EC 1099/2009 for abattoirs to put in measures aimed at preventing pre-stun shocks to protect bird welfare. Despite this requirement, research has shown that pre-stun shocks are still prevalent in poultry abattoirs [40], although several preventative measures have been suggested [35,41,42]. In a technical note published by the HSA, it was suggested that abattoirs may be able to prevent the incidence of pre-stun shocks by taking the following steps:

1. Ensuring that water does not overflow at the entrance to the water bath.
2. Ensuring there are sensing devices fitted so that the current is only switched on when birds are in the water bath. This is practical in low-throughput abattoirs where birds are stunned one at a time.
3. In high-throughput abattoirs where it is impractical to switch off the current due to multiple birds passing through the water bath at any given time, a steep ramp (extended over the water) should be bolted to the entrance to the water bath to ensure that the head and wings of the bird enters the water first (see Figure 2) [35].

3.2. Welfare Issues Associated with Ineffective Stunning

Water bath stunning of birds is one of the most problematic methods of stunning from a welfare standpoint. Its effectiveness depends on several factors: bird size, foot resistance/impedance, amount of electrical current, amount of voltage, and frequency. In

addition to the welfare issues associated with inversion, shackling, and pre-stun shocks, birds may also be stunned with electrical currents that are not of sufficient magnitude. In the European Council Regulation EC 1099/2009, it is stated that birds must be stunned with a minimum of 100 mA; however, there is sufficient evidence to indicate that millions of birds are currently stunned in UK commercial abattoirs with currents far below the stipulated minimum in EC 1099/2009 and in UK legislation, namely the Welfare of Animals at the Time of Killing (WATOK, 2015) Regulation. A recent report published by the UK's Food Standards Agency (FSA) suggested that 3% of the 18.4 million birds slaughtered during the period of the survey (7–13 March 2022) were stunned using unapproved electrical parameters [43]. From an animal welfare perspective, the use of electrical parameters outside the regulations are likely to either not stun birds at all or merely immobilise them, thereby compromising the welfare of birds.

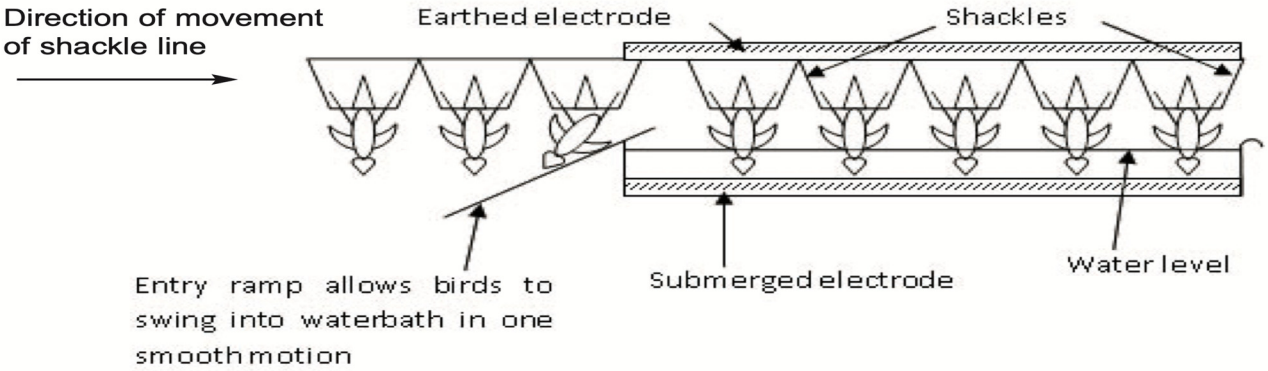

Figure 2. Prevention of pre-stun shocks with an entrance ramp which ensures that birds enter the water bath in a single smooth movement to be stunned immediately (image credit: Humane Slaughter Association (HSA). Reproduced with permission from the HSA from: Electrical Waterbath Stunning of Poultry, HSA 2016 [35]).

EFSA [24] identified poor electric contact as another factor responsible for ineffective stunning during water bath or dry electric head-only stunning of poultry. They explained that in the case of water bath stunning, this occurs between the legs and shackles or between the shackles and earth. In the case of dry electrical stunning of poultry, poor electrical contact may occur between the electrodes and the bird's head due to dirty electrodes, incorrect electrode placement on the head, or simply the case of an intermittent contact. Table 2 outline some of the welfare hazards associated with water bath stunning.

Table 2. Animal welfare hazards associated with water bath stunning, and their definitions (definitions adapted from [24]).

