

Recent Methods of Slaughtering and its Effect on Meat Safety and Hygiene

Dr. Ibrahim Hussein Ahmed Abd El-Rahim

Professor of Infectious Diseases and Epizootiology, Department of Environmental and Health Research, The Custodian of the Two Holy Mosques Institute for Hajj and Umrah Researches, Umm Al-Qura University, Makkah Al-Mukaramah, Kingdom of Saudi Arabia.

E-mail: vetrahim@yahoo.com

Abstract

Islam has meant the development of the legal provisions governing the slaughter of animals. The Islamic Sharia achieved civilized scoop where imposed Islamic slaughter on ruminant animals which is permissible to eat their meat such as cattle, camels, sheep and goats, and the development of many of the Arts and the legal provisions during the slaughtering process. The slaughtering process is of a significant impact on the meat safety and hygiene. On the other hand it is of significant impact on human health. The Halal slaughter involves cutting of jugular veins, carotid arteries, throat and esophagus, which facilitates draining of blood from the animal and thus prevents growth and multiplication of harmful micro-organisms. The halal slaughter of animals has a great role in preventing infectious diseases, and is seen one of the main reasons for the popularity of the product even among non-Muslims. In addition to complete bleeding of flowing blood, there are numerous benefits of severing all the blood vessels of the throat including increased shelf life; absence of bacteria; and make a slaughter with no pain.

Studies have shown that halal slaughter protects consumers from many diseases which are not possible in the conventional recent methods used in many countries. It was confirmed that the conventional methods of slaughtering used in the western countries, i.e. stunning, shutting, electrical shock...etc., are hindering the bleeding process. This research paper discuss the difference between the halal (Islamic) and the recent (conventional) methods of animals slaughter and explain the effect of each method on the meat safety and hygiene. It was concluded that the halal method of slaughtering is the only correct method of the scientific point of view. As well as, the halal method is of great importance for human health as protecting consumers from the infectious diseases as well as it has significant impact on the meat safety and hygiene. It was recommended that all non-Muslims people should move closer to the Halal method of slaughter and stop causing extra pain to the animal through stunning.

Introduction

Several criteria define a good slaughter method of the scientific point of view: a) animals cannot be treated cruelly; b) animals cannot be unduly stressed; c) bleeding must be done as quickly and as complete as possible; d) carcass bruising must be minimal; e) slaughter must by hygienic, economic and safe for the operators (Swatland, 2000). In addition, the humane conditions must be presented during pre-slaughter handling (Roça, 2002).

The best method of slaughter is the Sunnah method which consists of a horizontal cut on the throat of the animal and severing all four vessels of the throat in order to remove all the impure blood from the animal. This is the only method which ensures that the meat slaughtered is lawful for Muslims of all schools of thought to consume and the method which removes all doubts (Halal advocates of America, 2011a).

1. The Halal (Islamic) slaughter

In holy Quran and Hadith, there are some orders followed by Muslims. Hence, meat is authorized for consumption when it is Halal condition, meaning lawful and legal for Muslims. The religious orders:

1.1. Mention the Name of ALLAH:

The name of God (Allah) is to be pronounced as a reminder that we do not have the right to take the animal's life except by the permission of God to meet our need for food (ISNA Halal Certification Agency, 2010).

﴿ فَكُلُوا مِمَّا ذُكِرَ اسْمُ اللَّهِ عَلَيْهِ إِنْ كُنْتُمْ بِآيَاتِهِ مُؤْمِنِينَ ﴾ [الأنعام: ١١٨].

﴿ وَلَا تَأْكُلُوا مِمَّا لَمْ يُذْكَرِ اسْمُ اللَّهِ عَلَيْهِ وَإِنَّهُ لَفِسْقٌ ۗ وَإِنَّ الشَّيَاطِينَ لَيُوحُونَ إِلَىٰ أَوْلِيَائِهِمْ لِيُجَادِلُوكُمْ ۗ وَإِنْ أَطَعْتُمُوهُمْ إِنَّكُمْ لَمُشْرِكُونَ ﴾ (الأنعام ١٢١)

1.2. Only the Halal meat:

يقول الله تعالى: ﴿ حُرِّمَتْ عَلَيْكُمُ الْمَيْتَةُ وَالِدَمُّ وَلَحْمُ الْخِنْزِيرِ وَمَا أُهْلِيَ لِغَيْرِ اللَّهِ بِهِ وَالْمُنْخَنِقَةُ وَالْمَوْقُوذَةُ وَالْمُتَرَدِّيَةُ وَالنَّطِيحَةُ وَمَا أَكَلَ السَّبْعُ إِلَّا مَا ذُكِّيْتُمْ وَمَا ذُبِحَ عَلَى النَّصْبِ وَأَنْ تَسْتَقْسِمُوا بِالْأَزْلَامِ ذَٰلِكُمْ فِسْقٌ ۗ الْيَوْمَ يَبْسُ الَّذِينَ كَفَرُوا مِنْ دِينِكُمْ فَلَا تَخْشَوْهُمْ وَاخْشَوْنَ الْيَوْمَ أَكْمَلْتُ لَكُمْ دِينَكُمْ وَأَتَمَمْتُ عَلَيْكُمْ نِعْمَتِي وَرَضِيْتُ لَكُمْ الْإِسْلَامَ دِينًا فَمَنِ اضْطُرَّ فِي مَخْمَصَةٍ غَيْرِ مُتَجَانِفٍ لِإِثْمٍ فَإِنَّ اللَّهَ غَفُورٌ رَحِيمٌ ﴾ [المائدة: ٣]

وقال جل من قائل: ﴿ قُلْ لَا أَجِدُ فِي مَا أُوحِيَ إِلَيَّ مُحَرَّمًا عَلَى طَاعِمٍ يَطْعَمُهُ إِلَّا أَنْ يَكُونَ مَيْتَةً أَوْ دَمًا مَسْفُوحًا أَوْ لَحْمَ خِنْزِيرٍ فَإِنَّهُ رِجْسٌ أَوْ فِسْقًا أُهْلِيَ لِغَيْرِ اللَّهِ بِهِ فَمَنِ اضْطُرَّ غَيْرَ بَاغٍ وَلَا عَادٍ فَإِنَّ رَبَّكَ غَفُورٌ رَحِيمٌ ﴾ [الأنعام: ١٤٥].

