Effect of conditioning time, muscle type and freezing period on quality attributes of camel meat and meat products

By
Saliha Hmmad Kafe Teya
B.Sc. (1997) University of Kordofan
M.Sc. (2002) University of Khartoum

A thesis submitted to University of Khartoum in fulfillment of the requirements for the Degree of Doctor of Philosophy in Animal Production (Meat Science).

Supervisor:
Prof. Ibrahim Musa Tibin

Co-Supervisor:
Dr. Ikhlas Ahmed Nour
Department of Meat Production

Faculty of Animal Production

University of Khartoum

October 2012
DEDICATION

TO THE PURE SOUL OF MY FATHER
TO MY MOTHER, HUSBAND, BROTHERS,
SISTERS, FRIENDS,
AND LOVELY SONS AND DAUGHTER
WITH SINCERE LOVE
AND RESPECT

SALIHA
ACKNOWLEDGEMENTS

First of all my endless praise and thanks to Allah, the Almighty, most gracious and most merciful, who gave me the strength and support to pursue such work.

I would like to express my sincere gratitude, indebted, deepest appreciation and respect to my supervisor Professor Ibrahim Musa Tibin, Department of Meat production, University of Khartoum, for his patience, guidance, support, constructive and interest throughout this study.

Grateful thanks extended to my co-supervisor Dr. Ikhlas Ahmed Nour, Director of Institute for Studies and Promotion of Animal Export, University of Khartoum, for her helpful, guidance and patience.

Words are inadequate to express my deepest grateful thanks and respect to Professor Salih Ahmed Babiker, Department of Meat Production, Faculty of Animal Production, University of Khartoum, for continuous advice and encouragement.

I should like to express my grateful thanks and gratitude to Dr. Abd Alwahab Hassn, Dr. Alfatih Mohamed and Pro. Mohamed Elkhier Abdallah, for their Help and support in statistical analysis.

I am so grateful to the technicians in the Meat Laboratory, Faculty of Animal Production, University of Khartoum, for their great assistance.

My deep thanks are also due to the staff of Michigan Laboratory, for providing the laboratories and making all facilities available.

My heart-felt appreciation and respect are extended to my husband, for his, encouragement and support.

I am deeply indebted to my family, friends and colleagues, for their kind help and moral support.
# LIST OF CONTENTS

<table>
<thead>
<tr>
<th>Title</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>DEDICATION</td>
<td>I</td>
</tr>
<tr>
<td>ACKNOWLEDGEMENTS</td>
<td>Ii</td>
</tr>
<tr>
<td>LIST OF CONTENTS</td>
<td>iii</td>
</tr>
<tr>
<td>LIST OF TABLES</td>
<td>Vii</td>
</tr>
<tr>
<td>LIST OF FIGURES</td>
<td>Viii</td>
</tr>
<tr>
<td>ABSTRACT</td>
<td>ix</td>
</tr>
<tr>
<td>ARABIC ABSTRACT</td>
<td>Xi</td>
</tr>
<tr>
<td>CHAPTER ONE: INTRODUCTION</td>
<td>1</td>
</tr>
<tr>
<td>CHAPTER TWO: LITERATURE REVIEW</td>
<td>6</td>
</tr>
<tr>
<td>2.1 Dromedary Camel (<em>Camelus dromedarius</em>)</td>
<td>6</td>
</tr>
<tr>
<td>2.1.1 Historical Background of the Dromedary Camel</td>
<td>6</td>
</tr>
<tr>
<td>2.1.2 Distribution of the One-Humped Camel</td>
<td>6</td>
</tr>
<tr>
<td>2.1.3 Type of Sudanese Camels</td>
<td>7</td>
</tr>
<tr>
<td>2.1.4 The Potential of Camel as Meat Producer</td>
<td>7</td>
</tr>
<tr>
<td>2.1.5 Chemical Composition of Camel Meat</td>
<td>8</td>
</tr>
<tr>
<td>2.2 Eating Quality of Meat</td>
<td>8</td>
</tr>
<tr>
<td>2.2.1 Meat Colour</td>
<td>8</td>
</tr>
<tr>
<td>2.2.2 Juiciness of Meat</td>
<td>10</td>
</tr>
<tr>
<td>2.2.3 Meat Tenderness</td>
<td>11</td>
</tr>
<tr>
<td>2.2.4 Meat Flavour</td>
<td>11</td>
</tr>
<tr>
<td>2.2.5 Meat Palatability</td>
<td>12</td>
</tr>
<tr>
<td>2.3 Water-Holding Parameters</td>
<td>12</td>
</tr>
<tr>
<td>2.3.1 Water-Holding-Capacity of Meat</td>
<td>12</td>
</tr>
<tr>
<td>2.3.2 Drip loss and Weep loss of Meat</td>
<td>13</td>
</tr>
<tr>
<td>2.3.3 Cooking loss of Meat</td>
<td>14</td>
</tr>
<tr>
<td>2.4 Meat Conditioning (aging)</td>
<td>14</td>
</tr>
<tr>
<td>2.4.1 Protein Denaturation</td>
<td>15</td>
</tr>
<tr>
<td>2.4.2 Proteolysis</td>
<td>15</td>
</tr>
<tr>
<td>2.4.3 Other Chemical Changes</td>
<td>21</td>
</tr>
<tr>
<td>2.5 Meat Processing</td>
<td>22</td>
</tr>
<tr>
<td>2.5.1 Type of Sausages</td>
<td>22</td>
</tr>
<tr>
<td>2.5.2 Ingredients in Sausage Processing</td>
<td>22</td>
</tr>
<tr>
<td>2.5.2.1 Meat ingredient</td>
<td>22</td>
</tr>
<tr>
<td>2.5.2.2 Fat</td>
<td>23</td>
</tr>
<tr>
<td>2.5.2.3 Binders and extenders</td>
<td>23</td>
</tr>
<tr>
<td>2.5.2.4 Ice water</td>
<td>23</td>
</tr>
<tr>
<td>2.5.2.5 Seasonings and flavoring</td>
<td>23</td>
</tr>
<tr>
<td>2.5.2.6 Sugar</td>
<td>24</td>
</tr>
</tbody>
</table>
CHAPTER THREE: MATERIALS AND METHODS

3.1 Experiment One

3.1.1 Source of Meat

3.1.2 Sample preparation

3.1.3 Objective Measurements

3.1.3.1 pH Determination

3.1.3.2 Proximate Chemical Analysis

3.1.3.3 Protein Fractionation

3.1.3.4 Color Measurements

3.1.3.5 Water Parameters measurement

3.1.3.5.1 Water holding capacity measurement

3.1.3.5.2 Cooking loss measurement

3.1.3.5.3 Drip loss measurement

3.1.3.5.4 Weep loss measurement

3.1.3.6 Electrophoresis

3.1.3.6.1 Gel preparation

3.1.3.6.2 Preparation of the 12.5% running gel (Separating gel)

3.1.3.6.3 Preparation of 4% stacking gel

3.1.3.6.4 Loading of Samples on gels

3.1.3.6.5 Separation the samples

3.1.3.6.6 Staining the gel

3.1.3.6.7 De-staining the gel

3.1.3.6.8 Molecular weight determination

3.1.4 Subjective measurement (Sensory evaluation)

3.1.5 Microbiology evaluation

3.1.5.1 Determination of microbial load

3.1.5.2 Psychrophilic counting

3.1.5.3 Pseudomonas spp Determination

3.1.5.4 Determination of Listeria monocytogenes

3.1.5.5 Determination of Streptococcus faecalis

3.1.5.6 Staphylococcus aureus Determination

3.1.5.7 Determination of Total coliform bacteria
5.2.7 Microbiological properties studied ......................................................... 114
5.3.1 Physical analysis .................................................................................. 121
5.3.2 Chemical composition of fresh camel sausage ..................................... 122
5.3.3 Sensory Evaluation .............................................................................. 123
5.3.4 Microbiological Parameters of Camel sausage .................................... 124

CHAPTER SIX: CONCLUSION AND RECOMMENDATION ......................... 125

CHAPTER SEVEN: REFERENCES .................................................................. 128
# List of tables

<table>
<thead>
<tr>
<th>Table</th>
<th>Title</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Sausage recipe</td>
<td>48</td>
</tr>
<tr>
<td>2</td>
<td>Proximate chemical composition of Semitendinosus (ST) and Deep Pectoral muscles from one-humped camel (<em>Camelus dromedarius</em>)</td>
<td>51</td>
</tr>
<tr>
<td>3</td>
<td>Effect of conditioning time and muscle type on pH value of one-humped camel meat</td>
<td>52</td>
</tr>
<tr>
<td>4</td>
<td>Effect of conditioning time and muscle type on colorimetric parameters of one-humped camel meat</td>
<td>56</td>
</tr>
<tr>
<td>5</td>
<td>Effect of conditioning time and muscle type on protein fractionation of one-humped camel meat</td>
<td>61</td>
</tr>
<tr>
<td>6</td>
<td>Effect of conditioning time and muscle type on water holding parameters of one-humped camel meat</td>
<td>66</td>
</tr>
<tr>
<td>7</td>
<td>Effect of conditioning time and muscle type on myofibrillar protein degradation of camel meat, conditioned at 2°C for (1, 3, 5 and 7 day)</td>
<td>71</td>
</tr>
<tr>
<td>8</td>
<td>Effect of conditioning time and muscle type on sensory evaluation of camel meat</td>
<td>74</td>
</tr>
<tr>
<td>9</td>
<td>Effect of conditioning time and muscle on microbiological parameters of camel meat</td>
<td>80</td>
</tr>
<tr>
<td>10</td>
<td>Effect of conditioning time and freezing period on physical properties of camel sausage</td>
<td>88</td>
</tr>
<tr>
<td>11</td>
<td>Effect of conditioning time and freezing period on proximate chemical composition of camel sausage</td>
<td>91</td>
</tr>
<tr>
<td>12</td>
<td>Sensory evaluation of fresh camel sausage as affected by conditioning time and freezing period</td>
<td>94</td>
</tr>
<tr>
<td>13</td>
<td>Effect of conditioning time and freezing period on microbiological parameters of camel sausage</td>
<td>97</td>
</tr>
</tbody>
</table>
### List of Figures

<table>
<thead>
<tr>
<th>Figure</th>
<th>Title</th>
<th>page</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fig. (1)</td>
<td>pH value of camel meat as affected by conditioning time and muscle type...</td>
<td>53</td>
</tr>
<tr>
<td>Fig. (2)</td>
<td>Colorimetric parameters of fresh camel meat as affected by conditioning time and muscle type...</td>
<td>57</td>
</tr>
<tr>
<td>Fig. (3)</td>
<td>Protein fractionation of fresh camel meat as affected by conditioning time and muscle type...</td>
<td>62</td>
</tr>
<tr>
<td>Fig. (4)</td>
<td>Effect of conditioning time and muscle type on water holding parameters of camel meat...</td>
<td>67</td>
</tr>
<tr>
<td>Fig. (5)</td>
<td>SDS-Polyacrylamide gel electrophoresis of myofibrillar protein extracted from Semitendinosus and Deep Pectoral muscles of one-humped camel (<em>Camelus dromedarius</em>) conditioned at 2°C for 7-days...</td>
<td>70</td>
</tr>
<tr>
<td>Fig. (6)</td>
<td>Effect of conditioning time and muscle type on sensory evaluation of camel meat...</td>
<td>75</td>
</tr>
<tr>
<td>Fig. (7)</td>
<td>Showed the effect of conditioning time and muscle type on microbiological growth on fresh camel meat...</td>
<td>81</td>
</tr>
</tbody>
</table>
Effect of conditioning time, muscle type and freezing period on quality attributes of camel meat and meat products

