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Legitimate Tests for Halal Meat Products

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Legitimate Tests for Halal Meat Products

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Dedication:

First of all, I would like to dedicate this study to Allah, who gave me the strength and knowledge to accomplish this research.

To my parents, Mr. Yasser and Mrs. Jamlah who inspired me to be strong despite of many obstacles in life.

To my loving husband and sons, Jamil Abu Reda, Nassem Al-Bahar, Ayham for their understanding and for their overwhelming, support morally and financially.

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To my supervisor Dr. Ibrahim Afaneh, to my home land Palestine to my beloved mosque All-Aqsa.

Declaration

I certify that this thesis submitted for the degree of master, is the result of my own research, except where otherwise acknowledged, and this thesis has not been submitted for the higher degree to any other university or institution.

Eman Yasser Saed Dagash

Signed: …….

Date: ……

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Abstract:

Forty eight rabbits to study the difference between Islamic slghtering method and other conventional method through investigating three major aspects, mainly, microscopic ,visual ,and glycolysis.

All rabbits from same bread and same characteristics; color, weight, height, age, and gender were slaughtered by six different slaughtering methods, namely; “Zabeh Halal”, mechanical stunning then “Zabeh Halal”, extreme stunning then “Zabeh Halal”, “Zabeh Halal” with complete separating head, death due to suffocate ,” Zabeh” without mention Allah name (Al Tasmiah) on the animal. Vital organs (brain, heart, lung), muscular tissues (thigh and chest), and spinal cord were used to prepare a cross and longitudinal colored microscopic tissue slides by standard microtone technique.

All samples were subjected to visual examination, while the prepared tissue samples examined under microscopic (NIKON microscope equipped with HITACHI monitor for saving photos). Direct snapshots were taken by LG G4 mobile (12 mp) .

Results obtained showed the ability to distinguish between the Islamic slaughtering method (Zabeh Halal) and other non Islamic slaughtering methods at three different levels: at visual level, at microscopic level, and tissue’s blood content.

These differences among slaughtering methods were very obvious in tissues came from lungs and spinal cords. Less variant, limited to microscopic level, were manifested for lung and chest tissues. While no variation remarks were recorded for tissues originated from muscular tissues. However, the PH decline trend and end value were studied enable to help to introduce solid explanation and better understanding for the differences between Islamic and non Islamic slaughtering methods.

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List of Terms:

NO.	Terms	Meaning
1	Haram	Unlawful in Islamic rules
2	Allah	God - the creator
3	Kebab	Name of dish
4	Barriani	Name of dish
5	Quozi	Name of dish
6	Tarshi	Name of dish
7	Circassian	Name of dish
8	Burgal	Name of dish
9	Kashri	Name of dish
10	Pasta	Name of dish
11	Sunnah	The sayings and actions of the Prophet peace be upon him
12	Quran	Holy book – word of our god
13	Halal	Lawful in Islamic rules
14	Bismillah Allahu Akbar	In the Name of Allah; Allah is the Greatest.
15	Al-Dhabh	The act of slaughter
16	Kiblah	The direction of Makkah Al-Mukarramah
17	Halqum	The trachea
18	Maree	Esophagus
19	Wadajain	Jugular veins

Chapter One

1. Introduction

Food is necessary for life and human activities, it is like "Fuel" which the body converts into the energy needed to build cells and tissues, needed by the human body to survive.

While it is possible to obtain nutrients in a scientifically controlled manner, common food is the most efficient way of obtaining energy and nutrients (Abd El-Rahim, 2013).

Food can be classified into two main groups: energy and nutrients. Fats, proteins and carbohydrates are analyzed by the body to produce energy from a given amount of food. Fats and carbohydrates are the main source of energy, meanwhile protein split up into amino acids which are consumed in building and repairing cells and tissues. All vitamins and minerals are considered as nutrients food body needs to stay healthy against sickness.

Food products are like any other industrial products responds to the demands of the consumer. Nowadays some people all over the world looking for healthy food for example food with low calories, others are interested in organic food which produced without the use of synthetic pesticides and other non-natural chemicals. Variations of habits and religions lead the food industry to produce suitable food for different groups such as the Chinese, Japanese, Italian, Indian, Mexican, vegetarian, Jewish, and Muslim.

Many of the features that shape dietary habits are derived from religious laws. All over the world many people choose to eat or avoid certain foods according to their religious beliefs. When a dietary practice is preserved by religious dogma it is given additional force. Dietary differences linked to religion should be considered when planning a balanced diet. While not all religions have specific guidance regarding food, here are some of the major religions and a brief look at how they impact eating habits (Abd El-Rahim, 2013).

1.1 Christianity:

Christian religion does not prohibit any type of food or drink, in general there are no restrictions on food. But it is subject to the rule of the New Testament. Everything is permitted, but not everything useful. While alcohol is considered a sin, the drinking of

moderate amounts of alcohol is not a sin. In Christian culture and worship, prayer is often done before and after food to thank God for blessings. There are no standard Christian dishes, but dishes vary from country to country in different cultures. In some cultures, such as India, Christians have their own kitchen, such as the Roman Catholic cuisine and the Catholic Mangalore cuisine. Even Though some Christian groups prohibited certain food for example some of orthodox prohibited consumption of pig meat (Albala, K, Eden T, 2011)

1.2 Judaism:

In the Jewish religion, it is allowed to eat meat of animals with four legs and all that has a cracked cleft and has no fangs. However, camel meat, rabbits and pigs are forbidden and its forbidden to eat all seafood, except fish with fins and husks, the rest of all sea fishing is forbidden, so permitted food is called kosher, meaning allowed to eat, and it is written on food in food stores so that the Jew can be sure before buying

It is also forbidden to mix meat with milk, so it is not permissible to cook meat in ghee and butter. Also, it is forbidden to eat meat, cheese, butter, or yogurt in one meal, even it is forbidden to put meat in a container where milk or cheese was placed (Diaz, S, 2011)

1.3 Islam:

The main food practices in Islam involve specific ritual slaughtering procedures for animals of consumption (haram practices), fasting during the month of Ramadan, the avoidance of pork and of intoxicating liquor. Foods are categorized as halal (those than may be eaten) and haram (those that should be avoided), as are other aspects of life. Most foods are halal while the list of haram foods includes pork, alcohol and any products that may contain emulsifiers made from animal fats (such as gelatins and margarines). Bread and bread products fermented by yeast may contain traces of alcohol and in some cases, may be considered haram. Moderation in all things, including eating and dietary habits, are an integral part of Islam (Abd El-Rahim, I, 2013)

Islam has linked every work done by the Muslim in his life with a great and a noble goal for which the Muslim lives, or is the realization of slavery to Allah.

‘‘قل إن صلاتي ونسكي ومحياي ومماتي لله رب العالمين ’’

القرأن الكريم (سورة الانعام 6،162)

“Indeed, my prayer, my rites of sacrifice, my living and my dying are for Allah, Lord of the worlds”

Holy Quran (Sura Al-An’aam 6,162)

’’وما أمروا إلا ليعبدوا الله مخلصين له الدين حنفاء ويقيموا الصلاة ويؤتوا الزكاة وذلك دين القيمة‘‘

القران الكريم (سورة البينه 98,5)

“And they were not commanded except to worship Allah “

Holy Quran (Sura Al-Bayyina 98,5)

And nutrition considers like any concept of the life of a Muslim which its purpose is to strengthen the obedience to Allah and the use of this food in the provision of energy necessary for the body and to maintain its health to ensure its survival and continued to perform duties and the rights of slavery to Allah and the reconstruction of the land according to the instructions of Allah.

righteous predecessors used to say:

(اني لأحتسب لله أكلتي وشربتي كما أحتسب نومتي وقومتي)

فارس,م.ع.(2011)

This philosophy has had a great impact on the rationalization of the Muslim view of food and the rationalization of dealing with it. The Muslim considers it away, not a purpose for which it is striving to achieve its desires. Thus, ensuring that he avoids the excesses of wasting food and requesting it, and thus also relieved himself of many health problems.

In this sense, Prophet Mohammad (peace and blessings of Allah be upon him) said:

(تعس عبد الدرهم ، تعس عبد الدينار، وتعس عبد القطيفة ، تعس عبد الخبيصة (وهي نوع من أنواع الطعام) ، تعس وانتكس،....)

(البخاري, 1380 هـ)

Since Islam has stimulated his followers to save their bodies and to avoid anything that causes harmto the Allah says:

"ولا تقتلوا أنفسكم ، إن الله كان بكم رحيما"

القرأن الكريم (سورة النساء 4، 29)

"And do not kill yourselves [or one another]. Indeed, Allah is to you ever Merciful"

Holy Quran (Sura An-Nisaa 29,4)

It has become a duty of the Muslim to take care of his food, and be serious to meet the needs of the body of all the nutrients that ensure availability to keep the body intact and away from diseases, as well as to avoid harmful foods that cause health problems and diseases of the body.

The Muslim's view of food was reflected in the life of Arabs in the early days of Islam. The Arabs did not care much about improving and developing their foods. And it was not mentioned about them doing that. They followed the traditions of other nations, that later entered Islam. andThey experienced there ways in preparation of food and meals, and many of these nations dishes and cooking transferred to the Arabs and they still retain non-Arabic names to this day, such as: Kebab, Barriani, Quozi, Burgal, Tarshi, Circassian and Kashri, pasta and other food.

With time passing, and the spreading of the Islamic countries, Muslim scholars have become increasingly interested in the management of food and its traditions, and some books were

concerned in this subject, such as the book Al wala'em (الولائم) by Shams al-Din Muhammad bin Ali bin Tulun Damascene (1475-1546), The Book of eating manor ((اداب الاكل by Ibn Imad al-Sufahbi (1349-1405), and the book food handling (تدبير الاطعمه) by Kendi (801-856).

The contribution of Islamic civilization was not only about the management of food and its traditions, but also had a major impact in the development of nutritional concepts and health, and in the formation of healthy nutrition behavior and highlighting food as an important factor in human health, which was a cultural precedent and scientific miracle which confirms the truthfulness of prophecy and the Prophet Muhammad (Abd El-Rahim, 2013).

The moderationn of consuming food, was mentioned in many Verses of holy Quran Allah said:

"وكذلك جعلناكم أمة وسطا لتكونوا شهداء على الناس ويكون الرسول عليكم شهيدا"

القرأن الكريم (سورة البقرة 2، 143)

"And thus, we have made you a just community that you will be witnesses over the people"

Holy Quran (Sura Al-Baqara 143,2)

It was mentioned in the Sunnah evidence about forbidding excessive eating and drinking, prophet Mohammad said:

(ما ملأ ابن آدم وعاء من شر من بطنه ، بحسب ابن آدم لقيمات يقمن أوده، فإن كان لا بد فاعل فثلث لطعامه وثلث لشرابه وثلث لنفسه).

(ابن ماجه,1422هـ)

Studies of modern science have shown that obesity caused by excessive eating is considered one of the most serious diseases of the age, as it results in many diseases that threaten the life of the human being, such as diabetes, high blood pressure, atherosclerosis and gout, which confirms the validity of the saying" :

(المعدة بيت الداء والحمية رأس كل دواء)

(ابن القيم,1998م)

Also mentioned in holy Quran and sunnah the importance of mentioning foods such as meat, dates, honey, and milk, and indicating its importance and its usefulness in health and nutrition, Allah said about the importance of honey:

"فيه شفاء للناس"

القرأن الكريم (سورة النحل 16، 69)

"in which there is healing for people"

Holy Quran (Sura An-Nahl 69,16)

and prophet Mohammad said about the importance if dates:

" بيت لا تمر فيه جياع أهله"

(الترمذي,1996)

and it was motioned about prophet Mohammad that he said about milk (and yogurt):

"اللهم بارك لنا فيه وزدنا منه"

(البخاري, 1380 هـ)

he also said when he eats or drink other food:

(الله بارك لنا فيه وأطعمنا خيرا منه)

(البخاري, 1380 هـ)

The treatment using food for diseases is one of the most important bases of medical treatment for some diseases in hospitals in Islamic cities in the Umayyad and Abbasid periods. And the food was mentioned in the books of Muslim doctors, such as:

(الأشربة) لابن ماسويه (777-857) , (تدبير الأصحاء بالمطعم والمشرف) لحنين ابن اسحق (809-873) و(الارجوزة في الحميات) لابن عزروت و (الأرجوزة في الأغذية والترياق) للسنان الدين ابن الخطيب (1313-1375)

Islam has defined the legal rules that govern the slaughter of animals which its meat is eaten. Because The slaughter process has a great impact on the health and safety of these meat, and this has a great impact on human health. Islamic law has made a civilized achievement by imposing legal rules on what can be eaten from animals (such as cattle, camels, and livestock), and by putting many religious instructions and rulings during slaughter.

“The Islamic method of slaughtering animals has been the object of much criticism from many people. One may consider the following points, which prove that the Islamic method of slaughtering is not only humane but also scientifically the best:

The Islamic mode of slaughtering an animal requires the following conditions to be met:

- The animal must be slaughtered with a sharp object (knife) and in a fast way so that the pain of slaughter is minimized.

- Slaughtering is to be done by cutting the throat, windpipe and the blood vessels in the neck causing the animal’s death without cutting the spinal cord.

- Blood must be drained completely before the head is removed. The purpose is to drain out most of the blood which would serve as a good culture medium for microorganisms. The spinal cord must not be cut because the nerve fibers to the heart could be damaged during the process causing cardiac arrest, stagnating the blood in the blood vessels.

- Blood is a good media of germs, bacteria, toxins, etc. Therefore, the Muslim way of slaughtering is more hygienic as most of the blood containing germs, bacteria, toxins, etc. that are the cause of several diseases are eliminated.

- Meat slaughtered by Islamic way remains fresh for a longer time due to deficiency of blood in the meat as compared to other methods of slaughtering.

- "The swift cutting of vessels of the neck disconnects the flow of blood to the nerve of the brain responsible for pain. Thus, the animal does not feel pain. While dying, the animal struggles, writhers, shakes and kicks, not due to pain, but due to the contraction and relaxation of the muscles deficient in blood and due to the flow of blood out of the body." (Naik.Z,2010, p 22)

1.3.1 The Islamic (Halal) method of slaughter can be described as follows:

"Islamic law requires that animals intended for human consumption be slain in a certain manner. The conditions for Halal slaughter can be summarized as follows:

- The animal to be slaughtered must be from the categories that are permitted for Muslims to eat.
- The animal must be alive at the time of slaughter.
- No electric shock, bullet or any other means should be used before slaughtering. Using any such method may lead to the death of the animal before it is cut. Islam prohibits Muslims from eating any meat coming from an animal that is dead before slaughter. Muslims are also advised to avoid eating anything doubtful.
- The animal must be slaughtered using a sharp knife. The knife must not kill due to its weight. If it kills due to the impact the meat may not be permissible.
- The windpipe (throat), food-tract (esophagus) and the two jugular veins must be cut.
- The slaughtering must be done in one stroke without lifting the knife. The knife should not be placed and lifted when slaughtering the animal.
- Slaughtering must be done by a sane adult Muslim. Animals slaughtered by a Non-Muslim will not be Halal.
- The name of Allah must be invoked (mentioned) at the time of slaughtering by saying:
  Bismillah Allah Akbar. (In the Name of Allah; Allah is the Greatest.)
- If at the time of slaughtering the name of anyone else other than Allah is invoked (i.e. animal sacrificed for him/her), then the meat becomes Haram "unlawful."

- If a Muslim forgets to invoke the name of Allah at the time of slaughtering, the meat will remain Halal. However, if he intentionally does not invoke the name of Allah, the meat becomes Haram.
- The head of the animal must not be cut off during slaughtering but later after the animal is completely dead, even the knife should not go deep into the spinal cord.
- Skinning or cutting any part of the animal is not allowed before the animal is completely dead.
- Slaughtering must be made in the neck from the front (chest) to the back.
- The slaughtering must be done manually not by a machine, as one of the conditions is the intention, which is not found in a machine."

  (Irish department of Halal certification," http://halalcertification.ie/halal/islamic-method-of-slaughtering")

- The slaughtering should not be done on a production line where not permitted animal are slaughtered. For example, any instrument used for slaughtering pigs should not be used in the Halal slaughtering.

The animal must be lawful to eat, alive, healthy, to be slaughtered only for the reason of food, in the name of The Creator, ALLAH and not for any other reasons (it has to be well-fed, not thirsty handled and moved gently and individually).

The slaughter-man must be in possession of a clear mind and not under the influence of alcohol or drugs, trained in the job, with an awareness of what he is doing.

The act of slaughter (Al-Dhabh) starts by pronouncing the name of ALLAH, to take His permission and in order to make the Slaughter-man accountable and responsible and to give compassion and mercy to the animal during this act. Besides, any action we do in our daily life should be commenced with the mention of the name of Allah the Most Kind, The Most Merciful.

The Quran says:

"And eat not of that where on ALLAH's name has not been mentioned for verily it is abomination"

Holy Quran (Surah Al-N'aam 6,121)

" وَلَا تَأْكُلُوا مِمَّا لَمْ يُذْكَرِ اسْمُ اللَّهِ عَلَيْهِ وَإِنَّهُ لَفِسْق"

القرأن الكريم (سورةالانعام 121،6)

Then, by a very, very sharp knife (which should be kept like a surgeon's knife in sharpness and cleanliness, Deep swift cut done instantaneously and quickly to the blood vessels of the neck (the two caroid arteries which carry blood to the brain and head, the two jugular veins which bring blood from the brain back to the heart), the trachea (windpipe) and the oesophagus (gullet), but the central nervous system (the spinal cord) should be kept safe and intact (not cut). Ghulam Khan (UFAW, 1971),

This deep, large cut through all the blood vessels of the neck causes acute blood loss and hemorrhagic shock: we know the blood is under great pressure, especially in the big carotid arteries (systolic pressure) and at high speed and, according to physical law, the pressure always goes from the high to low resistance - the point of the cut is the scene of low resistance for blood to and from the brain. As we have a fully intact, alive heart, so most of the blood is going to be pumped and poured out instantaneously and quickly under pressure leading to a rapid fall in the blood pressure.

Thus, depriving the brain of its main source of oxygen and glucose, and with no blood which is necessary to keep the animal alive and functioning and able to deal with any perceptive sensation this leads to anoxia and almost immediate loss of consciousness (anesthetization or "stunning").

The cerebrospinal fluid pressure falls even more rapidly than the blood pressure because of the jugular veins being cut, and this results in a deep shock and more loss of consciousness.

The animal, at this stage after the cut, is in a stable and quiet state with no movement or any distressed behavior. One would assume, if there was any pain or suffering, it would kick, move, or show signs.

After this short resting phase, and because the brain is deprived of oxygen and blood due to the huge amount of bleeding, the heartbeats increase in order to increase the flow of blood to the brain and other deprived areas.

Tonic and clonic involuntary contractions and convulsions start and occur as automatic physiological reflexes in order to send and push blood up, especially to the brain.

These contractions and convulsions are ‘painless’ (not, as the layman would imagine, that the kicking is due to the pain) especially when the animal is already unconscious and still has an intact spinal cord with safe nerve centers to the limbs, muscles, and organs. So, we have a huge amount of bleeding from the initial cut then blood loss is continuing with the squeezing pressure of these contractions and convulsions, leading to maximum bleeding-out and less retention of blood in the carcass, giving a better quality of meat [both safer and healthier. This is like direct method of slaughter, “but without stunning”.

The animal loses consciousness immediately. It is difficult to conceive a more painless and rapid mode of death; for a few seconds after the cut is made, the animal makes no movement its body is then convulsed, the convulsive movements continue for about a minute and then cease. The interpretation of this fact is clear: the cut is made by a knife so sharp and so skillfully handled that a state of syncope with its associated unconsciousness follows instantaneously upon the severing of the blood pressure. (Lord Horder GCVO, MD, FRCP, 2012)

The movement of the animal which begins at about 90 seconds are epileptiform in nature and are due to the blood-less state of the brain (cerebral ischemia with complete anoxaemia). Sensation has been abolished at the moment of the initial syncope.

Of course, there have been many other statements by eminent scientists giving the same explanations and conclusions about the direct act of slaughtering such as Leonard Hill (1923), Sir Lovatt Evans, Harold Burrow, I M Levingen (1979), F R Bell. Mr. Openshaw, Mr. Hayhurst.

Apart from the clear Divine laws and orders to us, and the clear physiological and scientific evidence, I would like to mention one golden rule in Islam which, again, fits into the perfection of mercy to every individual animal.

However, Islam didn’t come to sophisticate human’s life. Islam regulated people’s life enable to protect their life and to maintain their bodies healthier. Therefore, one of the major aspects that Muslim people would be concern of is their food either its prepared according to Islamic supervision which mean “Halal”, or not.

In this term, no doubt that meat food is ranking first in Muslims thoughts and thinking.

The purpose of this investigation is to help in distinguishing between meat slaughtered under Islamic supervision and other slaughtering methods. This will help in introducing scientific interpretation for the strong believe in Muslims people that “Halal” meat is healthier and has better sensorial characteristics.

Chapter Two

2. Literature Review

2.1 Introduction

On reviewing the available literature, it is evident that extensive research has been carried out to address the process of Islamic "Zabeh". With this in mind, in an attempt to simplify and delimit the subject to some extent, this chapter will focus primarily on the work that has been carried out on "Zabeha" which is "Zubehat on Islamic way" & on "Zabeha" "Zubehat" without name of Allah on it.

The primary objective of this chapter is to provide an insight into the theoretical and practical aspects of "Zabeh" even if "Zabeha" which is "Zubehat on Islamic way" & on "Zabeha" "Zubehat" without name of Allah on it. This will include an examination of bioproperties related to the process "Zabeh" with major emphasis being placed on the tissues blood & its content. physical changes accompany blood movement in animal body before & after the process of Zabeh. Thus, the chapter will review and highlight the structural, biological, and physical changes occurs on tissues & blood of meat after the process "Zabeh".

2.2 Stunning and slaughter methods

2.2.1. Overview of current slaughter practices

Animal production and stunning and slaughter procedures that produce meat for the consumer need to maintain product quality as well as protecting animal welfare. Slaughter methods, if not optimally employed, can adversely affect quality, operator, and food safety and as a result cause downgrading of carcass and meat. Undesirable defects include hemorrhages, bruising, broken bones, pale soft exudative (PSE) and dark firm dry (DFD) meat, short shelf life and even condemnation of meat. Inefficient or incorrect stunning and slaughter could not only compromise animal welfare but endanger operators and public health.

Slaughter procedures are usually regulated by legislation, codes of practice and recommendations for different species also exist. The suitability of commonly used methods depends on species, availability of facilities, consumer demands and economic considerations. This review deals with aspects of conventional methods as well as religious slaughter methods and their acceptability in terms of legislation, effects on welfare and quality.

Slaughter methods can be classified as conventional and religious applications.

2.2.1.1 Conventional methods

Effective stunning is aimed at ensuring that animals do not feel pain and distress as well as facilitating carcass control and effective bleed out either in unconscious animal or killing by cardiac arrest.

According to the EU Council Directive (European Community, 1993) and the impending European COUNCIL REGULATION ((EC) No 1099/2009) (European Community,2009) on the protection of animals at the time of slaughter it is stated that animals brought into abattoirs for slaughter shall be either moved or lairaged, restrained and stunned to make them unconscious before slaughter. Permitted methods for stunning are:

1) captive bolt pistol: mechanical methods, 2) electrical stunning and 3) gas stunning.

2.2.1.1.1 Electrical stunning

This is the most common stunning and slaughter application (Gregory and Wotton, 1985; Anil et al., 1997) It works by producing brain dysfunction and unconsciousness with or without subsequent killing by cardiac arrest so that bleed out (exsanguination) is carried out (Cook et al. 1996; Anil, 1991; Anil and McKinstry, 1991; Anil and McKinstry, 1992; Cook et al., 1999).

2.2.1.1.1.1 Head-only electrical stunning

Electrical currents, in sufficient quantities, applied on the head produce epilepsy ("grand mal" or seizure-like state), spreading across parts of the brain stimulating other cells. This effect, characterized by rapid and extreme depolarization of the membrane potential and development of a synchronized electrical response, can be measured and observed on the recorded electroencephalogram (EEG) as small waves with high amplitude in the tonic phase (rigid), and low frequency in the clonic phase (high motor activity in muscles) resulting in depression of electrical activity in pigs, sheep and cattle (Lambooij,1982a,b; Anil, 1991; Anil and McKinstry, 1992; Anil and McKinstry, 1998). Human subjects are known to become unconscious during epilepsy, by analogy, the effect is also assumed to be similar in other mammals. It has been demonstrated that several neurotransmitters are released in the brain during such an insult. Several studies have suggested that the general epileptiform insult induced by electrical stunning is dependent on the release of vasopressin, oxytocin, glutamate, aspartate, and GABA (gamma amino-4-butyric acid). The first effect, tonic phase, occurs through the release of glutamate, followed by the release of GABA that helps with recovery if the animal is not killed. A minimum current threshold level that is a function of electrical impedance in the head is required for producing such an effect.

The most common electrical stunning method for animals uses a frequency of (50) Hz alternating current (AC.), similar to mains electricity, with sinusoidal waveform. The frequency can be high e.g. (1800) Hz (Anil and McKinstry, 1992; Lambooij et al. 1997) and the waveform can be square or rectangular. High frequency electrical stunning can induce epilepsy in the brain. However, the durations are shorter than those with (50) Hz and high frequencies do not fibrillate the heart.

2.2.1.1.1.2 Head-to-back (cardiac arrest) electrical stunning

This method involves induction of an epileptic state in the brain with concomitant cardiac arrest by electrical currents applied in the chest. The idea behind this method is that animal welfare is maintained because any possible recovery is prevented as stopping the heart kills the animal (Anil and McKinstry, 1991; Wotton et al. 1992; Gregory, 1994). Additionally, convulsions caused by epilepsy are greatly reduced making carcasses more manageable hence improving operator safety. Neuro-physiological studies and assessment of other

parameters than general epileptiform insult and analgesia have indicated stunning and killing system may be humane. EEG and neurotransmitter release measurements have been used to assess the effects of electrical head only stun duration on welfare (Cook et al. 1992, 1995, 1996, 1999; Lambooij, 2004). Stress before killing increases some neurotransmitters that in turn may affect post stun reflexes and unconsciousness (Bodnar, 1984; Tume and Shaw, 1992; Cook, 1999). Combining head-only stunning with exsanguination could have a synergistic effect on the release of glutamate and aspartate thereby increasing the duration of unconsciousness (Cook, 1996). Exsanguination/sticking after a stun needs be carried out as soon as possible when using head-only stunning as it takes time depending on the species before brain responsiveness is lost following sticking (Hoenderken, 1978; Anil et al. 1995a, b). Cardiac arrest at stunning has distinct advantages in that a rapid loss of brain function occurs as well as ensuring animal does not regain consciousness because killing is not dependent on accurate sticking.