1.3. The animal should be rested and Sharp knife should be used:

قال صلى الله عليه وسلم: " إن الله كتب الإحسان على كل شيء فإذا قتلتم فأحسنوا القتلة، وإذا ذبحتم فأحسنوا الذبحة، وليحد أحدكم شفرته وليرح ذبيحته" (من سنن ابن ماجة، كتاب الذبائح، باب إذا ذبحتم فأحسنوا الذبحة (٢١٧٠)، والترمذي في كتاب الديات ويا ب ما جاء في دية الجنين (١٤٠٩)).

1.4. Prevent Pain and Agony for Animals before Slaughtering

As in the above mentioned Hadith, annoyance for animals before slaughtering is strictly prohibited. It is obvious that one of the most important purposes of this order is related to ethical issues. However, researchers have indicated that this issue is of importance from the viewpoint of meat hygiene as well (Hajmohammadi, et. al. 2014).

1.5. Accessibility of Animals to Drinking Water before Slaughtering

One of the most important issues in Islamic slaughtering method is accessibility of animals to drinking water before slaughtering. Animals should have access to water freely before slaughtering. Because, drinking water reduces secondary microbial infection of animal carcass. Furthermore, sufficient drinking not only helps animals reduce stress but also glycolysis causes the meat to be less perishable (Lahucky et. al. 1998).

1.6. Avoid Slaughtering Animals in the Sight of Others

According to the Islamic slaughter, killing an animal in the sight of the others is abominable. It appears that this action causes them severe stress. Stress leads to decrease meat quality and safety via reduction of glycogenic source and unusual increasing in pH of muscles (Lahucky et. al. 1998; Hajmohammadi, et. al. 2014).

1.7. Horizontal cutting all of the vessels of the throat

The Sunnah halal method of slaughter is to drain all of the impure blood from the body of the animal by cutting all of the vessels of the throat including the carotid arteries, trachea, esophagus, and the jugular veins. The blood can only be completely drained from the body if the vessels of the throat are cut. In addition to complete bleeding of flowing blood, there are numerous benefits of severing all the blood vessels of the throat including increased shelf life; absence of bacteria; and make a slaughter with no pain (Halal advocates of America, 2011a).

1.8. Avoid Complete Cutting of Animal's Head during Bleeding

Prevention of neck separation is very important to complete the bleeding process to remove all the blood from carcass. In accordance to the Halal slaughtering procedures, it is preferred to avoid complete cutting of animal's head during bleeding. Based on scientific evidences, natural bleeding

time in domestic animals is about 3-6 minutes and during this period, 40% - 60% of blood volume exits from the body. The rest of the blood remains mostly in viscera and vessels (Hajmohammadi, et. al. 2014).

1.9. Procedure of the Halal slaughter

Here, the present research paper summarizes the standard which was developed by the Standardization Expert Group of the Organisation of the Islamic Conference (OIC).

1.9.1. In case of Manual slaughter

- a) The animal to be slaughtered has to be an animal that is Halal.
- b) The animal to be slaughtered shall be alive or deemed to be an alive at the time of slaughter. The slaughtering procedure should not cause torture to animals and should be done with animal welfare/rights consideration.
- c) The slaughterer shall be a Muslim who is mentally sound and fully understands the fundamental rules and conditions related to the slaughter of animals.
- d) If animals have arrived from long distance, they should first be allowed to rest before slaughtering.
- e) The animal may be slaughtered, after having been hung or laid preferably on its left side facing Kiblah (the direction of Makkah Al-Mukaramah). Care shall be given to reduce suffering of the animal while it is being hung or laid and not to be kept waiting much in that position.
- f) At the time of slaughtering the animals, the slaughterer shall utter "BISMILLAH WALLAHUAKBAR" which means "In the Name of Allah Almighty Great" and he should not mention any name other than Allah otherwise this make it non-Halal. Mentioning the name of Allah should be on each carcass "Zabaha" (killed by slaughter) or on each group being slaughtered continuously and if the continuous process is stopped for any reasons he should mention the name of Allah again.
- g) Slaughtering shall be done only once to each animal. The "sawing action" of the slaughtering is permitted as long as the slaughtering knife shall not be lifted off the animal during the slaughter.
- h) The act of Halal slaughter shall begin with an incision on the neck at some point just below the glottis (Adam's apple) and after the glottis for long necked animals.
- i) The slaughter act shall sever the trachea (halqum), oesophagus (mari) and both the carotid arteries and jugular veins (wadajain) to hasten the bleeding and death of the animals.
- j) The bleeding shall be spontaneous and complete. The bleeding time must be not less than 2.5 minute to insure fully bleeding.

- k) Slaughterer should grab the head by left hand, stretching it down tightly and shall cut the throat by a sharp slaughtering knife held in the right hand. The sharp edge of knife which used for slaughter should be not less than 12 cm.

1.9.2. In case of the Mechanical Slaughter

- a) The operator of the mechanical knife shall be a Muslim.
- b) The slaughterer shall recite “BISMILLAH WALLAHUAKBAR” prior to switching on the mechanical knife and shall not leave the slaughter area.
- c) Should the slaughterer leave the slaughter area, he shall stop the machine line and switch off the mechanical knife. To restart the operation he or another Muslim slaughterer shall recite “BISMILLAH WALLAHUAKBAR” before switching on the line and mechanical knife.
- d) The knife used shall be of single blade type and shall be sharp. e) The slaughter act shall sever the trachea (halqum), oesophagus (mari) and both the carotid arteries and jugular veins (wadajain) to hasten the bleeding and death of the animals
- e) The slaughterer is required to check that each poultry is properly slaughtered and any birds that missed the mechanical knife shall be slaughtered manually.
- f) A backup slaughterer with knife shall be ready to check any neck not cut well during mechanical slaughtering and rapidly cut it manually.
- g) Bleeding period shall be minimum 60 seconds but during winter this period shall be increased by 5-10 seconds.

1.10. Effects of the halal slaughter on the animal and meat safety and hygiene

There are numerous advantages to halal un-stunned meat including complete drainage of blood, better consistency of the meat, and no concern of the animal dying due to the stunning (Halal advocates of America, 2011b).