(Ph.D. Meat Science Thesis)
Saliha Hmmad Kafe Teya

ABSTRACT
This study was conducted in Khartoum State, Sudan. The aim was to evaluate the effect of conditioning time, muscle type and freezing period on the quality attributes of fresh camel meat and meat products. In experiment one, ten camels (Camelus dromedarius), approximately about 7 years old, were slaughtered at Alsalam slaughter house. Deep pectoral (DP) and semitendinosus (ST) muscles were dissected out from one side of the carcass. The muscles were put in crushed ice and transferred in an ice box to the Meat Laboratory, Faculty of Animal Production, University of Khartoum. Each muscle was divided into four groups and conditioned at 2°C for 1, 3, 5 and 7 days. Proximate chemical composition, colorimetric parameters, proteins fractionation, water holding parameters, protein electrophoresis with the assistance of SDS-page, sensory evaluation and microbial properties were studied. In experiment two, the same muscles were taken from left and right sides of the 7 camel’s carcasses; the muscles from the left side were processed immediately into fresh sausage and the others (from the right side) were conditioned for 5 days at 2°C then processed. The sausages were frozen for 0, 1 and 30 days. Then physical parameters, proximate chemical composition, sensory evaluation, and microbial properties were studied. Analysis of variance under complete randomized design, factorial two ways was used to analyze the data. Differences between factors and combinations of factors were compared pair wise with Duncan multiple range test, at $P = 0.05$. With assistance of SPSS program, Version 10.5.
pH values decreased significantly with increasing conditioning time, and DP muscle had lower pH value. Color L* increased and a* and b* decreased significantly with time, while ST muscle had significantly higher L* and lower a* and b*. Myofibrillar proteins extractability and non-protein-nitrogen increased, but sarcoplasmic and connective tissue proteins decreased significantly with the progress of conditioning time, and ST muscle had superior percentage over DP muscle. The disappearance of desmin and troponin-T and appearance of a band with molecular weight of 30 KDa with conditioning time indicated increased meat tenderness. The mean scores of sensory increased significantly with the progress of conditioning time, and ST muscle was superior over DP muscle. Total viable count, psychrophilic bacteria, _Pseudomonas, Listeria monocytogenes_ and _Streptococcus faecalis_ increased significantly during conditioning time, while _Staphylococcus aureus_, total coliform bacteria and _Escherichia coli_ decreased. Moreover, DP muscle had significantly greater mean counts and higher growth rates. In experiment two, sausage made from unconditioned meat had significantly (P<0.05) higher pH value, greater WHC, cooking yield and red color compared to sausage made from 5 days conditioned meat; however, these properties decreased with increasing freezing period. Microbial growth increased with the progress of conditioning time and decreased with freezing period.

It could be concluded that conditioning time and freezing period have significantly improved camel meat and meat products quality.
تأثير زمن التعقيق ونوع العضلة وفترة التجميد على الخصائص النوعية للحم الإبل ومنتجات اللحم

(أطروحة دكتوراة في علم اللحوم)
صالحة حماد كافي تية

المستخلص

أجريت هذه الدراسة بولاية الخرطوم-السودان. كان الهدف من الدراسة معرفة تأثير زمن التعقيق ونوع العضلة وفترة التجميد على الخصائص النوعية للحم الإبل الطازج ومنتجات اللحم. في التجربة الأولى ذهبت عشرة جبال عمر 7 سنوات تقريبا في مسلخ السلام. اخذت عضلات شبه الوردية والصدرية العميقة من جانب واحد للذبابة وضعمت العضلات في حافظة بها ثلج مجموش ونقلت الي معمل اللحوم بكلية الانتاج الحيواني-جامعة الخرطوم. قسمت كل عضلة الي اربع مجموعات وعنتقت في (2م) لمدة 1 و 3 و 5 و 7 أيام. اجريت تحليل للتركيب الكيميائي التقريبي وصفات اللون وتجزئة البروتينات وصفات حمل الماء والرحل الكهروباتي للبروتينات والتقييم الحسي والخصائص الميكروبية. في التجربة الثانية أخذت العضلات نفسها من الجهة اليسرى والجهة اليمنى للجمال السبعة، وصنع السجوك مباشرة من عضلات الجهة اليسرى وعنتقت العضلات من الجهة اليمنى لخمسة أيام (2م) ثم صنعت. جم السجوك لمدة صفر و واحد وثلاثين يوم. درست كل من الخصائص الفيزيائية و التركيب الكيميائي التقريبي والتقييم الحسي والخصائص الميكروبية. حلت النتائج باستخدام تحليل التباين للتصميم كامل العشوية وقررنت الفوارق بين العوامل والتفاعل بين العوامل باستخدام اختبار دانكن تحت مستوى معنوية 5% بمساعدة برنامج التحليل الإحصائي للدراسات الاجتماعية.

قيم درجة الحموضة تقل معنوي بزيادة زمن التعقيق والعضلة الصدرية العميقة لها درجة حموضة أقل. اللون الأبيض يزداد والأحمر والأصفر يقل معنوي مع الزمن، بينما العضلة شبه الوردية لها لون أبيض أعلى وأحمر وأصفر أقل. استخلاص البروتينات الليفية
والنيتروجين غير البروتيني يزداد معدناً، لكن البروتينات الساركوبلازمية وبروتينات
الأنسجة الرابطة تتناقص معدناً مع تقدم زمن التعقيبة والعضلة شبه الوترية تفو قت على
العضلة الصدرية العميقة. صفات حمل الماء تحسن معدناً بزيادة زمن التعقيبة والعضلة
شبه الوترية تفو قت معدناً على الصدرية العميقة. اختفاء بروتين الدسمين والتروبونين-تي
وظهر شريط بوزن جزئي 30 كيلو دالرون دليل على زيادة طروحة اللحم. متوسط نقاط
التقييم الحسي يزداد معدناً مع تقدم زمن التعقيبة والعضلة شبه الوترية تفو قت على
الصدرية العميقة. العد الكلي للبكتريا والبكتريا المحبة للبرودة وبكتريا السيدوموناس
واللستريا مونوسايتوجين والبكتريا العنقودية يزداد معدناً بزيادة زمن التعقيبة والبكتريا
السحية وبكتريا القولون والإ كولاي تقل معدناً بزيادة زمن التعقيبة، والعضلة الصدرية
العميقة لها عد ميكرولي أكبر ومعدلات نمو أعلى معدناً. في التجربة الثانية السجوك
المصنع من اللحم غير المعقت له درجة حموضة أعلى وقابلية حمل الماء وحاصل طهي و
لون أحمر أكبر مقارنة بالسجوك المصنع من اللحم المعقت وتقل هذه الخصائص بزيادة
فترة التجميد. النمو الميكروبي يزداد مع تقدم زمن التعقيبة ويقل مع فترة التجميد.
يمكن الاستنتاج في الختام بأن زمن التعقيبة وفترة التجميد قد أثرتا إيجابياً بتحسين
خصائص لحوم الأبل ومنتجات لحوم الأبل.
CHAPTER ONE
INTRODUCTION

Camels are one of the most fundamental resources of the national economy and food security of many countries in the world. Owing to the increasing human population and the declining productivity of arable agricultural land in Africa, there is an urgent need to develop marginal lands, such as arid land zones, and optimize their utilization through appropriate livestock production systems of which camel production is the most suitable (Farah and Fisher, 2004; Kadium et al., 2006).

Dromedary camel is a good source of meat especially in areas where the climate adversely affects the performance of other meat animals, because of it's unique physiological characteristics and high metabolic process (Elgasim & Alkanhal, 1992). The impact of environmental changes and shortage of rainfall forced many of agropastorlist in Northern Kordofan and Darfour to raise camels in place of cattle due to their ability to withstand hard conditions. The specialized morphology and the unique dexterity of the mouth parts allow the camel to browse upper storey plants. Its preferred diet is largely ignored by other animals, and camels can therefore contribute substantially to the solution of food problems, where hunger and malnutrition are prevalent (Fadlalla, 2005). Also large groups of the inhabitants of north Kordofan and Darfour migrated to the big towns searching for work and better life. These new settlements created good markets for camel meat and more consumption of camel meat will be expected.

There are about 24.2 million camels in the world, with 80% of them in Africa and the highest population in Somalia (7 million) and Sudan (4.5 million).
which represent about 18% of the world camel population (FAO, 2009). The number of camels in Sudan is expected to be more than 5.4 million in the 2025 according to the annual growth rate of (5.14%) (Faye et al., 2011). Camel meat production is increasing rapidly. This indicated that the demand for camel meat is increasing which encourage further processing of this commodity into different meat products to satisfy the consumer preference. The demand for camel meat appears to be increasing due to health reasons, as their meat is low in fat as well as has less cholesterol and relatively high polyunsaturated fatty acids than other meat animals (Elgasim & Alkanhal, 1992).

One of the major reasons today for the importance of Sudanese camel meat is the health- promoting attributes of the grass-fed livestock of Sudan. Sudanese beef, mutton and camel meat are produced from pasture grazed animals. Pastures in Sudan are not dressed with artificial fertilizer, pesticides or any chemicals, and the animals are not treated with growth promoting chemicals.

The general public perception is that, camel meat is associated with toughening and low quality characteristics compared to other red meat because their meat comes mostly from old animals that are primary kept for milk, racing, and transportation rather than for meat production (Kadium et al., 2008). So by improving the quality attribute of fresh meat and processing camel meat products we could induce some modification to enhance the consumption of camel meat and products.

The ability to optimize the production of a tender meat depends on in-depth understanding of the mechanism involving the tenderization process. It is well known that conditioning “aging” of meat improves tenderness. This improvement has been found to be influenced principally by the connective tissue and by the proteolysis of key myofibrillar protiens and other associated
proteins (Koohmaraie, 1996). Both factors have been reported to be highly influenced by the length of the ageing period (Palka, 2003) and by the studied muscle (Strandine et al., 1949).

Processing camel meat into some products induces modification using one or more procedures. These modifications contribute to preservation, convenience, appearance, palatability, variety, and safety giving consumers a wide choice of meat products. In addition they reduce the risk and cost of transportation of live animals for marketing and exportation.

Meat preservation as well as processing involves many techniques. Hot-boning of meat from the carcass before the chilling process usually involve pre-rigor meat, as well as meat that has entered the onset of rigor, (Claus & Sorheim, 2006). Widespread commercial application of hot processing under a variety of industry conditions have not been realized, even though economic benefits and high quality products can result from this technique. Hot process of meat offers several economical advantages which result from reduction of weight loss during chilling (about 1.5%), reduction of drip loss during storage of vacuum-packaged by (0.1 – 0.6%), reduction in cooler space by (50 – 55%), saving of refrigeration energy by (40 – 50%), quicker turn-over of meat at plant, reduction of capital cost for buildings, higher final yield of products, saving on labour by 20% and saving on transport cost (Pisula & Tyburcy, 1996). Hot-processing resulted in higher fat retention during cooking, higher cooking yield and more desirable pink / red color (Berry, Bigner George & Eastridge, 1999). Bentley et al., (1988) showed that, not only hot-boned meat but also hot-boned fat could increase the final yield of Luncheon loaves.

In Sudan some problems of slaughter-houses include poor waste disposal systems and environmental sanitation, lack of workers training and
understanding of the importance of sanitation (Ibrahim, 1989). During meat aging microorganisms increase gradually, since aging is always carried out at temperatures above zero °C. Fresh meat is subjected to continuous refrigeration during slaughter processing and throughout retail display. Thus, psychrotrophs are of particular importance (Nottingham, 1982).

Meat quality attribute is a generic term used to describe properties and perception of meat, the most important elements are chemical composition, the eating quality, health issues such as microbial contamination and production-related issues (Maltin et al., 2003). Despite the efforts to control and optimize the pre-slaughter environment, which has a particular impact on tenderness, there is still unacceptable variation in eating quality, suggesting that determinants of meat eating quality are multifactorial and complex. Because muscle is intrinsically a highly organized and complex structure, so that the properties of meat are likely to be determined at different levels ranging from the molecular to the mechanical (Moloney et al., 2001; Fergusson et al., 2001).

