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# A comparative study between the legislations of the poultry slaughtering process in the United State of America, European Union, and Saudi Arabia

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**Abstract:** The purpose of the current study is to raise the question about making a comparison between international legislation in the United States, European Union, and legislation of Saudi Arabia derived from Islamic law regarding the poultry slaughtering process and the relationship of that to achieving safe and healthy food for humans. In addition, the study utilized the Holy Qur'an and the texts of the Prophet's hadith as primary sources. Additionally, various national and international laws, reports, and legislations were referenced as secondary sources for the review. Moreover, this study addresses a research gap by providing a comparative analysis that links Islamic and international legislation regarding poultry slaughter and examines its impact on food quality and safety. The study's findings indicate that Islamic Sharia provisions are in harmony with the regulations of the Kingdom of Saudi Arabia related to poultry slaughtering process. This alignment ensures the primary goal of the slaughter process, which is to quickly get rid of the blood and achieve the well-being of the poultry. Consequently, this results in high quality meat with low microbial content that can be preserved for a longer period compared to regulations in other global markets such as the USA and the European Union.

**Keywords:** laws and legislation; food safety; poultry slaughtering process; meat quality; global markets

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## 1. Introduction

Islamic dietary regulations delineate halal criteria, specifying permissible and lawful foods. With numerous halal products emerging from non-Muslim predominant regions, the risk of inadvertently consuming haram items is heightened. Halal certification serves as a pivotal mechanism for implementing halal standards and safeguarding the rights of Muslim consumers. This is due Islamic dietary laws are based on the Holy Quran, which is a revealed book, as well as the Hadith, which comprises the traditions of Prophet Muhammad PBUH. Muslim jurists further derive and deduce these laws from both sources through extrapolation (Al-Mahmood and Fraser, 2023).

In Islam, there are widely recognized guidelines for Halal (allowed) and haram (forbidden) practices. The fundamental principle is that everything created by Allah is permissible, with certain exceptions like pork, blood, alcohol intoxicants, meat not slaughtered according to Islamic law, and food dedicated to someone other than Allah. Only Allah has the authority to determine what is lawful and unlawful, and changing this is considered a grave sin. The prohibition of what is permitted or the permission of what is prohibited is akin to ascribing partners to Allah and falls outside the sphere of Islam. The prohibition of certain things is based on their impurity and harmfulness, and Muslims are not required to question the reasons behind these prohibitions. What is allowed is abundant, and what is prohibited is needless. Good intentions cannot

justify wrongdoing, and Islam emphasizes the use of lawful means to achieve praiseworthy ends. Doubtful matters should be avoided to avoid doing anything wrong. Moreover, Islamic laws apply universally to all individuals, regardless of race, creed, or sex (Regenstein and Chaudry, 2001).

Moreover, when comparing poultry slaughter regulations between the United States of America (USA) and European Union (EU) as global markets with Kingdom of Saudi Arabia (KSA), as Islamic countries, there are some notable differences. In Islamic countries like Saudi Arabia, the process of Halal slaughter is followed strictly and adheres to Islamic dietary laws. This involves specific requirements for the slaughter method, such as using a sharp knife to swiftly sever the trachea, esophagus, and Blood vessels located in the bird's neck while reciting a religious blessing (WHO, 1997). In the USA, the United States Department of Agriculture (USDA) regulates poultry slaughter. The USDA enforces guidelines under the Federal Poultry Products Inspection Act to ensure food safety and prevent the spread of diseases. The regulations focus on sanitary conditions, proper handling, and inspection of poultry products. Both nations emphasize the safety and quality of poultry items, but the specific regulations and requirements differ due to cultural, religious, and legal factors. It is important to consult the official regulations and guidelines of each country for a comprehensive understanding of the specific requirements for poultry slaughter (USDA, 2022).