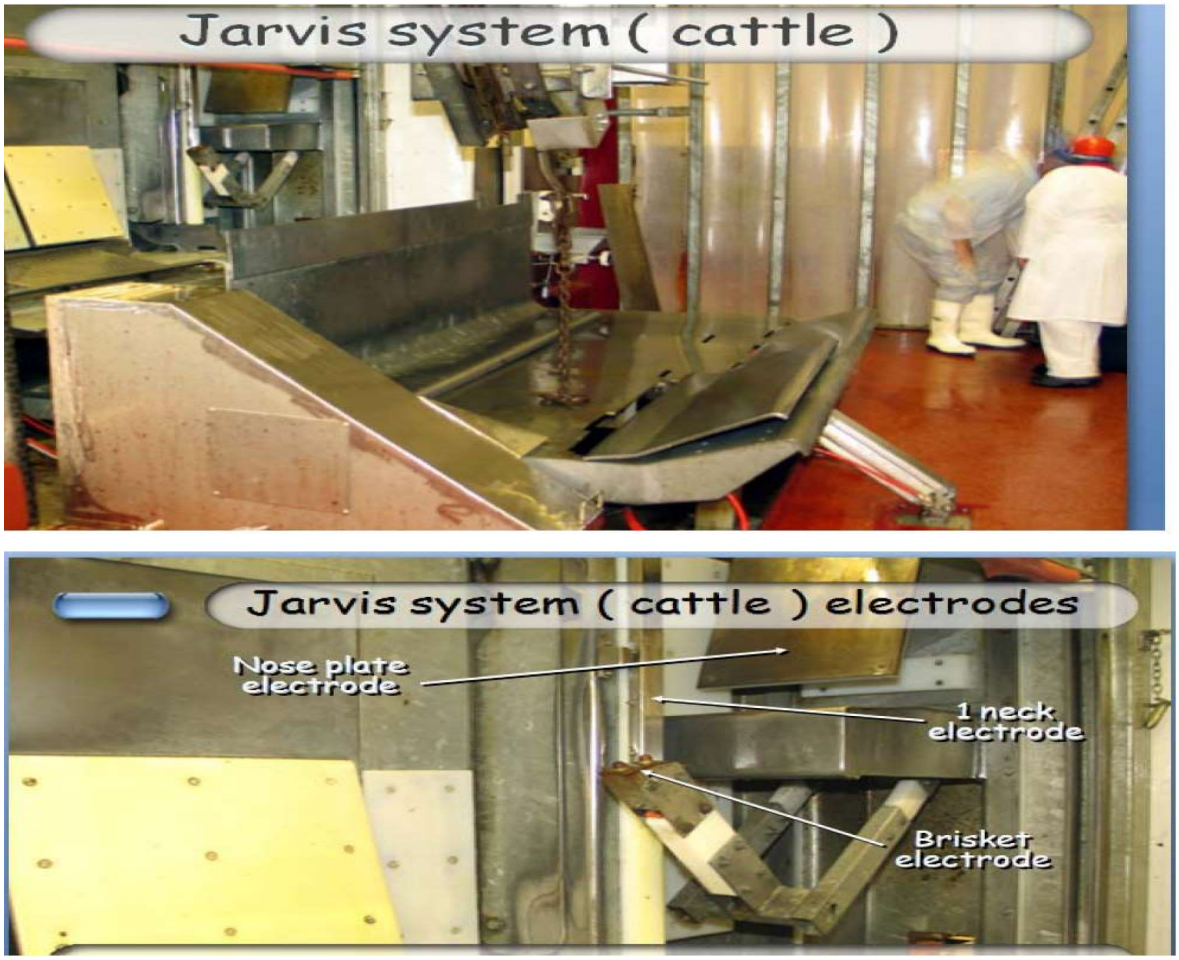

Figure 1. Jarvis Electrical stunning (www.awtraining.com)-cradle and electrode positions

Electrical stunning of cattle has become popular in recent years and is the chosen method in New Zealand where Jarvis stunning system that is incorporated in a restraining box is used. In the UK a few meat plants in England, Scotland and Northern Ireland also installed this system. Two main applications are possible: head-only stunning, mainly used for Halal slaughter, and head-to-body stunning (stun/kill method). However, disadvantages of the head-only technique in cattle/calves include relatively short duration of the epilepsy and excessive convulsions. Inclusion of cardiac ventricular fibrillation or rapid sticking (chest sticking) can prevent the former and electro-immobilization using a low voltage applied on spinal cord before sticking can resolve the latter problem. However, electro-immobilization may potentially mask signs of recovery or consciousness. The following applications can be used:

2.2.1.1.1. 3Jarvis cycle:

• First, a (3) sec head-only cycle (nose electrodes to neck yoke) to induce unconsciousness

• Second, a (15) sec cardiac cycle (brisket/nose electrodes) to induce cardiac Fibrillation (This would be excluded for Halal).

• Third, a 4-sec spinal cycle (rear end/nose electrodes) can be applied to prevent kicking. The stunner delivers current at (550) V, (50) Hz sinusoidal AC. about (3.5) A If the above application is usually part of an integrated Jarvis system that includes a restraining pen with in-built electrodes. Once stunning is carried out, the animal is ejected out of the pen onto a cradle for exsanguination. If cardiac arrest was applied, then a chest stick is carried oZaEF in out on the cradle in horizontal position before hoisting. In cases of Halal slaughter, electro immobilization on the spinal cord is applied before the neck cut.

In trials carried out by Wotton et al (2000) it has been shown that currents in excess of (1.15) amperes using (50) Hz AC would be required for successful stunning of cattle. The same study showed that unconsciousness lasted for (50) seconds before return of rhythmic breathing, palpebral reflexes. In order to achieve cardiac arrest a (5) seconds application of (1.15) amperes was sufficient.

In other studies, with adult cattle, different types of electrodes have been tested for head-only electrical stunning (Cook et al, 2002). Devine et al (2002) stunned cattle with (2.5) A (400 V, 50 Hz) passed through neck yoke electrodes behind the ears in a stunning pen.

With respect to stunning calves,) (1.25) A (50Hz, 150 V) is needed when the current is applied (Lambooij et al. 1983. Gregory et al (1996) recommended using at least (150) V.

After head only stunning of cattle and calves prompt sticking is essential to ensure no recovery occurs before death.

If neck cutting is carried out studies have shown that an isoelectric, flat EEG is observed within (30) to (127) sec after stunning (Bager et al. 1992; Devine et al. 1986; 1987). However, chest sticking, severance of the major blood vessels arising from the heart, has been shown to reduce this interval (Anil et al. 1995a, b).

In practice, (60) sec could be said to be the time interval between stunning and sticking for cattle. If head-only stunning is followed by the induction of cardiac fibrillation recovery is prevented. Because cardiac output and blood circulation is impaired, reducing oxygen supply to the brain and unconsciousness will be permanent.

Commercially available equipment that is used in New Zealand is effective but expensive for use in many other countries. Some handheld electric stunning systems have also been used for stunning adult cattle. However, this type of manual application is not as effective. Disadvantages and potential problems with electrical stunning cattle manually are:

• Cattle are big size animals and during passage of current from the head to the feet the animal may feel pain if current bye passes the brain or if the animal is not immediately made unconscious.

• Hand held tongs are difficult to apply and maintain contact during fall of the animal.

• Convulsions are too severe for carcass control and shackling and pose a threat to operator safety

• Exsanguination needs to be carried out quickly if cardiac arrest is not used Excessive convulsions after electrical stunning in cattle need to be managed both to protect operators and facilitate high throughputs. Electrical immobilization (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. Simmons et al (2006) have considered ways of solving this problem by suggesting combinations of waveforms and frequencies developed by Daly (2005).

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. This method can be carried out either individually in standing animals in a pen or in a restraining conveyor, usually V-type. Stunning is usually applied on exit and exsanguination is performed on recumbent animal before shackling. Head-to-back (stun/kill) technique is also popular especially for conventional slaughter that involves passing a current simultaneously through the brain and through the heart.

In cattle and calves' major challenges with head-only electrical stunning are short duration of the epileptiform activity and the occurrence of strong clonic convulsions. Various studies have shown that the duration of unconsciousness – measured from the resumption of normal breathing – was between (20) and (90) seconds. Effective bleeding must be achieved within this period to avoid resumption of consciousness. As thoracic (chest sticking) sticking induces a dramatic blood pressure loss within eight seconds and evoked responses were not present after five seconds in calves (Anil et al. 1995b), simple calculation of (20) minus eight seconds suggests that thoracic sticking should be carried out within (12) second after the stun. Thus, rapid thoracic sticking resolves the problem of short duration of unconsciousness after electrical head only stunning. In Australia and New Zealand thoracic sticking immediately after the Halal neck cut is routinely practiced to avoid problems of prolonged consciousness but also carcass quality problems, which could arise if bleeding is impaired (Pleiter, 2005).

The recommended minimum amperage is (1.5) ampere for adult cattle and (1.3) ampere for calves up to six months of age. In practice depending on the construction and placement of electrodes often two to three amperes are applied in cattle. Voltages used are (350) to (400) Volts. Electrode position for handheld tongs is preferably temporal between the eye and the ear. With automatic current application, the current flows through the brain between neck electrodes and a nose plate. Current can be applied for at least four seconds to the head (EFSA, 2004). If ventricular fibrillation is to be induced at least (1.5) ampere are recommended for cattle and about (1.0) ampere for calves, applied for minimum five

seconds, but in practice again often higher currents and longer application times are used (EFSA, 2004).

For sheep and goats, the same principles apply as for cattle (EFSA 2004; Blackmore and Delany, 1988). The tongs should be positioned between the eyes and the base of the ears on both sides of the head preferably on wet skin. Lower effectiveness of stunning is achieved through presence of wool and a dry skin surface or when tongs are in caudal position behind the ears (Velarde et al. 2000). Pointed electrodes (electrodes with pins) give good grip and electrical contact, because they penetrate the wool. Electrodes with serrated edges may work in shorn sheep and if the area of application is wetted. With small areas of contact between the sheep's head and the electrodes, wool-burning and marked carbonizing of the electrodes can occur. This, in turn, leads to a poor electrical contact due to an increased electrical resistance in the pathway and special care is necessary to keep the electrodes clean.

It is claimed that although lower currents in excess of (0.5) A may be sufficient effective head-only stunning in sheep should be induced using minimum currents of (1.0) Ampere. A minimum of (250) Volt should be used to deliver the current. Duration of current flow should be a minimum of two seconds and maximum stun-to-stick interval is suggested to be between eight seconds (EFSA, 2004) and (15) seconds (Anil and McKinstry, 1991).

Signs of efficient stunning in sheep include tonic and clonic activity and absence of normal rhythmic breathing. 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).

2.2.1.1.2 Captive bolt (Mechanical) stunning

This method, used correctly, can provide a satisfactory stun instantly meeting the main objective of stunning:
"to render the animal immediately unconscious". To maintain welfare the "unconsciousness" must be maintained until death without any recovery. Therefore, captive bolt stunning must either be irreversible or possible recovery must be prevented. It is mainly used in cattle, less frequently in sheep.

Mechanical equipment used for stunning and killing, can be classified as penetrating and non-penetrating guns and work by inducing concussion. These devices referred to as captive bolt guns used for this purpose also include use of free bullet and rifles. Captive bolt guns are different from the latter two in that they fire blank cartridges and expel housed bolts at high speed that retract back inside the barrel. In addition to conventional stunning cattle and to a lesser extent sheep guns are routinely used for emergency killing casualties, on-farm culling and for disease control. Captive bolt guns are required by legislation to be present as backup devices in case of failure of the main stunning equipment at abattoirs.

Other missiles used for stunning and killing of animals include free bullet, water jet and air pressure. After successful stunning animals collapse immediately and have a short tonic spasm for approximately (10) s prior to relaxation and immediately followed by excessive convulsions (Lambooij and Spanjaard, 1981). EEG (electroencephalogram) reveals major changes (delta and theta waves, slow waves, and isoelectric lines) and the animal is regarded to be unconscious due to similar EEG changes described in man (Lambooij, 1982b; Lopez da Silva, 1983; Daly and Whittington, 1986; Daly et al. 1986; Daly et al. 1987; Daly and Whittington, 1989; Daly, 2003). For a captive bolt to be effective certain criteria need to be met. Firstly, an appropriate gun with high enough cartridge strength needs to be employed so that the bolt is fired at high speed. Provided the correct target is hit then the impact on the skull should cause concussion by accelerating the head and the brain (Lambooij, 1981; Lamboiij and Spanjaard, 1981). This is possible if the bolt at high speed imparts sufficient kinetic energy.

In general, firing of a missile onto the head and brain can cause injury by laceration and crushing (<100 m/s), by shock waves [about 100 to 300 m/s] (Hopkinson and Marshal, 1967) and by temporary cavitation effect (>300 m/s). Using the following formula:

$e = 1/2\ mv^2$, where e = energy, m = mass, and v = velocity

We can show that the delivered energy required for effective stunning is determined by the velocity that determines the energy (Daly et al. 1987; Anil and Lambooij, 2009). However, secondary tissue damage by penetration also prevents possible recovery.

The following factors determine success of captive bolt stunning:

1. Provision of a suitable gun with the correct strength in optimum working order
2. Hitting the right target area (variations between species)
3. Bolt velocity (at least (50) m/second) and impact on head
4. Tissue damage
5. Penetration
6. Amount of energy (most important determinant)
7. Gun type and condition, choice of cartridge/air pressure Carbon deposits built up inside the barrel must be brushed out.

CB guns, depending on type, are activated by either trigger or on contact. The choice is usually based on availability, personal preference, and experience.
Cartridge strength is expressed in terms of grain size, (21) grain equals (0.0648) gram. It is essential that correct cartridges are used for each type of gun. The color for cartridge strength, gun power ((0.22) or (0.25) caliber) and head stamp on cartridge (manufacturer) are used as identifiers.

Table 1.Typical cartridges

Animals	Gun calibre	Cartridge
Very large (e.g. heavy bull)	.22 .25	4-4.5 4-6
Other large (e.g. cattle, horse)	.22 .25	3-4 5
Small (sheep, calves)	.22	1.25

Pneumatically operated captive bolt guns are not recommended for sheep and cattle because of increased risk of contamination of carcasses with brain material.

1. Shooting positions – see diagrams for species. More critical for correct stunning cattle than for sheep. Repeat shooting must be avoided as second and subsequent shots would not be as effective.
2. Bolt velocity must be at least (50) m/seconds for effective stunning on impact
3. Tissue damage ensures non-recovery, but would not improve stunning effectiveness. Non-penetrating CB stunning can also induce a stun.

4. Penetrating CB stunning results in the bolt entering the cranial cavity ((7.5-8) cm) and causing tissue damage. However, the main determinant of the stun is the impact. Although non-penetrating CB stunning can induce a stun, some recovery is possible if bleed out is delayed.
5. Effectiveness of captive bolt stunning is determined by the amount of energy imparted by the bolt during the impact on head:

Energy - Kinetic energy

Energy $=1/2mv_2$, where; m = mass, size of bolt & v = bolt velocity

Therefore, the amount of energy imparted by the bolt is more important than penetration. Hence, non-penetrative stunning guns can be as effective.

2.2.1.1.2.1 Types of guns:

- Penetrating: - blank cartridge, air injected bolt, air activated/injected bolt
- Non-penetrating Mushroom head bolt delivering a blow without penetration.

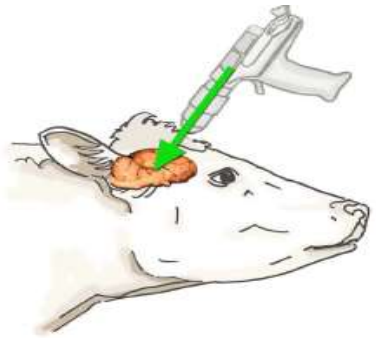

Figure 2. Penetrating guns fire the bolt into the brain through the cortex, midbrain and brain stem

This type of captive bolt stunning is designed to cause concussion by transmitting the energy from the missile (bolt) into the cranium and brain. Kinetic energy is transferred by the impact of a cylindrical steel bolt (mass) at speeds of (100) m/s in the air. As a result, fractures occur and shearing forces also cause hemorrhages and lacerations. Captive bolt stunning is widely used for red meat farm animals. To fire the bolts cartridges filled with gunpowder, compressed air or springs under tension can be used against and through the skull of farm animals. After penetration about (7.5) cm the bolt returns back into the barrel by the action of the buffers.

The ideal shooting position in cattle is the intersection of two lines between eyes and horns on the frontal bone (figure 2).

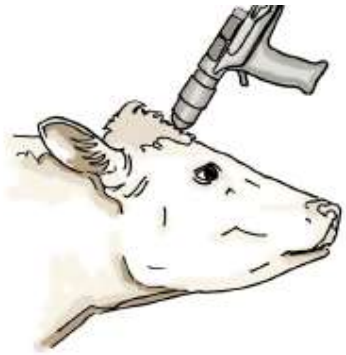

Figure 3. Non-penetrating guns deliver a blow on the skull damaging the cortex, midbrain and brain stem

Cerebral concussion is generally agreed to be a traumatically induced derangement of the nervous system, resulting in an instantaneous diminution or loss of consciousness without gross anatomical changes in the brain (Ommaya et al. 1964; Ommaya and Gennarelli, 1974). Irrespective of the type of force which produces the traumatic depolarization of the cell membrane there is now evidence that powerful pressure waves are provoked within the cranial cavity by a blow on the head and that the frequency and force of the waves vary in different parts of the brain (Ommaya et al., 1971). It has been suggested that it is not the pressure as such developed by these waves that is the important factor but the rapid oscillations in this pressure (Lambooij et al., 1981). It should be noted that many investigators (EFSA) consider blood flow impairment as being primarily responsible for the electrical changes in the brain, although the immediate changes in the brain cannot be explained by this theory.

With the impending introduction of the new directive (EC) No 1099/2009 (European Community, 2009) non-penetrating captive bolt guns will no longer be permitted to be used in adult from January (2013) only to be permissible in animals below (10) kg. This is the result of scientific considerations concluding that current design of non-penetrating guns are not effective enough.

Checks for effective captive bolt stunning should be made regularly to ensure good welfare and diagnose potential and existing problem:
Signs of an effective captive bolt stun:

• Animal should collapse immediately
• Eyes fixed
• No corneal reflex (no blinking when eye ball is touched)
• No rhythmic breathing, but heart does not stop for some time

Signs of an ineffective captive bolt stun:

• Attempts to raise head and stand up requiring repeat stuns
• Eyes rolled down
• Positive corneal reflex
• Rhythmic breathing

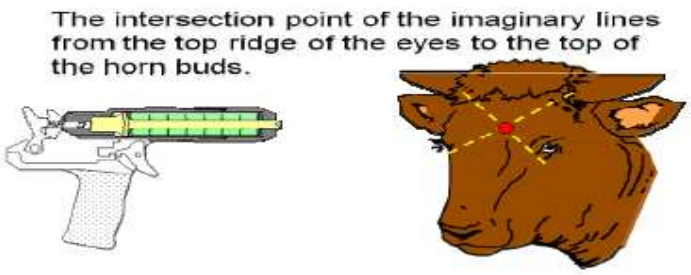

Figure 4. Shooting position in cattle

• Cattle: Intersection point of the lines drawn between the back of eyes and horn buds (figure 4)
• Sheep with no horns: Highest point on head gun aimed vertically (figure5) (Same for all goats).
• Sheep with horns: Midline behind the ridge between horns aimed at base of the tong.

Figure 5. Captive bolt shooting in sheep

2.2.1.1. 2.2 Sticking after CB stunning

Bleed out either by neck cutting or by chest sticking should be carried out as soon as possible. After the use of penetrating CB stunning, provided that there are no signs of recovery sticking can be delayed for over a minute for operational reasons. However, if non-penetrating CB gun is used, sticking must be performed immediately. For a good bled out the current widely popular method is chest sticking which involves cutting the skin longitudinally from the neck down to the chest following the midline and then cutting into the chest near the heart (see sticking). However, transverse neck sticking could also be used which must include severance of both carotid arteries and jugular veins.

General recommendations on captive bolt stunning:

• Follow manufacturer's recommendations/instructions.

• Keep guns in good working order, use devices suitable for species, correct cartridge size

• Clean out guns regularly every day -bolt, barrel, and buffers.

• Send guns for servicing every two years. Elongated bolts often need replacing.

• Keep a back-up gun for failure/emergency slaughter.

• If an animal fails to collapse immediately, check guns, shooting position and cartridge.

• The small area to be targeted on the head for effective stunning in cattle needs to be presented in such a way to facilitate correct shooting.

• Check for signs of effective stun must be before shackling.

• Avoid injury from kicking to operatives during shackling. e.g. provide sufficient space.

• Exsanguination (sticking) should be carried out as soon as possible.

Free bullet and rifle Killing by free bullets is not used regularly for cattle except, for emergencies e.g. by a marksman and not used for sheep in the UK. In some other countries for example Canada rifles have to be used for logistical reasons if animals are in wild areas. Bisons are also shot with special free bullets that remain inside the cranium.
Free bullets have a lower mass than bolts of captive bolt stunners, and travel with higher velocity (typically >300 m/s for rifles).

2.2.1.1.3 Other stunning and slaughter methods

2.2.1.1.3.1 Carbon dioxide

Because conventional electrical stunning methods can have adverse effects on carcass and meat quality gas stunning methods have been introduced and used in the last (3) decades. Carbon dioxide, the principle agent, and inert gases such as argon and nitrogen can be used and pigs and poultry are the chosen species. Although cattle and sheep are not suitable for gas stunning due to size and presence of wool some recent trials in sheep have been carried out at IRTA, Spain successfully (Dalmau et al. IRTA, Spain, personal communication).

2.2.1.1.3.2 Water jet and air pressure

High water jets developed for cutting and drilling in solid materials are available for use as stunners. Experiments to explore the suitability of water jets for stunning and killing purposes were conducted under laboratory conditions using post mortem materials (e.g. pig heads) and also on live slaughter pigs (Schatzmann et al., 1990). Immediate unconsciousness as determined by EEG, was initiated by a rapid penetration of the skin and skull. In these studies destructions of the brain occurred within (0.2) to (0.4) s. The water jet, if employed, should be aimed frontally on the head, and injected into the cranial cavity at the intersection of the imaginary lines from the ear to the opposite eye. A potential problem with water jets could be the excessive convulsions, that can appear after the use of this stunning method (Lambooij and Schatzmann, 1994). This is because – whenever an animal is decerebrated - convulsions (i.e. muscle contractions) of the carcass, caused by stimuli evoked in the medulla oblongata, mainly occur in the hind limbs.

2.2.1.1.3.3 Neck dislocation and neck cutting

Some predators use the method of cervical dislocation to immobilize and kill their victims. This is achieved by turning the head in opposite direction to the body while stretching the neck and concomitantly crushing and bleeding vessels. This method is not used in cattle and sheep. However, punctilla employed in South America operates by thrusting a knife into the intervertebral space between the head and the 1st or 2nd vertebra of cattle. After dislocation or thrusting a knife a tonic cramp occurs resulting in paralysis after (5) to (10) s (Gregory and Wotton, 1990). Removal or inhibition of the contact between brain and spinal cord causes apnoea and loss of (pain) sensory perception from the body and spinal shock, with the exception of the face innervated by the 5th cranial nerve (Eichbaum, 1975).

2.2.1.1.3.4 Heating.

Since the end of the (19) th century high frequency electric currents have been used to heat tissues. Long wave diathermy, using frequencies in the order (1) MHz required the use of electrodes which were in direct contact with the skin and consequently the risk of burning was high. Later frequencies known as short wave diathermy were introduced with the advantage that it was not necessary for the electrodes and the skin to be in contact being air between it (Lambooij et al. 1990). In a reported procedure (Guy and Chou, 1982) heads of rats were irradiated with micro waves of (2450) MHz for (1) s the temperature in the brain increased up to (75-90) °C within the next (1) s. Consequently, it was shown the brain enzymes are inactivated very rapidly, that they can be used in neuro-chemical investigations. It was observed that an increase of about (10) °C in the brain resulted in a clinical state of unconsciousness using (2450) MHz (6kW) for (1,5) to (2) sec. A change of (6.4) °C at a depth of (3) mm could cause a stunning effect using (915) MHz after seizure the rats lay in an unconscious state for a period of (4) to (5) min.

2.2.1.1.3.5 Cooling down

The current pre-slaughter process used for fish consists of live chilling to immobilize them prior to evisceration. Assessment of live chilling revealed that this method is stressful as

vigorous activity of the animals and irregular heart rates were observed (Lambooij et al. 2002). Responses to pain stimuli disappeared at a body temperature of approximately (8) to (10) °C, that occurred after (10) to (15) min, suggesting that consciousness is lost by this time. A patented alternative method of stunning and killing eels (Lambooij et al. 2002) involves cooling them down gradually until death. According to the patent description the eels should ideally remain at least for (10) min in a medium with a temperature below (-20) °C. A saturated brine solution at (-15) °C may also be used. In addition, the eels should be stunned prior to killing by cooling down the body temperature to between (0) and (5) °C. Placing eels in brine at (-18) °C is an effective method to kill the eels. However, it cannot be recommended to place conscious eels in cold brine water, because it takes more than (27) s before unconsciousness may be induced.

2.2.1.1.3.6 Fragmentation

Instantaneous fragmentation in a high-speed grinder could kill a small animal within a short time. Grinders with rotating blades are employed for small birds (Anil and Lambooij, 2009). However, there are objections on welfare grounds that it is argued that animals should be made unconscious first (e.g. placement in CO2 atmosphere first).

2.2.1.1.3.7 Magnetic stimulation

All stunning methods have disadvantages relating to quality, public health as well as possible misstuns. There is a need for research to develop alternative, ideally non-invasive, stunning methods (Knight and Anil, 2003). A non-invasive method that does not result in tissue damage before death could also be acceptable by Jewish and Muslim communities. Magnetic stunning is based on passing a large current through a copper coil by which an intense magnetic field is generated. The coil is positioned close to the head so that the brain lies within this magnetic field. Transcranial magnetic stimulation (TMS) has been used in humans for years. The technique also reliably initiates seizures in humans as an alternative to ECT for the treatment of depression (Lisanby, 2002). Bristol research has provided evidence for insensibility during the TMS application (Anil et al. 2000). Using similar technology, studies aimed at producing seizure activity and prolonged insensibility without

a painful induction have been conducted using new equipment and special coils in sheep, pigs (Anil et al. unpublished) and broilers (Lambooij, Anil et al. 2011). If fully developed, magnetic stimulation, a potential technique for stunning animals, could be used in future.

2.3 Effects of stunning and slaughter on carcass and meat quality

Stunning methods can have adverse effects on carcass and meat quality and cause downgrading. These could be visual effects such as bruising and hemorrhages, pelt burn in sheep, bone fractures, color changes caused by DFD 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:

• **Petechial hemorrhages** (blood splash) and bruising in both species caused by:

Electrical stunning, traumas during transport and preslaughter handling Bruising in cattle:

- ✓ □ during heavy falls after stunning
- ✓ □ impact from shutting gates on the back in race and stunning pen

• Animals developing bruising after hitting gateways and race fittings during passage to pens and restrainers

• Pelt-burn in sheep during head-to-back stunning where the rear electrode makes contact on back of neck

• Petechial hemorrhages in sheep can be seasonal and related to nutritional factors

• DFD in cattle due to tiredness and long-term stress, (Gregory, 1998)

During electrical stunning blood pressure changes, muscle spasms and convulsions can cause ruptures and hemorrhages in vessels and muscle as well as fractures (Gregory 1998). 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 (Troeger and Woltersdorf, 1991; Wotton et al. 1992). Sinusoidal

alternating currents with (50) Hz frequency have strong stimulation on muscles. This can however be reduced by higher frequencies to prevent occurrence of broken backs (Gregory et al. 1991), almost to the point of zero with (1500) Hz. The disadvantage of high frequency is that possibility of stopping the heart, if required, is also reduced (Anil and McKinstry, 1992; Wotton et al. 1992) Although hemorrhages can be induced by stunning and killing, the underlying mechanism is thought to be multi-factorial (Troeger and Woltersdorf, 1991; Gregory et al. 2011; Kranen et al. 2000).

Morphology of hemorrhages was shown to be dependent on the affected tissue, for example in the pectoral muscles extravasating blood followed direction of the muscle fiber; In fat tissue hemorrhages were petechial and diffuse hemorrhages in loose connective tissue (Hillebrand et al. 1996; Kranen et al. 2000). Histological studies on structures where hemorrhages occurred showed that blood leaking out of vessels is determined by the type of surrounding tissue and also the amount of blood leaving the circulation. Some hemorrhages were associated with hyper contracted and disrupted muscle fibers, indicating that they were caused by severe muscular strain.

Many hemorrhages 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).