Several studies have been published concerning the physical characteristics, chemical composition, sensory properties and nutritive values of fresh camel meat, but negligible data has been published on improving quality attributes of camel meat and processed camel meat products. The objectives of the current study are:

- To investigate the effect of conditioning time and muscle type on improving the quality attributes of fresh camel meat.
- To determine the effect of conditioning overtime postmortem on proteolytic changes in muscle proteins and relate them to the differences in camel meat quality attributes.
-To determine the possibility of using hot-boned camel meat for processing into fresh camel sausage without adversely affecting product quality characteristics.
-To determine the shelf life of fresh camel meat and fresh camel sausages refrigerated (2°C) or frozen (-18°C) for different storage periods.
CHAPTER TWO
LITERATURE REVIEW

2.1 Dromedary camel (Camelus dromedrius)

2.1.1 Historical background of the dromedary camel

Camels originated 40 million years ago when the land masses were still joined. Camels that migrated south developed anatomical and physiological characteristics against the cold and lack of oxygen; these were the Ilama, aplcas, vicunas, and guanacos. Camel migrated to the cold desert of Asia developed into two-humped Bactrian Camels. Those that migrated to the arid and hot areas of North Africa became the one-humped “Dromedaries” (yagil, 1985). A specimen of camel hair rope of the old kingdom was found at Fayum in Upper Egypt dating about 2 980 - 2 475 B.C., indicated that the animal had moved south by that period. In Sudan, the oldest evidence is a bronze figure of a camel with a saddle found at Meroe and estimated to date to between 25 – 15 B.C (Addison, 1934; Robison, 1936).

2.1.2 Distribution of the one-humped camel

The dromedary is found in almost all the arid and a semi arid region of North Africa. In the western and central part of that area it ranges south to about 13º north latitude. To the east it is found in the northern Sudan, in northern Kenya almost to the equator, in Eastern Ethiopia, and (in great numbers) in Somalia. In Asia the dromedary occurs throughout the Arabian peninsula, in Syria, Lebanon, Jordan, Turkey, Iran, Iraq, Afghanistan, Pakistan, in northwestern India, in China, and in the southwestern Soviet Union, mainly Turkmenistan (Ganthere & Dagg, 1980). In Sudan the camel population is concentrated between approximately isohyets 100 and 300 mm (map 1), constituting the “camel belt”. This area includes the states of North and South-
Darfur, North and South-Kordofan, Khartoum, Gezira, Kassala, Red Sea, River-Nile, Northern Sudan, White Nile, Blue Nile and Sennar State. North Kordofan state only has the highest camel population with more than one million heads, representing approximately 5% of the whole world camel population (Faye, 2009).

2.1.3 Type of sudanese camel

- **Pack camel**: the Arab camel; found in northern Darfur and northern Kordofan states, it is a sandy-grey, large, heavily built animal with a well developed hump. A mature animal weight about 400 – 500 Kg and can carry about 275 kg over 25 – 30 km per day. The Rashaidi camel; herded mainly by the Rashida nomads of eastern Sudan, some Rashaidi camels are owned by Shukrya and Batahyn. Are pink-red in color, slightly shorter than the Arab (EL Amin, 1979).

- **Ridding camel**: Anafi camel; fastest, it has longer legs, light body weight, small hump and a long narrow head. The Bishari camel; Found in eastern Sudan, are stronger and slightly larger than the Anafi type, (EL Amin, 1979).

2.1.4 The potential of camel as meat producer

In Sudan, Southern Darfour camels have live weight between 395-465kg and dressing percentage of 51.4 in males and 47.4 in female Wilson, (1984). The dressing percentage of Sudanese male camel was 56.6kg on warm carcass and 55.8 kg on cold carcass bases. Camel carcass of 251kg average cold weight was found to be composed of 56% muscle, 19% bones, 13.7% fats and 7.5 trimming (Babiker and Yousif, 1989). Camel carcass consists of approximately 53-77% meat, 4.8% fat and 16-38% bones. 76% meat, 12% fat and 20% bones for both male and female respectively (Kurtu, 2004). Camel dressing percentage was 57.85 and 54.42 % of slaughter weight of camels fed molasses and sorghum grains based diets It molasses-based diets are
comparable to sorghum-based diets for camel meat production systems in Sudan (Isameldin et al. 2011).

2.1.5 Chemical composition of camel meat

The composition of meat can be approximated to 75% water, 19 percent protein, 3.5% of soluble non-protein substances and 2.5% fat (Lawrie, 1991). Sudanese desert camel meat had 70.60 to 79.01% moisture, 20.19% to 22.05%, protein, 2.94% to 5.8% fat and 0.84% to 1.31% ash (Saliha, 2001; Fathi El-rhmanr, 2005; Isam et al., 2006 and Dalia, 2008). Omani camels had 76.7% moisture, 18.6% protein, 1.1% fat and 1.4% ash (Kadium et al., 2006). The major fatty acids in camel meat were palmitic 26-0%, oleic 18-9% and linoleic 12-1% (Tarik N. Rawdah, 2003). Camel meat contained 27.9 Calcium, 41.0 Magnesium, 180.9 Sodium, 762.2 Potassium, 416.9 Phosphorus, 0.215 Chromium, 0.101 Nickel, 0.040 Molybdenum and 0.014 Vanadium mg/100g on dry matter basis (Al Qadi, 2007).

Since the striated muscles of mammalian body were each designed for a specific role in the living animal, it would be expected that their composition would vary, just as the great differences in their size, shape and anatomical complexity would reflect the wide range of tasks they were required to perform (Marsh, 1974). Semitendinosus is intermediate tender, while Deep pectoral is tough; tough muscle had higher moisture content than tender one, although tender muscle had great protein, fat, and ash (Smith et al., 1988).

2.2 Eating quality of meat

2.2.1 Meat colour

Muscle colour varies with species, age, sex, breed, location of muscles, their function, morphology of the muscle and post-mortem storage (Lawrie, 1991).
Map 1: Camel distribution in Sudan according to the states mainly included between the isohyets 100 and 300mm. Source (Faye et al., 2011).
Meat colour is dependent upon the quantity and oxidation states of muscle pigment myoglobin, so different between muscle types were generally significant for colour value during and after oxygenation of pigment (Matsumoto et al., 1983). The concentration of the total pigment and rate of pH fall on colour traits are factors inheritant to the type muscle (Lawrie, 1991; Guignot et al., 1992).

Lower temperature promote increased penetration of oxygen into the surface layer of the meat as well as the amount of oxygen dissolved in tissue fluids, both of which factors can assist in maintaining myoglobin and haemoglobin in their oxygenated forms (Lawrie, 1991; Warris, 2000).

A low muscle pH increased muscle protein denaturation, as a consequence, light scattering properties of the meat increase and therefore, the measured L* values increase (Pommier et al., 1990; Offer, 1991). Renerre & Bonhmme, (1991) found that, L* value increased significantly, while (a*) and (b*) values decreased not- significant during conditioning time (1, 2, 3, 4 days). Klont et al., (2000); Gonzalez, et al., (2008) stated that L* value increased significantly, while (a*) and (b*) of veal carcasses be stable or constant during ageing period of (2, 3, 4, 7 and 14 days). Chambaz et al., (2003); Vieira et al., (2006) found no effect of ageing on any of the colorimetric parameters. Nour, (2003) found that, L* increased, While a* and b* values decreased significantly during ageing period of (1, 5, 10, 15 days).

2.2.2 Juiciness of meat

The degree of shrinkage on cooking is directly correlated with loss of juiciness to the palate. Good quality meat is juicier than poor one, the difference being at least partly attributable to the higher content of intramuscular fat (Forrest et al., 2001). Morucha pure breed, the scores of juiciness increased significantly
until 10 days of ageing, where as in Charolais cross breed juiciness did not increased significantly after 7 days (Vieria et al., 2006).

2.2.3 Meat tenderness
Muscles differed in their content of collagen and elastin, as different muscles have differing proportions of epimysial, perimysial, and endomysial connective tissue, and these are characterized by differing types of collagen; so the polypeptide chains would be more or less firmly cross-linked, and affected by heat to different extent (Bendall and Resrall, 1983; Lawrie, 1991).

Artificial tenderizing, include beating, cutting, marinating with vinegar, wine or salt, ageing and enzymic tenderizing. Certain plants, fungi and bacteria produced nontoxic proteolysis an enzyme was followed by their incorporation into commercial meat tenderizer, by stimulation of muscle's own proteolytic (Catheptic) activity; induced vitamin E deficiency would enhance the activity of the lysosmal enzymes; their liberation from the containing cell particles may be increased by excess vitamin A. Sodium chloride itself, and other salts, have tenderizing action on meat, these effectives are due to an enhanced (WHC) through a concomitant rising of the pH (Bendall and Resrall, 1983).

2.2.4 Meat flavour
The pre-slaughter factors affecting the flavour include species, breed, sex, age, fatness and feed. Other factors, such as post-mortem ageing, storage and cooking procedure may also affect the final flavour (Hendrick et al.1980). An important biochemical variable arises from the changes which occur when meat is held for some time after the ultimate pH has been reached to "age" or "condition" it. During this period there is, a marked increase in high MW hydrocarbons, benzenoid components and pyrazines; changes in the free fatty acid contribute to the flavor, thus, the level of oleic acid in the intramuscular
fat L.dorsi has been increased during 21 days storage of beef at 2°C; moreover, progressive nucleotide breakdown, here by ADP and AMP are ultimately split to ribose, hypoxanthine, phosphate and ammonia may be a contributing factors (Coppok and Mc lead, 1977). Since there are systematic biochemical differences between muscles, these should have different flavours when cooked, bovine L.dorsi has a stronger flavour than Semitendinosus (Ford and Park, 1980). The delayed increase in flavour intensity is a result of the accumulation of the products, which can be considerable as flavour precursors, derived from proteolysis occur during ageing (Campo et al., 2003).

2.2.5 Meat palatability
The variation in overall acceptability between muscles cannot be attributed simply to fiber type and tenderness is clearly complex and it is likely that other variables interact with fiber type characteristics to determine eating quality (Morrison et al., 1998; Maltin et al., 2001).

2.3 Water holding parameters
2.3.1 Water-holding-capacity of meat
The power with which water is bound by the muscle proteins is of great importance for the quality of meat and meat products. Several factors influence the number of reactive groups on muscle proteins and their availability for binding water (Forrest et al., 2001). Conditioning the meat increases its WHC and this at various environmental pH values. The increases in the WHC is more likely to be caused by changes in the ion-protein relationships, there being a net increases in change through absorption of K+ ions and release of Ca++ ions (lawrie, 1991). Large excess of potassium ions on the muscle protein and the net charge onto the latter increased and, thereby, the water-holding capacity increased. This might be due to an increased
osmotic pressure, caused by the breakdown of protein molecules to small units; much intramuscular rearrangement, causing changes in the electrical charges on the protein, might also be responsible (Lawrie, 1985). The improved (W.H.C) could be due to the proteolytic degradation of cytoskeletal proteins, which had subsequently, first; caused swelling of the myofibrils and allowed the meat to retain water, second; removing inter-myofibrillar connections and thereby reduce or remove the linkage between the rigor-induced lateral shrinkage of the myofibrils and shrinkage of the whole muscle fibre (Huff-lonegran & Lonegran, 2005).

2.3.2 Drip loss and weep loss of meat
Conditioning had little effect on drip loss in camel meat (Al-Owaimer, 2002). Vieria et al., (2006) observed no significant difference of drip loss during ageing period. The percentage of drip loss decline throughout the 7 days of conditioning, the highest percentage was exhibited by the unconditioned samples and this could be explained by improvement in water-holding capacity during the conditioning (Boakye & Mittal 1993; Abdul Rahim et al., 2006). Klont et al., (2000) studied weep loss in three groups of veal carcasses selected on the basis of their pH fall and found that weep loss increased significantly within each group during the ageing period of (2, 3, 4 and 14 days). Gonzalez et al., (2008) studied weep loss in Semmitendinosus and Longissimus thoracis muscles, of beef during (1, 2, 5, 8 and 10 days) of ageing, they found that, weep loss increased during ageing period for both muscles (2.85% and 1.89% for ST and LT respectively) probably due to accentuated proteolysis, with consequent reduction of ionic stretch, after 8 ageing days (Huff-lonergan and lonergan, 2005).
2.3.3 Cooking loss of meat

Cooking loss decreased significantly during ageing period, the percentage of cooking loss differed significantly between different muscles, and the effect of conditioning on cooking loss was found to be independent of the muscle type Gonzalez et al., (2008). Al-Owaimer (2002) noted that, conditioning had little effect on cooking loss of camel meat. Vieria et al., (2006) reported no effect on cooking loss during ageing period. During cooking, the liquid comes from constitutive water and from the fat melted during heating, so the difference between muscles is attenuated (Mandell et al., 1997; King et al., 2003). Moreover cooking induces structural changes, which decrease meat (WHC), and thermal shrinkage causes loss of protein immobilizing water (Tornberg, 2005).