In recent years, there has been an increasing interest in food regulations and slaughter policies worldwide, particularly concerning Halal with other religious mandates. Numerous studies have examined the impact of these regulations and policies on food quality and safety. The regulations and policies related to poultry slaughtering are vital for ensuring poultry meat quality and safety. For example, it has been found that the differences in legislation between USA and EU (Lever and Miele, 2012) that can significantly impact poultry meat quality and safety (Sirri et al., 2017).

In the USA, Prior to being slaughtered, broilers typically undergo electrical stunning for the induction of unconsciousness. Low voltage (12–38 V) electrical pulse direct current (DC) water bath stunning is the most widely used stunning method in the USA and is currently employed in more than 95% of poultry processing facilities (Riggs et al., 2023). Electrical stunning immediately induces unconsciousness although it is a recoverable stun which means the poultry being capable of regaining consciousness if no neck cut is administered. Conversely, in the EU, irreversible stunning methods are employed, resulting in fatal stunning by using high voltage (50–150 V) water bath alternating current (AC) (Bourassa et al., 2017). However, Using ES in poultry meat production may affect residual blood and product quality (Osborn et al., 2024).

On the contrary, in KSA, as an Islamic country, a non-stun slaughtering method has been used to produce poultry meat called Halal slaughter which results in more blood loss with positive effects on meat quality and safety (Farouk et al., 2014). In the KSA, controls on poultry slaughter are based on legislation issued by the Saudi Food and Drug Authority “SFDA” which is compatible with the provisions of Islamic Sharia that aim to ensure the provision of safe and high quality food that meets the standards set for people in the Kingdom.

On the other hand, there is as indication of alignment and uniformity between

Islamic Sharia and the various laws and legislation in KSA, which includes following the provisions of Islamic Sharia law in slaughtering poultry, which was translated into the purpose of ensuring the quality of meat that is consumed, whether the slaughtering takes place within the Kingdom or the meat is imported from abroad to meet the increasing food demands of the population with the highest quality standards, which is consistent with the Kingdom's Vision 2030.

Despite multiple studies addressing poultry slaughter regulations in USA, EU, and KSA, there is a lack of comprehensive comparative analysis linking Islamic and international legislation and their impact on food quality and safety. This study aims to fill this gap by conducting a comparative analysis of these regulations and their impact on the quality and safety of meat in these three regions.

## **2. Materials and methods**

The study focused on the main legal sources of Islam, including the Holy Qur'an was utilized such as the Quran (II-172) states "O you who believe! Eat of the good things wherewith we have provided you, and render thanks to Allah, if it is He whom you worship". Moreover, The Quran (V: 3) states: "Forbidden unto you (for food) are: Carrion and blood and swine flesh, and that which has been dedicated unto any other than Allah, and the strangled, and the dead through beating, and the dead through falling from a height, and that which has been killed by the goring of horns, and devoured of wild beasts saving that which you make lawful and that which has been immolated to idols and that you swear by the divining arrows. This is an abomination...". In addition, and the Prophet's hadiths of Messenger of Allah Prophet Muhammad PBUH said, "What is lawful is clear and what is unlawful is clear, but between them are certain doubtful things which many people do not know. So he who guards against doubtful things keeps his religion and his honour blameless. But he who falls into doubtful things falls into that which is unlawful, just as a shepherd who grazes his cattle in the vicinity of a pasture declared prohibited (by the king); he is likely to stray into the pasture. Mind you, every king has a protected pasture and Allah's involved limits is that which He has declared unlawful. Verily, there is a piece of flesh in the body, if it is healthy, the whole body is healthy, and if it is corrupt, the whole body is corrupt. Verily, it is the heart" (Nawawi, 2014).

Additionally, the secondary data for this study included various international legislations issued by the USA and the EU concerning poultry meat production using Electrical Stunning (ES). The ES parameters in the USA typically involve low voltage (12–38 V), which is the most common method of stunning (Code of Federal Regulations, 2022; Riggs et al., 2024). However, in the EU, the regulations legally enforce and require higher voltage (50–150 V) than what is typically used in the USA (Bourassa et al., 2017; Council of European Union, 2009).