In order to reduce petechial hemorrhages and bruising following can be considered:

 Shorten stunning to sticking interval so that blood leakage through ruptured vessels is reduced

 Captive bolt stunning may be preferable to electrical stunning if blood splash is a problem as muscle spasms are less pronounced after captive bolt

 Electrical stunning currents are applied in a continuous and uninterrupted manner

 in lambs electrical stunning with cardiac arrest may reduce blood pressure and blood splash.

2.4 Stunning methods and public health implications

Although, stunning methods have effects on animal welfare, in some instances, public health measures taken and concerns, especially as a result of the BSE threat, have inevitable welfare consequences too. To this end, a detailed EFSA opinion on stunning methods and public health implications has been prepared (EFSA, 2004). Potential public health concerns from TSE infected animals have been considered and reviewed (Anil et al. 1999; Anil and Austin, 2001). CNS embolism of (4) and (2) per cent in jugular blood of cattle stunned with penetrating and non-penetrating captive bolts, respectively, has been reported (Coore et al. 2004; 2005). In sheep, higher frequencies (23) and (14) per cent, respectively for cartridge activated and pneumatically activated guns) of CNS embolism in jugular blood have been reported (Anil and Harbour 2001; Coore et al. 2004). 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 (Schmidt et al. 1999) but also when stunning is performed without air injection (Anil et al. 2002; Coore et al. 2004; Coore et al. 2005) In NPCB stunned cattle, CNS material was detected in jugular blood of 2% animals (Coore et al. 2004; Coore et al. 2005). In addition to hematogenous contamination of edible tissues with CNS material, other public health concerns may also be associated with 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).

2.2.2 Religious slaughter methods

Religious slaughter of meat animals has been subjected to much controversy and received attention in recent decades. This debate has intensified especially with the concomitant increase in Muslim populations in European countries, meat exports into the Middle and Far East and also consumer concerns and demands in both secular and Muslim groups. Questions and calls for changes about and for current practices and legislation have also become more frequent. Most religious slaughter in Europe and the Western countries, where allowed by law, is carried out either by mostly the Muslim/Halal and to a lesser extent by the Jewish

(Shechita) methods. As a result of the above, an EC funded project, DIALREL, has attempted to consult interested parties, collect information stimulated a debate about religious slaughter (http://www.dialrel.eu)

Although legislation in most European countries requires preslaughter stunning, there can be exemptions for animals slaughtered by religious methods if individual countries so decide. Several countries in Europe (EU and others) do not allow slaughter without stunning (e.g. Sweden, Denmark, Norway and Switzerland). As far as UK is concerned, where this exemption exists, the Farm Animal Welfare Council published a report on religious slaughter methods in 2003 (FAWC, 2003) on the welfare of livestock when slaughtered by religious methods. This report recommended that UK government should repeal the exemption, however this was rejected. Therefore, current legislation (WASK 1995) allows these practices with or without preslaughter stunning.

Debate and concerns about religious slaughter focus on three questions:

i) Is there undue stress during handling prior to religious slaughter (Dunn 1990; Grandin, 1994; Grandin and Regenstein, 1994);

ii) Is the neck incision painful during the cut and/or immediately afterwards (Gibson et al. 2009a, b, c, d);

iii) Is sensibility and consciousness lost quickly enough following exsanguination ["sticking"] (Daly et al. 1988; Kalweit et al. 1989; Grandin and Regenstein, 1994; Anil et al. 1995a, b; Rosen, 2004)

In regard to stress of handling, as no specific religious requirements exist, the first question also applies to all other methods of slaughter. Some traditional practices however are still reported such as tying legs of sheep probably before religious slaughter that would be of concern. Others in cattle include the use of a casting pen (no longer permitted in the UK) and hoisting cattle by one of the hind legs prior to slaughter. It is argued that above practices are unduly stressful if practiced.

The second and third questions are related. Scientific methods to trying to measure 'pain' had limitations and did not provide 'proof' to answer the second question conclusively for many years. However, irrefutable loss of sensibility has been possible to assess by measuring evoked responses and brain activity. Studies on this have reported early loss of sensibility

(10-20 seconds) following incision although others have shown delays lasting up to (2) minutes. Objections to these findings have been made on grounds that possible sensations did not necessarily mean pain. (C. Johnson and his team) in Zealand have recently developed a new technique to study pain in slaughter animals. Their series of publications report examination of EEG patterns in calves following neck cutting (Gibson et al.2009a, b, c, d). Their reported comparative analysis concludes that ventral neck cutting results in responses to noxious stimuli, in particular when blood vessels are severed. These reports now provide scientific evidence to suggest pain after slaughter without stunning and the debate continues. In contrast Rosen (2004) claimed that Shechita cut is painless because the cut is made with a very sharp knife and no pain can be possible because brain function is lost immediately. There is some evidence to suggest specific problems may occur in calves and adult cattle if the cut carotid ends develop clots restricting blood flow following slaughter (Anil et al. 1995a, b). The development of these occlusions has been attributed to inadequate sharpness of the knife by some claims. However, this problem has also been reported following (Shechita) slaughter employing a razor-sharp knife (Anil, personal observations; Levinger, (1976). It is now believed other factors are involved. Gregory et al. (2011) observed an incidence of 10% carotid occlusions (aneurysm) in cattle slaughtered by Halal and (Shechita) and suggested an alternative neck cutting position higher up in the neck.

The potential problem of sensibility during and after neck cutting could be minimized by the use of preslaughter electrical stunning provided that this is correctly applied and is acceptable. In regard to (Shechita) preslaughter stunning is precluded. Some (Shechita) in the UK used to be practiced with post cut captive bolt stunning. However, UK and European (Shechita) organizations do not accept that any more. In contrast, stunning provided it does not stop the heart before exsanguination, for is used Halal slaughter in some countries in Europe, Far East and invariably employed in New Zealand and Australia for export to countries in the Middle and Far East with the approval of the appropriate religious authorities. However, objections to stunning during Halal slaughter have been increasing in recent years in Europe. Reasons for this trend include potential welfare problems during stunning, perceived uncertainty regarding the effects of stunning on heart function and other myths about stunning and reluctance to move away from tradition.

2.2.2.1 Halal slaughter

In practice Muslim method of slaughter, now commonly referred to as Halal method, is shown to vary in the way it is applied. The variations are possibly due to differences in the interpretation of the Quran and the Hadith (the sayings of the prophet Mohammed), different traditions as well as lack of sufficiently trained slaughter men, interested individuals and certifiers. This situation is in contrast with the approach of (Shechita) organizations that have strict and more consistent rules and applications.

The act of slaughter (Al-Dhabh) is allowed in the name of God; therefore, pronouncing the name of Allah is the usual practice. This is to remind the slaughterer that he is taking the life of a living creature. Animals are restrained but there are no specific religious regulations as to how this should be done other than traditional methods employed. Following restraint, slaughter is carried out by severing the neck to achieve instant and copious exsanguination using a sharp knife. The usual type of incision is transverse severance of the vessels in the retrograde fashion following an initial stab incision in the neck.

Muslims believe that they are required to ensure rapid and maximum blood loss and that this is crucially important during and after Halal slaughter, because consumption of blood is forbidden. Effective exsanguination however, has been a source of concern in that in some cases occlusions can impede bleed out rate and delay loss of consciousness (Anil et al. 1995a, b). Another claim was that stunning methods could impede blood loss during Halal slaughter. Comparative studies in sheep and cattle have shown, however, that there is no significant difference between stunned and non-stunned sheep (Anil et al. 2004) and cattle (Anil et al. 2006). This issue will be discussed later in this review.

2.2.2. 1.1Rules of Halal slaughter references in the Quran and the Hadith

Slaughtering practices before acceptable meat products are obtained for Muslim consumers are of utmost importance (Halal slaughter and meat), especially for those who want to ensure they comply with requirements (Anil and Sheard, 1994). There are references in the Koran and the Hadith (the sayings of the prophet) to permissible and forbidden foods as well as practices and rules of slaughter. However, interpretations and perceptions of the effects of procedures may differ. Since pig meat is forbidden, other red meat and poultry species is the subject of interest.

The above mentioned differences in interpretations of rules have led to some confusion and controversy regarding Halal slaughter. One of the major aims of Dialrel project was, to consult scholars to explore of determining and verifying Halal slaughter rules. This was achieved by holding consultations and workshops in cooperation with a partner in Egypt (Mansoura University) including scholars from Al-Azhar University, known as the center of excellence in Islamic studies. The following is a summary of the work in Egypt as well as other relevant information and religious decrees (fatwas) on rules in literature, misunderstandings of slaughter practices, international efforts in finding a globally agreed set of standards and certification issues.

Provision and consumption of meat for Muslim communities is an essential part of the religious life and certain conditions must be met so that the meat is lawful, Halal. If the treatment and slaughter of meat animals do not meet the criteria then the meat may be regarded as unlawful, Haram.

Some species such as pigs, carnivorous animals and carrions are forbidden. Rules relating to Halal slaughter are based on i) The Holy Quran; ii) Sunnah and Hadith and iii) Views of religious scholars.

There are direct and indirect references in the Quran (Quran translation) relating to food in general and slaughter (1).

(2:168)O ye people! Eat of what is on earth, Lawful and good; and do not follow the footsteps of the evil one, for he is to you an avowed enemy.

(2:16) 9For he commands you what is evil and shameful, and that ye should say of Allah that of which ye have no knowledge.

(2:170)When it is said to them: "Follow what Allah hath revealed:" They say: "Nay! we shall follow the ways of our fathers." What! even though their fathers Were void of wisdom and guidance?

(2:171)The parable of those who reject Faith is as if one were to shout Like a goat-herd, to things that listen to nothing but calls and cries: Deaf, dumb, and blind, they are void of wisdom.

(2:172)O ye who believe! Eat of the good things that We have provided for you, and be grateful to Allah, if it is Him ye worship.

(2:173)He hath only forbidden you dead meat, and blood, and the flesh of swine, and that on which any other name hath been invoked besides that of Allah. But if one is forced by necessity, without willful disobedience, nor transgressing due limits, - then is he guiltless. For Allah is Oft-forgiving Most Merciful.

(5:1)O ye who believe! fulfil (all) obligations. Lawful unto you (for food) are all four-footed animals, with the exceptions named: But animals of the chase are forbidden while ye are in the sacred precincts or in pilgrim garb: for Allah doth command according to His will and plan.

(5:3)Forbidden to you (for food) are: dead meat, blood, the flesh of swine, and that on which hath been invoked the name of other than Allah. that which hath been killed by strangling, or by a violent blow, or by a headlong fall, or by being gored to death; that which hath been (partly) eaten by a wild animal; unless ye are able to slaughter it (in due form); that which is sacrificed on stone (altars); (forbidden) also is the division (of meat) by raffling with arrows: that is impiety. This day have those who reject faith given up all hope of your religion: yet fear them not but fear Me. This day have I perfected your religion for you, completed My favor upon you, and have chosen for you Islam as your religion. But if any is forced by hunger, with no inclination to transgression, Allah is indeed Oft-forgiving, Most Merciful.

(5:5)This day are (all) things good and pure made lawful unto you. The food of the People of the Book is lawful unto you and yours is lawful unto them. (Lawful unto you in marriage) are (not only) chaste women who are believers, but chaste women among the People of the Book, revealed before your time, - when ye give them their due dowers, and desire chastity, not lewdness, nor secret intrigues if any one rejects faith, fruitless is his work, and in the Hereafter, he will be in the ranks of those who have lost (all spiritual good).

(5:87)O ye who believe! make not unlawful the good things which Allah hath made lawful for you, but commit no excess: for Allah loveth not those given to excess.

(5: 88)Eat of the things which Allah hath provided for you, lawful and good; but fear Allah, in Whom ye believe.

(6:118)so eat of (meats) on which Allah's name hath been pronounced, if ye have faith in His signs.

(6:119)Why should ye not eat of (meats) on which Allah's name hath been pronounced, when He hath explained to you in detail what is forbidden to you - except under compulsion of necessity? But many do mislead (men) by their appetites unchecked by knowledge. Thy Lord Knoweth best those who transgress.

(6:121)Eat not of (meats) on which Allah's name hath not been pronounced: That would be impiety. But the evil one's ever inspire their friends to contend with you if ye were to obey them, ye would indeed be Pagans.

(6:145)Say: "I find not in the message received by me by inspiration any (meat) forbidden to be eaten by one who wishes to eat it, unless it be dead meat, or blood poured forth, or the flesh of swine,- for it is an abomination - or, what is impious, (meat) on which a name has been invoked, other than Allah's". But (even so), if a person is forced by necessity, without willful disobedience, nor transgressing due limits, - thy Lord is Oft-forgiving, Most Merciful.

(6:146)For those who followed the Jewish Law, We forbade every (animal) with undivided hoof, and We forbade them that fat of the ox and the sheep, except what adheres to their backs or their entrails, or is mixed up with a bone: this in recompense for their willful disobedience: for We are true (in Our ordinances).

(16:114)So eat of the sustenance which Allah has provided for you, lawful and good; and be grateful for the favors of Allah, if it is He Whom ye serve.

(16:118)To the Jews We prohibited such things as We have mentioned to thee before: We did them no wrong, but they were used to doing wrong to themselves.

In addition to the Quran, Sunnah and Hadith are used for guidance. Sunnah is the tradition and the examples set by the Prophet, model for Islamic life and practice, whereas Hadith is stories and the sayings of the Prophet. Crucially the importance and requirement of animal welfare in Islam have often been emphasized. The following Hadith of the prophet is a good example:

"Allah Who is Blessed and Exalted, has prescribed benevolence towards everything; so, when you must kill a living being, do it in the best manner and, when you slaughter an animal, you should sharpen your knife so as to cause the animal as little pain as possible".

There are numerous other Hadith that can be cited (Masri 1989). These include accounts that place more emphasis on animal welfare such as preclusion of sharpening a knife before an animal, preventing animals witnessing slaughter.

2.2.2.1.1.1 Discussions at Mansoura Workshop

Details of this workshop are included in the report on the Dialrel website. The following is a summary.

According to Prof. Dr. Samir El-Sheikh Professor of Islamic Law, Al-Azhar University, Cairo, and agreed by other scholars, the following are based on Islamic Sharia (Law):

- Islam is comprehensive; Sharia looks after everything for good. Allahu Ta'ala provided rules
- All food, fish, nuts, grains, vegetables, fruits are good for us. Haram things are unlawful. Also, animals are lawful and must be killed according to Islamic rules
- Haram (unlawful) foods include pigs, dogs, donkeys, carnivores, reptiles, insects, animals killed by strangulation, blow/clubbing; natural death/causes, beasts with fangs, birds of prey are carrion, Fish are exempt prophet pbu allowed things that come from sea as lawful, they are not no carrions. Animals if not sacrificed according to Islamic rules and those killed for gods other than Allah are Haram.
- Tasmiyyah is essential
- To avoid certain diseases blood must be cleared out of animal's body. Blood should not be retained in the veins and congeal, for hygiene reasons. Good flow of blood is required
- Animal must only die from slaughter, no dressing while alive
- However, anything can be eaten during necessity
- Muslims or People of the books (Christian and Jews), male or female can slaughter animals
- Basmalah/ Tasmiyyah, citing of god's name, is a must.
- Facing Qiblah (Mecca) is recommended, but not required. Majority of scholars agree
- Animal's head must not be removed during slaughter
- Run away animals that are out of control can be shot

• In regard to stunning if suffering occurs, or if animal dies before slaughter and if blood is congealed and retained, then that would be haram. Otherwise stunning is acceptable if the following are observed: Tasmiyyah, No suffering and Flow of blood

It is understood that there are two main requirements: Mercifulness to animal and Slaughtered animal must be healthy.

New technological methods would be fine as long as suffering is minimized and sufficient blood flows out to protect consumers. Islam does not say it has to be done by hand. Automatic cut is fine. Electric current killing is haram, but electric blades are fine.

The meeting continued with discussions on importance of blood loss, perception of pain and its duration during Halal slaughter with or without stunning and effects of various stunning methods. Although there was agreement on importance of exsanguinated blood being Haram (forbidden), and mercifulness to animals, it became clear there were some misunderstandings of scientific findings (listed under myths). These included lack of difference between stunning and slaughter methods and blood loss, immediacy of stunning methods and when death occurs after stunning and slaughter. The above were explained by examples of literature and video recordings and discussed.

The following conclusions were arrived at the Workshop held in Mansoura:

• Alive animal is required before death by exsanguination
• Flow of blood before death is essential
• Tasmiyyah is required during slaughter, not required for each bird if automatic neck cutting is used
• Eating of any meat in necessity and from people of the books is acceptable
• More flexibility in rules than thought
• Qiblah (facing Mecca) is not necessary, but optional
• Recommendation for latest techniques confirmed
• Stunning acceptable if above conditions are met
• Misunderstandings of techniques and effects still exist that require addressing globally

2.2.2.1.1.2 Decisions (Fatwa) on Halal Rules in regard to slaughter

Although there is no universally accepted hierarchical system there have been attempts over the years to issue rulings on Halal slaughter. For example, in (1978) Al Azhar University issued a fatwa allowing stunning of animals before slaughter (in those countries where stunning is performed); previously in (1977) a fatwa had been issued in Saudi Arabia that allowed captive bolt stunning. However, in (1995) Al Azhar issued another fatwa stipulating that stunning by captive bolt should not be allowed because it was similar to delivering a manual blow on the head of animals.

The debate on deciding the correct rules is still continuing that include a number of organizations and working groups in the world. The prominent ones are the Organization of Islamic Countries (OIC) working group and Malaysian standards. OIC Standards are now used by individual countries as guidelines -the following excerpts from the OIC draft (courtesy of Dr. Hamid Ahmad) is presented as an example:

This Standard was developed by the Standardization Expert Group of the Organization of the Islamic Conference (OIC).

2.2.2.1.2 General guideline on Halal Food

2.2.2.1.2.1 Islamic Rules

It means what ALLAH Legislate for Muslims which gain its rules from the holy Quran, and the honourable prophet method (Sunnah).

2.2.2.1.2.2 Halal Food

Halal food is the food which is allowed to be consumed according to Islamic rules and that comply with the requirements mentioned in this standard.

2.2.2.1.2.3 Prerequisite Programmes (1PRPs)

Basic conditions and activities necessary to maintain a hygienic environment throughout the food chain suitable for production, handling and provision of safe final products and safe food for human consumption.

2.2.2.1.2.4 Good Manufacturing Practice (GMP)

Actions regarding personnel and building hygiene in order to ensure safe and healthy production, storage, and distribution of food.

2.2.2.1.2.5 Good Hygiene Practice (GHP)

Measures taken in stages of food chain to ensure the provision of safe food for consumption.

2.2.2.1.2.6 Food safety

Concept that food will not cause harm to the consumer when it is prepared and/or eaten according to its intended use.

2.2.2.1.2.7 Food Chain

All stages involved in the production of food including processing, production, packaging, storage, transportation, distribution, and supply to the market, from raw material and its origin to consumption.

2.2.2.1.2.8 Halal animals

The following examples are considered as Halal:

- Domesticated animals such as cows, buffalos, sheep, goats, camels, chickens, geese, ducks, and turkeys.
- Non-predatory wild animals such as deer, antelope, chamois, wild cows, zebras.
- Non-predatory birds such as pigeons, sparrows, quails, starlings, and ostriches.
- Grasshoppers.

2.2.2.1.2.9 Non – Halal animals

The following examples are considered as non-Halal:

- Pigs, dogs, and their descendants
- Animals not slaughtered in the name of Allah
- Animals not slaughtered according to Islamic rules
- Animals that died by themselves.
- Animals with long pointed teeth or tusks which are used to kill prey or defend themselves such as tigers, bears, elephants, cats, monkeys, wolves, lions, tigers, panthers, jackals, bears, foxes, squirrels, martens, weasels, and moles, etc.
- Predatory birds with sharp claws such as hawks, falcons, eagles, vultures, ravens, crows, kites, owls and also lizards, snails, insects, mouse, crocodiles, and alligators.
- Pests and venomous animals such as rats, centipedes, scorpions, snake, wasps, and other similar animals.
- Animals which are considered repulsive like flies, maggots, ticks, spiders, and other similar animals.
- Animals that are forbidden to be killed in Islam such as honeybees and hoopoe.
- Donkeys and mules.
- Any ingredient derived from the non-Halal animals is not Halal.

2.2.2.1.2.10 Aquatic animals

Poisonous aquatic animals that are harmful to human health are non-Halal, unless the harmful or poisonous material is removed. Also, all fish with scales including their eggs as well as shrimps are considered as Halal.

2.2.2.1.2.11 Amphibious animals

All amphibious animals are non-Halal.

2.2.2.1.2.12 Blood and other materials of human or animal origin

All types of blood and products made from blood are non-Halal.

2.2.2.1.3 Rules of Slaughtering in practice

2.2.2.1.3.1 Requirements of the Animals to be slaughtered:

a) The animal to be slaughtered has to be an animal that is Halal.

b) A certificate must be issued by a Veterinary Authority which attests that animals to be slaughtered are healthy.

c) 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.

d) For a certain period before slaughtering, animals should be fed with Halal food. This period is minimum (3) days for Halal animals. Feeding of animals should be cut down for a period of (6) hours before slaughtering.

e) If animals have arrived from long distance, they should first be allowed to rest before slaughtering.

2.2.2.1.3.1.1 Slaughterer

a) The slaughterer shall be a Muslim who is mentally sound and fully understands the fundamental rules and conditions related to the slaughter of animals.

b) The slaughterer shall have a certificate of Halal slaughtering issued by a competent authority supervising matters relating to health, hygiene, sanitation, and rules of Halal slaughtering.

c) A slaughterer performed by religiously observant Jews or Christians who properly meets all Halal requirements described herein may be used when a Muslim slaughterer is not available and not with persons from other religion.

2.2.2.1.3.1.2 Stunning

a) Stunning is not recommended. One of the Halal slaughter methods recognized at national/international level shall be preferred. Animals must be alive during using the electrical shock and must be low voltage on the head only.

b) Electrical current and duration shall be validated and determined by the organization, taking into account the type and weight of the animal and other varying factors.

2.2.2.1.3.1.3 Slaughtering procedure of animals

In addition to Clause (**2.2.2.1.3.1),** the following requirements are applied.

2.2.2.1.3.2 Health checks of animals before slaughtering

In addition to ante mortem control, the following requirements are also applied.

Animals to be slaughtered shall undergo health checks. These checks include assessment of veterinary medicine residues, age, and pregnancy, diagnosis of diseases which hinder slaughtering (such as anthrax and rabies etc.), communicable diseases or any feverous diseases. Those animals which are found sick or suspected to be sick shall immediately be segregated in an isolation area and legal formalities should be fulfilled.

Animals which have completed (1/3) of their pregnancy shall not be slaughtered.

2.2.2.1.3.3 Leading animals to slaughtering area

Animals to be slaughtered shall be led into the slaughter area by qualified personnel through a corridor. Giving a light slap to legs with a stick or slight twisting of tail in the case of cows and use of low voltage electrical operated device are considered as normal practices.

At the end of the corridor that animals are led through for slaughtering, it should be ensured that animals waiting in the line are prevented from seeing those being slaughtered, with the help of a movable curtain or a partition system.

2.2.2.1.3.4 Procedure of Islamic slaughtering

a) The animal may be slaughtered, after having been hung or laid preferably on its left side facing Kiblah (the direction of Mecca). 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.

b) 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 "Zabiha" (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.

c) 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.

d) 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.

e) The slaughter act shall sever the trachea (halqum), oesophagus (mari'e) and both the carotid arteries and jugular veins (wadajain) to hasten the bleeding and death of the animals.

The bleeding shall be spontaneous and complete. The bleeding time must be not less than (2.5) minute to insure fully bleeding.

2.2.2.1.3.5 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’e) and both the carotid arteries and jugular veins (wadajain) to hasten the bleeding and death of the animals

f) The slaughterer is required to check that each poultry is properly slaughtered and any birds that missed the mechanical knife shall be slaughtered manually.

g) A backup slaughterer with knife shall be ready to check any neck not cut well during mechanical slaughtering and rapidly cut it manually.

h) Bleeding period shall be minimum (60) seconds but during winter this period shall be increased by (5-10) seconds.

2.2.2.1.3.5.1 Fish and grasshoppers

Fish and grasshoppers do not need to be slaughtered. In case of fish they should be taken from water while still are alive and death should happen outside the water.

Animals that are hunted and killed properly are regarded as being slaughtered. However, those animals captured alive should be slaughtered according to the Islamic rules.

b) The honeybees falling parts in the honey and the non-avoidable parts are excluded from the non-Halal animals.

c) the product or its ingredients shall be safe and not harmful.

d) the product is prepared, processed, or manufactured using equipment and facilities that are free from contamination with non-Halal materials.

e) during its preparation, processing, packaging, storage, or transportation it shall be physically separated from any other food that does not meet the requirements specified in items a), b), c) and d) or any other things that are described as non-Halal by Islamic rules.

Guideline parameters for electrical stunning

Type of animal	***Current (Ampere)***	***Duration (Second)***
**Chicken*	*0,25-0,50*	*3,00-5,00*
Lamb	*0,50-0,90*	*2,00-3,00*
Goat	*0,70-1,00*	*2,00-3,00*
Sheep	*0,70-1,20*	*2,00-3,00*
Calf	*0,50-1,50*	*3,00*
Steer	*1,50-2,50*	*2,00-3,00*
Cow	*2,00-3,00*	*2,50-3,50*
Bull	*2,50-3,50*	*3,00-4,00*
Buffalo	*2,50-3,50*	*3,00-4,00*
Ostrich	*0,75*	*10,00*
Note: Electrical current and duration shall be validated and determined by the organization, taking into account the type and weight of the animal and other varying factors.		

*DIALREL NOTE: The above table will need to be amended. For example, the high currents given for poultry, if used with (50) Hz, would kill the birds before slaughter.

2.2.2.1.4 Stunning and Halal slaughter:

Preslaughter stunning is carried out for conventional killing of meat animals with the aim of managing the carcass and preventing potential pain and distress during the neck cut.

Stunning is required to induce immediate unconsciousness that should last until death usually by exsanguinations. There are various stunning techniques that include electrical, mechanical and gas stunning with different applications and effects on both welfare and product quality.

Whether stunning should be acceptable before Halal slaughter has been subject to controversy for decades. Certain types of stunning methods have been regularly used for decades in some countries. For example, New Zealand, where stunning is compulsory, has been exporting Halal red meat since the (80) s and in UK, Germany, Holland, France, and Spain Halal meat is produced from both stunned and non-stunned animals (where legislation provides exemption) for the Muslim market. Poultry slaughter in large numbers also often employs preslaughter stunning in these countries and in Turkey. Some European countries, however, such as Sweden, Norway and Switzerland have imposed bans on slaughter without stunning. A New European Union regulation that will come into force in (2013) will maintain the exemption. However, each member country will have the option to implement it or have derogation. The most popular stunning method is the use of electrical currents. Specific electrical currents and frequencies need to be used for Halal slaughter, mainly so that death is prevented but only a stun is achieved. Either non-lethal voltages and currents or high frequencies (>100 Hz) are used only to stun animals for Halal slaughter.

There are (3) views in regard to stunning: i) Those who accept it if conditions are met because welfare of animals is protected and rules are maintained (Al-Hafez Masri 1989); ii) Some reject the idea of stunning completely as they think stunning is not necessary, against religious rules or creates problems for animals (Katme 1986); iii) Others either not sure or want assurances in both cases. Dialrel project has found that consumer trust in Halal products is low in Europe. In addition to legislative changes, post-cut stunning is also being considered as a compromise for the objectors in Europe.

2.2.2.1.5 Conditions of "Zabeh or Dabh" in Islamic way:

"Zabiha" is a clearly defined method of killing an animal for the sole purpose of making its meat fit for human consumption. The word "Zabiha" in Arabic means purification or rendering something good or wholesome. The following conditions must be fulfilled for "Zabiha" to meet the requirements of the shariah (jurisprudence).