2.4 Meat conditioning (ageing)

In the absence of microbial spoilage, the holding of unprocessed meat above the freezing point is known as “conditioning” or “ageing”; and it has long been associated with an increase in tenderness and flavor. During the first 24-36 hr post-mortem, the dominant circumstance is post-mortem glycolysis, even before the ultimate pH has been reached, however, other degradation changes have commenced. These continue until bacterial spoilage or gross denaturation and desiccation of the proteins have made the meat inedible (Lawrie, 1991). There was strong evidence that lysosomal proteases were released during conditioning, once the muscle pH had fallen to pH 5.50. lysosomal membranes were susceptible to pH conditions with a low pH causing disruption of the membranes allowing the lysosomal enzymes to become free within the cytoplasm, a decreased pH in postmortem muscles provided conditions which were more favorable for action of lysosomal cathepsins, also allowed these enzymes to gain access to the myofibrillar
proteins (Wu et al., 1981; and Yates et al., 1983).

2.4.1. Protein denaturation

During post-mortem conditioning, the proteins of the myofibril and sarcoplasmic denature in varying degree. Immediately after death and before the onset of rigor mortis, muscles are pliable and tender when cooked. The principal proteins of myofibril, actin and myosin, are dissociated and myosin is extractable at high ionic strength. With the onset of rigor mortis the muscle becomes inextensible and is tough when cooked (Marsh, 1974). As conditioning proceed, the muscle becomes pliable once more and increasingly tender on cooking. Tenderness changes little in bovine Psoas ageing 4 days at 2°C, whereas in Semitendinosus it increases markedly during this period; it is significant that the latter has about three times the activity of Calsium activated sarcoplasmic factor (CASF) as bovine psoas, the extractability of myofibrillar protein is affected by the ultimate pH of the muscle, a high ultimate pH tending towards greater extractability (Lawrie, 1991).

The conditioning of hot boned muscle for a period of time at temperature ranging from 5-12°C has resulted in products equal or superior in their muscle properties to conventionally processed beef (Kastner, 1983). In addition, reduction in tenderness due to hot boning have been eliminated by delayed processing until 8h post-mortem. Hot boning of either Semimembranosus or Quadriceps early postmortem improved the color and stability of beef round muscles by accelerating postmortem chill rate (Seyfert et al., 2004).

2.4.2 Proteolysis

Denatured proteins are particularly liable to attack by proteolysis enzymes, leading to an increase in water-soluble nitrogen, due to the production of peptides and amino acids from protein (Lawrie, 1985). Myofibrillar protein
and non-protein-nitrogen percentage increased, but sacroplasmic protein decreased significantly during ageing periods, with varying degree between different muscles (Nour, 2003). It is well accepted that during conditioning proteolytic changes occur in the myofibrillar proteins leading to their increased fragility (Penny, 1980; Etherington, 1984).

Abdel Baki et al., (1957) observed that in camel meat during cold storage, the coagulable protein and alkali insoluble protein decreased gradually. In Longissimus dorsi and Semitendinosus muscles myofibrillar proteins were least extractable at 24h post-mortem, but their solubility was significantly higher at 168-336h than at 24h post-mortem and that sarcoplasmic protein was most extractable immediately after death and that its solubility decreased (Goll et al., 1964). In Deseret camel meat non-protein-nitrogen, was 0.56 for L.dorsi, 0.52 for Semitendinosus and 0.53 for Triceps brachii muscle with highly significant difference (P=0.01) between the three muscles (Babiker and Yousif, 1990). During conditioning the amount of water soluble nitrogen compounds increase, the rest of non-protein-nitrogen, being composed of peptides with smaller molecular mass (Warris, 2000). Non-protein-nitrogen of camel meat increased significantly during conditioning times (Saliha, 2001). The increase of non-protein- nitrogen during ageing time may be due to hydrolysis of meat proteins by the endogenous proteolytic enzymes of the muscle and those synthesized by the psychrophilic microflora of the natural contamination of meat (Ionescu et al., 2008).

Extensive proteolysis of the collagen and elastin of connective tissue might appear to be the most likely change causing increased tenderness. Collagen fibres appear to swell during conditioning, a feature which may signify that cross-links are, in fact, being broken. As tenderness increases, there is a
concomitant increase in the titre of free B-glucuronides. This enzyme can attack the mucoply saccharide of the ground substance or carbohydrate moieties in collagen itself. One of the points of attachment of carbohydrates to collagen is the amino group of lysine; and the amino glycosylamines are probably involved in binding collagen to the ground substance. It may be therefore, that splitting of both carbohydrate and peptide links contributes to increased tenderness in conditioning (Lawrie, 1985). Total collagen decreased during ageing period (2, 5, 8, and 10 days at 4°C) for both Semitendinosus and Longissimus thoracis muscles. The increase in collagen solubility during ageing was found to be highly significantly different between muscles the quantity of free hydroxyproline in beef increased 2-fold during 14-days post-mortem ageing, and only collagen could be its source (Kotczak et al., 1992; Kotczak et al., 2003; Gonzalez, et al., 2008). During ageing it takes place a limited process of proteolysis which leads to ultrastructural changes in skeletal muscle and to the improvement of meat tenderness, also a part of intramuscular collagen turns into soluble form, exo-endopeptidases of which may degrade to amino acids. Thus causing an increase in its solubility (Koohmaraie and Geesink, 2006). The changes in properties of intramuscular collagen might be responsible for an increase in spaces between adhering muscle fibres and weakening of intramuscular connective tissue (Nishimura et al., 1996; Kotczak et al., 2003). The lysosomal proteases capable of cleaving native insoluble collagen to soluble fragments are cathepsins B, L and N but little evidence is available to show the direct effect of such enzymes on collagen in conditioned meat (Lawire, 1991).

Camels are gluconeogenesis animal due to their presence of humps, so the amount of enzymes in the camel glycolytic pathway is, therefore, less than cattle causing slower glycogen degradation and pH decline (Immonen &
Puoianne, 2000); these may be linked to increased protease activity of camel meat. Camel usually transported for a long distance pre-slaughter, so it had higher level of cortisol which lead to an increases in hepatic glycogenolysis and gluconeognosis. Thus, a decrease in level of glycogen during rigor mortis was obtained which lead to a decrease in level of lactic acid and increase in pH of the meat (Saleem, 2006). Camel meat reached their ultimate pH after 48hr post-mortem, the pH values were 6.5, 6.1, 5.8, 5.7, and 5.6 for 6, 12, 24, 48, and 72hr respectively for Semitendinosus muscle (Soltanizadeh et al., 2008). Gonzalez et al., (2008) evaluated pH in two muscles (Semitendinosus and longissimus thoraces) during an ageing period of 10 days, and found that, the initial pH (ST = 5.67 vs LT =5.66) on day one, and fell faster on ST than on LT, although both reached the same value after 5days (5.58).

Myofibrillar degradation increased significantly during ageing time for both Semitendinosus muscle and longissimus thoracis with no variation between the two muscles (Gonzalez et al., 2008). The band of (MHC), due to its molecular weight was located close to the top of the gel and the part of the main protein fractions actin, myosin and a-actinin decreases during cold storage period (1 to 14 days), while the desmin band changed from 1.10% to 0.88% at (14 days) and the quantity of separated of it 38KDa fragment was significantly increased (P=0.05), there were two more bands of the myosin light chain (MLC) located in the lower part of the gel; they are MLC1 (25) and MLC2 (18KDa) are increased at the (14 days), I-troponin identified between the two MLC components, as pointed by its distance of migration increases, and the tropomyosin is visualized under T-troponin band and changes its relative part with 0.61% during the time of storage (1to14days), the amount of T-Troponin decreased for all period of storage (1, 6, 14 days)
which was related to the increase of 30KDa polypeptide during ageing., (Ho et al.,1996; Vasileva et al., 2010).

During the 10–day period of cold storage, a continuous increase in the content of 200KDa, protein was observed from 45 min, and 48, 96 and 240 h post slaughtered (14% to 16.07%). These changes indicate that, in the place of the band, which usually corresponds to myosin heavy chains (MHC), appeared also products of high-molecular protein degradation, the band 105KDa protein was not affected, which corresponds to a-actinin, the main element of the Z-disk, this observation confirms suggestion of Taylor et al., (1995), that the protein in question (105KDa) does not undergo rapid degradation. The process of degradation of proteins of the range 42-200KDa proceeded similarly to the degradation of 200KDa and some proteins constitute degradation products of higher molecular protein. Moreover, the appearance of these bands correlated ($R^2 = 0.82$) with meat tenderness on day 7 of cold storage, 43KDa corresponds to actin, within the protein of 42–200KDa it is possible to observe the desmin degradation change. In the second and fourth day of cold storage the content of products of desmin degradation increased intensively, where as the desmin band was conspicuous and disappeared only on day 10 storage. The appearance of protein below 42KDa could be associated with the proteolysis of high-molecular weight protein as well as those with lower molecular weights, such as Troponin- T The evaluation of changes in proportions of protein below 42KDa revealed a significant difference between their contents directly post-mortem at, 45 min, 48, 96, and 240 hrs (Iwanowska et al., 2010). a-actinin content does not change during ageing nor does its property of binding to F-actin. Myosin, actin, and alpha-actinin do not affect the processes of increasing of the meat tenderness (Goll et al., 1991; Koohmaraie, 1996).
Desmin is easily degraded at 4°C during ageing process. Further storage at 4°C results in an increase of proteolytic fragments and concomitant loss of intact desmin by 3 weeks postmortem, little un-degraded desmin remains in the muscle. Moreover a half of desmin of the Semitendinosus muscle was degraded between day 1 and 3 of cold storage, leading to rapid increase in meat tenderness (Hwan and Bandman, 1989; Taylor et al., 1995). Desmin is a secondary filament, surrounding the Z-disk of the myofibrils, it is located in the periphery of the Z-disk and connects the closely situated myofibrils on the level of their Z-lines, thus connecting the myofibrils with other cell structures including sarcolema (Robson, et al., 1995) and preserving the structural integrity of the muscle cells. The changes in desmin band in the muscle (L. darsi), had slow fading till 28th day of the refrigerated storage (Ho et al., 1997). The postmortem alterations of desmin due to its role location influence the tenderness of meat (Rowe et al., 2004).

The appearance of 30KDa polypeptide is an indicator of proteolysis and meat tenderness, related to Troponin-T. Troponin-T is determined as a regulatory protein without direct influence on the meat tenderization but its changes during postmortem might indirectly improve the tenderness of meat by breaking the thin filaments and the interaction between the thin and the thick filaments (Ho et al., 1994; Huff-lonergan et al., 1996; Negishi et al., 1996). There was light weakening of Troponin-T during cold storage up to 9 day at 2°C of buffalo meat (Soares et al., 1995). Tropomyosin was degraded to 33, 20 and 11KDa fragments during cold storage (Matsumato et al., 1983).

Penny, (1980) noticed the appearance of protein band with molecular masses of about 30KDa in aged meat. However, George et al., (1980) failed to find any correlation between the loss of Troponin-T and the decrease in shear force
during ageing. Parrish et al., (1981) failed to find differences in the 30KDa band between tender and tough maturity (old beef). Okitani et al., (1981) suggested that, the origin of 30KDa band is a proteolytic fragment of myosin. Koohmaraje et al., (1984) observed the appearance of a 30KDa band concomitantly with the disappearance of desmin and Troponint-T. These indicate that desmin might be the source of the 30KDa band. Regardless of the source, a parallel increase in tenderness with the increase in intensity of the 30KDa peptide has been reported by many researchers. O'Halloman et al., (1997) relate the process of meat ageing to proteolysis of troponin-T and appearance of fragments of molecular weight of 30KDa. This protein is often accepted as a good indicator of meat tenderization process.