1.10.1. No Pain during Slaughtering

A sharp blade and skill in slaughtering is required to minimize pain and unnecessary suffering for the animal. This is accomplished by a quick cut to sever the veins and arteries of the neck of the animal, without cutting the nervous system or spinal cord. The massive bleeding makes the animal unconscious in seconds (ISNA Halal Certification Agency, 2010).

Stopping of the blood supply to the brain due to cutting of the right and left common carotid arteries during Islamic slaughter disrupts the centers of sense in the brain and make the animal unconscious at once (within 1-3 seconds). This means no pain sensation in Islamic slaughter. In the Halal slaughter, by severing the structures at the front of the neck – the trachea, oesophagus, carotid arteries and jugular veins results in the immediate loss of consciousness; blood flow to the brain is completely

halted. In addition, blood empties rapidly from the brain. Electroencephalography (EEG) can be used in conjunction with stress hormone measurements in blood and physical observation, to monitor the presence of pain and stressful changes (Meat technology update, 2011). A team at the University of Hannover in Germany confirmed this theory. They examined these claims through the use of Electrocardiography (ECG) and EEG Electroencephalography (EEG) records during slaughter. Several electrodes were surgically implanted at various points of the skull of all the animals used in the experiment and they were then allowed to recover for several weeks. Some of the animals were subsequently slaughtered the halal way by making a swift, deep incision with a sharp knife on the neck, cutting the jugular veins and carotid arteries of both sides together with the trachea and esophagus but leaving the spinal cord intact. The remainders were stunned before slaughter using a captive bolt pistol method as is customary in Western slaughterhouses. The EEG and ECG recordings allowed to monitor the condition of the brain and heart throughout. With the halal method of slaughter, there was not change in the EEG graph for the first three seconds after the incision was made, indicating that the animal did not feel any pain from the cut itself. The following three seconds were characterized by a condition of deep sleep-like unconsciousness brought about by the draining of large quantities of blood from the body. Thereafter the EEG recorded a zero reading, indicating no pain at all, yet at that time the heart was still beating and the body convulsing vigorously as a reflex reaction of the spinal cord. It is this phase which is most unpleasant to onlookers who are falsely convinced that the animal suffers whilst its brain does actually no longer record any sensual messages (Mustaqim Islamic Art & literature, 2014).

1.10.2. Complete drainage of blood

Bleeding efficiency can be considered as an important requirement of slaughter operations in order to obtain a high quality product (Warriss, 1977). Blood has high pH (7.35 - 7.45) (Kolb, 1984), and due to its high protein content, it quickly undergoes putrefaction (Mucciolo, 1985). Therefore, the conservation capacity of improperly bled meat is very limited. In addition, it causes a visual problem for the consumer (Bartels, 1980; Hedrick et al., 1994).

An example for calculation of the amount of the blood, bovine blood volume is estimated in 6.4-8.2 L/100Kg live weight (BARTELS, 1980; KOLB, 1984). According to Bartels (1980), the amount of blood obtained by bleeding when the animal is laid down is approximately 3.96 L/100 Kg live weight, whereas with the use of aerial line is 4.42 L/100 Kg live weight. When bleeding is properly done, which is necessary for good conservation, about 60% of the total blood amount is removed, and the remaining blood is retained in the muscles (10%), and viscera (20 - 25%) (Piske, 1982; Hedrick et al., 1994; Swatland, 2000).

In case of Halal slaughter, cutting of the blood vessels of the throat facilitate the drain all of the impure blood from the animal body in a short time. Prevention of the neck separation during the Islamic slaughter is very important to maintain the connection of the brain to the rest of the body via the spinal cord in order to send nerve signals and hormonal alerts which are necessary to complete the bleeding process to remove all of the liquid blood from carcasses. Leaving the spinal cord intact

allow for convulsions that result from the contraction of the muscles in response to the lack of oxygen in the brain cells. This will allow for the maximum drainage of blood.

1.10.3. Improving of meat safety and hygiene

The post-mortem changes that take place when muscle is converted into meat have a marked effect on the quality of the meat. The Halal slaughter allow for the maximum drainage of blood, carrying away in part the waste and micro-organisms, thereby improving the meat's taste, shelf-life and healthiness (ISNA Halal Certification Agency, 2010).

1.10.4. Protect human beings (consumers) from infectious diseases

The Islamic halal slaughter of animals has a great role in the prevention of infectious diseases. Islam has meant the development of the legal provisions governing the slaughter of animals for human consumption. The importance of Islamic slaughter is to facilitate the blood flow from the animal body, as blood represents suitable enrichment medium for growth and multiplication of microorganisms, therefore its complete removal from the slaughtered animal is vital to protect the consumers from infectious diseases.

2. The recent (conventional) slaughter methods (Stunning)

2.1. Definition of humane slaughter

In the developed countries, there is an increasing demand for processes called humane slaughter, aiming at reducing unnecessary suffering of the slaughtered animal (Cortise, 1994; Picchi & Ajzentel, 1993). Humane slaughter can be defined as a set of technical and scientific procedures which guarantee animal welfare from loading at the farm up to bleeding in the slaughter plant (Roça, 2002).

2.2. Aims of the stunning

Stunning can be considered as the first operation of slaughter per se. Determined by the adequate process, stunning consists in putting the animal in an unconscious state which must last until bleeding (Gil & Durao, 1985). Conventional methods of bovine slaughter involve the stunning operation before bleeding, except for Jewish or Islamic ritual slaughters (Cortise, 1994).

The law in Europe requires that all animals and birds must undergo pre-slaughtering process (i.e. stunning) to render them unconscious before they slaughter (Sante, et. al. 2000). It is an established fact that the majority of conventional meat slaughterhouses in North America use some form of stunning to subdue and immobilize the animal before the slaughter (Halal advocates of America, 2011b).

2.3. Types of stunning

There are different types of stunning used for different species including turkeys, chickens, lamb, and cattle (Halal advocates of America, 2011b). The stunning instruments or methods which can be used are: mallet, cash knocker, firearm-gunshot, pneumatic-powered stunners, pneumatic-powered air injections stunners, cartridge-fired captive bolt stunners, cutting of the medulla, electro-narcosis, and chemical processes. Slaughter can also be made by jugulation (Kasher or kosher method), without previous stunning (Roça, 2002).