2.2.2.1.5.1 Animal

- Animals to be slaughtered must be animals that are permitted (Halal) to be eaten. Live animals living in their habitat (Hayat Mustaqirrah). The animal must be healthy and not in the state of stress. The respiratory tract, esophagus (channel for taking in food) and jugular vein must be severed, to assure maximum removal of blood and less suffering to the animal (wahab ,2004).

_ It is abominable to first throw the animal down on its side and sharpen the knife afterwards. It is narrated that the Prophet once passed by a person who, having cast a goat to the ground, was pressing its head with his foot and sharpening his knife while the animal was watching. The Prophet said, "Will this goat not die before being slain? Do you wish to kill it twice? Do not kill one animal in the presence of another, or sharpen your knives before them" (Khan, 1991).

_ It is abominable to let the knife reach the spinal cord or to cut off the head of the animal. In South Asia, the term used for cutting of the head, usually by hitting the animal from behind the neck, is called jhatka or killing with a blow. There is general abhorrence in the Muslim community to such killing.

_ It is abominable to break the neck of an animal or begin skinning it or cut any parts while it is convulsing or before its life is completely departed.

Muhammad said, "Do not deal hastily with the souls (of animals) before their life departs" (Khan, 1991). It is sometimes the practice in fast-pace commercial slaughterhouses to start removing the horns, ears, and front legs while the animal still seems to be alive. This is against the principles and requirements of "Zabiha" and must be avoided.

_ It is abominable to perform "Zabiha" with a dull instrument. Muhammad commanded that knives be sharpened and be concealed from animals to be slain.

_ It is also abominable to slaughter one animal while the next in line is watching the animal being killed. This is against the humaneness of the process of slaughtering.

From the foregoing description, it is clear that both intention and a precise method are conditions for the validity of "Zabiha". The insistence on pronouncing the name of God before slaying an animal is meant to emphasize the sanctity of life and the fact that all life belongs to God. Pronouncing the tasmiyyah induces feelings of tenderness and compassion

and serves to prevent cruelty. It also reinforces the notion that an animal is being slaughtered in the name of God for food and not for recreational purposes. It is not allowed in Islam to kill an animal for the sole purpose of receiving pleasure out of killing it.

2.2.2.1.5.2 The Slaughter Person

The person performing the act of" zabiha" must be of sound mind and an adult Muslim. The person can be of either sex. If a person lacks or loses the competence through intoxication or loss of mental abilities, he or she may not perform halal slaughter. The meat of an animal killed by an idolater, a nonbeliever, or someone who has apostatized from Islam is not acceptable.

Slaughtering must be performed manually by Muslim of sound mind, mature and he fully understands the fundamentals and conditions related to slaughtering (Wahab ,2004).

2.2.2.1.5.3 the instrument of" Zabeh" in Islamic way

The knife used to perform "zabiha" must be extremely sharp to facilitate quick cutting of the skin and severing of blood vessels to enable the blood to flow immediately and quickly, in other words, to bring about an immediate and massive hemorrhage.

Muhammad said: "Verily God has prescribed proficiency in all things.

Thus, if you kill, kill well; and if you perform "zabiha", perform it well. Let each of you sharpenhis blade and let him spare suffering to the animal he slays" (Khan, 1991). Muhammad is reported to have forbidden the use of an instrument that killed the animal by cutting its skin but not severing the jugular vein. It is also a tradition not to sharpen the knife in front of the animal about to be slaughtered.

All slaughtering devices must be sharp and are not made of bones, nails, and teeth. The use of sharp and clean slaughtering devices is to assure that the act of slaughtering is quick and not cruel to the animal and that the animal experience minimal pain as possible (Wahab, 2004)

The incision should be made in the neck at some point just below the glottis and the base of the neck. Traditionally, camels used to be slayed by making an incision anywhere on the neck. This process is called “nahr”, which means spearing the hollow of the neck. With modern restraining methods and stunning techniques, this procedure might not be appropriate any longer. The trachea and the esophagus must be cut in addition to the jugular veins and the carotid arteries. The spinal cord must not be cut. The head is therefore not to be severed completely. It is interesting to note that the kosher kill is very similar to the traditional method of “zabiha” described, except that the invocation is not made on each animal.

Tasmiyyah or invocation means pronouncing the name of God by saying Bismillah (in the name of Allah) or Bismillah Allahu Akbar (in the name of God, God is Great) before cutting the neck. Opinions differ somewhat on the issue of invocation, according to three of the earliest jurists. According to Imam Malik, if the name of God is not mentioned over the animal before slaughtering, the meat of such animal is haram or forbidden, whether one neglects to say Bismillah intentionally or unintentionally. According to the jurist Abu Hanifah, if one neglects to say Bismillah intentionally, the meat is haram; if the omission is unintentional, the meat is halal. According to Imam Shaf ’ii, whether one neglects to say Bismillah intentionally or unintentionally before slaughtering, the meat is halal so long as the person is competent to perform” zabiha” (Khan, 1991).

It is also enough to state here that the above tradition does not prove that the pronouncing of God’s name is not obligatory in performing “zabiha”. In fact, the tradition emphasizes that the pronouncing of God’s name was a widely known matter and was considered an essential condition of “zabiha” (Khan, 1991).

2.2.2.2 Shechita-Jewish methods

Jews consume beef, veal, mutton, lamb, and poultry, but not pork. These meats must be slaughtered and prepared in accordance with the rabbinical laws (Levinger, 1976).
Slaughter may only be carried out by an approved and trained slaughterman of the Jewish faith, called a Shocet. He must be a person of recognized high moral character and consistent

religious practice, often a Rabbi. He must obtain a license from the Rabbinical Commission in addition to the usual local authority license.

The slaughter is carried out by a Shocet. A single, transverse cut is made across the neck using a very sharp, special knife (chalaf). The knife has to be examined for its sharpness between each cut. It is usually 16 inches long for cattle. In the UK, after the neck cut, captive bolt stunning is used at some abattoirs.

Once an animal is dead, an incision is made through the abdominal wall and a Jewish Inspector feels at arm's length into the thorax to check for pleural adhesions or any other signs of abnormality. If any abnormality is found, the entire carcass is rejected for Jewish consumption on the ground that the animal was not healthy at the time of slaughter.

2.2.2.2.1 Current day practice

Slaughter may only be carried out by an approved slaughterman of the Jewish faith, called a Shocet. He must be a person of recognized high moral character and consistent religious practice, usually a Rabbi. He must obtain a license from the Rabbinical Commission in England and Wales (or from the Chief Rabbi in Scotland), in addition to the usual local authority license. The Shocet is not employed by the abattoir in which he serves but is appointed by the local Shechita Board.

The Jewish method of slaughter, Shechita, is preceded by positioning the animal, though this is not subject to regulation by the religious authorities. Sheep are placed on their backs in a cradle; cattle are placed in a restraint apparatus in an upright position and their neck is extended by a mechanically operated 'chin lift'. Most animals are restrained using the so-called Cincinnati pen. This is used in preference to the Weinberg type of pen, whose use was banned on 5th July 1992, following the recommendation of the Farm Animal Welfare Council (FAWC, 1983), on the grounds that it was unnecessary and inhumane to invert an animal (180°) before cutting its throat.

The slaughter is carried out by a Shocet. A single, transverse cut is made across the neck using a very sharp, special knife (chalaf). The knife has to be examined for its sharpness between each cut. It is usually (16) inches long for cattle.

2.2.2.2.2 Rules of Shechita

Shechita, the essential slaughtering step in the production of kosher meat is based on Halacha that constitutes the Jewish religious law. This law since its arrival continued to develop over the course of millennia across much of the globve. Zivotofsky (Dialrel project) described in his report the background and development of Shechita in detail.

Over the last (1500) years books have been written on the subject (A recent historical survey in English can be found in Jeremiah J. Berman, Shechita: A Study in the cultural and social life of the Jewish People, Bloch Publishing Company, NY 1941).

Of the Jewish Bible, the Tanach consisting of (24) Books, the first five are the most important known as Torah or the "Five Books of Moses. In addition to the verbatim instructions in these books, Moses was also given an oral Law. Rabbis later on wrote some of this information in Mishna. Because the Mishna is difficult to understand, rabbis produced versions of the Talmud that contains the Jewish Law.

The prohibition of "tza'ar ba'alei chayim" – causing anguish to living beings, is a general principle that is discussed in several contexts in the Talmud.

There is no question that in Judaism the consumption of meat is permissible and that man may make use of animals. In the opening chapter of Genesis (1:26) God states His intention to create man and declares that man would "have dominion over the fish of the sea, and over the birds of the air, and over the cattle, and over all the earth, and over every creeping thing that creeps upon the earth," and He so instructed them after their creation (Genesis 1:28).

After the second "creation" when Noah and his sons leave the ark, God again blesses them that "the fear of you and the dread of you shall be upon every beast of the earth… into your hand are they delivered" (Genesis 9:2).2 But this authority over lower life forms in no way was viewed as a carte blanche permission to abuse them. Quite the contrary, with power comes responsibility, and in Judaism man is viewed as responsible for the well-being of those animals under his control. Dails of Jewish rules regarding animals and food can be found in Zivotofsky's review who explains that. It is against this background of a tradition of general and specific rules designed to safeguard an animal's physical and psychological welfare that the laws of shechita are laid down in the Talmud and codified in the codes.

Kosher meat: There is a great deal more to kosher meat than the method of slaughter. It is emphasized that kosher meat is not meat “blessed” by a rabbi who only supervises the process.

Kosher species: The first requisite in the production of kosher meat is that the animal source be of a kosher type of the animal kingdom of five categories. These are: (1) terrestrial mammalian adrupeds, (2) birds, (3) fish, (4) invertebrates, and (5) “bugs”. Each of the first four categories includes kosher species. All members of the fifth category

and any creature that does not readily fit into one of the other categories are not kosher.

Among terrestrial mammalian quadrupeds, the Torah specifies physical characteristics of the kosher species. An animal is kosher if it both chews its cud and has fully split hooves. The kosher species include cows, sheep, goat, deer, antelope, and giraffe. Non-kosher species include camel, pig, rabbit, and dog.

According to the Torah, fish are kosher if they possess two physical signs: fins and scales. The Mishna (Niddah 6:9) observes that all fish with scales also have fins, although not all fish that have fins necessarily have scales. Thus, a fish that has scales may be categorized as kosher, and in practice there is really only one sign required in order to declare a fish as kosher. Kosher fish include tuna, salmon, carp, bluefish, flounder, herring, whitefish, and bass. Non-kosher fish include catfish, eel, and shark. In addition, non-fish seafood such as lobster and crab are non-kosher.

In order to be kosher invertebrates must have four physical signs: four walking legs, four wings, the wings cover the majority of the body, and two jumping legs.

The most widely accepted kosher species is Schistocerca gregaria, the desert locust.

Accepted kosher birds include chicken, turkey, duck, goose, pigeon, pheasant, and quail. Non-kosher birds include eagle, owl, and vulture.

Grasshoppers and fish do not require shechita and may be killed in any manner.

Shechita is the killing of the animal by exsanguination in as painless a means as possible. This is accomplished by cutting the throat with a sharp, smooth knife resulting in the severing of the trachea, oesophagus, jugular veins, and carotid arteries, but without decapitation, leading to almost immediate loss of consciousness and subsequent death.

The method of killing was commanded to Moses on Sinai."

Shechita is an incision performed on the neck, preferable from the front, although if done from the side it is also valid. However, if the cut is made from the back of the neck it is invalid. The neck is defined by upper and lower landmarks on the trachea and oesophagus as detailed in the Shulchan Aruch (Yoreh De'ah 20) that essentially includes the entire neck.

It is universally done with a special knife known as a chalaf (Figure 8). The chalaf is a sharp, smooth knife whose length is at least twice the diameter of the animal's neck. The essential point is to guarantee that the knife has absolutely no nicks, and in order to guarantee this, the chalaf must be examined for nicks along its cutting edge and on both sides. There is a requirement to inspect the chalaf both before and after the shechita. If it is found defective before it may not be used, and if upon inspection after the cut the chalaf is found to be defective it is presumed to have been nicked on the skin or some other object before the actual shechita and the Shechita is thus invalid. Shechita is performed only by a highly trained professional known as a shochet (ritual slaughterer). In order to train to be a shochet one must first study several years in a yeshiva (advanced religious seminary). If the student shows promise in mastering the requisite religious texts he may then be accepted as an apprentice to a shochet who will guide his studies, train him in the practical aspects, and eventually certify him. The training also includes the practical aspects of slaughtering and of inspecting each and every organ for treifa (rejected parts). Finally, and perhaps the most rigorous aspect, is learning to examine the knife for even the smallest nick and if found wanting, repairing the knife on whetting stones. Even after the entire training process and years of experience a shochet is never without supervision. The halacha requires that he regularly submit his knife to the local rabbi for inspection (Shulchan Aruch, Yoreh De'ah 18:17). In addition, a shochet operating in a commercial operation is under the supervision of the plant mashgiach (kosher supervisor by a certified, professionally trained shochet.), who is ultimately responsible for overseeing all aspects of the production. Thus, this is a major difference between kosher slaughter and other slaughter.

2.2.2.2.3 Current Shechita Practices

the animal's neck. There are five principal rules governing this act, if violated, render the shechita invalid (Shulchan Aruch,Yoreh De'ah 23:1). They are: 1) The cut must be made

without interruption.2) No pressing down, just the sharpness of the blade must cut;3) The knife must not be burrowed but rather must be exposed and visible from the beginning to the end of the cutting. Because there can be no undo pressure applied, animals used to be put in dorsal recumbency and slaughtered. In earlier times animals were thrown to the ground by tying two or three of their feet. More modern methods have been introduced such as the rotating or upright pens since then. Shochet involvement does not end with the death of the animal. An incision is made through the abdominal wall and a Jewish Inspector feels at arm's length into the thorax to check for pleural adhesions or any other signs of abnormality. If any abnormality is found, the entire carcass is rejected for Jewish consumption on the ground that the animal was not healthy at the time of slaughter.

Following this inspection, the meat is 'porged' to remove veins and other forbidden tissues. There are portions of the animal that are not kosher and must be removed. The three items are: blood, certain fats known as chailev, and the sciatic nerve known as the gid hanasheh. The consumption of blood is an abhorrence, the admonition of which is repeated several times in the Bible. The process of removing the large blood vessels, the forbidden fat, and the sciatic nerve is known as nikkur (in Hebrew), porging (in English), or treibering (in Yiddish) and is done by a trained menaker, porger, or treiberer. Because the vast majority of the chailev and the gid hanasheh are in the hind quarter of the animal (approximately defined as posterior to the 12th rib), the task of porging the hind quarters is significantly more tedious and time-consuming than the task in the forequarters and is generally not done except occasionally in Israel.

In the UK and possibly Europe, the hindquarter part of the carcass, because it is not easy to porge, is usually sold to domestic markets.

There are potential treifa in essentially every organ of the body. The shochet u’bodek must be intimately familiar with animal anatomy and what is and is not normal. Because there is a long list of potential treifa and most animals are healthy and do not have these defects there is in general no obligation to perform a comprehensive post-mortem to look for them. That is, the Shu” B does not have to open the skull and check the meninges, and then take out the spleen and examine it, and then kidneys and check them, etc. But as the animal is being dismembered attention must be paid to the possibility of such Treifa and anything that appears out of the ordinary must be examined in greater detail. This also requires that every piece be clearly labelled such that it can be traced back to a particular animal. In case a triefa

is found in an organ, all of the pieces of that animal need to be removed from the kosher production.

Shechita rules have been discussed in detail and effects on physiology, meat quality and animal welfare values explained by the following: Zivotofsky, Dialrel report; (Rosen, 2004; Levinger, 1995; Levinger, 1976; Levinger, 1961): It is claimed that Shechita is a humane method and death occurs immediately with no adverse quality effects. However, available scientific findings do not agree with some of these and will be discussed later in this review. Nevertheless, it is clear that shechita, is a skilled procedure carried out in selected kosher species by a highly trained professional, a shochet (Shochetim, plural). A special knife (chalaf) is used, to ensure that the animal did not die on its own or not slaughtered properly (neveila) and the meat is not fit (treifa), the post-mortem inspection carried out and non-kosher parts are removed before Kosher meat is ready.

2.2.2.3 Other religious slaughter methods

The only known religious slaughter method other than Halal and Shechita is Jakhta used by Sikhs (Anil and Sheard 1984). It is believed not to be commonly applied these days.

2.5 Effects and consequences of slaughter methods

2.5.1 Physiological effects

2.5.1.1 Neck cutting

Neck cutting is one of 2 slaughter methods to achieve exsanguinations in both cattle and sheep. Following conventional stunning and slaughter chest sticking is also commonly used. This, also known as thoracic stick, is carried out on the recumbent, or hoisted stunned animal and involves severing large vessels inside the thoracic cavity for rapid blood loss. Chest sticking has been shown to be very effective in that brain function is lost immediately (Anil

et al. 1995b). However, during religious slaughter chest sticking is not applied as it is not practical and probably against rules and tradition. Instead, invariably a transverse neck cut is used to severe tissues and blood vessels in the neck, except the spinal cord. If effective stunning is used then as long as exsanguinations is carried out soon enough there should be no recovery unless delays occur after reversible stunning. In regard to religious slaughter without stunning questions arise as to whether pain is felt and how long it takes before loss of consciousness and/or brain function. In the following section, the question of whether pain can be felt during the cut and times to loss of brain function after the cut is discussed.

The issue of whether the neck cut is painful has received much controversy and discussion. Then pain that may be perceived by the animal during its application and afterwards depend on a number of factors. Under the most optimistic successful slaughter conditions, it could be argued that if the incision is performed by a highly skilled slaughterman using a sharp knife

the least amount of pain will be inflicted though not totally eliminated (Brooks and Tracey, 2005; Woolf, 2004). Deviation from this scenario will probably worsen the severity of pain in an exponential manner. The greater the damage to tissues in the neck more nociceptors will be activated than after good cuts, thereby firing fibers and relaying signals to the brain (EFSA, 2004).

There are two camps about the pain issue. Those who think the cut is quick and painless and therefore slaughter without stunning can be effective and acceptable and other who argue that varying degrees of severe pain is inevitable. Levinger (1976) claims works as a stunning method and death occurs immediately due to rapid loss of blood. Grandin and Regenstein (1994) reported that they noticed no visible reaction from the body and legs of cattle to the neck cut in, provided that animals were restrained without -stress in upright pens, but only a slight flinch where the blade made contact. Bager et al (1992) also previously reported no recognizable reaction from calves. Most reports regarding reactions of animals during slaughter without stunning are anecdotal with no detail of specific conditions (e.g. cut, sharpness of the knife, skills of the operator), whether reactions occurred after the first cut. Another problem is it is possible that reactions may be masked due to the following: position of animal, restraint by a shackle or head restraint, fainting caused by hemorrhagic shock, defensive immobility (playing dead) or severance of tissues (e.g. no vocalization because of

cut trachea. Therefore, little or no reaction does not necessarily indicate absence of pain (EFSA, 2004).

Rosen (2004) in his comprehensive review also argues that Shechita maintains animal welfare and creates a situation where no pain is felt by the animal due to rapid physiological changes. Extreme sharpness of the Shechita knife (Chalaf), together with the smooth incision performed, implies minimal stimulation of the incised edges, below the threshold level required for activation of pain pathways. This is compared to the experience of surgeons, who cut themselves during an operation only to noticed it later (Rosen, 2004). However, it must be borne in mind that a neck cut would involve a large area and also pain is not merely related to the quality of the cut. In human subjects if injuries are deep and extensive (e. g. fractures, crushed tissues, amputations, and lacerating stab wounds), many of experience immediate pain (72%). Whereas in cases of injuries limited to the skin (e.g. lacerations, cuts, abrasions, burns), 53% have a pain free period immediately afterwards, and following fractures, numbness is felt first and persistent pain develops later when the pressures associated with hemorrhage, oedema and inflammation develop (Gregory, 2004; Melzack et al, 1982).

Other scientists argue that there will be substantial pain involved. For an effective bleed, out the cut is required to cause deep and extensive tissue damage where many pain receptors (nociceptors) are located to be activated (Kavaliers 1989). Tissues to be severed include skin, long hyoid bone muscle, trachea, oesophagus, both jugular veins and carotid arteries, nerves, and muscle. This high level of activation would lead to perception of pain (EFSA, 2004).

Nevertheless, behavioral observations provide a useful tool when assessing pain and suffering, especially in field conditions. Obtaining values of physiological measurements, such as heart rate, respiration rate and body temperature can be useful if combined with behavioral findings where possible (Barnett, 1997). However, some of the physiological changes do not occur immediately, for example the lack of an increase in blood cortisol reported in some studies (Tume and Shaw, 1992) is not surprising.

Recording and analysis of brain electrical activity to assess noxious stimuli and perception has been used for years. The signals recorded represent relayed information about not only pain but also other types of sensation. After recent methodological developments related to quantitative analysis of the electroencephalogram (EEG), the experience of pain can now be assessed more precisely. This methodology has been applied to the question of pain during

slaughter of calves by ventral-neck incision. The results show clear evidence for the first time that the act of slaughter by ventral-neck incision is associated with noxious stimulation that would be expected to be perceived as painful in the period between the incision and loss of consciousness (Mellor et al, 2009). Initially an EEG spectral analysis and a minimal anesthesia model were validated for assessment of noxious sensory input such as acute known painful procedures in calves such as dehorning (Gibson et al. 2009a, c). Then this model was used as a reference to test the effect of ventral-neck incision (Gibson et al. 2009b) that revealed a ventral neck incision has the potential to be a noxious stimulus and therefore painful in conscious animals. Subsequently, a second study showed the EEG responses after ventral neck incision were caused by severance of neck tissues but not interruption of blood flow to and from the brain (Gibson et al. 2009a). Although not tested in sheep it could be anticipated that the effect could be similar.

Gregory (2004) describes that the cut nerve after neck cutting would be able to relay signals for up to four seconds and directly activate neurons with the overall effect to be comparable to an electric shock. Subsequently, undamaged nerve endings and also nociceptors in the neck wound could be stimulated by other mechanical effects before consciousness is lost Another concern, if consciousness is not lost, is aspiration of blood into the trachea during exsanguination after a neck cut in cattle during religious slaughter without stunning (Gregory et al. 2009).

Anecdotal reports from Dialrel spot visits indicate reactions to the cut as vocalization, retracting movements, struggling, or shivering in cattle during Halal slaughter without stunning and (Shechita) carried out in turning pens.

It can be concluded that whilst the potential for pain perception exists, other risk factors such as changes in direction of the cut, multiple cuts, or performance of back up cuts, in adequately sharpened blades, thick necks, skin folds and insufficient tension of the neck could increase chances of more pain perception.

2.5.2 Stress, Fear, and Distress

Stress is physiological disturbance imposed by a stressor, e.g. threatening or harmful situation. At the brain level stress trauma and pain activate hypothalamo-pituitary-adrenal (HPA)-axis and sympathetic nervous system (SNS) leading to increased heart rate, blood

pressure, stress hormones and enhanced fight or flight behavior. The HPA-axis is also activated by trauma (Gregory, 2004). Measurable stress indicators can be used as tools as well as changes in behavior for assessment.

Fear and anxiety are emotional states leading to physiological and behavioural changes induced by perceived danger (Boissy, 1995). These conditions have important implications for animal housing and management and handling prior to slaughter (Grandin, 2000).

There are four types of fear commonly recognized in animals:

• Innate fears – e.g. isolation, fear of the dark, snakes, spiders;

• Novelty – e.g. strange objects, sudden movements;

• Fears learned by experience – anticipated pain;

• Fear provoked by signs of fear in others;

2.5. 3 Consciousness and Unconsciousness

2.5.3.1 Assessment of Consciousness / Unconsciousness

When assessing consciousness, physical collapse and uncontrolled movements are usually regarded as significant signs, albeit no definite signs of unconsciousness (Muir, 2007). This state indicates that cortex and cerebellum profoundly lost control of posture and function. It is also possible to regain and lose consciousness again.

Basic movement control and maintenance of posture is controlled by different parts of the brain as well as the autonomic nervous system and the spinal cord. Two types of movements can be observed: 1) Voluntary; 2) involuntary movements.

Some movements observed after slaughter such as attempts to stand up and head righting could be obvious indicators of consciousness. However, others are more difficult to interpret, e.g. convulsive physical activity due to earlier stunning (clonic phase) or loss of cortical function. Nevertheless, collapse of a standing animal is the earliest indicator of loss of consciousness after a neck cut.

Different cognitive responses can be used when assessing presence or loss of consciousness. These could be listed as blinking and head withdrawal responses to threatening movements, positive responses to painful stimuli or willful responses of different body parts. These responses are said not to occur without a functioning nervous system and could be used as useful tools (Limon et al. 2010).

Clinical indicators of general anesthesia (Muir, 2007) can be used to assess insensibility and unconsciousness as long as the slaughter method itself does not change or mask the clinical signs. However, under certain circumstances such as after electrical stunning checking reflexes could be fruitless due to excessive convulsions caused by stunning. Nevertheless, reflexes especially those including the cranial nerves are helpful to assess brain function. If all negative, it could be assumed that brain function is profoundly impaired (Gregory, 1998).

The following reflexes can be used as tools to confirm loss of consciousness:

• No eye reflex or blinking (palpebral or corneal)

• Widened pupils

• Fixed eye

• No response to threatening movements

• Absence of breathing activity

• Floppy head and relaxed tongue

The following reflexes may indicate residual consciousness:

• Rhythmic breathing

• Vocalization

• Kicking/struggling movements (except typical convulsions during epileptiform activity)

• Righting.

• Attempts to stand up and escape behavior.

2.5.3.2 Measurement and interpretation of brain electrical activity

In addition to the above-mentioned indicators, if available, recorded electrical activity of the brain, electroencephalogram (EEG with surface electrodes) or electrocorticogram (ECoG with implanted electrodes) can be used to assess brain function. Suppression or lack of electrical activity, changes in amplitude and frequency of waves are useful tools. Absence or significant reduction in size of somatosensory, auditory, or visually evoked responses can be used to determine whether an animal is unconscious or dead.

It is generally agreed that grand mal epilepsy, quiescent period, amplitude less than 10 per cent of the pre-stun recording in the EEG and absence of evoked responses are indicative of unconsciousness. However, presence of evoked potentials does not necessarily imply consciousness, because visual evoked potentials can be recorded in animals under anaesthesia (EFSA, 2004; Zeman, 2001; Gregory, 1998). Kalweit et al. (1989) recorded visual (VERs) and somatosensory (SERs) evoked responses after Shechita neck cutting

without stunning in cattle and compared responses after captive bolt stunning. In the latter cases, both recorded responses were lost immediately, whereas after neck cutting without stunning in the former, responses, although gradually being reduced, lasted sometime (Figures 12 and 13). Therefore, the fact that brain function is not completely lost gives an element of doubt about presence of sensibility if no stunning is used.