Lowey et al., (1969); Seller and Goodson, (1995) Stated that, one-dimensional Sodium dodecyl sulphate (SDS-page) of purified skeletal muscle myosin showed three light chain bands in addition to the heavy chain band, the light chain bands were called LC1, LC2, and LC3 with decreasing molecular weight, 25KDa, 18KDa, and 16KDa respectively. They also, - claimed that, the sub fragment of heavy meromyosin, with molecular weight about 110KDa can be further split by proteolytic enzymes, into three fragments: 25 KD (terminal), 50KDa (Central) and 20KDa (terminal) fragment. Matsumato et al., (1983) demonstrated that tropomyosin was degraded to 33, 20, and 11KDa fragments.

**2.4.3 Other chemical changes**

Conditioning is organoleptically at an optimum when the hypoxanthine level has reached 1.5-2.0 moles/ g. This attained after 10-13 days at 0°C, 5 days at 10°C, and 30-40hrs at 20°C and 10-11hr at 30°C. Hypoxanthine or its precursor inosinic acid was reported to enhance flavour when added to meat.
The breakdown of protein and fat during conditioning also contributes to flavour by producing $\text{H}_2\text{s}$, ammonia, and acetaldehyde, acetone and diacetylene. Apart from increase in free amino acids arising proteolysis, their concentration is also augmented by the breakdown of various peptides (Lawrie, 1991).

2.5 Meat processing
Sausages are comminuted seasoned meat products that may be cured, smoked, shaped, and heat processed. The degree of comminuting varies widely, some sausages are very coarsely comminuted like, Salami, Pork sausage, and Summer sausage. Some are finely i.e. frankfurters and bologna (Forrest et al., 2001).

2.5.1 Types of sausage
Sausages are commonly classified based on the types of meat ingredient and processing methods used in their manufacture.
- Fresh sausages.
- Fermented sausages.
- Smoked precooked sausages.
- Emulsion type sausages comprise ready-to-eat products.
- Cooked sausages are ready-to-serve products (FAO, 1985).

2.5.2 Ingredients in sausage processing
2.5.2.1 Meat ingredient
A basic requirement for producing uniform processed meat products is proper selection and preparation of meat ingredients. Animal tissues vary widely in moisture, protein, and fat content, in pigmentation, and in the ability to bind water and fat. Thus, the processor must know the properties and composition of the various available meat tissues in order to arrive at the correct meat formulation.
2.5.2.2 Fat

Beef fat is a valuable sausage material, it requires special care, and precaution must be taken against undesirable changes of fat. It has quite particular properties, but easily becomes sour or rancid if improperly handled or if kept under improper conditions. It’s far preferable to use the beef fat as fresh as possible without freezing or storing. If, however, the fat must be stored, the storage temperature should not exceed 5°C. The amount of added fat depends on the type of sausage and on the fat content of meat used in sausage manufacturing. In general, the total content of fatty tissue should not exceed 25% (FAO, 1991).

2.5.2.3 Binders and extenders

A variety of non-meat products are incorporated into sausage. These materials are commonly referred to as extenders, binders, or fillers. They included in formulation for, improve meat batter stability, improve water binding capacity, enhance texture or flavor, reduce shrinkage during cooking, improve slicing characteristics, and reduce formulation costs. In sausage, commonly used dried milk, soybean products and cereal flours.

2.5.2.4 Ice water

Ice water is used as a carrier for the curing agents, and improves the extraction of meat protein and the hydration of meat-extender proteins. The amount of added ice water depends on the raw materials used (FAO, 1991). The added water also serves to replace water that will be lost during processing operations. Thus, by adding water, the yield of finished product can be improved (Forrest et al., 2001).

2.5.2.5 Seasonings and flavorings

Seasoning added to improve or modify flavor, salt and pepper form the basis
for sausage seasoning formulas. All other seasoning ingredients are supplementation, but are very necessary to obtain distinctive flavours associated with various products. These seasonings include spices, herbs, vegetables, sweeteners, and other ingredients, such as monosodium glutamate, that contribute to flavour enhancement (Forrest et al., 2001).

2.5.2.6 Sugar
Dextrose, or corn sugar, is best for use in sausages. Dextrose prevents fading in the finished products and does not possess the sweetening characteristic of corn sugar. The range of sugar normally used in beef sausage-making from 0.5% to 2% (FAO, 1992).

2.5.3 Forming fresh sausage
Casings are special cylindrical containers used to protect sausages and various meat products, to give them shape and hold them together during further processing.

2.5.3.1 Natural casings
These are derived almost from gastro-intestinal tracts of cattle, sheep, and goat. They are somewhat irregular, difficult to use with high speed stuffing equipment. They are very permeable to moisture and smoke; they shrink and thereby remain in close contact with the surface of a sausage as it loses moisture. Natural casings are highly contaminated with bacteria and are often preserved for later use by packing in salt or saturated salt brine (FAO, 1991).

2.5.3.2 Artificial casings
These are uniform cylindrical shape, a range of specific diameters, suitable tensile strength, resistance to damage, ease of use, variety of sizes and low microbial level. They can be filled uniformly and linked either by hand or machine into regular length. Four types of artificial casings are available:
- Cellulose casings.
- Inedible and edible collagen casings.
- Plastic tubes or bags (Forrest et al., 2001).

2.5.4 Preservation of fresh sausage

Fresh sausage should be held at temperatures no-refrigeration (for several hours), 10-15°C (for 1-2 days), 0-4°C (2-4 days), freezing about (5-7 days), if protected (1-3 months) (FAO, 1991).

2.5.5 Quality properties of processed meat

Berry et al., (1999) reported higher moisture and fat retention in Patties made from hot-processed beef. Claus and Sorheim (2006) observed lower percentage of moisture and protein and higher fat in patties made from pre-rigor beef. Thomas et al., (2008) stated that proximate analysis revealed slightly higher moisture and protein contents and a significantly higher fat percent in sausage made from hot-boned meat. The moisture content of the sausage prepared from pre-rigor meat was significantly higher (P<0.05) than those prepared from post-rigor, and the fat content was lower in sausage that made or formulated from pre-rigor meat (Dzudic and Okubanjot, 1998). The extent of lipid oxidation was not significantly different for pre-rigor and post-rigor ground salted meat samples, although salt accelerated oxidation during storage (Elizabeth et al., 1988). The increase in fat could be attributed to the better binding properties resulting from increased solubility and thus extractability of actin and myosin in hot-boned meat (Salder & Sawan, 1997). This may be expected because permanent cross bridges between actin and myosin would not have formed in hot-boned meat at the time of processing and muscle will be in a more relaxed state due to their still higher ATP level (Thomas et al., 2008). Protein, fat and ash percentage decreased significantly (p<0.05), while pH, WHC increased slightly and significantly (p<0.05) with increasing both of the level of added camel meat for making burgers and
storage period, Color co-ordinates redness (a*) and yellowness (b*) increased not significantly (p>0.05) but panel scores; tenderness, flavour, juiciness and colour increased significantly (p<0.05) with increasing level of camel meat. Redness (a) decreased and yellowness increased significantly (p<0.05) but tenderness and colour decreased, flavour and juiciness increased slightly not significantly (p>0.05) with increasing the storage period at -18°C. Lightness (L) increased (p<0.05) with increasing both level of camel meat and storage period (Ghada, 2008). Dzudi and Okubanjot (1998) stated that WHC and pH value of emulsions prepared from pre-rigor meat were significantly (P<0.05) higher than those made from post-rigor. Thomas et al., (2008) demonstrated that, sausage made from hot-boned meat had higher pH compared with those made from cold – boned. Elizabeth et al., (1988) revealed that, pre-rigor grinding and salting reduced the post-mortem pH decline and extent of meat discoloration, also produces a more stable bright red colour, which appears to be associated with a lower percentage of met-myoglobin and a higher ultimate pH in the pre-rigor salted meat. The WHC of pre-rigor mince meat deteriorated during prolonged storage (Salder & Swan, 1997). Hot–boned or pre–rigor meat known to have superior binding properties when used as raw materials in comminuted meat products. The meat must be utilized directly after deboning before the onset of rigor or alternatively be pre-salted in the pre-rigor state (Pisula & Tyburcy, 1996). Pre-rigor beef has a higher water-holding capacity (W.H.C.) and better fat-emulsifying properties than post-rigor beef, which makes it more suitable for making comminuted meat products such as sausage and patties (Salder & Swan 1997).

The use of pre-rigor meat significantly reduced cooking loss (Dzudi and Okubanhor, 1998). Thomas et al., (2008) found that hot-boned sausage
resulted in significantly higher cooking yield compared with cold-boned. Hot-boned meat generally results in higher processing yields than does cold-boned meat (Boles & Swan, 1996; Claus & Sorheim, 2006; Gariepy et al., 1994), due to its higher pH value. An increase in redness value of unconditioned processed sausage appears to be associated with its lower met-myoglobin content (Salder & Swan, 1997) due to its more intensive respiratory action (Pisula & Tyburcy, 1996). Mendenhall (1989) reported that, patties from pre-rigor ground beef had more redness but lower yellowness and lightness. Camel meat frankfurter had higher (P<0.05) colour measurement values, pH values, and lower cooking losses and aerobic bacterial count compared with beef frankfurter (Fadlalla, 2005).

Dzudi and Okubanjot (199); Thomas et al., (2008) stated that hot-boned sausage had significantly better (P<0.05) appearance on the day of processing, the bright red appearance on the day of processing, could be attributed to their lower met-myoglobin content as a result of more intensive respiratory action (Salder & Swan, 1997). Thomas et al., (2008) did not find differences in sensory characteristics of patties prepared from hot-boned and cold-boned ground beef. In addition several researchers have found no significant differences among the overall acceptability of hot and cold – processed pork (Pisula & Tyburcy, 1988; Rhee et al., 1988). Moreover Bentley et al., (1988) reported that sensory panel evaluation scores of firmness, flavour and overall desirability for Luncheon loaves exhibited no significant differences as affected by hot or cold processed meat and fat. Camel meat frankfurters had higher (P<0.05) ratings for colour, flavor, juiciness, tenderness and overall acceptability compared with that made from beef (Fadlalla, 2005). Increasing the level of camel meat from 0% level to 100% in fresh sausage formula
resulted in a significant increase of moisture percentage, Lightness (L), redness (a) and yellowness (b) values and a decrease of the fat percentage, the protein and ash content were not significantly different among the treatments, Cooking loss percentage decreased significantly. Increasing the storage period from day one to day 14 at -18°C resulted in a significant improvement of the WHC, increase of the pH, oxidative rancidity values and colour co-ordinates yellowness (b). Cooking loss, drip loss and colour co-ordinates lightness (L) decreased significantly while shrinkage and redness (a) decreased not significantly, Sensory panel rating of tenderness, juiciness and acceptability increased not significantly with increasing the added level of camel meat and aging period. Colour and flavour were more desirable at day 1 and day 7 than at day 14. The 100% camel meat sample had higher scores than the control which showed the lowest panel score. Thus camel meat affects positively the processing characteristics and quality of fresh sausage (Mahassin, 2009).

2.6 Microbiology of meat and meat products

The muscle of healthy animals is considered to be free of bacteria or other contaminations. Contamination mostly came during the, slaughtering, cutting, processing, storage, and distribution of meat. Other potential sources are equipments, clothes, and hand of personnel, air, water, etc. Total microbial load and presence of specific pathogens are important factors in determining shelf life and safety of meat (Forrest et al., 2001). The mean total viable count of fresh meat grade I (satisfactory) should be less than $5 \times 10^5$ cfu/g, grade II (passable) $5 \times 10^5$ cfu/g, while grade III (unsatisfactory) $10 \times 10^6$ cfu/g, or more, deteriorative meat should had more than $10^5$/g total viable count (ICMSF, 1980; Banwart, 1989).
2.6.1 Factors affecting microbial activity in meat.
Temperature, moisture, oxygen, acidity, redox potential, other nutrients and interactions. At temperatures near growth minima or maxima, microorganisms generally become more sensitive to $a_w$, oxygen availability, and pH. Under anaerobic conditions, e.g., facultative bacteria may require higher pH, $a_w$, and temperature for growth than when aerobic conditions prevail. In fact, psychrophilic microorganisms usually are aerobic and generally have high Aw requirements. Consequently, lowering Aw or excluding oxygen from meat held at low temperatures rates of microbial spoilage (Forrest et al., 2001).