The majority of beef slaughterhouses in Western countries use a pneumatic stunner or a captive bolt pistol to subdue the animal before slaughter. Likewise, the vast majority of lamb and goat slaughterhouses apply a electric rod to the head of the animal before slaughter. The chickens are usually stunned through the reversible method of the electric water trough (Halal advocates of America, 2011b).

2.4. Adverse effects of stunning on meat safety and hygiene

All stunning methods have disadvantages relating to quality, public health as well as possible misstuns (Knight and Anil, 2003). Stunning methods can have adverse effects on carcass and meat quality and cause downgrading. These could be visual effects such as bruising and haemorrhages, pelt burn in sheep, bone fractures, colour changes caused by dark firm dry (DFD) meat as well as those manifested in eating quality such as toughness. In regard to specific effects in cattle and sheep the following can be listed as (Anil, 2012): (a) Petechial haemorrhages (blood splash) and bruising in both cattle and sheep caused by electrical stunning, traumas during transport and preslaughter handling; (b) Bruising in cattle during heavy falls after stunning or due to impact from shutting gates on the back in race and stunning pen; (c) Animals developing bruising after hitting gateways and race fittings during passage to pens and restrainers; (d) Pelt-burn in sheep during head-to-back stunning where the rear electrode makes contact on back of neck; (e) Petechial haemorrhages in sheep; and (f) Dark-cutting beef due to tiredness and long term stress.

2.4.1. Severe pain due to stunning

Non-Islamic slaughter methods dictate that the animal should be rendered unconscious before slaughter. This is usually achieved by stunning or electrocution. Is it less painful to shoot a bolt into a sheep's brain or to ring a chicken's neck than to slit its throat? To watch the procedure does not objectively tell us what the animal feels. Using the Western method, the animals were apparently unconscious after stunning, and this method of dispatch would appear to be much more peaceful for the onlooker. However, the EEG readings indicated severe pain immediately after stunning. Whereas in the first example, the animal ceases to feel pain due to the brain starvation of blood and oxygen – a brain death, to put it in laymen's terms – the second example first causes a stoppage of the heart whilst the animal still feels pain. However, there are no unsightly convulsions, which not only means that there is more blood retention in the meat, but also that this method lends itself much more

conveniently to the efficiency demands of modern mass slaughter procedures. It is so much easier to dispatch an animal on the conveyor belt, if it does not move (Mustaqim Islamic Art & literature, 2014).

2.4.2. Incomplete drainage of blood

Several factors are responsible for bleeding efficiency, such as the physical state of the animal before slaughter, stunning method, and interval between stunning and bleeding. All diseases which debilitate the circulatory system can affect bleeding. Feverish, acute diseases promote generalized vasodilatation, impairing an efficient bleeding. The same is observed in animals slaughtered in agonic state, when the circulatory system is markedly changed (Bartels, 1980, Petty et al., 1994).

As in the conventional slaughter methods, if the head is cut completely while bleeding is not finished yet, heartthrob and blood flow will be stopped. Thus, blood does not exit thoroughly and a condition occurred, called imperfect bleeding of carcass. Residual blood in muscles with pH of about 7, leads to the increase of muscle pH and consequently meat aw (activity water) raises. The two facts mentioned above (the rise of pH and activity water) result in proliferation of spoilage microorganisms in which cause spoilage of the meat (Lahucky et. al. 1998; Hajmohammadi, et. al. 2014).

2.4.3. Making the meat perishable

Sever and unusual environmental stimulants (such as beating, fearing, being in noisy environment, etc.) irritate animals, resulting in the release of a large amount of adrenalin to circulatory system. Consequently, glycogen sources in muscles are degraded before animal slaughtering. Therefore, due to the reduction of glycogen amount in muscles of live animal, perfect glycolysis and lactic acid production does not occur during rigor mortis. Hence, meat pH will be higher than the natural status, making the meat perishable because of the faster generation of spoiling microorganisms in higher pH (Hajmohammadi, et. al. 2014).

After slaughter the glycogen in the muscle is converted into lactic acid causing a fall in pH from an initial value of pH 6.8 - 7.3 to about 5.4 - 5.8 at rigor mortis. If animals are stressed immediately prior to slaughter as when they are roughly handled or fight one another the muscle glycogen is released into the blood stream and, after slaughter, is rapidly broken down to lactic acid while the carcass is still warm. This high level of acidity causes a partial breakdown of muscle structure which results in pale, soft and exudative meat (termed PSE). The meat loses some of its water-binding capacity which is so important in certain types of meat processing. Long-term stress before slaughter uses up the glycogen so that less lactic acid is formed after slaughter resulting in an abnormal muscle condition in which it remains dark purplish-red on exposure to air instead of a bright red colour. This is termed dark, firm and dry (DFD) meat. Such meat and products made with it have a pH above 6.0 and spoil quickly since the low acidity favours rapid bacterial growth. After slaughter as the glycogen in the tissues is exhausted rigor mortis sets in and the whole carcass becomes stiff. This is due to the contraction of the muscle fibres when the actin filaments of the muscle fibres slide inwards between the myosin filaments so shortening the myofibrils (Bender, 1992).

2.4.4. Stunned-meat act as source of infectious diseases for consumers

Although, stunning methods have adverse effects on the animal itself, in some instances, public health measures taken and concerns, especially as a result of the prion zoonotic incurable diseases (such as bovine spongiform encephalopathy BSE in cattle and scrapie in sheep) threat (Anil, 2012). Potential public health concerns from transmissible spongiform encephalopathy (TSE) or prion diseases infected animals have been considered and reviewed (Anil et al, 1999; Anil and Austin, 2003). Central nervous system (CNS) embolism in jugular blood of cattle stunned with penetrating and non-penetrating captive bolts and in jugular blood of sheep stunned with cartridge activated and pneumatically activated guns has been reported. As the heart continues pumping for several minutes between the stunning and the end of exsanguinations, some of the embolic CNS material dislodged by the penetrating captive bolt gun might enter venous blood vessels draining the head and consequently be disseminated to other organs/tissues. This can happen not only with use of a penetrating gun that injects air into the brain but also when stunning is performed without air injection (Schmidt et al, 1999a; Anil and Harbour 2001; Anil et al, 2002; Coore et al, 2004; Coore et al, 2005).