On the other hand, legislation related to the production of poultry meat within the KSA or the import of poultry meat from global markets such as the USA or the EU is issued by the Saudi Food and Drug Authority (SFDA), in alignment with the Kingdom's Vision 2030 (KSA Vision 2030, 2019). Moreover, as KSA is a Gulf country, the SFDA utilizes standards released by the Gulf Cooperation Council (GCC) Standardization Organization (GSO), including: Halal Food-Part 1: General

Requirements GSO-2055-1-2015, Halal Products-Part 2: General Requirements for Halal Certification Bodies GSO-2055-2-2015, and Animal Slaughtering Requirements According to Islamic Rules GSO 993/2015, which derive their legislation from Islamic law (SFDA, 2015).

The research methodology employed in this study is the comparative research method. This approach focuses on comparing different legislation and law between one or more countries to understand the differences and similarities and to evaluate their impact on issues of the current study. In addition, the objective of the study was to compare these legislations and assess their extent and compatibility, which led to the identification of contradictions and various outcomes. To address the research question, the study was divided into two sections. The first section involved comparing the legislation related to poultry slaughter derived from Islamic law, by the SFDA, with the legislation issued by the USA and EU. The second section focused on examining the impact of implementing Islamic law-compliant slaughter on the quality of poultry meat consumed by humans, in accordance with the regulations set by the SFDA and the Kingdom's Vision 2030, which aim to ensure the provision of safe and high quality food that meets the standards set for people in the Kingdom.

### **3. Results and discussion**

#### **3.1. The legislation related to poultry slaughter derived from Islamic law issued by SFDA compared with the legislation issued by the USA and EU**

Modifying, updating, or abolishing legislation is a feasible process, subject to the changing needs of a particular era. However, altering religious laws, given their sacred essence, presents a considerable challenge. Devout Muslims hold the fundamental Islamic laws in high esteem (Quran and Hadiths) as holy because they believe these laws are derived from divine sources (God and the Prophet Muhammad). The modern advancements in the meat production are constantly evolving to address contemporary demands, which may occasionally conflict with Islamic religious traditions. Recently, there has been increasing attention on the commercial production of Halal meat due to the growing Muslim population in Europe, the potential for meat production and export to Islamic world, and the ease of transportation, trade, and delivery (Abdullah et al., 2019). Regarding productivity, poultry represents the most significant category of animals slaughtered worldwide for human consumption. While they play a crucial role in meeting the protein demands of an increasing global population, there are distinct legislative, legal, and commercial challenges linked to the handling, stunning, and bleeding of birds before slaughter. The procedures involved in poultry slaughtering markedly differ from those used for livestock (Govindaiah et al., 2023). There are three primary methods for slaughtering poultry: non-stun slaughter that is called Halal Slaughter, pre-slaughter stunning in a controlled atmosphere that is called Controlled Atmosphere Stunning (CA), and pre-slaughter stunning by using water bath that is called Electrical Stunning (ES). These protocols are used for producing poultry meat all over the world. Presently, the most widely used technique for stunning in the USA is electrical water-bath stunning (ES) "regulatory information/code of federal regulations (annual edition)/ae 2.106/3:9). In EU, regulations legally mandate

the parameters for ES, requiring higher current and voltage levels than those commonly used in the USA “EU: Council Regulation (EC) No 1099/2009”.

However, the fundamental religious rules and guidelines governing production of meat in accordance with halal standards have been established for over 1400 years. The religious significance of the meat produced, as understood by Islam, is highly important to adhere to the religious doctrines of these communities. Hence, it is closely associated with the traditional practice of animal slaughter. However, diverse halal certification bodies may interpret and elucidate these practices differently, resulting in discrepancies in requirements and criteria. Consequently, numerous non-governmental organizations across various nations have formulated guidelines and criteria for halal meat production, encompassing various stages of the slaughtering process, including pre-slaughter, on-farm, on-slaughter, and post-slaughter procedures. These communities and organizations encompass the Arab Gulf Cooperation Council (GCC)/GCC Standard in the Arab Gulf region (Al-Shammari, 2021).