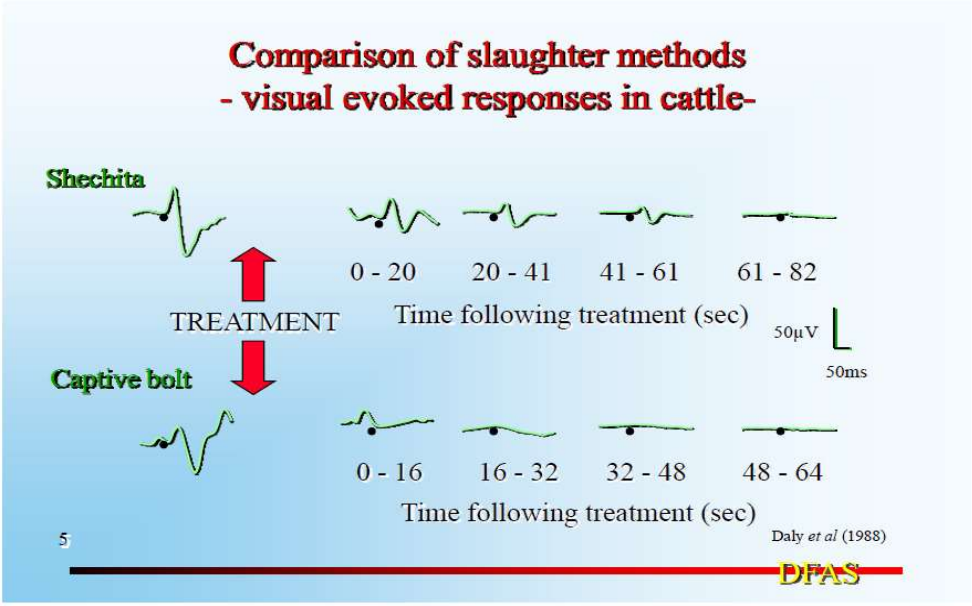

Figure13. Comparative effects of different slaughter methods on visual evoked responses (VERs)

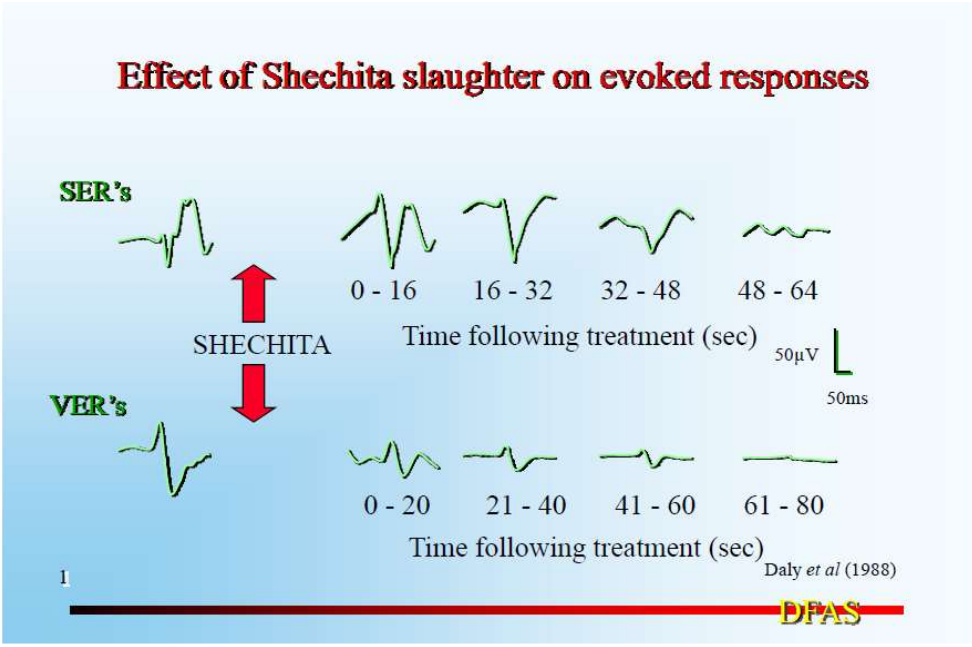

Figure12. Effect of Shechita on evoked responses (SER: Somatosensory evoked potentials; VER: Visually evoked potentials)

2.5.4 Death

Death is described as a state where physiological respiration and blood circulation have stopped as a result of their centers in the brain stem permanently losing function due to lack of oxygen and energy (EFSA, (2004)).

In terms of stunning and slaughter correct application should result in sufficient loss of blood to the brain and cause irreversible loss of vital functions (Michiels, 2004; Rosen, 2004; Pallis, 1982a, b, c, d).

2.5.5 Exsanguination or bleed out

Slaughter implies exsanguination by severing blood vessels in the neck or chest so that death is induced.

Although for conventional slaughter trachea and oesophagus can be left uncut there are exemptions for religious slaughter.

2.5.6 Loss of blood and blood pressure

Of the circulating blood volume,8% of body weight, 18% of cardiac output flows perfuses the brain (EFSA, 2004). Following effective cuts 40 to 60 % of blood volume is lost in similar patterns and rates in different species (Warriss and Wilkins, 1987). This rapid loss should result in a dramatic drop in blood pressure leading to inadequate perfusion of tissues and a state of shock and failure of the system's compensatory mechanism (Gregory, 2004).

It is claimed that immediate loss of blood pressure after neck cutting results in rapid loss of consciousness due to ischemia reduction of cerebrospinal fluid pressure (Rosen, 2004; Levinger, 1995; Levinger, 1976).

Blood pressure loss can be very disturbing to humans (Hamlin and Stokhof, 2004) and probably to animals of other species (EFSA, 2004).

In cattle following exsanguination it takes a certain amount of time for blood loss to reach critical levels. It is estimated that (50) per cent of total blood volume is lost during exsanguination. Levinger (1995,1976) reported that (33) per cent of total blood loss was

reached after (30) seconds, whereas Anil et al (2006) found (25) per cent was bled out after (17) seconds.

In sheep however, the time period is much quicker with (50) per cent being lost after (14) and (90) per cent after (56) seconds (Anil et al. 2004).

The critical low levels of blood pressure can be reached earlier, e. g. in sheep after about five to six seconds (Levinger, 1976) but not in all animals, e.g. cattle. Due to anatomical differences occlusions of the arteries in cattle can lead to recovery episodes in blood pressure in calves, however blood pressure fell sooner when no occlusion occurred (Anil et al. 1995b).

2.5.7 Cerebral perfusion after neck cutting

The brain of ruminants is perfused with blood from a vascular network called "rete mirabile" that receives branches from the carotid and vertebral arteries. In cattle, there are extra anastomosis that may bring in blood to rete mirabile and brain sometimes even after exsanguination, whereas in sheep and goats this is not the case (Baldwin and Bell, 1963a, b).

Although perfusion is possible and demonstrated it is argued whether that is sufficient to maintain consciousness. Rosen (2004) claimed that the cerebral blood flow after a neck cut would not be sufficient to supply the brain. Anil et al. (1995a) found that carotid occlusion delayed the time to isoelectric ECoG in calves. In the same study when carotid occlusion occurred, vertebral artery blood flow was maintained at about (30) % of its initial level for up to three minutes and in some animals, it increased substantially following sticking.

Similarly, Shaw et al. (1990) ligated the vertebral arteries in calves, looked at ECoG and concluded that other factors contributed to the delays in time to loss of electrocortical activity after slaughter in calves.

In sheep, severing both the common carotid arteries and the external jugular veins is the quickest method of abolishing brain responsiveness compared to cutting only one carotid artery, only the jugular veins or cardiac ventricular fibrillation (Gregory and Wotton, 1984a, b; Newhook and Blackmore, 1982b).

Sharpness of the knife and performing a complete uninterrupted cut could influence other factors such as vasoconstriction, clotting, ballooning known also as carotid occlusion or false aneurisms (Gregory et al. 2006; Anil et al. 1995a, b). Gregory et al. (2008) found a prevalence of large false aneurysms in (10) percent of cattle slaughtered by Shechita and Halal with implication for sustained consciousness during religious slaughter in cattle.

2.5.8 Time to loss of Consciousness after Exsanguinations

Following exsanguination, it is imperative that consciousness is lost rapidly. This duration depends on a number of factors such as the method of restraint, quality of the cut as well as species differences. Time to loss of brain function has been studied by various researchers who examined electrical activity of the brain such as EEG, evoked responses as well as

animal reactions and reflexes. Under laboratory conditions they found variations. Review of results showed using time to flat EEG/ECoG from (10) seconds to more than a minute (Newhook and Blackmore, 1982a; Kallweit et al. 1989); loss of evoked responses from (10) seconds up to (2) minutes (Gregory and Wotton, 1984c); loss of coordination up to (47) seconds (Blackmore, 1984). In contrast, abattoir investigations showed even longer durations before collapse was observed between (19.5) and (265) seconds after Shechita and Halal slaughter (Gregory et al, 2010).

In regard to sheep however, similar studies obtained much shorter durations between (2) and (43) seconds (Newhook and Blackmore, 1982b).

The implications of above findings are that following neck cutting delays in time to loss of consciousness would be serious welfare problems. However, some of the studies used do not necessarily prove presence of consciousness, rather showing residual brain function with possibility of feeling sensation. Nevertheless, ideally immediate loss of brain function should be aimed at for optimum welfare.

2.5.8.1 Clinical signs during the post cut period

Physical signs observed during and after the cut need to be evaluated with care, as some may indicate conscious or involuntary reactions such as reflexes. Physiological reactions to blood

loss after Shechita have been described by Rosen (2004) and Levinger (1995) who claim that the heart will beat for a few minutes, then lack of venous return would lead to diminished cardiac contraction.

Gregory et al. (2010) described the loss of posture of adult cattle after slaughter without stunning occurring on average (19.5) seconds post cut.

Blackmore (1984) reported sheep lost ability to stand up after four seconds, whereas calves took (40) seconds after satisfactory neck cutting.

Brain stem activity manifested by positive eye reflexes could be present for significant periods. However, these as well as respiratory gasps/gagging reflexes alone only indicate residual brain stem activity.

The following can be significant indicators:

- attempts to rise or to regain normal body posture

- reactions to cuts or manipulation of the wound

- eyes being able to follow stimuli from the surrounding with concomitant blinking

- vocalization

- response to threatening movements

2.3.9 Post Neck Cut Stunning

Stunning after neck cutting also called “post-cut stunning” is regarded by some as an improvement to animal welfare, compared to slaughter without stunning. This approach shortens the time during which possible sensations, if no preslaughter stunning is used, may be experienced, especially in cattle (Caspar and Koepernik, 2010).

Post cut stunning is used in some European countries applying a captive bolt. In the UK, captive bolt stunning used to be acceptable and applied in cattle after Shechita, but later abandoned and rejected by Shechita Boards.

2.6 Effects of Religious Slaughter on Quality

2.6.1 Carcass and Meat Quality

The main potential effects of stunning and slaughter on carcass and meat quality have already been referred to in previous chapters (section). These are carcass defects such as haemorrhages, bruising, broken bones and more importantly rate and total bleed out, particularly in relation to religious slaughter without stunning. As discussed, haemorrhages can be related to inappropriate preslaughter handling, electrical stunning using high voltages with currents and sometimes due to possible nutritional or unknown factors such as blood splash in sheep. These defects and resultant downgrading can occur during slaughter with and without stunning. If electrical stunning is used before religious slaughter as long as sticking is done early enough, rising blood pressure may not be a problem. Neck cutting in sheep and lambs while the heart is still pumping should result in (75) to (85) % of total blood being lost in the first (60) seconds (Blackmore & Newhook, 1976). Therefore, during the powerful clonic phase, the carcass should have lost half the blood to be exsanguinated. Therefore, blood pressure, under normal circumstances, should not be responsible for haemorrhages. Another factor is ensuring an uninterrupted flow of current during stunning (Kirton & Frazerhurst, 1983) to avoid carcass haemorrhages.

If the cause is electrical stunning parameters then this can be addressed by modifying electrical frequency, such as using high frequency stunners with square waveform instead of the conventional (50) Hz frequency with sinusoidal waveform. Effects on blood loss have already been mentioned and will be discussed further especially in relation to religious slaughter...

In regard to religious slaughter and meat quality Kirton et al (1980; 1981) reported that haemorrhages are less common in unstunned sheep carcasses. In addition to early sticking (Kirton et al .1978), the neck cutting technique used can also affect the bleed-out rate (Blackmore and Newhook, 1976). Other factors such as stress and restraint are also important and should be considered (Jemmi, 1984).

Velarde et al. (2003) studied comparative effects of electrical stunning versus no stunning on meat quality in lambs. They found no significant differences in muscle ultimate pH (pHu), chilling losses and carcass weights after (45) min and (24) h were not significantly different between treatments. The only effect observed by Velarde et al was petechial haemorrhages

in hearts caused by electrical stunning with (250) volts for (3) seconds. No carcasses with petechial haemorrhages, ecchymosis, haematomas or broken bones were found in either treatment. They concluded that meat quality and the incidence of haemorrhages are unaffected by head-only electrical stunning. This is in agreement with other studies by Anil et al. (2004) who also examined meat quality parameters as well as packed cell volume and carcass weights in lambs after religious slaughter without stunning or slaughter with electrical stunning in lambs. Comparing captive bolt stunning with Halal slaughter without stunning Anil et al (2006) also found no differences in packed cell volume and meat quality parameters between treatments in cattle. In an earlier limited study Anil et al (1993) reported effects of preslaughter handling and Halal slaughter on quality parameters including packed cell volume, pH and color in sheep and cattle. There were some increases

in pH and packed cell volume values probably due to long transport and preslaughter handling but no change in muscle colour.

However, with the recent significant increase in religious slaughter with and without stunning, there is a need to carry out further studies specifically looking at carcass and meat quality effects in more detail under current practices that vary within and between European countries. This can be attributed to variation of skills of slaughtermen who carry out religious slaughter, in particular Halal, and standards being reflected in the final product.

2.6.2 Blood loss and retention

It is of utmost importance to expel as much blood as possible to meet religious requirements of Halal and Shechita slaughter. In addition to consumption of blood being forbidden, there are two beneficial reasons put forward, firstly harmful blood constituents would be excluded and secondly keeping quality of meat would improve. The basis for better keeping of meat was that blood would provide a good medium for bacteria to grow. Another consideration is that if blood is left in vessels, after cutting, it could produce an unsightly appearance. However, it has been shown that minced meat mixed with blood and inoculated with bacteria showed no more growth of included bacteria than meat that had no added blood (see Gregory 1998). Nevertheless, although it is impossible to rid a carcass of its blood completely as there will be some retention of blood, efforts need to be made.

It was often claimed that stunning would adversely affect bleed out rate and total loss and that neck cutting without slaughter improved blood loss. The first study that directly compared blood loss between stunning and slaughter with that of neck cutting without stunning was carried out by Anil et al (2006; 2004) who examined exsanguination and compared stunning and slaughter versus slaughter with no stunning in sheep and cattle. Rate and total blood loss after neck cutting with electrical and captive bolt stunning or without stunning were measured and results corrected for differences in carcass and visceral organ weights in sheep and cattle. They found no differences in both bleed out rates measured every (10) seconds and total blood loss after complete exsanguination. These results were later confirmed by the study of Gomes Neves et al. (2009). Velarde et al. (2003) carried out similar studies in lambs and found a slight increase in blood loss after electrical stunning, rather than an improvement in blood loss by slaughter without stunning. The most recent investigation by Khalid (2011) compared exsanguination following three Halal slaughter treatments: electrical stunning, no stunning and neck cut as well as post-cut electrical stunning using a v-restraining conveyor. Both experimental and commercial trials were carried out in 440 sheep slaughtered in upright or horizontal position. They found no statistically significant differences in carcass weight and by-products as well as loss of blood confirming earlier results with addition of V-restraining and also post-cut stunning to treatments tested.

Earlier reported studies measured blood haemoglobin content in different muscles as an indicator of bleed out quality. Kallweit et al (1989) determined that haemoglobin did not differ in muscles of sheep and calves that were subjected to captive bolt stunning or Shechita. Levinger (1995), in his book on Shechita also reviewed experiments in which blood parameters, colour and pH were measured in different species slaughtered by Shechita or Halal or conventional methods showing no difference. However, Levinger concluded that sticking and blood loss could still be better after Shechita because of the very sharp knife used and efficacy of cut. Based on existing studies and available results it is reasonable to suggest that regardless of whether preslaughter stunning is used or not blood loss is not likely to be different.

2.7 Physical, Physiological and Psychological Reasons the prohibition of blood

Some of the reasons of the prohibition of blood can be easily understood. Blood carries nutrients and chemicals to the tissues and brings back the waste products of tissue metabolism into the circulation. These waste products of tissue metabolism are harmful to the body and are separated from the blood in the kidney. The concentrated solution of these harmful chemicals is excreted in the form of urine. Urine is thus the part of fluid blood.

If the objective is to drain away all the fluid blood in the circulation then what are the physiological and anatomical requisites. It is obvious that blood contained in a closed circuit can only be let out by cutting the blood vessels. Deployment of an incision to cut, vessels and the overlying skin is therefore absolutely essential. The larger the blood vessel, and greater number that is cut open, greater will be the amount of blood poured out through them. It is also obvious that the best place anatomically to cut these vessels is the neck where four major vessels are accessible, lying not far from the skin. It is also evident that the longer the heart beats from the moment the vessels are cut open and the more strongly it beats, the greater will be the blood loss. Conversely the animal which is half dead will bleed only half the time. It is also understandable that the stronger the suction effects of the lungs in the form of rapid and deep breathing greater will be the amount of blood sucked into the heart from the periphery, in turn to be pumped out, and thus thrown out of the body. Rapid breathing also assures adequate oxygenation of tissues and prevents stagnant an anoxia (lack of oxygen) which interferes with the (PH) of the tissues. (PH)of the blood is very important in extracting the blood from the tissues and influences the keeping quality of the meat. It is also conceivable that the squeezing action of the muscles on the blood vessels is essential to pour out the last drop of blood. All these factors are operative only and only when the blood vessels in the neck are severed while the animal is conscious with a normal vaso motor centre, a normal heart and normal circulatory and normal respiratory centre.

Students of physiology would appreciate that Zabah induces haemorrhagic shock, in which all the fluid blood is attracted into the circulation and escapes through the cut vessels, whereas the opposite happens when the animals are stunned first. Stunning in addition to being painful is less efficient way of bleeding. In stunning the animal cannot be bled unless the animal is brought under control by which time the animal could be dead (its heart stopped due to shock) there is then no point in bleeding.

Arterial baroreceptors are vitally important in the short term (seconds to minutes) control of mean arterial pressure (MAP) but are unimportant in determining the long-term level of (MAP). This based primarily on two observations: first, those baroreceptors rapidly reset to the prevailing level of (MAP) and second, that total baroreceptor enervation has no lasting effect on the average daily (MAP), although the variability of (MAP) is increased dramatically. This is the similar case when slaying animals and in purifying process of the meat from the blood, in a very short term (seconds to minutes). The Arterial Baroreceptors & (MAP) have thus a very essential action during Zabh.

2.8 Industrial Halal Slaughter Procedure

Under the Islamic jurisprudence (Shari'ah), a typical halal slaughter procedure is as follows. There are primary requirements that must be met, and there are secondary requirements that are not mandatory but merely recommendations.

2.8.1 Primary Requirements

1. Animal or bird must be of halal species and alive at the time of slaughter.
2. Slaughtering must be done by a mature Muslim of sound mind, trained in slaughtering method for the type and size of animal to be slaughtered.
3. The name of Allah (Bismillah Allahu Akbar) must be verbally invoked by the Muslim slaughter person while slaying the animal.
4. Slaughtering must be carried out on the neck from the front cutting the esophagus, wind pipe (trachea), jugular veins, and carotid arteries, without cutting the spinal cord beyond the neck muscle.
5. Slaughtering must be carried out by a sharp knife in a swift sweep so thatthe animal does not feel the pain of a slaying.
6. Blood must be drained out thoroughly and the animal must die of bleeding rather than any other injury, inflicted or accidental.

2.8.2 Secondary Requirements

1. Animal or bird to be slaughtered should be healthy and free from diseases and defects.
2. Animal or bird should be given water and handled humanely before slaughtering so that it is calm and not stressed out or excited.
3. Slaughter person should be facing Mecca while slaughtering is carried out.
4. Appropriate desensitizing or restraining method can be used to control the animal provided the animal is not dead before actual bleeding according to dabha standards. If animal dies as a result of the desensitizing method, the animal carcass becomes prohibited (haram) for Muslim consumption.
5. No part of the body should be cut prior to the actual slaughter or after slaughtering until the animal is completely dead.

Abominable Acts

It is not recommended to:

1. Starve the animal by holding back food and water.
2. Hold the animal down and then sharpen the knife.
3. Sharpen the knife while the animal is looking at it and frighten it.
4. Cut off the head or let the knife reach the bone.
5. Break the neck of the animal while it is bleeding.
6. Skin the animal while it is still alive.
7. Use a dull knife to perform “Zabha “or use a knife of the wrong size.

2.8.3 Industrial Halal procedure for mechanical slaughter of poultry

1. The birds must be of halal species: chicken, ducks, or turkey.
2. The slaughter person while pronouncing Bismillah Allahu Akbar starts the machine.
3. The birds are hung onto the conveyor railing one at a time without agitating
4. The birds are passed over electrified water, touching the beak to shock them unconscious.

5. A Muslim slaughter person is positioned behind the machine and bleeds the birds missed by the machine while continuously invoking the name of God. (Two Muslim workers might be required, depending on the line speed.)
6. Halal birds are completely segregated throughout the process.
7. Containers of chilled birds are labeled halal.
8. The birds are cut up, deboned, and processed on thoroughly cleaned equipment.
9. Further processing such as marinating, breading, and packing off are done under the supervision of an inspector. Nonmeat ingredients must not contain any non-halal ingredients.
10. Products are properly marked with halal markings.

2.8.4 Industry Perspective on Halal Production

According to Jackson (2000), until now many Muslims accepted kosher meat products because they believed the slaughter was similar to their requirements and because the animals at least received a blessing at the time of slaughter. They are now learning that this is not true and are less accepting of kosher meat as a halal substitute. Until recently, commercial halal-certified meat products were virtually nonexistent in U.S. supermarkets except for imported products and locally slaughtered meat. Internationally, only proper halal certification is acceptable, and monitoring agencies are being established to enforce halal requirements. This international attitude is moving into the U.S. market (Jackson, 2000).

Some meat producers think that to be halal, they only had to follow a book of procedures. Companies following this policy will encounter marketing problems.

The following are some corrections to notions on what can be considered halal meat (Jackson, 2000):

1. Muslim inspectors cannot say a blessing on a truck as it passes their houses on its way from the slaughterhouse to qualify the resultant meat as halal acceptable.
2. Inspectors cannot say a blessing only at the start of the slaughtering process. It must be said throughout the process on each animal as it is slaughtered.
3. A Muslim cannot say a blessing after all slaughtering is completed to cover all animals slaughtered that day.

4. Inspectors cannot use recordings of blessing to substitute for the devotion of an observant Muslim.
5. Meat producers cannot accept the word of the slaughterhouse that humane methods were used and the meat therefore should be considered halal.
6. Producers cannot accept that a product labeled as halal is indeed produced halal. It must be certified or accepted by certifying agencies.
7. Producers must never label a meat product as halal if there is no onsite Muslim participation. This is where the U.S. has lost competitively in the international market.
8. Producers cannot simultaneously process any pork or pork-derived product while producing halal-labeled meat.
9. Producers cannot process any pork or pork-derived product immediately prior to the processing of any halal-labeled meat product without a full, comprehensive, and detailed cleaning.

Chapter Three

3. Material and Method

3.1 Introduction:

Each investigation required tools, equipments, and procedures to be implemented in correct way. Accordingly, choosing the suitable materials to be used in appropriate methods to conduct a required tests and experiments play a major role to full fill the elements of a methodological approach.

This investigation applied multi diverse techniques, starting from reporting visual results, passing through chemical tests, and ended up with microscopic testing and analysis approach. These techniques will be conducted in certain methodology leads to understand and investigate the differences between different slaughtering methods.

This chapter will discuss the required materials and methods applied to conduct the predetermined methodology.

3.2 Materials Used:

3.2.1 Investigated Animal:

The investigated animal was (48) rabbit from local farm with minimum differences. these rabbits were divided into two groups. First group involved (18) rabbit for the purpose of dissection, while the second group involved (30) rabbit for the purpose of glycolysis monitoring through (PH) declining. Big effort was invested to have similarities between members of each group as much as possible. The following features were obtained:

- Female,
- White color,
- (3) months age,
- Same bread,
- Same weight,

- Same height, and
- Twins as much as possible.

3.2.2 Slaughtering and Dissection:

- Hummer
- Knife (not sharp)
- Knife (sharp)
- Binder
- Dissection kit

3.2.3 Tissue slide:

- Petri dish
- Formal saline (formaldehyde 40 %)
- Sodium chloride ((9) grams
- Distilled water (900) ml)
- Glass vials
- Saline solution
- Paraffin wax.
- Arealcohol or acetone or dioxane.
- Alcohols (70) %
- Alcohols (90) %
- Xylene
- Hematoxylin

3.2.4 PH Measurements:

- (PH) meter
- Puffer solution
- Cleaning solution
- Standardization solution (PH= (4) and PH= (9))

3.2.5 Studying Tissue Slides:

- (Nikon) Microscope
- (LG G4) mobile phone for taking photos

3.3 Methods:

Methods applied is varied, namely; slaughtering methods, slide tissue preparation, PH measurements.

3.3.1 Slaughtering methods:

The slaughtering methods applied is designed to distinguish between those non-Islamic methods and the Islamic method.

However, (6) different methods of slaughtering were decided. The (18) rabbit were divided into the (6) group. Each group contained (3) rabbits that will be slaughtered in the same method and samples will be taken from each rabbit. Each result will be a result of triplicate.

3.3.1.1 Non-Islamic Slaughtering Method:

The general terms are:

- The knife was shaped in front of the rabbit (to cause fear and stress)
- Using Hummer, the rabbits were hit violently on the head until reach loss of consciousness
- after that the rabbit was hung or laid not on its left side facing Kiblah (the direction of Makkah Al-Mukarramah), The rabbit was kept waiting much in that position (to causestress)
- At the time of slaughtering the rabbit, the slaughterer did not utter “BISMILLAH WALLAHUAKBAR”
- The bleeding was not spontaneous

3.3.1.2 Islamic Slaughtering Method:

The general terms are:

- The rabbit was allowed to rest (and wellfed) before slaughtering
- the rabbit was alive at the time of slaughter. The slaughtering procedure did not cause torture to animals and done with animal welfare/rights consideration.
- The slaughterer was a Muslim who is mentally sound and fully understands the fundamental rules and conditions related to the slaughter of animals.
- The animal was slaughtered, after having been hung or laid preferably on its left side facing Kiblah (the direction of Makkah Al-Mukaramah). Care given to reduce suffering of the animal while it was being hung or laid and not was kept waiting much in that position.
- At the time of slaughtering the animal, the slaughterer uttered "BISMILLAH WALLAHUAKBAR" which means "In the Name of Allah Almighty Great" and he did not mention any name other than Allah otherwise this make it non-Halal.
- The act of Halal slaughter was begun with an incision on the neck at some point just below the glottis (Adam's apple).
- The slaughter act was sever the trachea (halqum), esophagus (maree') and both the carotid arteries and jugular veins (wadajain) to hasten the bleeding and death of the animal.
- The bleeding was spontaneous and complete. The bleeding time was less than (2.5) minute to insure fully bleeding.

3.3.2 Code Naming Method:

Samples were named by coding enable to facilitate studying them, as shown in the following Table (3.1.)

Table (3.1): Coding and naming of the investigated tissue samples

Groups Codes	**Slaughtering Method**
01	Islamic slaughtering
02	Mechanical stunning followed with Islamic slaughtering
03	Electrical stunning followed with Islamic slaughtering
04	Islamic slaughtering with cutting off head
05	Choking death by holding a tight robe (binder) on the neck
06	Slaughtering without naming Allah
Organs Codes	
01	Skeletal –chest
02	Skeletal –thigh
03	Heart (cardiac)
04	Liver
05	Brain and Spinal Cord Where **B** refers to Brain, **S** refers to Spinal cord.
06	Lung
Sample Codes	
01	From the first rabbit of the group
02	From the second rabbit of the group
03	From the third rabbit of the group

Each sample will be coded in the following form:

Two Digit—Two Digit—Two Digit

Group Code – Organ Code – Sample Code

For example, sample coded by 03-02-01, means:

Thigh tissue obtained from first rabbit slaughtered by Electrical stunning followed with Islamic slaughtering.