In addition to haematogenous contamination of edible tissues with CNS material, other public health concerns may also be associated with penetrating Captive bolt (PCB) methods. For example, cross- or airborne contamination of the stunning gun operator, the environment such as the stun-box and / or the animals consecutively stunned with the same gun could occur, based on studies using experimental contamination with marker bacteria (Prendergast et al, 2004; Daly et al, 2001).

In addition to the spoilage of the meat, incomplete drainage of blood (imperfect bleeding of carcass) in stunned meat create a suitable media for proliferations of harmful micro-organisms and subsequently facilitate the transmission of bacterial zoonotic infectious diseases to the consumers.

2.4.5. The use of mallet

The use of mallet as a slaughter method caused severe lesion of the bone tissue, with depression of the affected region. It produces a cranial-encephalic contusion, and not concussion, as reported by several researchers. There is also a large incidence of macroscopic and microscopic hemorrhages in the pons and the bulb, which can be considered as an indirect lesion, that is, a hemorrhage at the opposite point of the blow in the brain caused by the counter-blow of the basilar portion of the occipital bone (Roça, 1999).

2.4.6. The use of cash-knocker

The cash-knocker leads to diffusive brain lesion or injury caused by sudden blow and changes in the intra-cerebral pressure, resulting in a rotational deformation of the brain, with consequent lack of motor coordination (Bager et al., 1990; Leach, 1985).

2.4.7. The use of electrical stunning

Excessive convulsions after electrical stunning in cattle need to be managed both to protect operators and facilitate high throughputs. Electrical immobilisation (90 V and 10 ms pulses delivered at 15 Hz during the bleeding procedure) to suppress convulsive activity used in New Zealand is not acceptable in most European countries. In addition, this technique can have adverse effects on pH and meat quality. For sheep the head-only technique is commonly employed using hand held electrodes placed between the eyes and the base of the ears on both sides. (Anil, 2012). Resumption of rhythmic breathing can occur during the second clonic phase, as in lambs the seizure activity after high voltage head-only stunning includes a tonic and two clonic phases (Velarde, et. al., 2002).

2.4.8. The use of firearms

The use of firearms is considered as a high-risk operation in slaughter plants (Leach, 1985).

2.4.9. The use of captive bolt stunners

The use of captive bolt stunners (pneumatic or cartridge-fired) causes lesions of the central nervous system, spreading of CNS tissues throughout the animal organs (Schmidt et al. 1999b).

2.4.10. The use of pneumatic-powered air injections stunners

The use of pneumatic-powered air injections stunners considered as an effective method for cattle slaughter. It produces severe brain laceration (Roça, 1999).

2.4.11. The use of gas mixture stunning

Gas killing methods may be used to kill on site poultry, and young animals. The gaseous euthanasing method should guarantee that the animal is dead at the end of the exposure. Inhalation of high concentration of carbon dioxide on its own or with argon or nitrogen may be distressing to animals. If the carbon monoxide used in confined space, the method is hazardous for operators (European Food Safety Authority, 2004).

2.4.12. The use of post-slaughter stunning

In Australia and New Zealand, thoracic sticking immediately after the Halal neck cut is routinely practised to avoid problems of prolonged consciousness but also carcass quality problems, which could arise if bleeding is impaired (Pleiter, 2005).

Discussion

Modern Western farming and slaughter aims at the mass consumer market and treats the animal as a commodity (Mustaqim Islamic Art & literature, 2014). Islam is a balanced way of life. For Muslims, the privilege of supplementing their diet with animal protein implies a duty to animal welfare, both during the rearing of the animal and during the slaughter. Modern Western farming and slaughter, on the other hand, aims at the mass consumer market and treats the animal as a commodity. Just as battery hens are easier for large-scale egg production, Western slaughter methods are easier for the meat industry, but they do neither the animal nor the end consumer any favours. The Islamic way guarantees a healthier life for the animal and a healthier meat for the consumer (Mustaqim Islamic Art & literature, 2014). The way the slaughtering process is carried out is of a significant importance for both human health and safety and quality of the meat. Islamic slaughter means cutting of the jugular veins, carotid arteries, throat and esophagus without any type of pre-slaughter stunning. Islamic slaughter aims to facilitate the blood flow from the animal body, which provides suitable enrichment media for growth and multiplication of harmful microorganisms. There are also numerous benefits to severing all the vessels of the throat including increased shelf life, absence of bacteria, and complete drainage of flowing blood.

The current paper define the Halal slaughter as slaughter of a religiously acceptable species, by a trained Muslim slaughterman, without prior stunning, by cutting the neck in order to sever the jugular veins and carotid arteries, oesophagus and trachea, without severing the spinal cord, while the animal is alive. The present paper also clarified the absence of the pain sensation during the Halal slaughter. Where, the animal suffers loss of consciousness very quickly by anemia of the brain caused by the simultaneous and instantaneous severance of the carotid arteries with a sharp knife.

Islamic slaughter of animals has a great role in the prevention of infectious diseases. Keeping of the head and neck connected to the slaughtered animal will maintain the connection the brain to the rest of the body via the spinal cord in order to send nerve signals and hormonal alerts which are necessary to complete the bleeding process and remove of all of the liquid blood from carcasses. Because of the blood is a typical media for the proliferation of different kinds of microbes, thereby protecting the consumers from infectious diseases. So that, it is necessary to educate all Muslim butchers about the scientific reasons of the non-separation of the neck of the carcass during slaughter only after confirming out of the soul.

On the other hand, there are numerous types of stunning including the pneumatic stunner which delivers a blow to the head of the animal, captive bolt pistol which shatters the brain of the animal, electric water trough which delivers a electric shock to poultry, and electric brain stunner for sheep. Some methods are reversible and others are irreversible. When irreversible methods of stunning are applied, the animal will die if it is not slaughtered within a few minutes. Other methods are reversible in theory and the animal can get up and walk around if not slaughtered in a few minutes. The common factor in all these methods of stunning is causing extra pain to the animal above and beyond the pain experienced during the slaughter itself. For this reason, many scholars have declared that the act of stunning is extremely disliked and close to being impermissible (Halal advocates of America,

2011b). Various stunning methods and electrical parameters have been reported to have a different effect on pH and Post mortem rigor development in various studies (Devine et al, 1984; Gregory, 1994; Bilgili, 1992; Hillebrand et al, 1996; Bilgili, 1999; Roth et al, 2002; Roth et al, 2003). Post-mortem metabolism can be influenced by indirect stimulation by nerves. Broken vertebrae can occur when stunned with head-to-back electrode positioning if the voltage and the current is too high. Also the disadvantage of high currents frequency is that possibility of stopping the heart (Wotton et al, 1992).