On the other hand, the Saudi Food and Drug Authority (SFDA) serves as a governmental body in KSA tasked with formulating and implementing regulations and benchmarks for processed food items, seafood, fresh produce, and processed animal feed. Over recent years, the SFDA has swiftly introduced fresh directives, regulations, and standards (SFDA, 2015). They have presented preliminary regulations to the World Trade Organization (WTO) for public comments, encompassing directives on marketing specifications for the registration and recognition of competent bodies in food-exporting nations like the USA (USDA, 2022). Moreover, in late May 2018, the SFDA enforced a portion of GSO 993, which originated from an Islamic religious decree dating back over twenty years, prohibiting the stunning or immobilization of poultry during the slaughtering process. This restriction on stunning arises from the belief that stunning prior to slaughter preventing the bird from obtaining a halal certificate. Consequently, this mandate has resulted in the cessation of U.S. poultry meat and product exports to KSA (SFDA, 2015; USDA, 2022).

Moreover, Gulf Cooperation Council “GCC” Standardization Organization (GSO) released Gulf Technical Regulation GSO 2055-1:2015 and GSO 2055-2:2015 that defines Halal food. In addition to this, if any country in the Gulf Cooperation Council imports poultry carcasses or their products from foreign countries, a Halal slaughter certificate must be attached to them. Moreover, the issuance of Halal slaughter certificates necessitates that the slaughter of poultry and livestock occurs within a duly authorized slaughterhouse and adheres to the Islamic slaughtering protocols outlined in the Islamic law and regulations as described in GSO number 993:2015. In addition, Exports of both whole meat and meat parts necessitate the inclusion of halal slaughter certificates, affirming that the livestock and poultry slaughtered for shipment to KSA meet the stipulated requirements of GSO 993:2015 (SFDA, 2015; USDA, 2022).

Therefore, based on the review above, it can be said that there is a conflict between poultry slaughter regulations in the USA and EU with regulations derived from Islamic law. Therefore, the determination of the best legislation can be judged by identifying the differences between poultry slaughter methods on meat quality and identifying the effects of different slaughter methods on meat quality of poultry.

### **3.2. Comparison between poultry slaughter methods derived from legislation of Saudi Arabia based on Islamic law with legislation from USA and EU**

In Electrical Stunning Method, birds are usually electrically stunned by inundation their heads in a water bath with submerged electrodes. While conscious, birds are suspended upside down on a conveyor belt equipped with metal shackles and conveyed through an electrified water bath, enabling the electrical current to pass through their bodies towards the shackles (Che Man and Sazili, 2010). Moreover, there are different protocols that are used based on the regulations and policies released by countries. In the USA, Low-voltage ES systems are utilized for bird immobilization, allowing birds to potentially regain consciousness within two minutes if not promptly bled. Conversely, in the EU, irreversible stunning methods are employed, resulting in fatal stunning. Furthermore, the effectiveness of poultry in enduring the same voltage and surviving electrical stunning varies, even among birds within the same weight categories. This variance can lead to some birds dying from the process of stunning prior to slaughter or experiencing delayed slaughter, which affects blood drainage efficiency. Consequently, the stunning methods employed in both the USA and the EU do not align with Halal meat production standards and contradict Islamic regulations that prohibit the consumption of unbled meat and discourage the consumption of meat slaughtered through doubtful practices. As a result, electric shock is not deemed permissible in the halal poultry industry (Lever and Miele, 2012). On the other hand, Rao et al. (2013) reported that potentially painful pre-stun shocks occurred during water bath stunning if a bird's wing or any other body part contacts the electrified water before its head. This problem is more likely to happen when there is a size disparity within the flock, causing smaller birds to arch their necks or lift off due to a pre-stun shock, sometimes flying across the entire length of the water bath stunner.