3.4 PH Measuring:

3.4.1 PH Measurement Without Controlling Glycolysis:

Separate rabbits were used to perform this test. (6) rabbit slaughtered according to the predetermined slaughtering method mentioned in above Table (3.1). The (PH0 probe was inserted directly in the right thigh of the slaughtered rabbit. The rabbit kept for (24) ours at ambient temperature.

3.4.2 PH Measurement with Controlling Glycolysis:

Separate rabbits were used to perform this test. (24) rabbit slaughtered according to the predetermined slaughtering method mentioned in above Table (3.1).

- Rabbits were immersed in % (5) salt solution for (10) min and followed with immersing in (0.3) % citric acid solution for (10) min.
- Rabbits then kept in the cabinet at predetermined temperature, namely; (7 ˚C, 15˚C, 25˚C, and 37˚C).
- The PH probe was inserted directly in the right thigh of the slaughtered rabbit. The rabbit kept for (24) hour at ambient temperature.

- Each rabbit was used to measure the PH decline at different temperatures, namely; (7 ˚C, 15˚C, 25˚C, and 37˚C).

3.5 Tissue Side Preparation:

3.5.1 Hematoxylin eosin staining procedure

3.5.1.1 Fixation of tissues:

The objectives of this laboratory are to obtain tissue from an experimental animal, to be used in the future lab, experiments for micro technique and to place it in a fixative.

The first rabbit which was slaughtered according to none Islamic rules, dissected. different organs (brain, lungs, heart, thigh, chest, spinal cords, liver are located and removed &

maintained in formal saline in separate glass vials (labeled). Each organ is cut in to small section (5mm) or less thick and replaced in formal saline fixative for (24) hours. Same procedure was done with the second rabbit which was slaughtered according to Islamic rules.

3.5.1.2 Paraffin Wax Technique (Dehydration):

Dehydration is necessary step, especially that fixative solution used is miscible with paraffin wax. the three solutions, that can be used for this purpose, arealcohol, acetone, dioxane.

The tissues for each rabbit are passed through increasing concentrations of alcohols, along with its label. forceps carefully transfer it from one alcohol concentration to another at the appropriate time s while allowing it to drain for a few seconds on blotting paper between each change. the container should be closed tightly to prevent evaporation.

For tissues fixed in formal saline follow the following schedule:

- Alcohol (70) % (3) hours
- Alcohol (90) % (3) hours
- Absolute alcohols 1 (3) hours
- Absolute alcohols 2 (3) hours
- Absolute alcohols 3 (3) hours

Notes: sensitive Tissues such as Spinal Cords & Brain remained in the previous solution only for (3) hours to avoid damage, other tissues spent (4) hour.

3.5.1.3 Paraffin Wax Technique (Clearing – Infiltration)

A- Clearing:

Table (3.2): Paraffin Wax Clearing Technique Features

Thickness of tissues	Clearing agents employed	Molten paraffin	No. of wax changes
(3-5) mm	Xylene 1 (15) Minutes	(2) hours	Two
(3-8) mm	Xylene 2 (15) Minutes	(3) hours	Two

The term relates to the appearance of tissues after the fluid chosen to remove the dehydration agents has treated them. the clearing agents must be miscible with both alcohol and paraffin wax, the most common clearing agents are xylene, toluene chloroform and cedar wood oil, as shown in Table (3.2).

B- Infiltration:

The tissues are transferred from the clearing agents to a bath of molten paraffin wax in the oven (60-67˚C). during this stage, the clearing agent is eliminated from the tissues by diffusion in to the surrounding melted wax and the wax diffuses into the tissues replace it. the exact number change the time, which the tissues requires in each .is dependent upon the density & size of the block of tissue and the clearing agent used.

3.5.1.4 Paraffin Wax Techniques:

A- Embedding -Trimming:

After infiltration is complete, the tissue is embedded in paraffin wax to [prepare it for sectioning. paraffin wax is a mixture of hydrocarbons produced in cracking of mineral oil. the melting point being in the range (45-55 ˚C) it is used for soft tissues .to prepare thin sections & in the sides of the block, which in sectioning are perpendicular to the knife edge, are trimmed in order to be able to mount the mould correctly on the microtone for sectioning.

B- Sectioning – Mounting:

The embedded paraffin wax blocks are sliced thin sections to facilitate the microscopic study of the tissue sections. uniform thickness can only be assured by using a microtome. Microtomes are various types: rotary, rocking orsliding microtone. the rotary microtone is used extensively in research and clinical laboratories .it is excellent for the preparation of serial sections. The following procedure is applied:

- The rotary microtome is set for section thickness (6 or 7)
- The blocks are adjusted in position and clamped
- The microtome knife is inserted and clamed tightly. the knife is held in the clamps at proper angle for optimal sectioning, producing a minimal amount of compression and allowing the sections to adhere to each other.

The feed screw handle is turned, moving the feed mechanism backward or forward until the face of tissues block barely touches the cutting edge of a knife. an old knife can be used to start trimming into the block until the desire area is reached, then a good knife is placed for using.

Sectioning requires an easy rhythm .as the ribbon form it is held away from the knife with a camel's hairbrush, it is cased forward so that the sections do not remain on the knife.

The ribbons formed during sectioning can be mounted directly on slides. floated on a water bath or laid in order in a box.

The sections can be stored in closed paper boxes protected from dust until you are ready for the next step, which is mounting the sections on slides.

C- Mounting:

Before sections are mounted, a glass marketing pencil should be used to make an identifying mark on one end of the slide, such as a tissue number. this mark also enables the worker to distinguish on which sides of the slides the sections are mounts and thus avoid mistakes during the staining process.

If water bath is used for spreading the sections, the temperature is adjusted to (5-10) ˚C below the melting point of paraffin being used. if agar gelatin is added to the water bath, un aumenized slides can be used.

- When removing the sections from the micrometer knife or from the box, they are stretched as flat as possible as they are placed on the water surface, after they have warmed a bit, they are pulled to nearly their size with a couple of dissecting needles.
- A slide is dipped the flattened section. the section is transferred to the side, shiny surface towards the bottom. the section is held on the side with a needle while removing it from bath.

- Excessive water is drained off, using filter paper or cleaning tissue.
- Mounted sections are dried either on a hot plate (45) ˚C or hot oven at (50) ˚C.
- Slides are ready for staining – they can be stored in paper boxes (closed).

3.5.1.5 Staining Procedure:

The steps were explained as shown in Tables below respectively

A- Dewaxing:

Table (3.3): Dewaxing Technique Features

Subject	**Time**
Xylene	(2-3) Minutes
Absolute Alcohol	(30) Sec – (1) Minutes
Absolute Alcohol	(30) Sec – (1) Minutes

B- Hydrating

Table (3.4): Hydrating Technique Features

Subject	**Time**
(90) % Alcohol	(2-3) Minutes
(70) % Alcohol	(30) Sec – (1) Minutes
Wash with d.H2O	(30) Sec

C- Staining

Table (3.5): Staining Technique Features

Subject	**Time**
Stain with hematoxylin	(15) Minutes
Wash with running tap H_2O	(3) Sec

D- Differentiating

Table (3.6): Differentiating Technique Features

Subject	**Time**
Acid - alcohol	(1) Sec
Wash with running tap H_2O	(1) Sec
Stain with eosin	(2) Minutes
Wash with water	until excess eosin is removed

E-Dehydrating

Table (3.7): Dehydrating Technique Features

Subject	**Time**
(70) % alcohol	(30) Sec
(90) % alcohol	(30) Sec
absolute alcohol	(30) Sec
absolute alcohol	(30) Sec

F-Clearing

Table (3.8): Clearing Technique Features

Subject	**Time**
Xylene	(5) Minutes

G- Mounting of Sections

After the section has been stained it must be prepared as a permanent preparation for microscopic examination. this is accomplished by mounting the section in suitable medium under a glass cover slip.

The mount ants most commonly used for mounting stained sections are Canada balsam.

Chapter Four

4. Result and Discussion

4.1 Introduction:

Variation among morphological characteristics of cells and tissues playing the key role to study the differences between those animals slaughtered under different methods.

Variant appearance of certain features among cells consistently were used as a pinch mark for distinguishing cells for animal slaughtered under Islamic supervision and other slaughtering methods. The interpretation for such variants were correlated to a scientific evidence is that; the blood removed from the slaughtered animal is highly dependent on the animal slaughtering method. Other interpretations were gathered due to visual notes on tissues during preparation and upon studying under microscope. The studied tissues (longitudinal and cross section) came from vital organ namely; heart, brain, kidney, lunges, spinal cord, as well as muscular tissues namely; thigh and breast.

This chapter of the investigation will show the differences between vital organs and muscular tissues for different slaughtering methods side by side with most possible interpretations and explanation. As the literature review is very weak in such field.

4.2 Variation at Visual Level:

The slaughtering methods showed obvious variation between the rabbit slaughtered under Islamic supervision and other slaughtering methods, in term of tissue colour obtained from the carcass during dissection. This variation was confirmed through a controlled glycolysis development in both slaughtering methods.

This variation was confirmed through comparing the glycolysis for rabbit slaughtered under Islamic technique and a rabbit slaughtered under non-Islamic technique by controlling the internal gylcolysis and avoiding other factors could be raised, mainly; temperature alteration of the carcass during rigor mortis and microbial invasion.

4.2.1 Variation in Tissue Colour:

During slaughtering, the slaughtered rabbits, regardless slaughtering method, showed no differences. While during dissection a major apparent variant was obtained.

The lung tissue sample obtained from rabbit slaughtered under Islamic supervision showed much lighter colour than those tissue obtained from lungs of other non-Islamic-slaughtered rabbit. The lung tissue's colour of the Islamic-slaughtered rabbit appeared to be red pinkish colour, while the other five types of slaughtering method rabbits the lung tissue were very dark red brownish in colour, as appear in Figure (4.1).

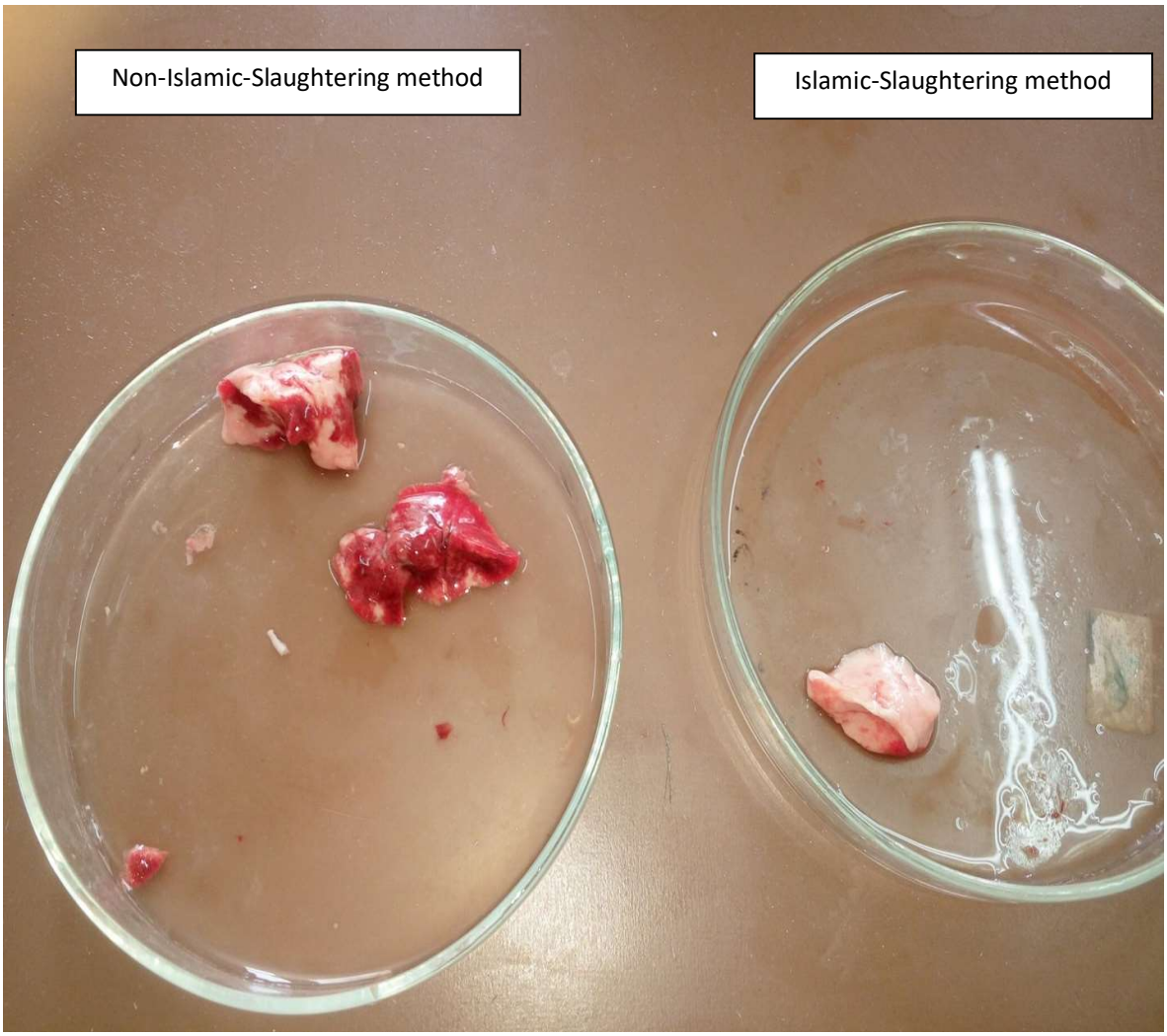

Figure (4.1) Fresh lung tissue obtained from Islamic and non-Islamic-slaughtered rabbit.

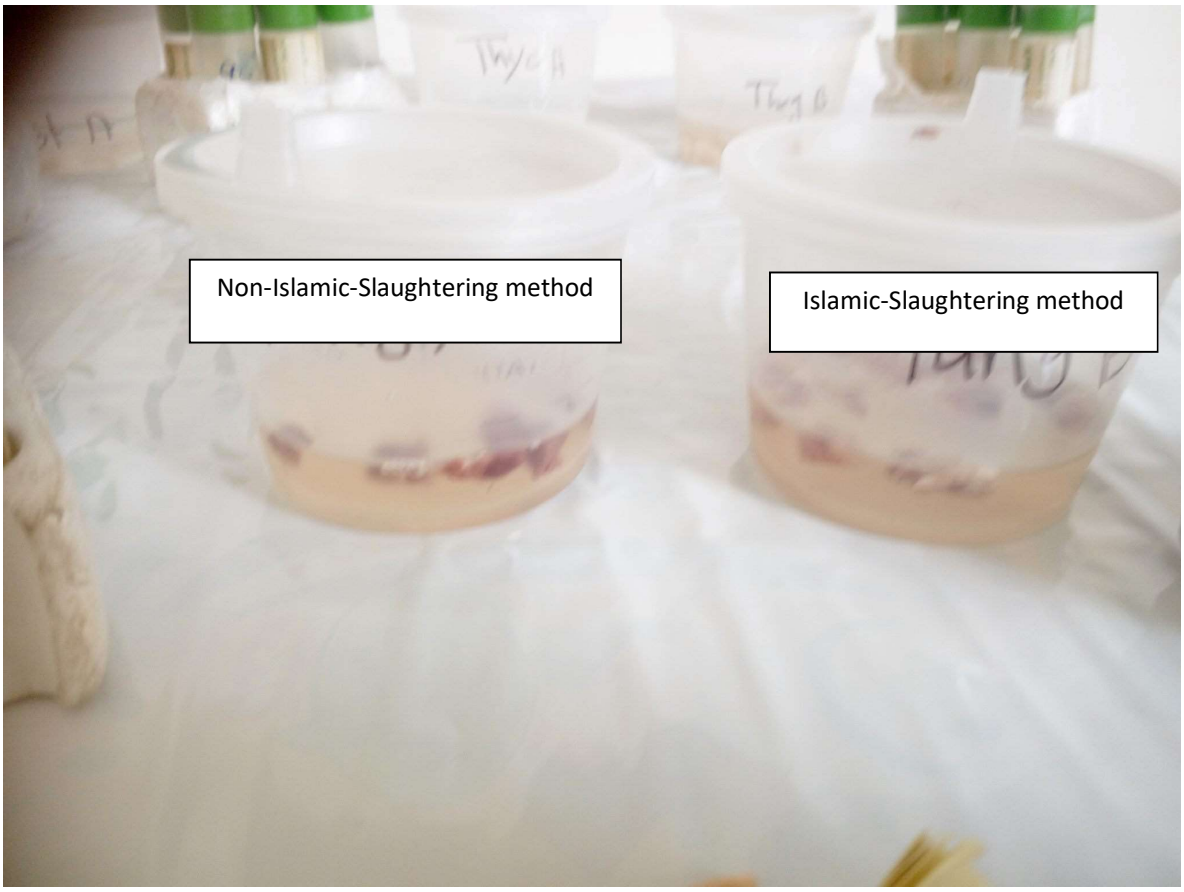

Figure (4.2) Lung tissue marinated in formalin solution obtained from Islamic and non-Islamic-slaughtered rabbit.

It is obvious that this variation in lungs colour were due to the blood clotting inside the lung blood vessels. Which in turn helped in creating dark red colour.

This evidence was confirmed once the tissues were placed in the fixation solution. The Islamic-slaughtered rabbits' lung was very light in colour around pinkish colour, while all non-Islamic-slaughtered rabbit's lung kept the dark red brownish colour.

Another major visual difference was at spinal cord. It was so clear that the spinal cord obtained from all rabbits slaughtered under non-Islamic-slaughtering methods were kept no breached, not intact once placed in the formal saline fixative solution. The big surprising results when the spinal cord for the Islamic slaughtered rabbit was disappeared completely

and dissolved once placed in same solution (within 20 min). Same finding were obtained in three trials for each two Islamic slaughtered rabbit.

This is due to a possible explanation based on the component of the spinal cord which is from very fine proteins and fatty acids that is high affected by glycolysis during post mortem. The differences between glycolysis of different rabbit slaughtering techniques will be discussed next paragraph.

4.2.2 Variation in Glycolysis Development:

Glycolysis for non-Islamic-slaughtered rabbit showed higher acceleration, due to sharp decreasing in PH from (7.2) to reach PH= (5.5) in around (18) hour. Even more, the declined PH value was obvious to reach (5.4) for all non-Islamic-slaughtered rabbits, as shown in Figure (4.3).

On the other hand, the declining of PH for Islamic-slaughtered rabbit showed a smooth gradual decreasing within almost (22) hour. This trend of PH declining could played a role in developing the blood evacuation and bleeding, as blood rendering affected by blood viscosity which is increased with increasing acidity.

At the same time, the maximum development for the PH decreasing was limited to (5.6).

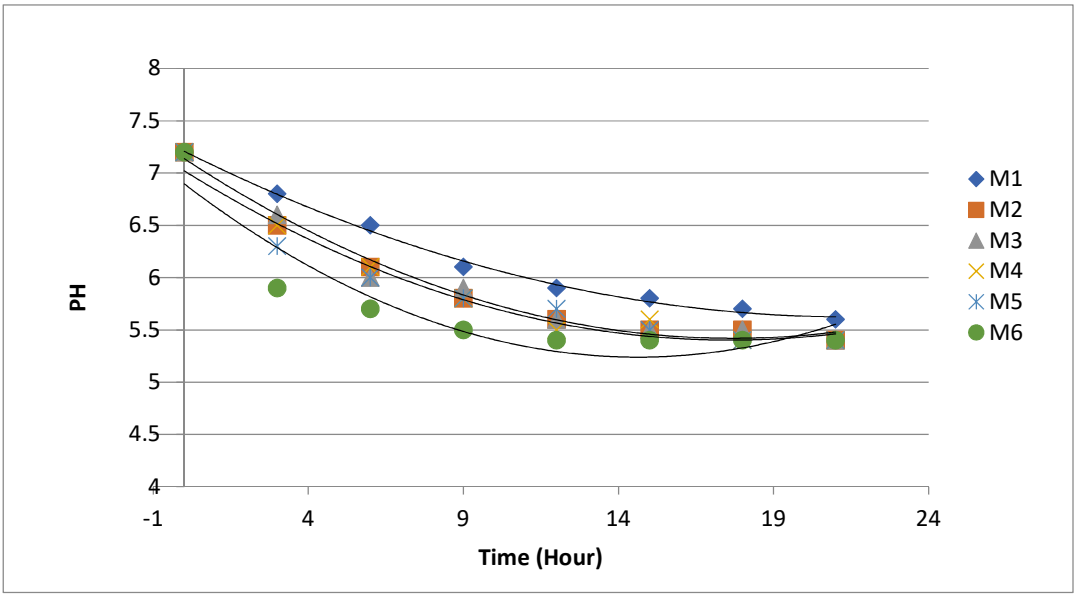

Figure (4.3) PH declined over time for Islamic and Non-Islamic-slaughtered rabbits. Were

(M1), Islamic method; (M2), Mechanical stunning followed with Islamic slaughtering; (M3), Electrical stunning followed with Islamic slaughtering; (M4), Islamic slaughtering with cutting off head; (M5), choking death by holding a tight robe (binder) on the neck; (M6), Slaughtering without naming Allah.

This variation in glycolysis revealed by PH declining rhythm and maximum PH end value created conditions for the amount of blood expel from veins and arteries, and thus the remained blood easily be clotted and appear in the prepared slides.

Nevertheless, this attitude of PH declining and end-value of PH were played a major role in manipulating the consistency and firmness of spinal cord.

One explanation could be invented in this incited Geneon case is the extreme high ability of spinal cord to denaturate upon small variation in PH value. Thus, in case of non-Islamic-slaughtering methods, the PH speedy declined and the high acidity ended value transformed the constituents of spinal cord, which are mainly amino acids and peptides, into a denaturised state. Thus, less ability to dissolve and higher compact consistency in comparison to spinal cord obtained from Islamic-slaughtered rabbit. This finding was confirmed by results obtained for investigating the variation among glycolysis according to slaughtering method.

Monitoring the controlled glycolysis conditions showed that the PH decline was very much like that one in the uncontrolled glycolysis conditions and specially for slaughtering at ambient temperature.

This revels the idea that the glycolysis behaviour is most likely controlled highly by the physiological status of the rabbit itself which is built up according to the slaughtering method, as shown in Figure (4.4).
The same figure shows also the end value result of PH was around (5.4). This value was also obtained in the uncontrolled glycolysis.

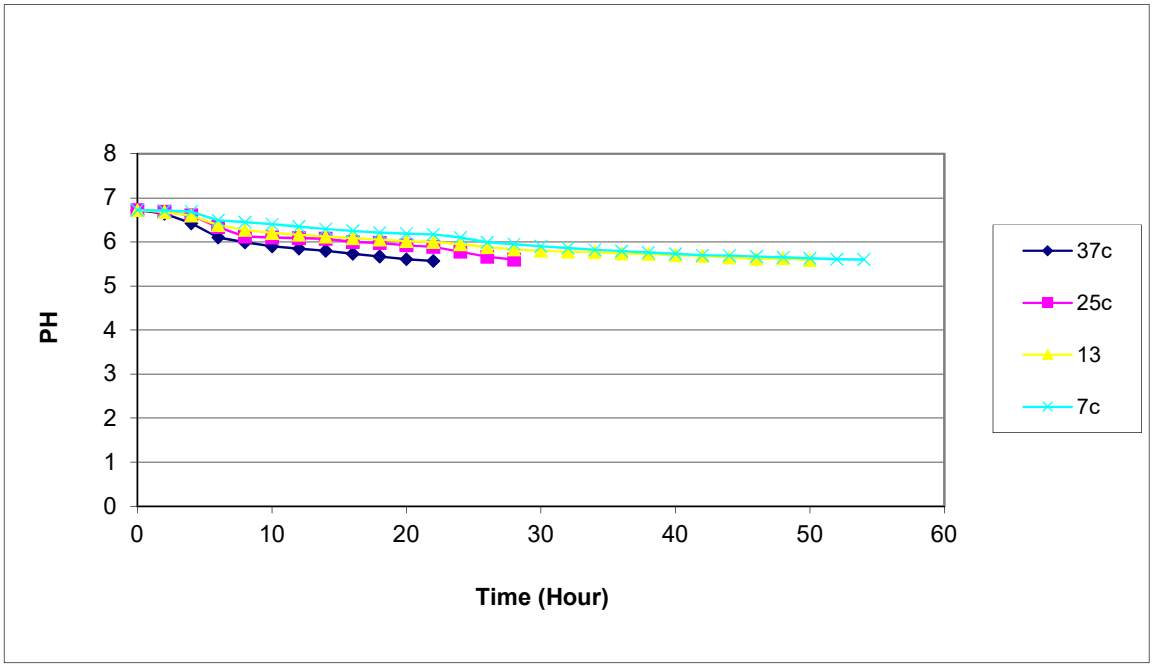

Figure (4.4) Controlled glycolysis for rabbit slaughtered under non-Islamic method.

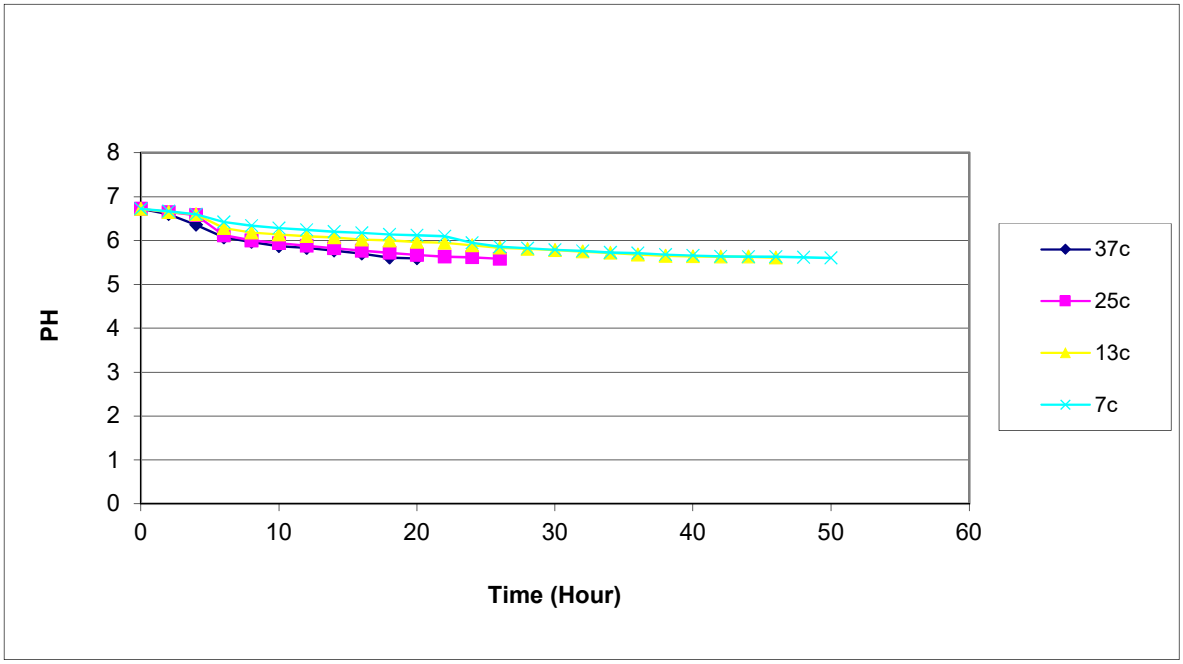

Figure (4.5) Controlled glycolysis for rabbit slaughtered under Islamic method.

Figure (4.5) express the result for the controlled glycolysis for Islamic-slaughtered rabbit.

A remarkable observation on the behaviour of PH-declining was much longer than slaughtering with uncontrolled glycolysis for the same slaughtering method. This observation somehow helped to understand that enhancing the slaughtering method's condition promote longer glycolysis thus smother rigor mortis.

However, the PH ended value kept the same figure which is (5.6).

It is clear that rigor mortis has been resulted in the same feature with and without controlling the glycolysis. Thus, different slaughtering methods ended up with different rigor mortis could be the valid interpretation for such result.