Welfare Hazard	Definition
Manual restraint	Catching and immobilising birds by hand.
Inversion	A method of restraint which involves holding birds in an unnatural upside-down position.
Shackling	A method of restraint which involves hanging birds in an upside-down position with both legs held in metal shackles.
Pre-stun shocks	Exposure of birds to electric shocks prior to loss of consciousness.
Poor electric contact	Insufficient electric contact for effective stunning of birds.
Short exposure time	Exposure to electric current too short to cause epileptiform activity in the brain.
Inappropriate electrical parameters	Use of electrical parameters (frequency, current, voltage, waveforms) of low magnitude incapable of inducing epileptiform activity in the brain.

Frequency is an important electrical parameter. There are also issues with the use of high-frequency electrical stunning of poultry, which is characterised by a short duration of unconsciousness that presents a danger that many birds may recover consciousness during bleeding. Birds that recover during bleeding will experience the pain associated with the neck cut until death supervenes through sufficient blood loss. Zivotofsky and Strous [44] concluded that the fact that some birds can recover during bleeding defeats the objective of stunning. In multi-bird water bath stunners, birds with high resistance also receive low amount of current in comparison to those with low resistance [26]. Birds receiving low amounts of current are unlikely to be effectively stunned; such birds receive painful electrical shocks [45]. While some of the issues associated with ineffective stunning can be mitigated, others are difficult to overcome. For instance, abattoirs using high frequencies and abnormally low-electrical-current water bath stunning can solve the welfare issues by changing the frequencies and currents, respectively. Hindle et al. [45] noted that it is more difficult to solve the issue of resistance because it is associated with different factors: the presence of multiple birds in the water bath, the condition of shackles (presence of faecal matter and feathers), and the bone structure and thickness of the skull.

3.3. Welfare Issues Associated with Controlled Atmosphere Stunning

Due to the apparent welfare issues associated with water bath stunning of poultry (as discussed above), there has been a decline in the number of abattoirs using this method of stunning in the UK over the last decade or so in favour of controlled atmosphere stunning. In 2011, only 37% of poultry were stunned using controlled atmosphere stunning. This figure had almost doubled to 71% by 2013, and, after a slight drop in 2018 to 70%, it now stands at 80% in 2022 [43,46,47]. While the move away from water bath stunning to controlled atmosphere stunning may have eliminated some welfare issues (including manual handling, inversion and shackling of live birds, pre-stun shocks, and ineffective stunning), controlled atmosphere stunning is not without its own problems and welfare issues. McKeegan and colleagues [34] noted that while controlled atmosphere stunning has the potential to improve bird welfare, there is a lack of consensus as to which gas mixtures are more effective and humane. Different approaches can be employed to stun poultry with gases or gaseous mixtures. In the UK, the most common approaches in commercial abattoirs include the following:

Biphasic approach, which involves exposure to two phases of gaseous mixtures; an anaesthetic phase (involving 40% CO_2, 30% N_2, or 30% O_2) is applied for approximately 60 s to induce brain dysfunction, followed by exposure to a high concentration of CO_2 (approximately 80%) in air for approximately 120 s.

Anoxia approach, which involves exposure to inert gases (argon or N_2) with less than 3% residual O_2.

Hypercapnic anoxia exposure, which involves exposure to inert gases with the addition of up to 30% CO_2 in less than 2% residual oxygen.

McKeegan et al. [34] found that birds exposed to hypercapnic anoxic medium showed strong respiratory responses, and this was exacerbated when birds were exposed to biphasic gas mixtures. On the other hand, birds exposed to anoxic conditions showed vigorous wing flapping while they were still conscious. It can be deduced from the findings of [34] that there are welfare issues associated with all three approaches; birds exhibiting strong respiratory responses are likely to be in respiratory discomfort, while those showing vigorous wing flapping are more likely to be injured as a result. Concerns have also been raised regarding the use of high concentrations of carbon dioxide to stun animals, including birds. Anton et al. [48] found that exposure of human subjects to high concentrations of CO_2 (between 40 and 55%) elicits pain sensations because it is nociceptive to humans. In birds, several researchers have shown that exposure to high concentrations of the gas is aversive because it activates both central and peripheral chemoreceptors which leads to painful respiratory responses [8,28,49]. It is worth noting that aversion to exposure to high

concentrations of CO_2 has also been reported in pigs [50–52]. Table 3 highlights some welfare hazards associated with exposure of birds to gases.

Table 3. Animal welfare hazards associated with the use of controlled atmosphere stunning of birds (descriptions adapted from EFSA [24]).