While 95% of commercial broiler production in the USA relies on ES, concerns about bird distress have surfaced in research (Erasmus et al., 2010). The practice of shackling birds while they are conscious and handling them while alive has been associated with elevated levels of corticosterone hormone and physical stress indicators, such as constant struggle and fluttering (Bedanova et al., 2007). Another welfare issue linked to electrical stunning (ES) involves the occurrence of a pre-stun shock, where a bird unintentionally comes into premature contact with the ionized water bath, often with a wing, resulting in an electric shock and subsequent adverse reactions such as flapping and lifting of the head. This scenario could result in a failed stun, necessitating the administration of a conscious neck cut and inflicting unnecessary distress. Additionally, smaller broilers in a flock may fail to reach the electrical water bath and be stunned due to the stunning system's incapacity to adjust for variations in bird size (Heath et al., 1981). In addition, ES poses a risk of consciousness recovery if not operated within USA parameters, this is particularly crucial if the neck incision is not properly executed or entirely overlooked within the specified timeframe after stunning (Gibson et al., 2016).

Another issue that can arise after the pre-slaughter process is related to the slaughter process itself. In Commercial production where Halal practices are not the

primary focus, mechanical slaughtering is often employed for production efficiency. These machines are designed to cut the throat with esophagus and sever the jugular veins with carotid arteries (Gregory and Wilkins, 1989). Moreover, there can be instances of mis-slaughter, such as cutting other parts of the body) or missed slaughter (failure to slaughter) by the machine. In poultry, Davis (1996) reported that decapitating the head prolongs the duration of death by disrupting the nervous system, resulting in asphyxiation and suffocation, whereas severing the jugular vein and carotid arteries without decapitation accelerates the process of death.

On the contrary, Controlled Atmosphere Stunning (CAS), another pre-slaughter method, gradually elevates Carbon Dioxide concentrations to induce unconsciousness slowly, ensuring animals remain unconscious before shackling. This approach is favored for its welfare benefits, reducing human-to-bird contact and eliminating live shackling. However, exposure to Carbon Dioxide during the induction of unconsciousness elicits negative physical responses in birds, persisting for an extended duration ranging from 60 to 90 s (McKeegan et al., 2006). Furthermore, Riggs et al. (2023) highlighted that the use of CAS in poultry slaughtering can lead to increased visible wing damage post-defeathering, the necessity for adjusting equipment parameters during defeathering when using Controlled Atmosphere Stunning (CAS) for broiler stunning is evident. Furthermore, notable disparities in breast fillet characteristics during deboning were noted in comparison to Electrical Stunning (ES). Ultimately, the utilization of CAS in a commercial environment led to divergences in subsequent product quality when compared to ES.

On the other hand, the fundamental religious laws with regulations governing Halal production for poultry meat that have been established for over 1400 years. The spiritual significance of the meat produced, as viewed by Islam, is a matter of importance to ensure compliance with the religious beliefs of these communities. Therefore, this issue is closely related to the traditional method of animal slaughtering. However, different halal certification authorities may interpret and explain these methods differently, leading to variations in requirements and standards. Consequently, many non-governmental organizations in various countries have established guidelines and standards for halal meat production, covering different stages of the slaughter operations, including on-farm, pre-slaughter, on-slaughter, and post-slaughter processes. These communities and organizations include Arab Gulf Cooperation Council (GCC)/GCC Standard in the Arab Gulf region (Al-Shammari, 2021).

On the contrary, in Islamic countries, the aim of effective and compassionate slaughter is to reduce blood retention and promptly cut off the oxygen supply to the brain (Gregory, 2007). In poultry, the slaughtering process commences with a precise incision on the neck just below the glottis (Che Man and Sazili, 2010). In Halal practices, throat cutting is meticulously carried out to sever the trachea, esophagus, and the two sets of carotid arteries and jugular veins, without head decapitation during the process (López et al., 2008). While the halal certification of meat usually influences the buying decisions of devout Muslims, there is a growing perception that Halal meats are not only religiously permissible but also wholesome and nutritious. This perception is largely linked to the belief that Halal slaughtering results in greater blood loss (Farouk et al., 2014).