2.6.2 Microbial growth during conditioning period
The effect of chilling on the microflora in a particular food will depend on the temperature characteristics of the organism as well as the temperature and the time of storage. Higher temperature of storage which may enhance aging and rapid increase of tenderness could not be used under normal conditions because of the expected microbial decomposition (Sokolov et al., 1960). Chilled beef prepared in a semi-tropical climate had a longer storage life under chilled conditions than did similar beef from cooler areas (ICMSF, 1980). Storage in polyethylene bags improved the hygienic condition during storage which may extend the shelf life of meat; it also aids to raise the temperature of storage which accelerates aging without marked microbial decomposition. Total bacteria count of camel meat stored at 4°C for 2 days was $110.0 \times 10^3$/gm, and $11.30 \times 10^5$/gm at day 14 (Foda et al., 1976; 1978). Aerobic bacteria in fresh refrigerated meat increased with progress of storage time (Hussein, 1987; Abdel Karium, 1992). Bacterial numbers at different sites on the same carcass differ significantly (Robert, 1980). Total aerobic count of beef retail cuts (from chuck and rump) stored for 0, 2 and 4 days at 5°C was
highest, followed by the psychrotrophs, the pseudomondaecae, the increase in total viable mean counts were significantly different throughout storage time, for chuck, the count were 5.5, 6.6 and 8.9 at day 0, 2, and 4 respectively, for rump steak were 6.1, 6.5 and 8.4 at day 0, 2, and 4 respectively with no significant variation between the two cuts (Nortje et al., 1989b). Total bacteria count of minced meat increased with highly significant differences during refrigeration storage at (4±2°C), the mean total bacteria count cfu/g was 1.78×10^5, 3.98×10^6 and 3.16×10^8 for 1, 5 and 10 days of storage respectively (Mona, 2000). Aerobic bacteria count of fresh meat obtained from Omdurman central slaughter-house was 7.8×10^7 cfu/g, samples collected from Khartoum North retail meat market had 2.2×10^8 cfu/g, and samples from Hilat-Kuku retail meat market had 1×10^8 cfu/g at day zero (Mervat, 2003). Total viable count of beef increased significantly with the increase in refrigeration storage period, the total means counted were 6.5, 6.8, 7.1 and 7.4 for 0, 3, 7 and 10 days respectively, (the counts were taken as (counted as log_{10} cfu/g) (Nazik, 2007). Fresh camel meat under refrigeration temperature (3±1°C) had about 5.58, 5.96, 6.90 as aerobic plate count on day 0, 3, and 6 respectively, and the meat spoiled by day 9 (Fallah et al., 2008).

Regarding psychrotrophic bacteria, since fresh meat was subjected to continuous refrigeration during slaughter processing and throughout retail display, spoilage organisms must be able to survive and grow at low temperature. Therefore, psychrotrophs are of particular importance. Psychrotrophic bacteria which include potential spoilage organisms of chilled meat were common in soil, water and vegetation (Duree and Thomas, 1970). It is some what surprising to find, therefore, that after storage at chill temperatures the meat bacteria populations are all dominated by Gram-
negative bacteria, particularly the psychrotrophic types (Gill, 1980). Psychrotrophs counts increased significantly with increasing storage time, there were about $4.11 \times 10^3$, $5.25 \times 10^3$ and $7.11 \times 10^3$ for chuck cut at day 0, 2 and 4 respectively, and counted $4.17 \times 10^3$, $4.96 \times 10^3$ and $6.23 \times 10^3$ respectively for rump steak, with significant variation between the two studied cuts (Nortje et al., 1989a). Psychrophiles growth increased significantly during refrigeration storage, the mean psychrophiles count were $1.54 \times 10^4$, $3.16 \times 10^5$ and $3.12 \times 10^6$ for day 1, 5 and 10 respectively (Mona, 2000). Bohaychuk and Greer (2003), showed an increased number of psychrotrophic in boneless pork loins during a 35 day storage periods. Psychrotrophics counts increased progressively with storage period, the means count were $2.6 \times 10^3$, $3.3 \times 10^3$, $3.7 \times 10^3$ and $4.7 \times 10^3$ at day 0, 3, 7 and 10 respectively (Nazik, 2007). Fallah et al., (2008), found about $4.81$, $5.11$, $6.01$, the mean counts of psychrophilic bacteria on day 0, 3, and 6 respectively, (counted as log$_{10}$ cfu/g).

Pseudomonas spp. has a marked advantage in growth rates as compared with other genera under aerobic conditions. Furthermore, this advantage tends to increase with decreasing temperatures. The Pseudomonas species were reported as frequent contaminant of fresh meat and incriminate in the spoilage of meat under aerobic conditions (Newton and Gill, 1980). At chill temperature under aerobic conditions, the spoilage flora of meat is dominated by Pseudomonas, the organisms attach glucose initially and amino acids subsequently (INCMSF, 1980; Lawrie, 1985). Both storage time, and meat cuts had highly significant effect on Pseudomonadaceae count. The mean Pseudomonadaceae count was $3.68 \times 10^3$, $4.27 \times 10^3$ and $5.02 \times 10^3$ at day 0, 2 and 4 for chuck cut, although rump steak recorded $4.33 \times 10^3$, $4.67 \times 10^3$ and $6.05 \times 10^3$ at the same periods respectively (Nortje et al., 1989a). Pseudomonas
species are widely distributed in nature, in soil and water and because of its wide occurrence it is a frequent contaminant (Monica, 2000). *Pseudomonas spp* in camel meat increased significantly (*P*=0.05) with increasing storage period at refrigeration temperature, they found about, log\(_{10}\) cfu/g 3.33, 5.86, and 8.08 for day 0, 3, 6, and spoiled at day 9 respectively (Fallah et al., 2008).

*Listeria monocytogene* was isolated from fresh and frozen meat and from cow’s fecal, this bacterium causes meningitis and septicemia mainly in the neonates, pregnant women and the immunosuppressed persons. Listeria is widely distributed in nature, found in soils, animal feces, silage and water. As a result of it's wide spread in the environment, it is able to survive to long periods of time under adverse conditions; and has ability to grow at refrigeration temperature. It is now recognizes as an important food-borne pathogen ((Skovgaard and Morgen, 1988; Wagner and Jr., 2000). The common source of the infection is contaminated meat (Monica, 2000). Fallaha et al., (2008), studied the microbial growth on camel meat at (3±1°C), demonstrated that, the mean log\(_{10}\) *Listeria monocytogenes* increased significantly during storage time, 3.91, 4.30, 4.81, for day 0, 3, 6, respectively, and the meat spoiled at day 9. The growth and survival of *Listeria monocytogenes* of camel meat storage at 4°C for 10days increased significantly, 3.02, 3.90, 4.27, 4.80 and 5.74 for day 1, 3, 5, 7, and 10 day respectively (Elmalti and Amarouch, 2008).

Bently et al., (1987); Husssein (1987); Kotula et al., (1987) reported that the microbial load of different types of meat and meat products during refrigeration storage increase frequently with progress in refrigeration time. *Streptococcus faecalis*, is the main pathogen in the genus Enterococcus, causing
about 95% of enterococcal infections (Monica, 2000). *Streptococcus faecalis* growth increased significantly during refrigeration storage, the mean *Streptococcus fecalis*. MPN/g was 211, 1430, and 3370 for day 1, 5 and 10 days respectively (Mona, 2000). Nasr, (2003) isolated Streptococci from nasal cavity, trachea lung tissue and bronchial lymph nodes of the one-humped camel slaughtered in Khartoum State.

Staphylococcus exists in air, dust, water and food or on food equipment, environmental surface, human and animal. Staphylococci in raw meat may originate from handlers; the main source of meat contamination (Duerden *et al.*, 1992; Wagner and Jr, 2000). Abdel Karium, (1992) who studied spoilage bacteria of beef during refrigeration storage, found that, the Staphylococci count decreased with increasing times. Selma, (2000), isolated Staphylococci from intestinal tract of one-humped camel. *Staphylococcus aureus* increased significantly during refrigeration storage at (4±2°C), the mean *Staphylococcus aureus* count was 1.58×10², 2.13×10² and 2.88×10² for day 1, 5 and 10 respectively (Mona, 2000). Nasr, (2003), isolated Staphylococci from nasal cavity, trachea, lung tissue and bronchial lymph nodes of the one-humped camel. Fallah et al., (2008) who studied the microbial properties of camel meat stored at (3±1°C) for 9 days, recorded about 3.80, 4.01, 4.44 for day 0, 3, 6, respectively and the meat spoiled at day 9.

Positive reaction in fecal coliform test may indicate fecal contamination (Fishbein *et al.*, 1976). Anil *et al.*, (1995) studied the microbiological quality of sausage during 1, 3, 7, and 14 and 21 days at refrigeration storage, they found that the total number of microorganisms increased significantly, but coliform bacteria decreased. Total coliform increased significantly during refrigeration storage, the mean coliform counts were 392 MPN/g, 1531 MPN
g and 7042 MPN/g for day 1, 5 and 10 respectively (Mona, 2000). Nazik, (2007) studied total coliform in beef meat, found that, the total coliform increased significantly with increased refrigeration storage time, the mean total coliform counts were 2.4 MPN/g, 2.8 MPN/g, 4.8 MPN/g and 11.20 MPN/g at 0, 3, 7 and 10 days respectively. Fallah et al., (2008) studied the total coliform bacteria in camel meat stored at (3±1°C) for 9 days, they recorded about, 3.61, 4.23, 5.11, for day 0, 3, 6, and the meat spoiled at day 9 (the means taken as log cfu/g).

Fatima, (1985) reported that, the most frequent coliform bacteria present in meat was Escherichia coli. The organisms derived from infected personnel or healthy carriers include E. coli, Staphylococcus aureus, Streptococcus spp and Colistridium spp (Lawrie, 1991). E. coli was an important and common human enteric pathogen which causes diarrhea and haemorrhagic colitis (Mansour, Linda and Dalia, (1993). Pathogenic bacteria, such as E. coli and Lestreia monocytogenes, are commonly found in fresh meats and represent a safety hazard when under cooked meats, are consumed (Gants, 1996). E. coli is an indicator bacteria of fecal contamination, Entero pathogenic E. coli is a significant cause of diarrhea in developing countries and localities of poor sanitation (Wagner and Jr., 2000). Nasr, (2003) isolated E. coli from nasal cavity, trachea lung tissue and bronchial lymph nodes of the one-humped camel. Nazik, (2007) recorded the mean count of E. coli on refrigerated beef as 0.20 MPN/g, 0.29 MPN/g, 0.45 MPN/g and 0.65 MPN/g at day 0, 3, 7 and 10 respectively. Fallah et al., (2008) stated that Escherichia coli were detected in all samples of camel meat during 6 days at cold storage (3±1°C).

Salmonella is found in soil, water, animals, wild birds, insects, flies, processing equipment feed and intestinal tract of human and animals
Mohamed (1990) showed no presence of *Salmonella spp* during refrigeration storage of processed meat. Abdel Karium (1992) reported that Salmonella was isolated at the rate of 6.2%, 2.7% from beef samples refrigerated for 7 and 10 days respectively. The gastrointestinal tracts of animal and man are common sources of Salmonella while high protein foods such as meat and meat products are most frequently associated with Salmonella food poisoning (Monica, 2000 Wanger and Jr., 2000). Mona, (2000) showed, the presence of *Salmonella spp* was 14.25% at 1 and 10 days of minced meat at refrigeration storage. Nazik, (2007) observed that, *Salmonella spp* was not detected throughout any refrigerated storage period tested, (0, 1, 3, 7, and 10 days). Elmalti and Amarouch, (2008) stated that, Salmonella was found only at day zero, it was *Salmonella dubolin* at refrigeration storage of camel meat (3±1°C).