4.3 Variation at Microscopic Level:

Tissue samples prepared from vital organs, namely; lung, heart, liver, brain, spinal cord, and muscular tissues, namely; thigh and chest were studied for both slaughtering methods, the Islamic and non-Islamic methods.

4.3.1 Vital Organs Tissue:

4.3.1.1 Lung Tissue:

Different results were obtained during studying the differences among slides prepared from rabbits slaughtered in different methods.
Obvious variation was obtained in lungs tissue samples. Figure (4.6) and (4.7) demonstrate the remarkable variation between lung tissue sample for rabbit slaughtered under non-Islamic method and rabbit slaughtered under Islamic method, respectively.

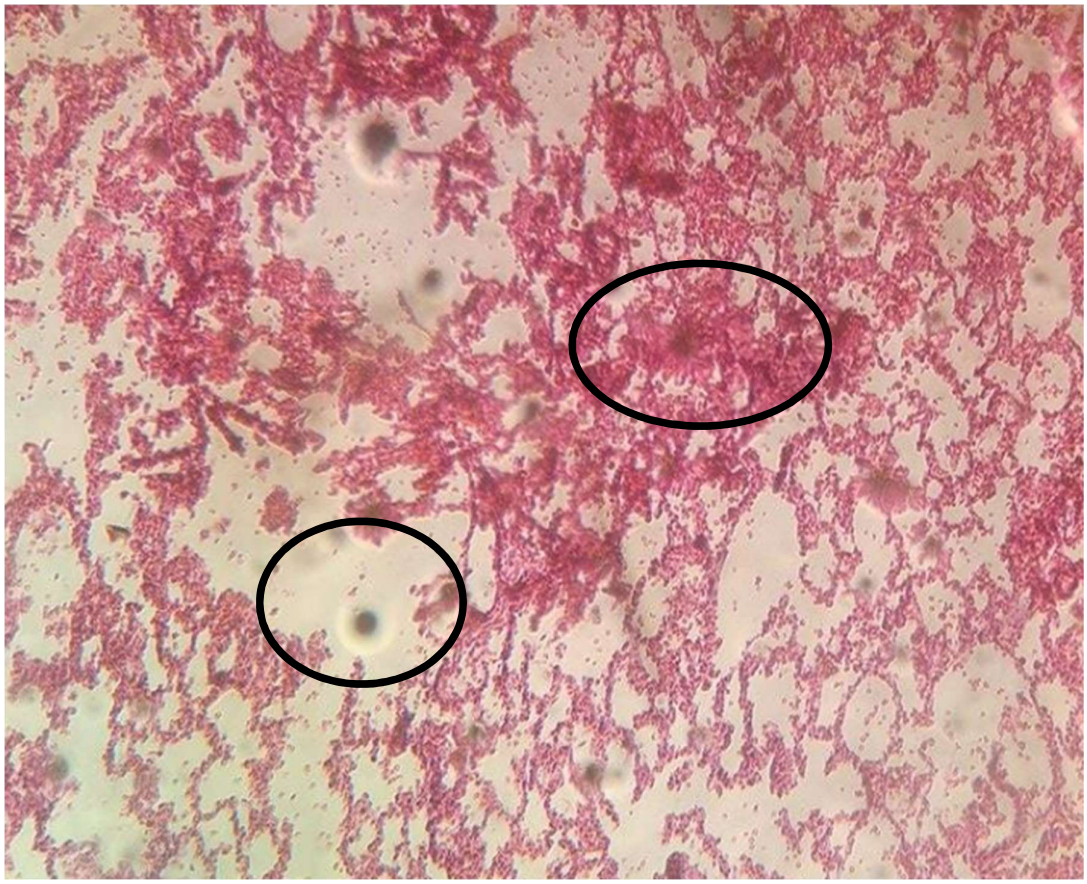

Figure (4.6) Lung tissue for rabbit slaughtered under non-Islamic method

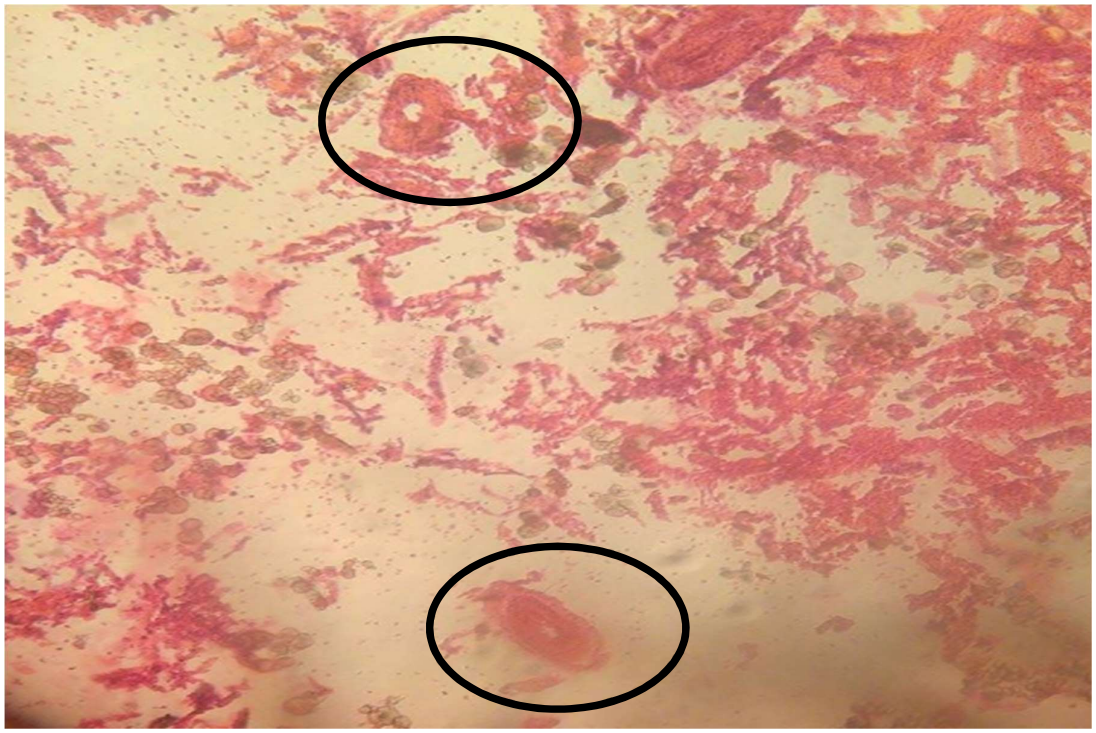

Figure (4.7) Lung tissue for rabbit slaughtered under Islamic method

In Figure (4.6) the marked alveoli with black circle showed its blood vessel is filled with blood and the smooth muscle is compacted...
On contrast, lung tissue from Islamic-slaughtered rabbit showed very clear empty alveoli contained an obvious and clear smooth muscle as remarked by black circle in figure (4.7).
These features obtained at microscopic level for lung tissue revealed the early observation for fresh lung's sample which appeared in dark color in case of non-Islamic-slaughtering and very light pinkish color in case of Islamic-slaughtering method.

These variations were in the cross section of lung tissues, while the longitudinal sections showed no differences. No variations were reported between the five different non-Islamic-slaughtering methods.

4.3.1.2 Heart Tissue:

Heart tissues showered certain variation between the two slaughtering method. The non-Islamic-slaughtering rabbit showed higher compact heart cells at the cross section, at the same time, the longitudinal section has proven this finding and showed high compact longitudinal fibril cells, as remarked in Figure (4.8) and Figure (4.9), respectively.

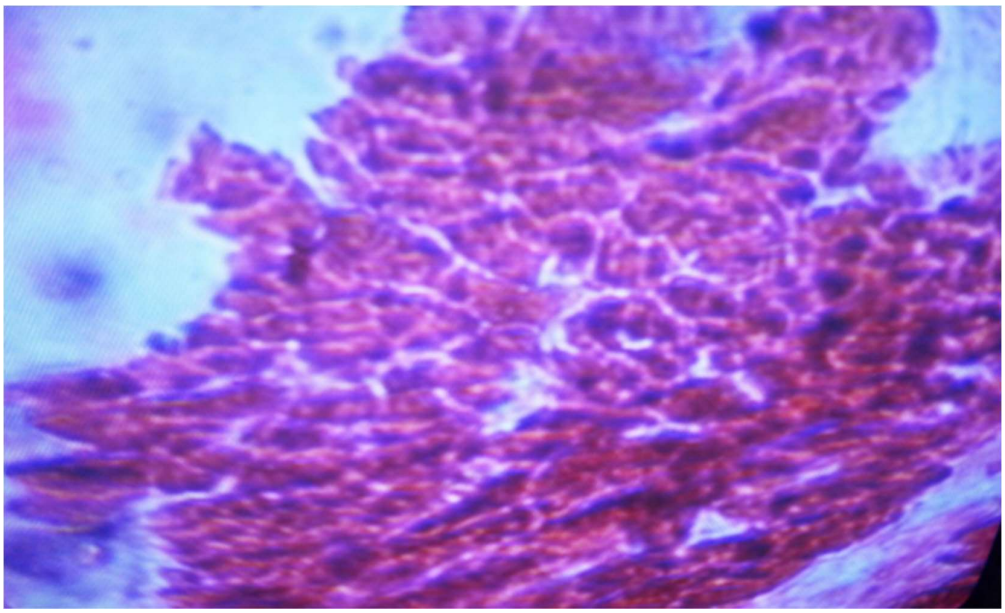

Figure (4.8) Heart cells for non-Islamic-slaughtered rabbit (cross section)

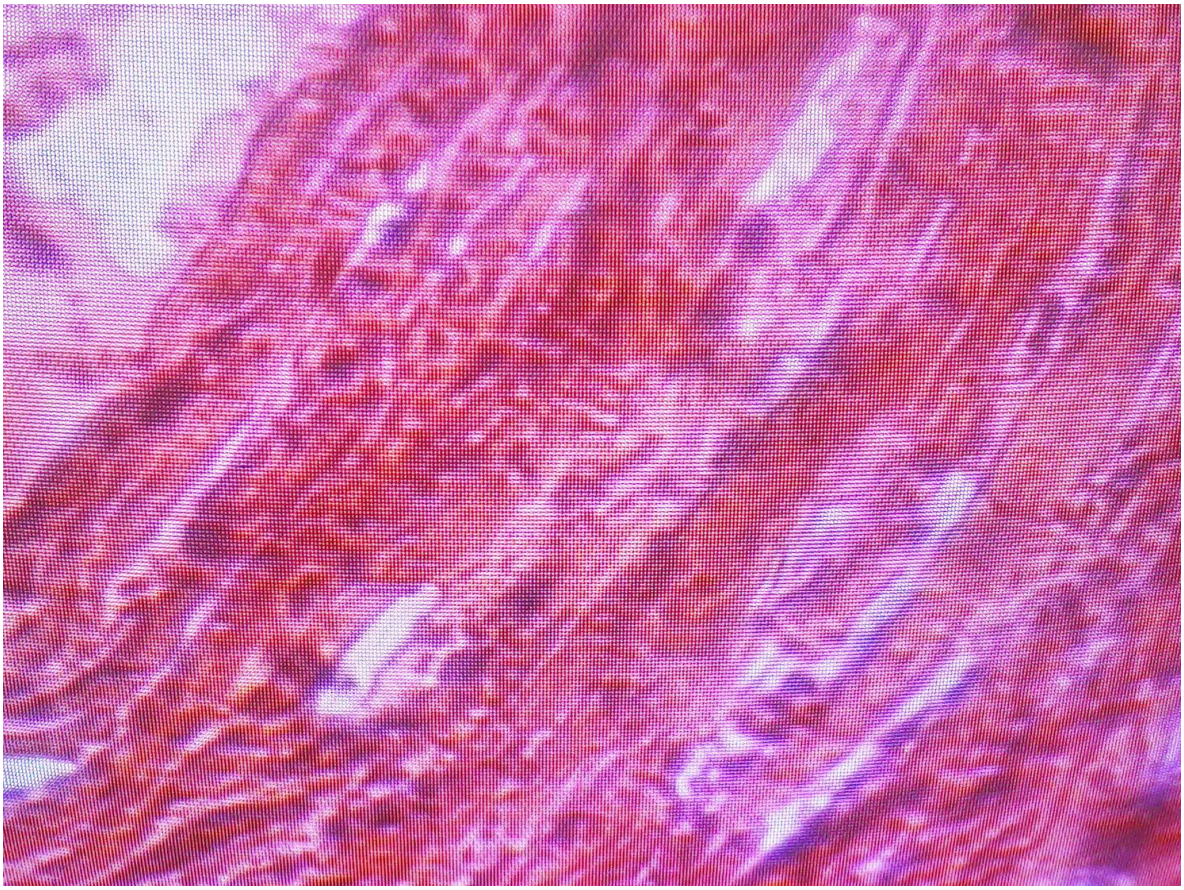

Figure (4.9) Heart cells for non-Islamic-slaughtered rabbit (longitudinal section)

On the other hand, the Islamic-slaughtering method resulted with less compact heart cells, as noticed in both sectional samples (cross and longitudinal). Studying heart cross sectioned in Islamic-slaughtered rabbit, see Figure (4.10), explains a small but clear variation between the two different slaughtering methods.

At the same time, the longitudinal section shot demonstrated in Figure (4.11) reveal this explanation, as the fibril cells is more compact and loose in comparison to that one in non-Islamic-slaughtered rabbit.

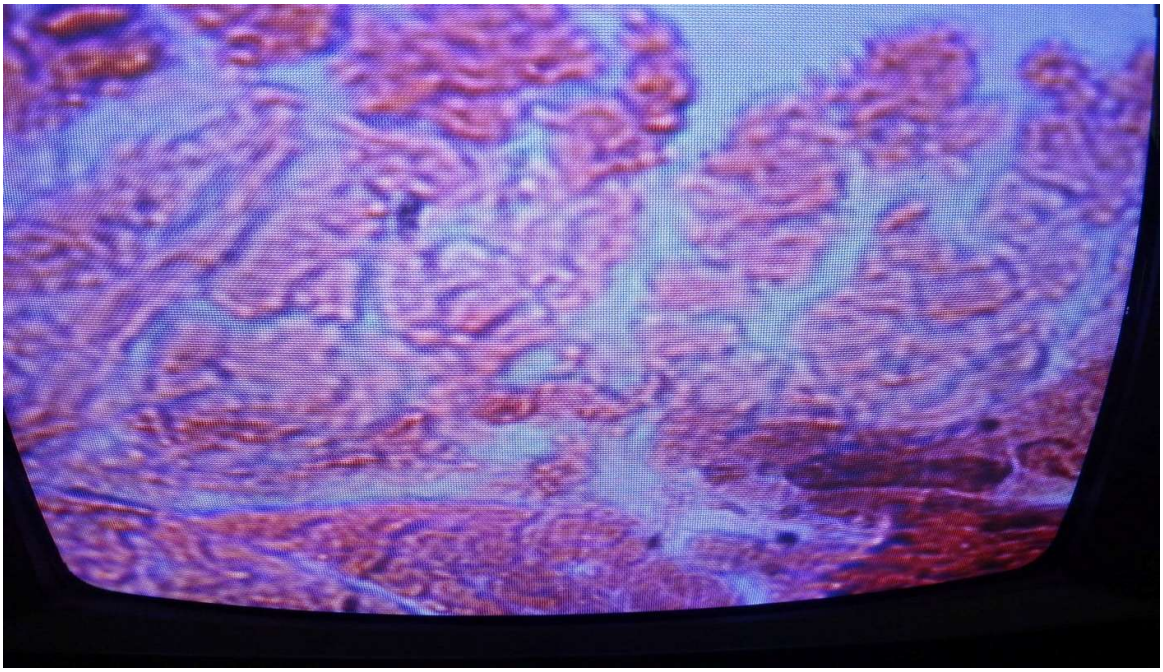

Figure (4.10) Heart cells for Islamic-slaughtered rabbit (cross section)

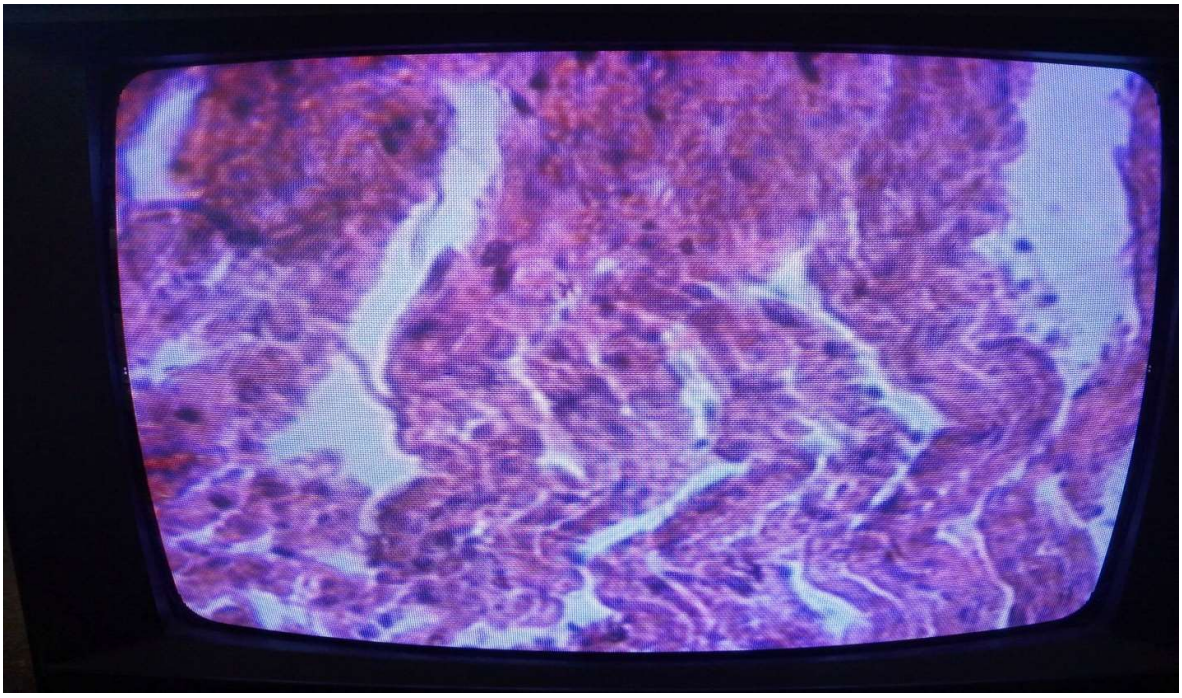

Figure (4.11) Heart cells for Islamic-slaughtered rabbit (longitudinal section)

4.3.1.3 Liver Tissue:

Liver tissue obtained from two different slaughtering methods showed in differences, as shown in Figure (4.12) in case of non-Islamic slaughtering method and Figure (4.13) for Islamic-slaughtering method.

This might be related to the function of liver that is highly operating during the living life of rabbit and food metabolism. However, this explanation doesn't ignore the fact that the time between rabbit slaughtering and tissue sample taken is less than (8) hours. However, the shots taken for the two different methods of slaughtering showed no variation between Islamic and non-Islamic-slaughtering method, and on the other side no variation as well reported between the five different non-Islamic-slaughtering methods among themselves.

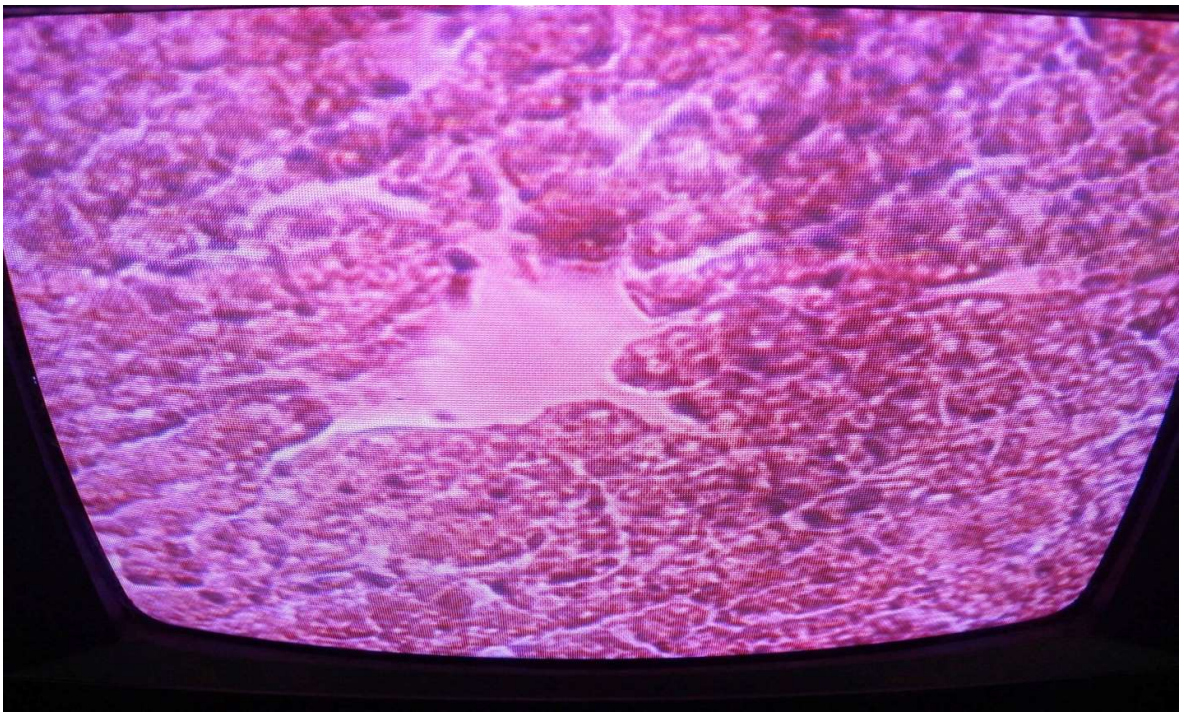

Figure (4.12) Liver tissue for non-Islamic-slaughtering rabbit

Figure (4.13) Liver tissue for Islamic-slaughtering rabbit

4.3.1.4 Brain Tissue:

Investigating the differences at brain level showed the same features for tissues came from rabbits slaughtered by non-Islamic and Islamic methods, as revealed in Figure (4.14) and (4.15), respectively.

During studying the prepared tissues under microscope, brain was the most tissues showed no variation.

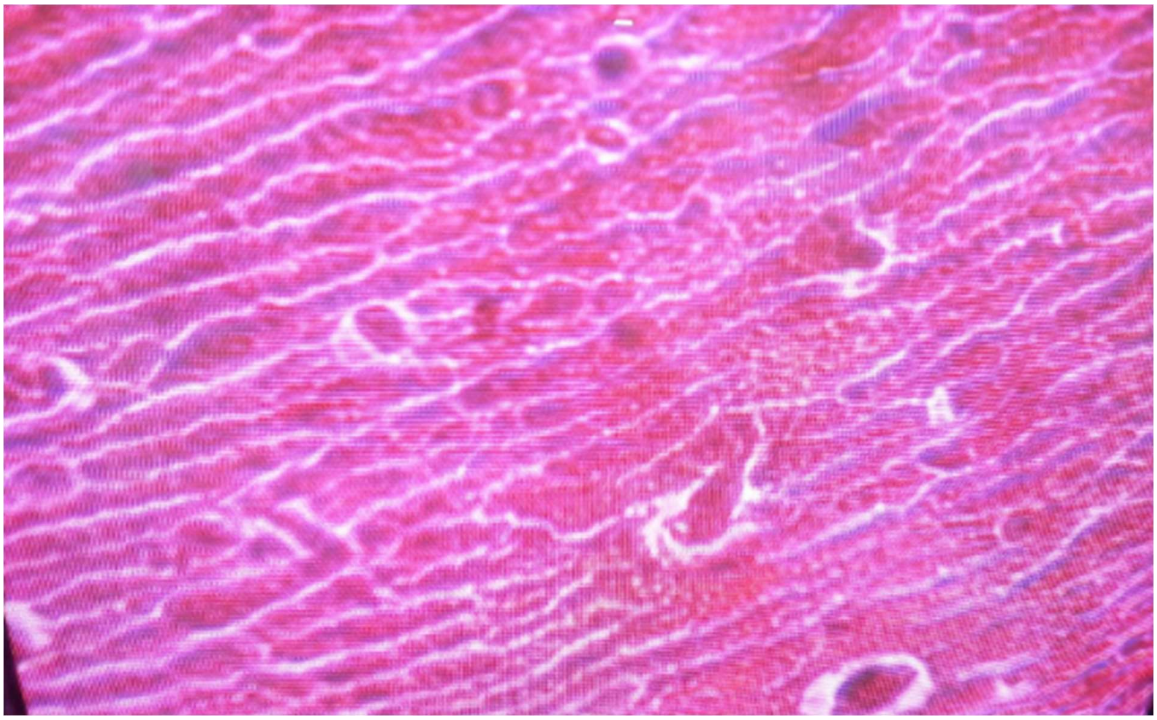

Figure (4.14) Brain tissue for rabbit slaughtered under non-Islamic method

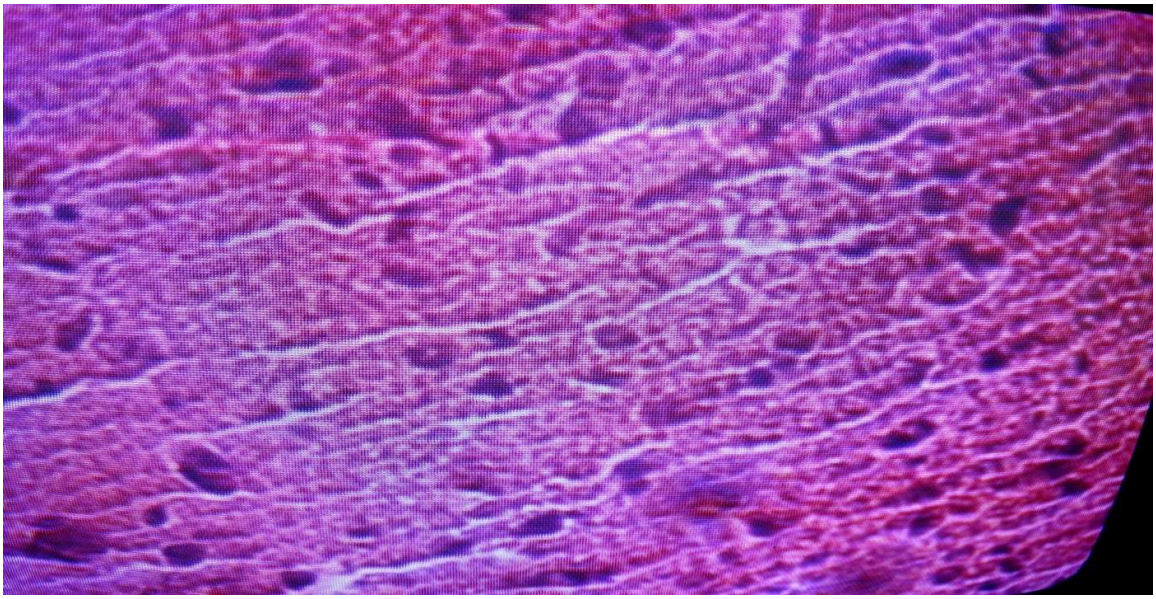

Figure (4.15) Brain tissue for rabbit slaughtered under Islamic method

4.3.1.5 Spinal Cord Tissue:

Figures (4.16) and (4.17) shows the cross and longitudinal section for spinal cord obtained from non-Islamic-slaughtered rabbit.

As shown in both figures, the cells arrangement and nucleus is good. The wholesomeness of the spinal cord is not affected by the process of slide preparation.