In accordance with Islamic principles, it is generally stipulated that only Muslims well-versed in the Islamic protocol for animal slaughtering (ritual slaughter) are permitted to carry it out. There are no prescribed types of knives for halal slaughter. During the actual slaughtering process, the specific Arabic phrase “Bismillah, Allahu Akbar,” which translates to “In the name of Allah, Allah is the greatest,” must be pronounced aloud by the slaughterer, and the animal must be alive. This aligns with the commands outlined in the Quran: “So eat of that over which the Name of God was pronounced”.

Numerous practices observed in certain abattoirs may conflict with Halal slaughtering regulations. One such practice involves the use of an automatic knife for neck cutting, a method that incorporates stunning during slaughter. This contradicts Halal guidelines, which stipulate hand slaughter performed by a qualified individual, preferably Muslim, with a blessing recited before incision (Velarde et al., 2014). Furthermore, improper neck cutting using a rotating knife is possible, resulting in reduced blood loss and compromised animal welfare. Conversely, comprehensive literature reviews have explored the criteria for Halal slaughter, with studies conducted by Farouk et al. (2014). Moreover, while the Muslim community generally agrees on these Halal slaughter criteria, some individuals are hesitant to adopt modern slaughter techniques due to various concerns, including the risk of animals dying before the ritual cut is made during pre-slaughter stunning, the absence of these techniques in religious scriptures, fears of reduced blood loss with new techniques, doubts about the ability of techniques to sever major blood vessels, concerns about the perceived cruelty of new techniques such as pre-slaughter stunning, and beliefs that certain new techniques may negatively impact meat quality (Fuseini et al., 2017). In addition, the key differences in poultry slaughter regulations between KSA, USA, and EU were shown in **Table 1**.

**Table 1.** Key differences in poultry slaughter regulations between Saudi Arabia, USA, and EU.

Items	Saudi Arabia	USA	EU
Authorization body	Saudi Food and Drug Authority (SFDA) Regulations	Code of Federal Regulations (CFR)	The European Union Council
Stunning Process	Prohibited in order to ensure Halal compliance	Birds passed through electrified water bath	Birds passed through electrified water bath with higher voltage
Stunning Methods	Stunning is generally prohibited based on Islamic law	Electrical Water-Bath Stunning (12–38 V) that leads to some birds dying prior to slaughter	Electrical Stunning with higher voltage (50–150 V) that leads to fatal stunning
Halal Requirements	Compliance with Islamic law; Halal certification mandatory	No specific Halal requirements; Optional Halal certification	Not compliance with Islamic law or Halal certification
Legislation References	1-GSO 993/2015 2-GSO 2055-1-2015 3-GSO 2055-2-2015	Regulatory information/code of federal regulations (annual edition)/ae 2.106/3:9/title 9—animals and animal products chapter III—food safety and inspection service, department of agriculture/subchapter a-agency organization and terminology; mandatory meat and poultry products inspection and voluntary inspection and certification	Council of the European Union, Council Regulation (EC) No 1099/2009 of 24 September 2009 on the protection of animals at the time of killing.

On the other hand, the differences in poultry slaughter regulations that discussed among KSA, the USA, and the EU are significantly influenced by their respective religion-state relations. In Saudi Arabia, Islamic law dictates stringent Halal



compliance, while the USA and EU balances secular values with religious freedoms with reflecting its diverse member states in USA or Countries in the EU. Moreover, as a result of the increasing demand for poultry meat in Islamic countries, producing countries may adhere to Islamic laws and amend regulations related to halal poultry slaughter to capture the global market. Additionally, Islamic countries with substantial poultry meat requirements might implement national self-sufficiency plans consistent with their national regulation and legislation. For instance, Saudi Arabia has set a plan to attain 80% self-sufficiency in poultry meat by the end of 2025.