Haemorrhages are usually induced by stunning. During electrical stunning blood pressure changes, muscle spasms and convulsions can cause ruptures and haemorrhages in vessels and muscle as well as fractures (Gregory, 1998). Some haemorrhages were associated with hyper contracted and disrupted muscle fibres, indicating that they were caused by severe muscular strain. Many haemorrhages were found near venules or veins where rupture was observed, not in arterial vessels. This indicates that venous blood pressure increase can cause rupture of venules and small veins (Kranen et al, 2000).

Pre-slaughtering stunning induces severe pain for the animal and may lead to death. The effects of different mechanical stunning methods on stress-related hormones, meat quality and electroencephalographic reactions in beef cattle were discussed. It was found that the animals subjected to penetrative mechanical stun had the lowest alpha and beta wave intensity immediately post-stunning, and at 30 seconds after throat cut compared to both low power non-penetrative mechanical stun and high power non-penetrative mechanical stun animals. This could possibly be explained by the animals' awareness of pain or other stressful factors attributed to the slaughtering procedure. Also, the presence of large intervals of higher frequency alpha and beta brain waves, which usually occur in conscious animals, suggest stressful conditions related to postslaughter pain (Meat technology update, 2011).

It was confirmed that the conventional methods of slaughtering used in the western countries leads to imperfect bleeding after slaughter, especially if the animal die just after stunning and before slaughtering. If the animal not die due to stunning, the cutting of the spinal cord in these methods before the bleeding allow no signals from the brain to the muscles leading to absence of muscular convulsions and subsequent imperfect bleeding.

Extremely perishable meat provides favorable growth condition for various microorganisms. It is, therefore, necessary to control meat spoilage in order to increase its shelf life and maintain its nutritional value, texture and flavor (Dave and Ghaly, 2011). In Islamic slaughter, the live animal should be good handled and allowed to rest before slaughtering. While in conventional methods, the animal usually stunned before slaughtering. Preslaughter handling of livestock and postslaughter handling of meat play an important part in deterioration of meat quality. The glycogen content of animal muscles is reduced when the animal is exposed to pre-slaughter stress which changes the pH of the meat, to higher or lower levels, depending on the production level of lactic acid. Lactic acid is produced due to the breakdown of glycogen content of animal muscles via an anaerobic glycolytic pathway. Higher levels of pH (6.4-6.8) result in Dark, Firm and Dry (DFD) meat. Long term stress causes DFD meat which has a shorter shelf life. Sever short term stress results in a Pale, Soft and Exudative (PSE) meat. PSE meat has a pH lower than normal ultimate value of 6.2 which is responsible for the breakdown of proteins, providing a favorable medium for the growth of bacteria (Miller, 2002;

Chambers and Grandin, 2001; Rahman, 1999). So that the Halal slaughter has many advantages concerning not only animal welfare, no pain sensation and perfect bleeding but also meat safety and hygiene in comparison to the conventional (stunning) methods. Because of absence of the stress, in the Islamic slaughter, keeping the glycogen content of animal muscles and subsequent normal glycolysis process and formation of lactic acid post slaughtering which keep the meat pH within the normal ultimate values. This provides unfavorable medium for the growth of bacteria, increase shelf-life, keep the colour of the meat bright red and make the meat tasteful.

Table 1. The main differences between the Halal and stunning methods of slaughtering

Comparison	Halal slaughter	Stunning slaughter
live animal	The animal should be alive	The stunned animal may die before slaughtering
Resting of the animal	The animal should be rested before slaughtering	Pre-slaughtering stunning induces severe stress for the animal
Pain	No pain (due to disruption of the sense centers in the brain and loss of consciousness as result of blood shortage immediately after cutting of the common carotid arteries)	Pre-slaughtering stunning induces severe pain for the animal
Bleeding	Perfect (complete bleeding process) due to severing of all throat vessels and keeping of the head connected to the carcass through the spinal cord	No bleeding if the animal die due to stunning, if still alive the bleeding is imperfect
Meat safety	Safe for human consumption	unsafe for human consumption
Infectious diseases	Protect consumers from infectious diseases (complete bleeding process give no chance for growth and multiplication of micro-organisms)	Represents a dangerous source of bacterial diseases, due to imperfect bleeding, and incurable prion diseases, due to contamination of the meat with the brain tissue.
Rigor mortis and glycolysis process	Normal (the breakdown of glycogen content of animal muscles into lactic acid via an anaerobic glycolytic pathway)	Abnormal
Meat pH	The meat pH within the normal ultimate values. This provides unfavorable medium for the growth of bacteria, increase shelf-life, keep the colour of the meat bright red and make the meat tasteful	- Higher levels of pH (6.4-6.8) result in Dark, Firm and Dry (DFD) meat which has a shorter shelf life - lower pH than normal ultimate value of 6.2 results in a Pale, Soft and Exudative (PSE) meat providing a favorable medium for the growth of bacteria
Conclusions	According to the scientific bases, the Halal Islamic method is the best method of slaughter. As it is characterized by no pain sensation; complete drainage of liquid blood from the carcass; increased shelf life; increased meat quality as well as improved meat safety and hygiene.	All stunning methods have disadvantages relating to animal welfare, meat safety and hygiene, and public health. The use of any type of pre-slaughter stunning makes the meat not lawful (not Halal) for Muslims due to incomplete bleeding as well as low quality meat.