Welfare Hazard	Description
Exposure to high concentrations of CO_2	Exposure of conscious birds to CO_2 concentrations higher than 40% in the first and second phases is aversive. If the first phase is too short, birds may arrive at the second phase while still conscious. The second phase will have higher concentration of the gas.
Exposure to low concentrations of CO_2	If birds are exposed to overly low concentrations of the gas, some birds may not be rendered unconscious and may simply be immobilised. Exposure to low concentrations may also lead to prolonged induction of unconsciousness, which results in respiratory distress.
Overly fast decompression	If the decompression rate is too fast, birds experience pain and respiratory distress.

To mitigate the welfare issues associated with the use of some gases or gaseous mixtures, several suggestions have been put forward. Raj [8] suggested a combination of gases that are likely to eliminate aversion, arguing that the use of 30% CO_2 and 60% argon in air or 90% argon in air can be humane. McKeegan et al. [34] argued that while some gas mixtures may expose birds to either respiratory discomfort (hypercapnic anoxia and biphasic exposure) or vigorous wing flapping (anoxia), respiratory discomfort is a "price worth paying" when compared with wing flapping. They therefore recommended hypercapnic anoxia and biphasic exposure over anoxia. This view is highly contentious because in all instances, the welfare of birds is compromised. If indeed the objective of humane slaughter is to protect animal welfare during slaughter, animals must not suffer during slaughter. In fact, sections of the Muslim and Jewish communities have long held the belief that stunning is painful [53]; this is a legitimate stance given the fact that some stunning methods are risky in terms of animal welfare. The quest to find truly humane methods for the slaughter of poultry must continue to ensure that birds do not go through potentially painful and aversive procedures during slaughter.

3.4. Welfare Issues Associated with Slaughter without Stunning

European Council Regulation EC 1099/2009 mandates the stunning of all animals prior to slaughter for human consumption. However, EU member states can apply a derogation which allows slaughter without any form of stunning for religious rites. The UK (now outside the EU), Ireland, France, Poland, and others permit slaughter without stunning. From animal welfare standpoint, there are concerns that slaughter without stunning compromises animal welfare [54]. These concerns are related to the stress associated with pre-slaughter restraint (e.g., inversion and shackling in the case of poultry), the pain associated with the neck cut, and the latency of the onset of unconsciousness following neck cutting and during bleeding [24]. Table 4 outlines the main welfare hazards, their consequences, and mitigations during slaughter without stunning. There is evidence to suggest that the neck area is surrounded by high-density nociceptors (pain receptors), which send pain signals to the brain when the skin and tissues are cut during slaughter. EFSA [24] noted that birds may experience increased pain if blunt knives, multiple neck cuts, or changes in cut direction are present during slaughter without stunning because more nociceptors are affected in each case. The pain associated with neck cutting has also been reported in other species. In an experiment involving calves, Gibson et al. [55] used electroencephalograms to measure the electrical activity of the brain and concluded that slaughter without stunning is perceived as a noxious stimulus; in other words, the procedure is painful and compromises animal welfare. Other researchers have made similar conclusions about different species [56,57]. However, it is worth noting that other

researchers, albeit a minority, have concluded that when performed correctly, slaughter without stunning can be humane [58,59].

Table 4. Animal welfare hazards, consequences, and mitigations during slaughter without stunning (EFSA [24]).

Welfare Hazards	Welfare Consequences	Mitigations
Restraint: manual restraint, inversion, shackling, drops, and inclination of shackle line	Pain and fear	Avoid inversion and shackling by using cones, manually holding birds, or restraining in lateral recumbency prior to slaughter. Duration of restraint must be kept to a minimum.
Neck cutting: incomplete cutting of carotids, repeated cuts/sawing, stimulation of wound, live birds entering scalding tank	Consciousness, pain, distress, and fear	Keep wound open to aid rapid blood loss in order to promote death and continuously monitor birds to ensure that they do not enter the scalding tank alive.

Despite these welfare concerns, some halal consumers have indicated a preference for meat processed in this manner; it is regarded as meat of the highest spiritual quality [60] because it guarantees that the animal is alive at the point of exsanguination. Fuseini and Knowles [61] carried out a survey of halal consumers in England and found that the majority of consumers (69.9%) preferred meat from animals slaughtered without stunning. It must be noted that the debate surrounding the acceptability of stunning for halal meat production centres on whether stunning results in death of animals prior to bleeding and whether the procedure obstructs the rate and volume of blood loss [62]. Wotton et al. [63] showed that while some water bath stunning currents/frequency combinations may lead to the death of birds, there are some parameters within Annex 1 of EC 1099/2009 that support the recovery of birds post-stunning. Khalid et al. [60], on the other hand, demonstrated that there is no significant difference in final blood loss between slaughter with stunning, without stunning, or with post-neck-cut stunning. From these findings, it can be concluded that some methods of stunning are non-lethal, and that stunning does not lead to the retention of more blood in the carcass in comparison with slaughter without stunning. It must be noted that the concerns of Muslim consumers around the death of animals due to stunning or the impact of stunning on blood loss are unlikely to be shared by consumers who are not members of this faith community.