### **3.3. Effects of poultry slaughter methods derived from legislation of Saudi Arabia based on Islamic law with legislation from the USA and EU and its impact on poultry meat quality**

Slaughtering is a crucial stage in commercial meat production cycle that have an impact on meat quality and public health (Maqsood and Ayyub, 2023). Various slaughtering techniques can affect postmortem muscle metabolism (Riggs et al., 2023). In EU, the parameters for electrical stunning (ES) are regulated by law and often involve higher current and voltage levels compared to those commonly used in the USA. The use of high voltage ES has been associated with disadvantages for meat quality that caused muscle hemorrhaging (Sirri et al., 2017). Despite this, electrical stunning has also been linked to poor meat quality due to factors like low bleeding efficiency, the occurrence of blood blisters, and tougher meat when insufficient time is allowed for rigor mortis to develop before filleting (Summers, 2006).

The application of high voltage and current in water bath stunning has drawn criticism for its adverse effects on meat quality. Studies by Mouchoniere et al. (1999) and Wilkins et al. (1998) have highlighted that these electrical stimulations can lead to muscular contractions, resulting in undesirable characteristics such as red wing tips. These alterations not only lead to reduced yield and saleable products due to trimming during carcass inspection, as noted by McNeal et al. (2003), but can also induce heart fibrillation. This condition, as observed by Fernández-López et al. (2010) and Gregory and Wilkins (1989), contributes to inefficient bleeding, greater hemorrhaging, and can potentially cause death before exsanguination.

Furthermore, the use of high current has been associated with various issues in broilers, including dislocation, fractures, redness at wing tips, and hemorrhaging in wing veins and deep breast muscles, as identified by Ali et al. (2007) and Mota-Rojas et al. (2008). These findings align with the conclusions drawn by Hindle (2010), who observed that higher amperage and voltage levels correlate with decreased carcass quality in broilers (Farouk et al., 2014).

The detrimental impact of high-voltage electrical stunning on meat quality, particularly muscle hemorrhage, has been underscored in existing literature (Sirri et al., 2017). Additionally, fatalities resulting from heart failure and oxygen deprivation during electrical shock have been documented (Tурсan et al., 2003). The pre-slaughter stunning of animals before exsanguination can influence the efficacy of the bleeding process with subsequent meat processing steps, which are significantly affected by biochemical changes occurring during slaughter. In addition, research conducted on broiler chickens has investigated the effects of various stunning methods

on meat quality characteristics, revealing significant alterations of enzymatic and hormonal profiles of blood that used as indicators to stress (Riggs et al., 2023).

Meat quality is a significant aspect of the poultry industry, and Halal meat production represents an Islamic approach to ensuring the production of permissible meat according to religious principles derived from the Quran and Hadiths. This method must align with administrative, economic, and health standards worldwide (Al-Shammari, 2021). Moreover, meat is typically sourced from the healthy, prepared carcasses of various livestock and poultry species. Consumers expect meat to meet specific criteria: it must be safe and suitable for human consumption, resistant to spoilage during or after preservation, and maintain its quality. Poultry meat, among various types of meat, enjoys widespread acceptance and consumption worldwide due to its lower health risks and the absence of significant religious or cultural barriers. The consumption of broiler meat is particularly on the rise, and the broiler industry has emerged as a promising sector. The increasing global population, especially in Muslim-majority regions, has fueled the demand for broiler meat due to religious considerations or cultural taboos associated with pork consumption (Bostami et al., 2021).

In the production of Halal poultry meat, the method of slaughtering significantly impacts the quality of broiler chicken meat, with the Halal method promoting enhanced blood drainage and consequently better meat quality and improved shelf life during refrigerated storage (Hafiz et al., 2015). Thus, the Islamic slaughtering method may serve as a means to reduce blood content, thereby retarding lipid oxidation, discoloration, and microbial growth in chicken meat during refrigerated storage (Addeen, 2014).