Conclusion

The current research paper concluded that:

- 1. The best method of slaughter is the Halal Islamic method which consists of a horizontal cut on the throat of the animal and severing all four vessels of the throat in addition to trachea and oesophagus, without any type of pre-slaughter stunning, in order to remove all the impure blood from the animal. This is the only method which ensures that the meat slaughtered is lawful for Muslims of all schools of thought to consume and the method which removes all doubts.**
- 2. The Halal method of slaughter has been the best way to slaughter in the past and will continue to be the best way to slaughter in the future. As it characterized by no pain sensation; complete drainage of liquid blood from the carcass; increased shelf life; absence of bacteria as well as improved meat safety and hygiene in comparison to all conventional (stunning) slaughter methods.**
- 3. At the time the Halal slaughter protect the human health from infectious diseases; the stunned meat represents a dangerous source of zoonotic bacterial diseases and incurable prion diseases for consumers.**
- 4. The use of any type of pre-slaughter stunning makes the meat not lawful (not Halal) for Muslims.**
- 5. All stunning methods have disadvantages relating to animal welfare, meat safety and hygiene, and public health, as well as the stunned animal may die before slaughtering.**
- 6. Further studies and researches are recommended to educate non-Muslims people to apply the Islamic Halal method of slaughter and stop causing extra pain to the animal through stunning.**

Reference:

- 1. Anil, M.H., Love, S., Williams, S., Shand, A., McKinstry, I.L., Helps, C.R., Waterman-Pearson, A., Seghatchian, J. and Harbour, D. (1999): Potential contamination of beef carcasses with brain tissue at slaughter. *Veterinary Record* 145, 460-462.**
- 2. Anil, M.H. and Harbour, D. (2001): Current stunning and slaughter methods in cattle and sheep: potential for carcass contamination with central nervous tissue and microorganisms. *Fleischwirtschaft International* 3, 26-27.**
- 3. Anil, M.H., Love, S., Helps, C.R. and Harbour, D., (2002): Potential for carcass contamination with brain tissue following stunning and slaughter in cattle and sheep. *Food Control* 13, 431-436.**

4. Anil, M.H. and Austin, A. (2003): Bovine Spongiform Encephalopathy: A Review of some factors that influence meat safety. Agrippa.
http://www.fao.org//DOCREP/ARTICLE/AGRIPPA/590_en.htm#P11_1213
5. Anil, M.H. (2012): Effects of slaughter method on carcass and meat characteristics in the meat of cattle and sheep. http://www.eblex.org.uk/wp/wp-content/uploads/2013/04/slaughter_and_meat_quality_feb_2012-final-report.pdf
6. Bager F., Shaw, F.D., Tavener, A., et al. (1990): Comparison of EEG and ECoG for detecting cerebrocortical activity during slaughter calves. Meat Science, Oxon, v.27, n.3, p.211-225.
7. Bartels, H. (1980): Inspección veterinaria de la carne. Zaragoza: Acribia, 491p.
8. Bender, A. (1992): Meat quality. In Meat and meat products in human nutrition in developing countries. food and Agriculture Organization (FAO), Rome. [http://www.fao.org/docrep/t0562e/T0562E02.htm#Meat quality](http://www.fao.org/docrep/t0562e/T0562E02.htm#Meat%20quality)
9. Bilgili,S.F. (1992): Electrical stunning of broilers– basic concepts and carcass quality implications: a review. Journal of Applied Poultry Science 1, 135-146.
10. Bilgili,S.F. (1999): Recent advances in electrical stunning. Poultry Science 78, 282-286.
11. Chambers, P.G. and Grandin, T. (2001): Guidelines for humane handling, transport and slaughter of livestock. G. Heinz and T. Srisuvan (Eds.). http://www.fao.org/fileadmin/user_upload/animalwelfare/guidelines%20humane%20handling%20transport%20slaughter.pdf.
12. Coore, R.R., Love, S., McKinstry, J.L., Weaver, H.R., Phillips, A., Hillman, T., Hiles, M.J., Shand, A., Helps, C.R. and Anil, M.H. (2004): Research note: Dissemination of brain emboli following captive bolt stunning of sheep: Capacity for entry into the systemic arterial system. Journal of Food Protection 67, 1050-1052.
13. Coore, R.R., Love, S., McKinstry, J.L., Weaver, H.R., Philips, A., Hillman, T., Hiles, M., Helps, C.R. and Anil, M.H. (2005): Brain tissue fragments in jugular-vein blood of cattle stunned by use of penetrating or non-penetrating captive bolt guns. Journal of Food Protection 68 (4), 882-884.
14. Cortise, M.L. (1994): Slaughterhouses and humane treatment. Revue Scientifique et Technique Office International des Epizooties, v.13, n.1, p.171-193.
15. Daly, D.J., Prendergast, D.M., Sheridan, J.J., Blair, I.S., McDowell, D.A. (2001): Use of a marker organism to model the spread of central nervous system tissue in cattle and the abattoir environment during commercial stunning and carcass dressing. Applied and Environmental Microbiology 68, 791-798.
16. Dave D.and Ghaly A.E. (2011): Meat Spoilage Mechanisms and Preservation Techniques: A Critical Review. American Journal of Agricultural and Biological Sciences 6 (4): 486-510.