4. Quality Assurance Schemes

Quality assurance schemes establish standards, policies, and procedures for the maintenance of animal welfare and product quality. Assurance schemes such as Red Tractor and the Royal Society for the Prevention of Cruelty to Animals (RSPCA) Freedom Food focus on raising animal welfare standards on farms, during transport, and at the point of slaughter. The schemes play a vital role in improving animal welfare by developing standards that require humane handling and slaughter of poultry and other species of animals. The schemes can be either independent or retailers' own schemes, which usually require farmers and meat processors to meet certain minimum welfare requirements that are usually above those required by legislation. The higher welfare measures are aimed at attracting specific groups of consumers [64]. Nonetheless, these assurance schemes approve stunning methods such as water bath stunning and high-concentration CO_2 stunning, which have both been shown to potentially compromise bird welfare. The Better Chicken Commitment (BCC) aims to remove practices that potentially compromise bird welfare. The BCC is a set of welfare standards that has been signed by over 200 leading global food brands with a commitment to eliminate some of the welfare issues highlighted in this paper by the 1 January 2026.

5. Small Poultry Abattoirs and Animal Welfare

Poultry abattoirs are classed as small-, medium-, or large-throughput based on the number of birds they slaughter; this can differ from country to country. The UK's Ministry of Agriculture, known commonly as the Department for Environment, Food and Rural Affairs (DEFRA) defines small-scale suppliers as those processing fewer than 10,000 birds per year [65]. These operations usually take place on farms and tend to be seasonal processors. Cegar et al. [66], on the other hand, categorised small abattoirs as those slaughtering fewer than 5000 birds per day in commercial facilities in Serbia.

Small-scale abattoirs, in comparison with large-scale abattoirs, may offer some environmental sustainability and welfare improvements. For instance, small-scale abattoirs are local to farms in most cases, thereby eliminating the need for birds to be transported over long distances. A UK All-Party Parliamentary Group for Animal Welfare (APGAW) cited a survey which found that some animals travelled nearly 1000 km to a large-throughput abattoir [67]. Nonetheless, the same report indicated that large abattoirs (poultry and red meat) have the financial means to invest in animal-welfare-friendly infrastructure, such as better lighting in the lairage; good transportation, handling, and restraining devices; and regular in-service training for slaughter operatives and animal handlers. All these investments, when utilised properly by trained operatives, are likely to safeguard bird welfare. One might argue that the lack of improvement in infrastructure in some small abattoirs may be the origin of animal welfare lapses during lairaging, restraint, stunning, and slaughter.

The UK's Food Standards Agency carried out a survey comparing non-compliance (with animal welfare regulations) in small-, medium-, and large-throughput abattoirs, and they reported that all categories of abattoirs showed good welfare standards. In fact, they reported that 99.9% of animals (all species of animals) that went through UK abattoirs during the period of the survey were treated in accordance with UK welfare regulations [68]. These findings must be interpreted with caution; it should not be assumed that there is 99.9% welfare compliance all year round in the UK, and these results should not be used to suggest the compliance of abattoirs in other countries.

6. Conclusions

In terms of throughput, poultry is the most slaughtered group of animals for human consumption globally. Despite its contribution to the protein needs of the expanding global human population, there are apparent welfare issues associated with pre-slaughter handling, stunning, and bleeding of birds. There are three main slaughter protocols for poultry: slaughter without stunning (mainly for consumption by people of certain faiths), pre-slaughter stunning with controlled atmosphere, and pre-slaughter stunning with water bath. Unfortunately, there are welfare challenges associated with all these methods. Pre-slaughter issues such as inversion and shackling associated with water bath stunning and slaughter without stunning are eliminated during controlled atmosphere stunning; however, controlled atmosphere stunning can also lead to vigorous wing flapping and respiratory distress.

Further research is needed to find more humane methods for poultry slaughter. Modification of the entry to water bath stunners, prevention of overflow of water, and the use of sensing devices to switch on the current when birds are in the water bath may eliminate the issue of pre-stun shocks. Inversion and shackling during slaughter without stunning can be avoided by restraining birds manually by hand; however, this is likely to affect throughput in commercial abattoirs. Further research is needed to identify appropriate gas mixtures to effectively stun birds. It is important that such gases must provide an improvement over current systems that result in respiratory discomfort and vigorous wing flapping. If adopted fully, the Better Chicken Commitment welfare standards will address some of the welfare issues highlighted in this paper, such as inversion and live-bird shackling and the use of carbon dioxide stunning.

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