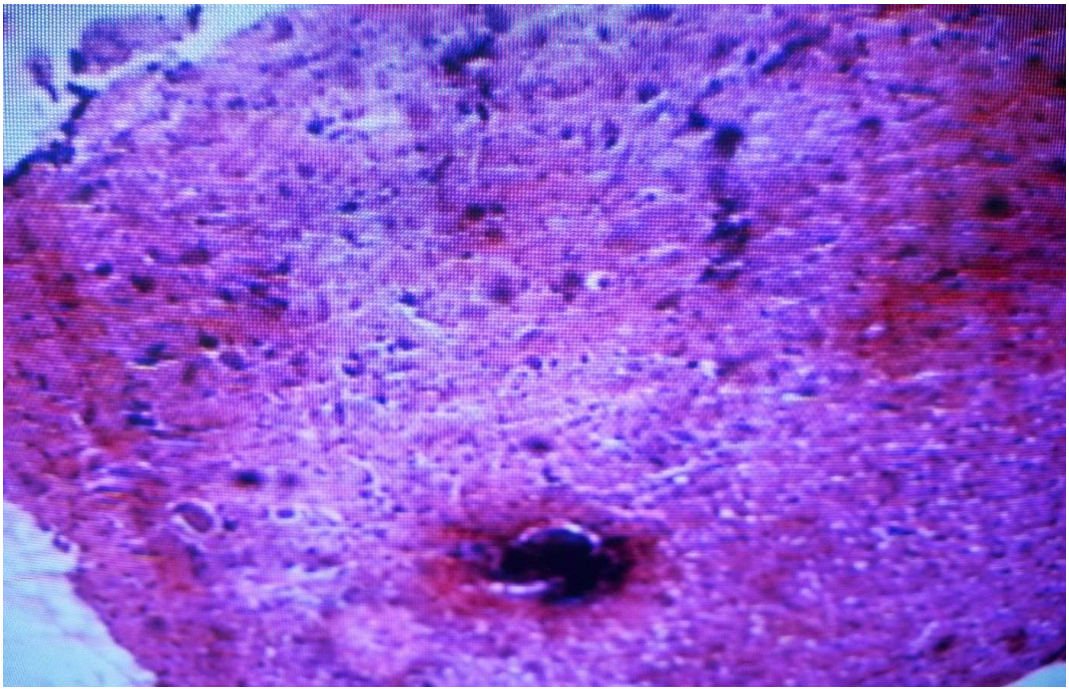

Figure (4.16) Spinal cord tissue for non-Islamic-slaughtered rabbit (cross section)

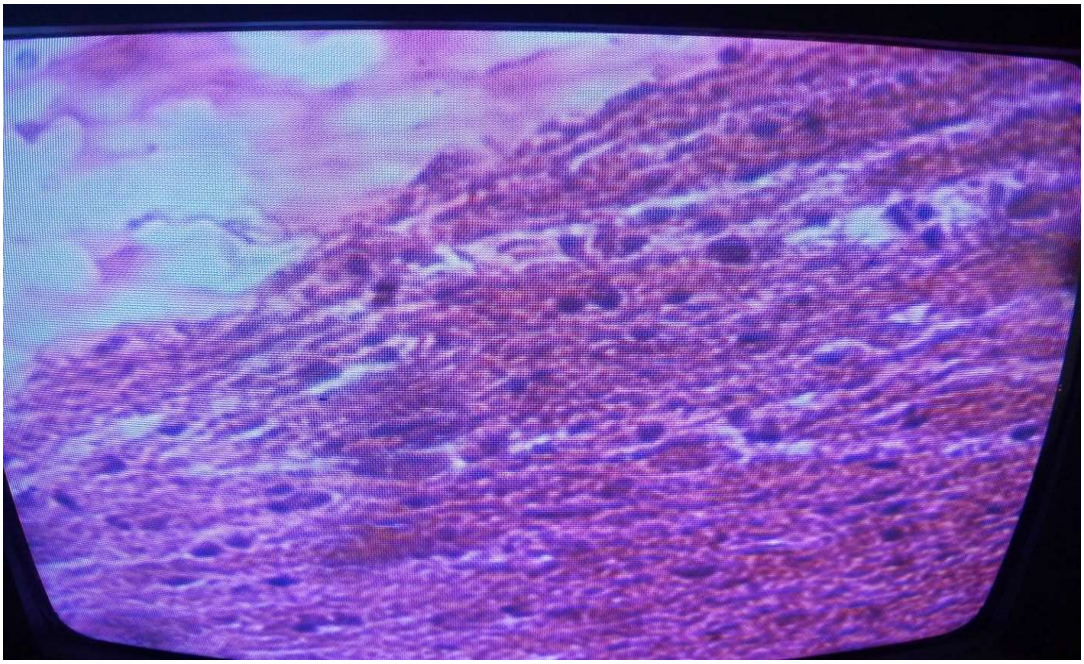

Figure (4.17) Spinal cord tissue for non-Islamic-slaughtered rabbit (longitudinal section)

This finding is in completely different than results obtained for spinal cord of rabbit slaughtered under Islamic supervision. The last mention is completely dissolved and disappeared while marinated in the formalin solution. This huge difference between the two methods of slaughtering is revealed by eighteen sample. The three Islamic-slaughtered rabbits produced a dissolved spinal cord while marinated in formalin solution, while the fifteen non-Islamic-slaughtered rabbit produced no single spinal cord could dissolve in formalin solution. This huge finding could be explained by the denaturantion effect took place for the very prime protein constituents of spinal cord was much faster in case of non-Islamic-slaughtering method in comparison to the Islamic method. This is due to the high acceleration of acidity development in relatively shorter time in case of non-Islamic-slaughtering method. Moreover, the end value of PH in case of non-Islamic-slaughtered rabbit reached to (5.4), while it didn't exceed (5.6) for rabbits slaughtered under Islamic supervision.

4.3.2 Muscular Tissue:

Two major muscle tissue types were obtained from rabbit slaughtered under non-Islamic and Islamic method, breast and thigh tissues were studied separately enable to find a variation among different slaughtering methods.

4.3.2.1 Breast Tissue:

Figure (4.18) shows the results obtained for breast tissue in non-Islamic slaughtered rabbit. A clear cluster of big number of cells were demonstrated for all non-Islamic-slaughtered rabbits. The boundaries and defend border for individual cell is lost.
It seems that the cells were gathered in a way that they lost their identity, as remarked with black circle.

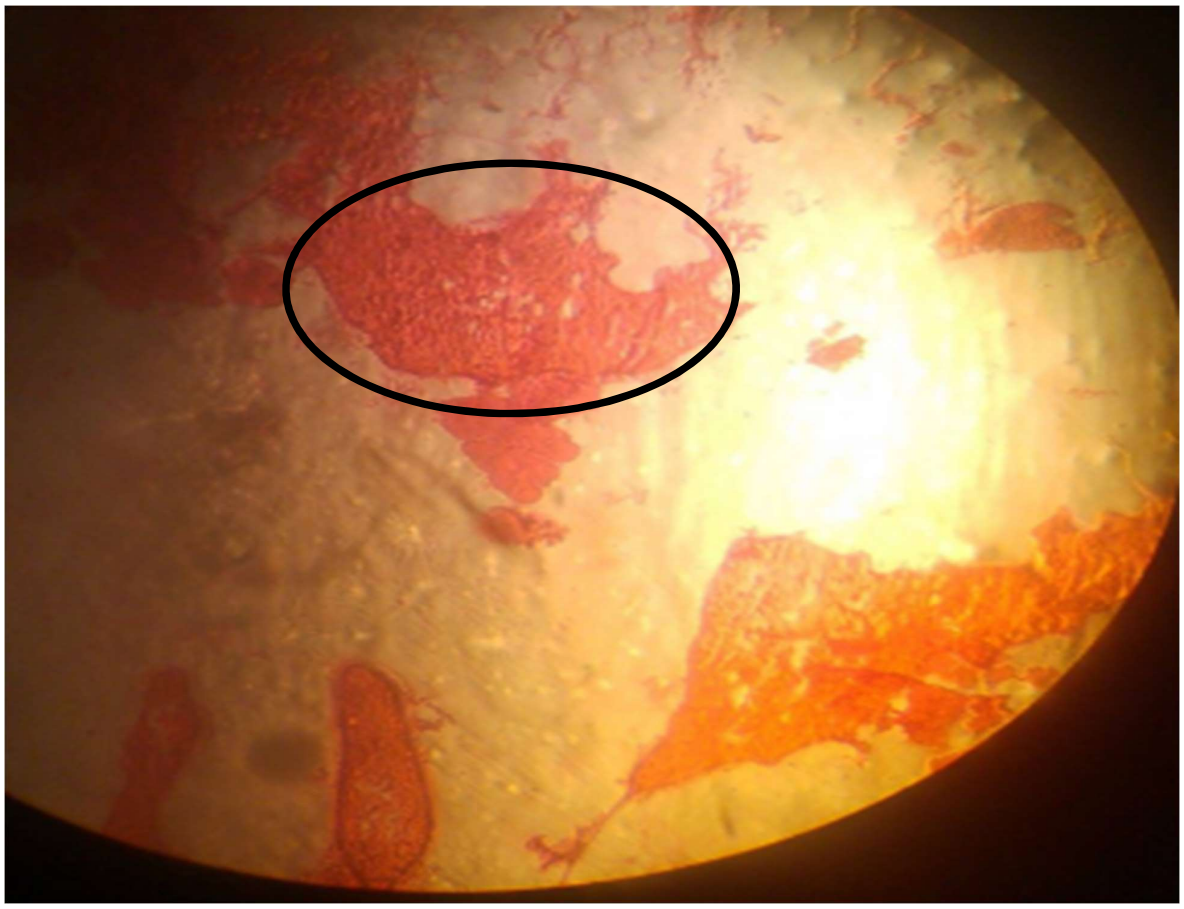

Figure (4.18) Breast tissue obtained from rabbit slaughtered under non-Islamic method.

While for the breast tissue obtained from rabbits slaughtered under Islamic supervision, each cell is defined clearly with a cell boundary. Although cells are kept the adjacency, but with individual isolation boarder (4.19).

This finding could explain the remarkable tenderness of meat resulted from Islamic-slaughtering method in comparison to those meats obtained from non-Islamic-slaughtering methods.

As the clusters of cells will create certain difficulty for tenderness and smoothing the tissue, hence, large number of united cells will demonstrate harder to heat penetration (upon cooking) and harder metabolism (upon digestion).

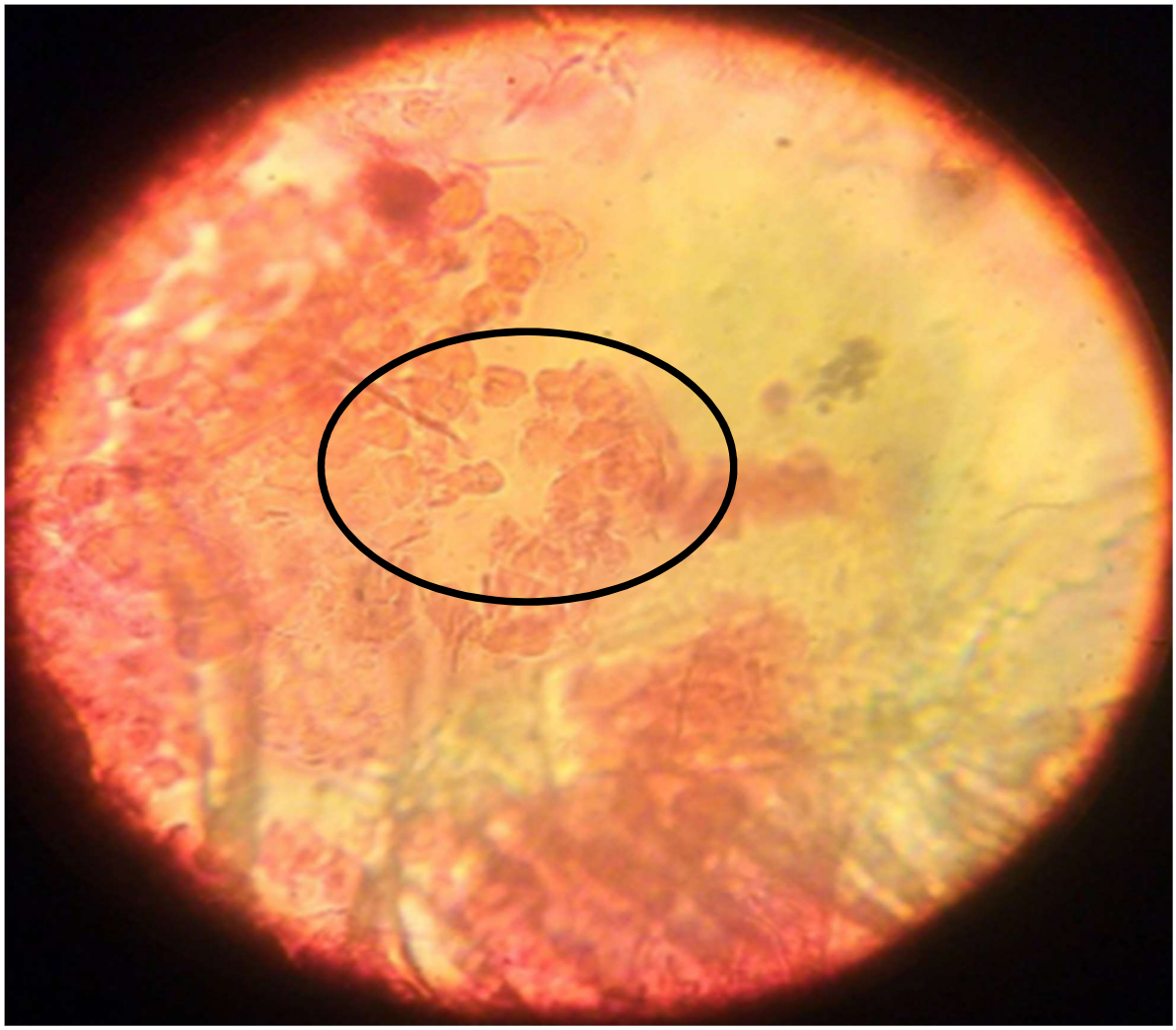

Figure (4.19) Breast tissue obtained from rabbit slaughtered under Islamic method.

4.3.2.2 Thigh Tissue:

Thigh tissues for non-Islamic and Islamic-slaughtering methods were studied under microscope and the snap shots were fixed in Figure (4.20) and (4.21), respectively.
Figure (4.20) clearly shows that the cells were embedded and clustered to form one unit, as marked in black circle.

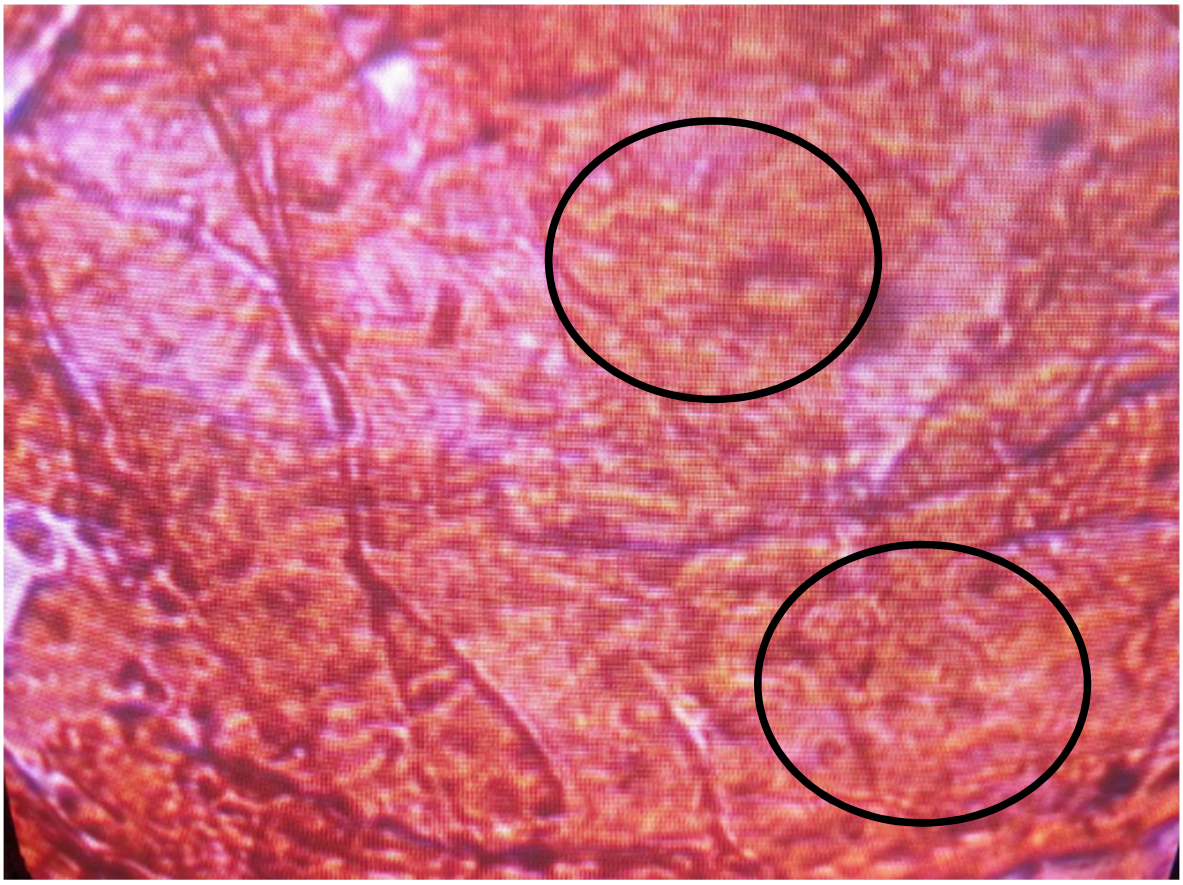

Figure (4.20) Thigh tissue for non-Islamic-slaughtered rabbit

Major difference was appeared by studying the Islamic-slaughtered thigh sample shown in Figure (4.21).
The black circle type (A) shows that cells are located in isolate for with well defined boarder. Stronger evidence was shown in black circle type (B) which shows even with high clustered cells the individual cells kept its walls and boarder clearly.

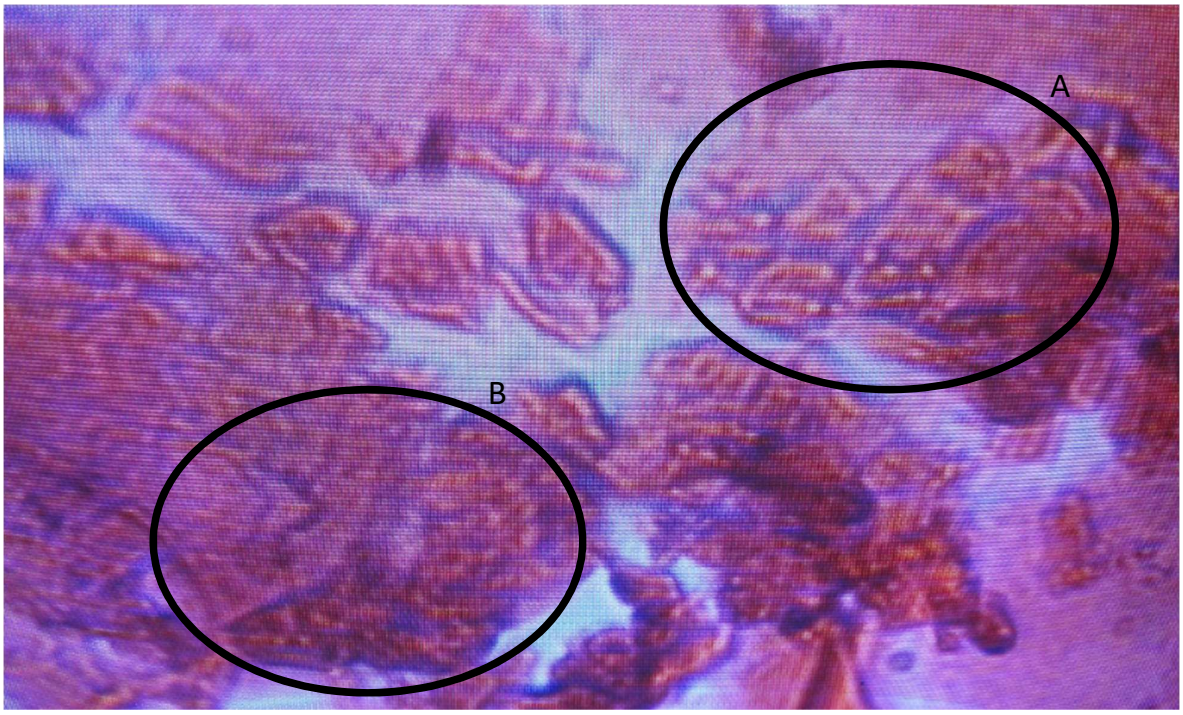

Figure (4.21) Thigh tissue for Islamic-slaughtered rabbit

This different behaviour of cells among non-Islamic and Islamic-slaughtering method were played a role in producing different meat tenderness, as Islamic-slaughtered meat is more tender than non-Islamic-slaughtered meat.

This is very acceptable explanation for the remarkable sensorial variation between the Islamic and non-Islamic-slaughtered animals.

However, the five different non-Islamic-slaughtered rabbits showed no differences.

López.M, Carrilho M.C, Campo M.M, Lafuente R. made an experiment on (50) rabbit which had the same characteristics to distinguish the difference between the method of slaughtering on rabbits, some basic animal welfare features were evaluated.

Rabbits from Halal slaughtered group had neither vocalization, spasms, or movements during the hanging phase nor after slaughtering also Their bodies remained totally relaxed and floppy on the chain from the beginning. The rabbits from the Stunned group also had not vocalizations or movements before slaughtering and one rabbit of this group arched and flexed its back for a moment after slaughtering. According to our result Only rabbits which slaughtered on the Islamic rules felt relaxed and safe, on the other hand our results was the same with him in case of blood losses which were higher in the rabbits which were slaughtered according to Islamic rules. (López M et al. ,2008)

The end of this chapter we illustrate and highlight numerous conclusions in table (4.1).

Table (4.1): main differences between different type of slaughtering:

None Islamic rules	Islamic rules
visible results	
screamed loudly	comfort and they did not make any sound
The rate of bleeding -not high	The rate of bleeding – high
The color of the lungs was unclear and covered with blood (dark brownish color), it seems like bloody spots distributed on the surface of the tissues after slaughtering.	The color of the lungs clears without blood, pale pinkish color.
the spinal cords were burned	the spinal cords were dissolved (formalin solution) in the first step of fixation
Morphology of the cells	
the cells in thigh & chest for were formed clusters rabbits	the cells in thigh & chest for rabbits were circular or polygon
Blood accumulation	
the accumulations of blood were clearly observed in all samples for different tissues (especially in lungs)	No presence for the blood accumulations
Glycolysis Variation	
The glycolysis trend was highly variant between rabbit slaughtered under Islamic supervision and non-Islamic slaughtered rabbit.	
The time required to reach the end value of glycolysis was much shorter (18 HOUR)	The time required to reach the end value of glycolysis was much longer (22 hours) longer (22 HOUR) longer
The end value of the glycolysis is around 5.4	The end value of the glycolysis is around 5.6
Bleeding after slaughtering	
not spontaneous	spontaneous (less than 2.5 minutes)

Chapter Five

5. Conclusion and Recommendation

5.1 Introduction:

Due to heavy results obtained in this investigation, numerous conclusions were highlighted. However, the major conclusions, on the basis of the results and discussion presented within this research, can be drawn:

5.2 Conclusions:

5.2.1 Visible Variations:

- The rabbits which were slaughtered according to none Islamic rules screamed loudly due to fear, on the contrary of rabbits which were slaughtered according to Islamic rules which were comfort and they did not make any sound.
- The rate of bleeding with the fear rabbits were not high on the contrary of rabbits with slaughtered according to Islamic rules
- Top results showed that there were many differences between Al-Zabeh al Halal & and the slaughtering according to none Islamic regulations which were observed clearly in lungs tissues, the variation in color were observed clearly.
- The color of the lungs especially for those rabbits which were slaughtered according to none Islamic rules were unclear and covered with blood, it seems like bloody spots distributed on the surface of the tissues after slaughtering.
- Spinal cord also gave visible observations between rabbits in both method of slaughtering, the spinal cords for those rabbits which were slaughtered according to none Islamic rules were dark in color tough consistency. While spinal cord for rabbit slaughtered by Islamic method was dissolved in the formalin solution and disappeared.

5.2.2 Morphology of the cells:

- The results under the microscope showed the morphology of cells especially for the cell membrane and nuclei which were observed on all tissues with different arrangement according to the type of tissues, for example the cells in thigh & chest for rabbits which were slaughtered according to Islamic rules were individual circular, on the contrary with other methods for the same tissues the cells were clustered.
- The morphology of cells was not the only difference between rabbits in both method of slaughtering.

5.2.3 Blood accumulation:

- The accumulations of blood were clearly observed in all samples for different tissues especially for the none Islamic slaughtering, but clearly noticed in lungs, the Blood vessels were full of bloods.

5.2.4 Gylcolysis Variation:

- The glycolysis trend was highly variant between rabbit slaughtered under Islamic supervision and non-Islamic slaughtered rabbit.
- The time required to reach the end value of glycolysis was much shorter in case of non-Islamic-slaughtered rabbit
- The end value of the glycolysis is around (5.4) while it was (5.6) in case of Islamic-slaughtered rabbit.

5.3 Recommendations:

Results obtained is very promising and promoting extraordinary understanding for the variations between the Islamic and non-Islamic-slaughtered rabbits.

Therefore, it is highly recommended to investigate more animals ranged from small ruminant to large ruminant. It is highly recommended as well to study different tissues and to apply more diversed slaughtering techniques.

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ملخص:

ثمانية واربعون ارنب تم استخدامها لدراسة الاختلاف بين طريقة الذبح على الشريعه الاسلاميه ووطرق الذبح التقليديه المختلفه من خلال التحقيق في ثلاث جوانب رئيسيه : بصريه ,مجهريه والتحلل الجلايكولي .

جميع الارانب المستخدمه في البحثكانت من نفس الفصيلة والصفات؛ اللون، الوزن، الطول، العمر، والجنس تم ذبحها بست طرق ذبح مختلفة وهي ذبح كامل , صعق ميكانيكي ثم ذبح حلال ,موت بالصعق وبعد ذلك ذبح حلال , حلال كامل مع فرس للرأس , موت غير حلال (بالخنق), ذبح بدون تسميه .واستخدمت الأعضاء الحيوية (الدماغ والقلب والرئة)، والأنسجة العضلية (الفخذ والصدر)، والحبل الشوكي لإعداد مقطع طولي وعرضي للأنسجة المصبوغة على الشرائح المجهرية بواسطة تقنية ميكروتون القياسية.

تم فحص العينات بصريا في حين تم فحص الأنسجة باستخدام المجهر الالكتروني)NIKON(الموصول بشاشة عرض من نوع)HITACHI(لحفظ الصور, وتم التقاط عدد من الصور بواسطة جهاز LG) (G4 حيث كانت دقة وضوح الصورة.(12 MP)

أظهرت النتائج التي تم الحصول عليها القدرة على التمييز مابين طريقة الذبح الإسلامية (الذبح الحلال) والطرق الأخرى الغير إسلاميه في الذبح على ثلاث مستويات مختلفة : البصري , المجهري , محتوى الدم في الأنسجة .

هذه الاختلافات في أساليب الذبح كانت ظاهره بشكل واضح في الرئتين والنخاع الشوكي . وتظهر متغيرات اقل على المستوى المجهري لأنسجة الرئة والصدر, في حين لم تسجل أي ملاحظات على اختلاف الأنسجة العضلية . على كل حال, قياسات وسلوك الانخفاض في درجة الحموضه درست لتساعد في تقديم فهم افضل للفروقات بين طرق الذبح الحلال وغير الحلال.