Borgstrom, (1955) reported that, cells which were still viable immediately after freezing died gradually on storage in the frozen state. Woodburn and Strong, (1960) observed a significant decrease in number of viable bacterial cells stored at -11°C and -30°C over ten weeks period. Woodburn and Strong (1960) reported that at -30°C, the viable numbers of *S. aureus* and *Strep. Faecalis* did not decrease significantly after 10-weeks of frozen storage. Ann Ma-lin and Becuat (1980) reported that, cells of bacteria which had been exposed to temperature of 2°C for periods of time as short as 30 minutes, showed signs of damage and death rate of approximately 50% when frozen, despite the great benefit of freezing to food industries, a number of workers had observed that many pathogenic bacteria survived prolonged storage in various kinds of frozen foods.
CHAPTER THREE
MATERIALS AND METHODS

3.1 Experiment one

3.1.1 Source of meat

10-male (about 7 years old) one-humped camels (Camelus dromedarius), were slaughtered at Alsalam slaughter house. Animals were slaughtered and dressed following Muslim (Halal) practice. Muscles Semitendinosus (ST) and Deep pectoral (DP) were removed from the left side of each carcass within 3hrs post-slaughter, collected in plastic bags and transported in an insulated ice box to the Meat laboratory, Faculty of Animal Production, University Khartoum.

3.1.2 Sample preparation

Samples were arranged into four groups, and each group was conditioned at 2°C for 1, 3, 5 and 7 days. Following conditioning each portion was further divided into sub-portions for objective, subjective and microbiological evaluations; as described below, (all measured parameters were done on the conditioned sample except proximate chemical composition). The experiment was replicated ten times.

3.1.3 Objective measurements

3.1.3.1 pH determination

pH was determined at 4, 6, 8, 10, 12, 24, 72, 120, and 168 hrs post-mortem. 1 gram of minced meat was homogenized with 10 ml distilled water, and a laboratory pH meter (adjusted with buffer, 7.0 at room temperature) was used to read muscle pH (AOAC, 1984).
3.1.3.2 Proximate chemical analysis
Unconditioned samples were used, the proximate chemical composition of the muscle tissue was determined according to the standard methods of AOAC, (2000). Moisture content was determined by drying the sample for 24 hour at 105°C. Protein was determined using Kjeldahl. Fat was determined by Soxhlet extraction using petroleum ether. Ash content was determined by ashing samples in a muffle furnace at 500°C for 24h.

3.1.3.3 Protein fractionation
Protein fractionation was determined according to procedure of Babiker and Lawrie, (1983). Sample for protein fractionation was trimmed of excessive subcutaneous connective tissue before mincing. The ratio of muscle tissue to extractant solution was 1:10(W/V). All fraction procedures were carried at 4°C. A 5g sample was weighed, put into a micro-blender jar maintained in an ice-bath and 50 ml of cold 0.025M potassium phosphate buffer (pH 7.2) was added. The contents of the micro jar were blended at full speed for 1minute and at low speed for 5minutes. After homogenization, the homogenate was transferred to 100ml capped centrifuge tube and centrifuged for 20 minutes (35000g at 4°C). The supernatant was kept and the residue was resuspended in another 50ml of the same potassium phosphate buffer, homogenized and centrifuged as before. Supernatant was decanted and the solution obtained was filtrated through filter paper (Whatman No.4) to remove fat and other particulate material not removed by centrifugation. The filtrate contained both sarcoplasmic protein and non-protein-nitrogen fractions. The protein concentrated in the supernatant was determined by Biuret method (Babiker and Lawrie, 1983). The result was expressed as a percentage of fresh meat weight. From the combined filtrate (containing both sarcoplasmic protein and
non-protein-nitrogen fractions) 30ml sample was taken and homogenized with 10ml of trichloroacetic acid 20% (W/V, for 15 minutes and filtered through filter paper (What man No. 1 to obtain non-protein-nitrogen in the filtrate. Kildehal method was used to determine the nitrogen content of this fraction, according to the method (AOAC, 1990). The filtrate free of proteins was mineralized, with concentrated sulfuric acid in presence of catalysts; the content of nitrogen was determined from mineralized sample after dilution and alkalization by the micro-kjeldahl method, non-protein-nitrogen content expressed as a percentage of fresh sample weight. For myofibrillar protein, the residue remaining from the extraction with phosphate buffer (pH 7.4) using the same method of sarcoplasmic protein, extraction after centrifugation action for 20 minutes, the supernatant, was filtrated through glass wool and the filtrate was used for myofibrillar proteins determination by Biuret method. Bovine serum albumin was used as standard for making the calibration curve for both sarcoplamic and myofibrillar proteins. The result was expressed as a percentage of fresh meat weight.

Connective tissue protein, calculated by subtraction, the equation was, Connective tissue = total protein-(myofibrillar protein+ sarcoplasmic protein+ non-protein-nitrogen).

3.1.3.4 Color measurements

Color measurements were performed on conditioned samples, Hunterlab Tristumuls colorimeter model D25 M-2 was used. Hunter color components lightness (L*), redness (a*) and yellowness (b*) were recorded.
3.1.3.5 Water parameters

3.1.3.5.1 Water-holding-capacity
A 0.5gm fresh minced meat (duplicate samples) were placed on humidified filter paper whatman No.4 in a desiccator over saturated KCl solution and pressed between two plexiglass plates for two minutes at 25 kg load. The meat film area was traced with a ball pen and the filter paper was dried. Meat and moisture areas were measured with a compensating planometer. The resulting area covered by the moisture was divided by meat film area to give a ratio expressed as water-holding-capacity of meat. A large ratio indicates an increase in the watery condition of the muscle or a decrease in the water-holding-capacity (Grau and Hamm, 1953; Briskey et al., 1959).

\[
\text{Water-holding-capacity} = \frac{\text{moisture film area} - \text{meat film area}}{\text{meat film area}} \times 100\%
\]

3.1.3.5.2 Cooking loss
Weighed meat sample was put into plastic bag and cooked in water bath at 90°C for 1.5 hrs. The cooked sample was cooled in running cold water and weighed. The cooking loss percentage was determined as the difference in weight of the sample before and after cooking and was expressed as a percentage of the meat weight before cooking (Bouton and Harris, 1978).

\[
\text{Cooking loss} = \frac{\text{weight before cooking} - \text{weight after cooking}}{\text{weight before cooking}} \times 100\%
\]

3.1.3.5.3 Drip loss
Meat sample about 2 x 2 x 7cm was cut, dried by paper towel, weighed and frozen at -20°C (over five days). It was then thawed at 2+1°C for 50 hrs. Excess exudates were removed by paper towel and sample was reweighed. The difference in weight before and after freezing and thawing was taken as
drip loss and expressed as percentage of weight before freezing (Babiker, 1981).

Drip loss = \frac{\text{weight before freezing} - \text{weight after freezing and thawing}}{\text{Weight before freezing}} \times 100\%

3.1.3.5.4 Weep measurement
Sample was dried by paper towel and weighed before ageing. After the completion of each ageing period, it was dried and reweighed. The difference between the initial and final weights was expressed as a percentage of the initial weight and considered as weep loss percentage (Follet et. al., 1974).

Weep loss = \frac{\text{weight before ageing} - \text{weight after ageing}}{\text{Weight before ageing}} \times 100\%

3.1.3.6 Electrophoresis
Electrophoresis was conducted on slab gels according to the procedure of Laemmli (1970).

3.1.3.6.1 Gel preparation
12 cm gels were prepared in glass rectangular plates (15 cm total length) with an inside diameter of 1.5 mm. The stacking gel length was 3-4 cm, and resolving gel (running) about 11-12 cm.

3.1.3.6.2 Preparation of the 12.5% running gel (Separating gel)
The resolving gel contained (4.2 ml Acrylamide, 3.1 ml Dist. H₂O, 2.5 ml Resolving buffer’ “18-15 gm Tris-oH of (1.5 M Tris-oH), 80 ml dist-H₂O adjustal pH to 8.3 then completed to 50 ml”, 100 µL 10% SDS, 10 µL TEMED, 100 µL APS “0.01 gram APS + 100 µ Dist. H₂O”). Then immediately poured these contents between the two plates and converted with methanol and left for 1hr. at room temperature. Then the methanol was removed with the help of tissue paper.
3.1.3.6.3 Preparation of 4% stacking gel
Approximately 3-4 cm of stacking gel solution (1.3ml Acrylamide, 4.0 ml Dist. H$_2$O, 2.5 ml staking buffer “3 gm of Tris-Hcl of (0.5M Tris-Gs, 40 ml dist. H$_2$O adjusted pH to 6.8 then completed to 50 ml”, 100 µL 10% SDS, 10 µL TEMED, and 100 µL APS 0.02 gm APS in 100 µL Dist H$_2$O). Then left for 1hr. at room temperature.

3.1.3.6.4 Loading of samples on gels
10-20µL of homogenous myofibrillar protein samples + 10 µL of loading buffer (1ml Dist H$_2$O, 1ml 0.05M Tris-OH pH8-4”, 0.8ml Glycerol 1.6ml 10% SDS, 0.1ml 2-mercaptothanol, and 0.2ml 0.05% bromophenol blue ), boiled for 1 minute in boiling water bath and applied 20 µL of the sample in the well of the staking gel.

3.1.3.6.5 Separation the samples
Electrophoresis was performed with a current of 80 mA for about 1- 2 hrs.

3.1.3.6.6 Staining the gel
The gel was removed and put in the stain solution overnight, the staining solution contains 23ml Glacial acetic acid, 114ml Methanol, completed to 250 ml Dist.H$_2$O, and 0.63 gm stain powder (Commassie Brilliant Blue).

3.1.3.6.7 De-staining the gel
The gel was destained until clear bands were seen, using (Glacial acetic acid 10 ml, Methanol 80 ml, and Dist.H$_2$O 100ml).

3.1.3.6.8 Molecular weight determination
The Unstained Protein Molecular Weight Marker was used (it is a mixture of 7 purified proteins that resolve into sharp bands in the range of 14.4KDa to 116.0KDa when analyzed by SDS-PAGE and stained with Coomassie Beilliant Blue R-250). Determination of molecular weight was carried out considering the linear relationship between log molecular weight vs. RF. The
RF of particular band was calculated by dividing the distance of its migration by the length of the gel. The RF value standards and their logarithmic molecular weights were calculated and plotted in a graph from which the molecular weights of the various protein components were determined (Shapiro et al., 1967).

3.1.4 Subjective measurement (Sensory evaluation)

Sensory panel evaluation was conducted with a 10-member semi-trained panel as described by Parrish et al., (1973). The frozen camel meat samples were thawed at 4°C overnight, wrapped in aluminum foil and roasted in an electric oven at 175°C to an internal temperature of 75°C without salt or spices, for 45 minutes (Griffin et al., 1985). Every sample was cut into 2 cm² and served hot (60°C approx.). The samples were presented simultaneously in a compartmented plate. The order of presentation was varied and the panel members did not know anything about experimental protocol or sample codification. In test room, panelists assessed eight samples. Parameters measured included colour, tenderness, juiciness, flavour and overall acceptability according to (AMSA, 1980). The scores used ranged from 8 to 1 basis on hedonic scale (8 being extremely desirable for colour, extremely tender, extremely intense for flavor, extremely juicy and extremely acceptable while 1 being extremely undesirable, extremely tough, extremely bland and extremely dry respectively. The average of 10 panelist values was used as the colour, tenderness; flavor, juiciness and acceptability score for each sample.

3.1.5 Microbiology evaluation

Minced meat was dissolved in sterile peptone water. Ten grams of each sample were weighed and added to a conical flask containing 90 ml sterile 0.1
peptone water and was shaken for 45 minutes using electric shaker at speed 150 RPM to release any microorganisms. This dilution is the mother solution (dilution $10^{-1}$), one ml of mother solution was pipetted aseptically, with sterilized pipetted into 9 ml sterile peptone water (dilution $10^{-2}$) and serial decimal dilutions to $10^{-6}$ were prepared as described by (Harrigan, 1998).

3.1.5.1 Determination of microbial load
Plate count agar was dried in the incubator for adequate time to prevent a drop of fluid from running over the surface of the plate. A drop of each dilution was deposited by calibrated dropping pipette onto the surface of the dried nutrient agar in duplicating manner. The volume of the drop was 0.02 ml and allowed to fall from a height of 2.5 cm onto the surface of medium, where it was spread over an area of about 1.5-2.0cm diameter, and then the plates were incubated at 37°C for 24 hours. The colonies was counted in the duplicate dilution, then the average number of colonies was calculated and multiplied by dilution to give the number of colonies forming unit per ml for aerobic bacteria and, according to (Harrigan, 1998).