- Devine, C. E., Ellery, S., Wade, L. & Chrystall, B. B. (1984): Differential effects of electrical stunning on the early post-mortem glycolysis in sheep. *Meat Science*, 11, 301–309.
17. European Food Safety Authority (2004): “Welfare Aspects of Animal Stunning and killing Methods” Scientific Report of the Scientific Panel for Animal Health and Welfare on a request from the Commission related to welfare aspects of animal stunning and killing methods.
 18. Hajimohammadi B., Ehrampoush M.H. & Behrooz Hajimohammadi (2014): Theories About Effects of Islamic Slaughter Laws on Meat Hygiene. *Health Scope.*; 2(4):e14376.
 19. Halal advocates of America (2011a): The Two-Vessel Only Vertical Cut on Cattle. <http://halaladvocates.org/site/our-issues/vertical-cut/>
 20. Halal advocates of America (2011b): Stunning Method on Animals. <http://halaladvocates.net/site/our-issues/stunning-animals/>
 21. Hedrick, H.B., Aberle, E.D., Forrest, J.C., Judge, M.D., Merkel, R.A. (1994): Principles of meat science. 3.ed., DUBUQUE:Kendal/Hunt Publ. Co., 354p.
 22. Hillebrand, S.J.W., Lambooy, E. and Veerkamp, C.H. (1996): The effects of alternative electrical and mechanical stunning methods on hemorrhaging and meat quality of broiler breast and thigh muscles. *Poultry Science* 75, 664-671.
 23. ISNA Halal Certification Agency (2010): “Halal / Haram / Zabiha.” <http://www.isnahalal.ca/info.html>
 24. Gregory, N.G. (1994): Preslaughter handling, stunning and slaughter. *Meat Science* 40, 56-80.
 25. Gregory, N.G., (1998): *Animal Welfare and Meat Science*. CABI Publishing.
 26. Gil, J.I. & Durao, J.C. (1985): Manual de inspeção sanitária de carnes. Lisboa: Fundação Calouste Gulbenkian, 1985. 563p.
 27. Knight, A.C. and Anil., M.H., (2003): EC Accompanying Measure QLK2-CT-2002 30531 UK.
 28. Kranen, R.W., Lambooy, E., Veerkamp, C.H., van Kuppevelt, T.H. and Veerkamp, J.H. (2000): Haemorrhages in muscles of broiler chickens. *World’s Poultry Sci. J.* 56, 94-126.
 29. Lahucky, R., Palanska, O., Mojto, J., Zaujec, K. & Huba J. (1998): Effect of preslaughter handling on muscle glycogen level and selected meat quality traits in beef. *Meat Sci.*; 50(3):389–93.
 30. Leach, T.M. (1985): Pre-slaughter stunning. In: LAWRIE, R., ed. *Developments in meat science - 3*. London: Elsevier Appl. Sci. Publ. p.51-87.
 31. Meat technology update (2011): Effect of slaughter method on animal welfare and meat quality. http://www.meatupdate.csiro.au/data/MEAT_TECHNOLOGY_UPDATE_11-1.pdf

32. Miller, R.K. (2002): Factors affecting the quality of raw meat, In: Meat processing Improving quality. Joseph, K., K. John and D. Ledward (Eds.), CRC Press, FL, USA, pp: 26-63. ISBN: 978-1-59124-484-4.
33. Mucciolo P. Carnes (1985): estabelecimentos de matança e de industrialização. São Paulo:Íncone. 102p.
34. Mustaqim Islamic Art & literature (2014): The Halal Slaughter Controversy: Do Animal Rights activists protect the sheep or the Butcher?. <http://www.mustaqim.co.uk/halal.htm>
35. Petty, D.B., Hattingh, J., Ganhao, M.F., Bezeuidenhout, L. (1994): Factors which affect blood variables of slughetered cattle. Tydskr. S. Afr. Veterinary Ver., v.65, n.2, p.41-45.
36. Picchi, V. & Ajzental, A. (1993): Abate bovino segundo o ritual judáico. Revista Nacional da Carne, São Paulo, v.18, n.202, p.53-57.
37. Piske, D. (1982): Aproveitamento de sangue de abate para alimentação humana. I. Uma revisão. Boletim do Instituto de Tecnologia de Alimentos, Campinas, v.19. n.3, p.253-308, 1982.
38. Pleiter, H. (2005): Electrical Stunning before Ritual Slaughter of Cattle and sheep in New Zealand. in: Luy J. et al. [ed.] Animal Welfare at Ritual Slaughter. DVG Service gmbH, http://www.ernagraffstiftung.de/cms/download/tierschutz_bei_der_rituellen_schlachtung.pdf
39. Prendergast, D.M., Sheridan, J.A., Daly, D.J., McDowell, D.A., Blair, I.S. (2004): The use of a marked strain of pseudomonas fluorescence to model the spread of brain tissue to the musculature of cattle after shooting with a captive bolt gun. J. Applied Microbiology 96,437-446.
40. Rahman, S.F. (1999): Post harvest handling of foods of animal origin. In: Handbook of food preservation. Rahman. S.F. (ed). Marcel Dekker, NY, pp: 47-54. ISBN: 0-8247-0209-3.
41. Roça,R.O. (1999): Abate humanitário: o ritual kasher e os métodos de insensibilização de bovinos. Botucatu: FCA/UNESP, 1999. 232p. Tese (Livre-docência em Tecnologia dos Produtos de Origem Animal) - Universidade Estadual Paulista.
42. Roça, R.O. (2002): Humane slaughter of bovine. First Virtual Global Conference on Organic Beef Cattle Production September, 02 to October,15 – 2002. 1-14.
43. Roth, B. (2003): Electrical stunning of Atlantic salmon (*Salmo salar*). PhD. Thesis, Dept of Fisheries and Marine Biology, University of Bergen, Norway.

44. Roth, B., Moeller, D., Veland, J.O., Imsland, A. and Slinde, E., (2002): The effect of stunning methods on rigor mortis and texture properties of Atlantic salmon (*Salmo salar*). *Journal of Food Science* 67, 1462-1466
45. Sante V., Le Pottier G., Astruc T. , Mouchoniere, M. and Fernandez X. (2000): Effect of Stunning Current Frequency on Carcass Downgrading and Meat Quality of Turkey. *Poultry Science* 79:1208–1214.
46. Schmidt, G.R., Hossner, K.L.; Yemm, R.S. and Gould, D.H. (1999a): Potential for disruption of central nervous system tissue in beef cattle by different types of captive bolt stunners.
47. Schmidt, G.R., Hossner, K.L., Yemm, R.S., et al. (1999b): An enzyme-linked immunosorbent assay for glial fibrillary acidic protein as an indicator of the presence of brain or spinal cord in meat. *Journal of Food Protection, Desmonines*, v. 62, n.4, p.394-397.
48. Swatland, H.J. (2000): Slaughtering.
Internet: <http://www.bert.aps.uoguelph.ca/swatland/ch1.9.htm>. 2000. 10p.
49. Velarde, A.; Ruiz-de-la-Torre, J. L.; Rosello, C.; Fabrega, E.; Diestre, A.; Manteca, X. (2002): Assessment of return to consciousness after electrical stunning in lambs. *Animal Welfare* 11, 333 -341.
50. Warriss, P.D. (1977): The residual blood content of meat. A review. *Journal of Science Food Agriculture, London*, v.28, p.457-462.
51. Wotton, S.B., Anil,M.H., Whittington, P.E. and McKinstry, J.L. (1992): Pig slaughtering procedures: head-to-back stunning. *Meat Science* 60, 203-208.