In electrical stunning methods, the efficacy of poultry in withstanding the same voltage current and surviving electrical stunning varies, even among birds of similar weight categories. This variance can lead to some birds dying from the stunning process prior to slaughter or experiencing delayed slaughter. Moreover, some birds of a smaller size may enter the next stage of production without being slaughtered and these are considered as dead birds. Some bird handlers and butchers opt not to dispose of these deceased birds; instead, they blend them with regular, healthy meat for human consumption. This practice poses significant risks to food safety and hygiene (Martin et al., 2019). The primary hazards to Halal hygiene and safety stemming from these practices include health implications and potentially conflicting with the Islamic beliefs of Muslim consumers (Sohaib and Jamil, 2017).

Furthermore, fatalities may arise from cardiac arrest and cerebral hypoxia stemming from electric shock (Turcsan et al., 2003). In addition, stunning animals prior to exsanguination can influence the efficacy of the process of bleeding and subsequent stages in meat processing, which are notably influenced by biochemical changes occurring during slaughter. Studies on broiler chickens have highlighted the effects of different stunning techniques on meat quality characteristics, alongside significant shifts in biochemical, enzymatic, and hormonal of blood profiles linked to stress (Li et al., 2022). Moreover, Sohaib et al. (2020) reported elevated Iron (Fe) and Magnesium (Mg) levels in deceased bird meat compared to Halal-slaughtered bird meat. Conversely, Mn was solely detected in Halal-slaughtered bird meat. Furthermore, the pH of deceased chicken meat was lower in comparison to Halal-

slaughtered bird meat. Additionally, Halal-slaughtered meat exhibited lower lipid oxidation and haem iron values than deceased bird meat (Sohaib et al., 2020).

Recent findings have demonstrated that chickens slaughtered according to Islamic rules exhibit lower residual blood in the meat, along with reduced bleeding and death time, leading to decreased bacterial counts and extended shelf life during the postmortem stage that reduced risk of contamination with foodborne pathogens in meat and sausages from broiler chickens slaughtered using the Halal method. However, certain practices such as stunning only the head before neck severance in Halal pre-slaughtering have been associated with poor meat quality such as slow decline in blood pressure with blood splash in various organs in poultry carcasses. Additionally, electrical stunning may result in low bleeding efficiency, blood blisters, muscular contraction, and red wing tips all of which negatively affect meat quality and can lead to downgrading of boiler carcasses. Instances of high hemorrhages with inefficient bleeding and followed by heart fibrillation in broilers exposed to high voltage stunning have been reported (Al-Shammari, 2021).

On the other hand, Wang et al. (2024) reported that health concern can indirectly affect the willingness to purchase organic meat through perceived benefit, moral norms, and controllability which can provide the recent strategies for enterprises organic food marketing. This could achieve a comparative advantage in increasing future consumer demand for poultry meat slaughtered according to Islamic law, which results in higher quality meat when compared to other slaughter methods.

#### **4. Conclusion**

The current study concluded that there is compatibility between the provisions of Islamic Sharia and the regulations of the Kingdom of Saudi Arabia related to the poultry slaughtering process. It was found that slaughtering poultry according to the regulations leads to rapid blood disposal, reduced microbial content in poultry meat, and increased meat quality. Consequently, the poultry meat can be preserved under refrigerated or frozen conditions for longer periods compared to other poultry slaughter regulations in global markets such as the USA and the EU. Furthermore, it is necessary to conduct more research and studies to achieve compatibility between the use of modern technologies in poultry slaughterhouses and the production of halal meat in accordance with Islamic law, considering the increasing demand for poultry meat not only in the Gulf region but in all Islamic communities worldwide. This ensures that market requirements are met. Future advancements could include automated processing systems that adhere to halal standards and innovations in food safety monitoring and traceability technologies, which would be beneficial in meeting the growing demand for Halal food globally in the near future.

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