3.1.5.2 Psychrophiles counting
0.1 ml from suitable dilution was streaked in readily poured and dried plate count agar; the plates were incubated at 5°C for 7-10 days. A colony counter was used for counting psychrophilic bacteria (Harrigan, 1998).

3.1.5.3 Pseudomonas spp Determination
Cephaloridine-fucidin-cetrimide agar (CFCA) was used. Prepoured predried of CFCA with 0.1ml amount of dilution, Spreaded with a sterile glass spreader. Incubated at 5°C for 48hrs. Colonies producing yellow-green fluorescent pigment can be assumed to be pseudomonas. Other Pseudomonas species will produce smooth translucent white or cream colonies.
3.1.5.4 Determination of *Listeria monocytogenes*

L. monocytogenes counted using Half Fraser broth as secondary enrichment medium. This secondary enrichment medium subcultured on to Oxford agar and Polymyxin-Acrlavine-Lithium chloride-ceftazindime Aesculin Mannitol (PALCAM).

To 225ml of $10^{-1}$ dilution in Fraser broth base, 2.25ml of a sterile solution of Lithium chloride was added, 0.23ml of a sterile solution of nalidixic acid, and 1.12ml of a sterile solution of acriflavine, and 2.25ml of a sterile solution of ammonium iron citrate. Mixed to form the primary enrichment in Half Fraser broth. Incubate at 30°C for 24hrs. A loopful of the primary enrichment culture was streaked on to a plate of Oxford agar and another loopful on to a plate of PALCAM agar. The plates were incubated at 35°C for 48hrs (the Oxford agar plates aerobically, and the PALCAH agar plates under the micro aerobic condition). Then transferred 0.1ml of the primary enrichment broth to a tube containing 10ml of Fraser broth to give a secondary enrichment. Incubated at 37°C for 48hrs. The secondary enrichment medium was used to repeat the plating step as described above. Oxford agar for the selective isolation of *Listeria monocytogenes*. Colonies of Listeria on oxford agar are 2-3mm in diameter with dark brown or black haloes. (Due to aesculin hydrolysis) the colonies often have sunken centres. Colonies of Listeria on PALCAH agar are 1.5-2mm in diameter, green and have black haloes (they may have black centres).

3.1.5.5 Determination of *Streptococcus faecalis*

Triplicates with 9 ml azide dextrose broth one ml of suitable dilution were added. The tubes were incubated at 35°C for 48 hrs and examined for turbidty. For confirmation of faecal streptococcus, esculin azide was used. Counting as most probable number (MPN/g).
3.1.5.6 Determination of *Staphylococcus aureus*

From suitable dilution (mother dilution $10^{-1}$), 0.1 ml was spreaded on solidified Staphylococcus No. 110 medium and the plates were incubated at 37°C for 24 hrs. Counting was expressed as (cfu/g).

3.1.5.7 Determination of total coliform bacteria

For presermitive test one ml of each the three first dilutions ($10^{-1}$, $10^{-2}$, and $10^{-3}$) was inoculated aseptically in triplicates of 9 ml sterilized Mac Conkey broth used the three – tubes technique with Durham tubes. The tubes were incubated at 37°C for 48 hrs. Positive tube gave gas in the Durham tube. All tubes of the dilution showed gas fermentation in 24 hrs, were submitted to confirm test used brilliant green bile lactose broth fermentation tubes with Durham tubes, and then incubated at 37°C for 48 hrs. The most probable number (MPN) was recorded. The most probable number (MPN) tables were used according to FAO (1992).

3.1.5.8 Determination of *Escherichia coli*

3 loopfuls of each confirmed positive tube were subcultured into EC broth medium and then incubated at 44.5°C for 24hrs. Tubes showed any amount of gas production was considered positive. The most probable number was recorded.

3.1.5.9 Determination of *Salmonella spp*

10ml of sample was and mixed well with 90ml sterile nutrient broth. This was incubated at 37°C for 24hrs. Then 1ml was drawn aspectively and added to 10ml of selenite cystine broth. The broth was incubated at 37°C for 24hrs. Then Bismuth sulphite agar plates were used. The plates were incubated at 37°C for 72hrs. Black metallic sheen colonies indicated the presence of Salmonella.
3.2 Experiment two

3.2.1 Sample methodology
Meat was obtained from Semitendinosus and Deep pectoral muscles from seven carcasses of one–humped camels (*Camelus dromadarius*). Meat from left side was processed immediately, and the other was conditioned at 2°C for 5 days, and then processed. Hump was used as source of fat.

3.2.2 Processing of fresh sausage
Fresh sausage was prepared according to the procedure of (FAO, 1991); muscles were reduced in size by passing them through meat grinder. Then bowl cutter was used to mix the minced meat, fat, ice water and functional ingredients (Salt, seasonings, and additives) were added (the ingredients were taken as a recipe of Kramlish, et al., (1973), table (1). The product was then filled out in natural casings (sheep casings were used), packed in polyethylene bags, and then conveyed to storage at (-18°C) up to 30 days.

3.2.3 Measured parameters

3.2.3.1 pH measurement, as in (3.1.2.1).

3.2.3.2 Water-holding-capacity determination, as in (3.1.2.5.1).

3.2.3.3 Color co-ordinate measurement, as in (3.1.2.4).

3.2.3.4 Cooking yield
The weight of sausage piece was recorded before and after cooking and the cooking yield was calculated, as:

\[
\text{Cooking yield} = \frac{\text{Weight of cooked sausage}}{\text{Weight of raw sausage}} \times 100\% 
\]


3.2.3.5 Proximate chemical analysis
Moisture content, fat, protein and ash of fresh raw sausage were determined by standard procedures (AOAC, 2000).
3.2.3.6 Microbiological properties
Total viable count, psychrophilic bacteria *Staphalococcus aureus*, Total coliform, and *E. coli*, determined as in (3.1.4).

3.2.3.7 Sensory evaluation
Sensorial traits were measured as (Parrish et al., 1973), as in (3.1.3).

3.3 Statistical analysis
The experiments were carried as factorial two ways with ten and seven replicates in experiment one and experiment two respectively. The obtained data were then subjected to analysis of variance under complete randomised design, following the method of analysis described by Steel & Torris (1981), the means were compared using the Duncan Multiple Range Test (DMRT). The data of proximate chemical analysis in experiment one was analysed using the method of student’s T-test (Steel & Torris, 1981). SPSS program version 15 was used.
<table>
<thead>
<tr>
<th>Ingredient</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lean camel meat</td>
<td>80</td>
</tr>
<tr>
<td>Hump fat</td>
<td>10</td>
</tr>
<tr>
<td>Bread crumbs</td>
<td>3</td>
</tr>
<tr>
<td>Ice water</td>
<td>3</td>
</tr>
<tr>
<td>Salt</td>
<td>2</td>
</tr>
<tr>
<td>Mixed spices</td>
<td>1.4</td>
</tr>
<tr>
<td>Sugar</td>
<td>0.5</td>
</tr>
<tr>
<td>Fresh garlic</td>
<td>0.1</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>100</strong></td>
</tr>
</tbody>
</table>
CHAPTER FOUR
RESULTS

4.1 Proximate chemical composition of Semitendiousus (ST) and Deep Pectoral (DP) muscles from one-humped camel (Camelus dromedarius)

Table (2) showed that, moisture, protein and fat content differed significantly (P=0.01) between the two studied muscles. While the ash content was not-significantly (P>0.5) different although it was slightly higher in ST muscle. The DP muscle had higher moisture, lower protein and fat than the ST muscle.

4.2 Effect of conditioning time and muscle type on quality attributes of fresh camel meat

4.2.1 pH value

Table (3) showed that, there were highly significant (P=0.01) differences between conditioning times and between muscles type, as well as highly significant (P=0.01) variation due to the interaction between the two studied factors. The pH value decreased significantly (P=0.05) with the progress of conditioning time, the lowest value was attained on 168 hrs. The decreasing rate was slow at the first 12 hrs, while it was significantly rapid at the next 12 hrs. (0.38 units vs. 0.61 units respectively), moreover, the rates of pH decline were 0.17, 0.07 and 0.05 unit vs. 72, 120 and 168 hrs). ST muscle had significantly higher pH value compared to that of DP muscle (6.14 vs. 5.98 respectively). During conditioning time DP muscle had significantly (P= 0.05) lower pH value, the rate of pH decline was significantly higher in DP muscle from 4hr. up to 12hr the rates of declining were (0.43 unit in DP muscle vs. 0.34 unit in ST muscle), at the next 12hrs. the rates of pH fall were (0.62 unit in DP muscle vs. 0.60 unite in ST muscle), at the first 24 hrs. the pH values
were (5.78 vs. 5.59 in ST and DP muscles respectively), until the last time of experiment DP muscle still had significantly higher rate of pH declining and lower pH value; figure (1).
Table (2) Chemical composition of Semitendinosus and Deep pectoral muscles from one-humped camel (*Camelus dromedarius*).

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Muscle type</th>
<th>t-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Moisture</td>
<td>76.48±1.30</td>
<td>78.48±1.03</td>
</tr>
<tr>
<td>Protein</td>
<td>20.92±0.74</td>
<td>19.71±0.65</td>
</tr>
<tr>
<td>Ash</td>
<td>1.50±0.22</td>
<td>1.42±0.21</td>
</tr>
<tr>
<td>Fat</td>
<td>2.65±0.62</td>
<td>2.12±0.34</td>
</tr>
</tbody>
</table>

In this and subsequent tables, ST: Semitendinosus. DP: Deep Pectoral, NS: not significant (P>0.05), *: significant at 5% (P=0.05), **: significant at 1% (P=0.01).
Table (3) Effect of conditioning time and muscle type on pH value of one-humped camel meat

<table>
<thead>
<tr>
<th>Conditioning time (hrs)</th>
<th>Muscle type</th>
<th>Conditioning effect</th>
<th>SE</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>ST</td>
<td>DP</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>6.72&lt;sup&gt;a&lt;/sup&gt;</td>
<td>6.64&lt;sup&gt;b&lt;/sup&gt;</td>
<td>6.68&lt;sub&gt;A&lt;/sub&gt; cond.=0.03**</td>
</tr>
<tr>
<td>6</td>
<td>6.65&lt;sup&gt;b&lt;/sup&gt;</td>
<td>6.56&lt;sup&gt;c&lt;/sup&gt;</td>
<td>6.60&lt;sub&gt;B&lt;/sub&gt; muscle=0.01**</td>
</tr>
<tr>
<td>8</td>
<td>6.57&lt;sup&gt;c&lt;/sup&gt;</td>
<td>6.46&lt;sup&gt;d&lt;/sup&gt;</td>
<td>6.51&lt;sub&gt;C&lt;/sub&gt; inter.=0.03**</td>
</tr>
<tr>
<td>10</td>
<td>6.48&lt;sup&gt;d&lt;/sup&gt;</td>
<td>6.34&lt;sup&gt;e&lt;/sup&gt;</td>
<td>6.41&lt;sub&gt;D&lt;/sub&gt;</td>
</tr>
<tr>
<td>12</td>
<td>6.38&lt;sup&gt;e&lt;/sup&gt;</td>
<td>6.21&lt;sup&gt;f&lt;/sup&gt;</td>
<td>6.31&lt;sub&gt;E&lt;/sub&gt;</td>
</tr>
<tr>
<td>24</td>
<td>5.78&lt;sup&gt;g&lt;/sup&gt;</td>
<td>5.59&lt;sup&gt;h&lt;/sup&gt;</td>
<td>5.69&lt;sub&gt;F&lt;/sub&gt;</td>
</tr>
<tr>
<td>72</td>
<td>5.62&lt;sup&gt;h&lt;/sup&gt;</td>
<td>5.42&lt;sup&gt;i&lt;/sup&gt;</td>
<td>5.53&lt;sub&gt;G&lt;/sub&gt;</td>
</tr>
<tr>
<td>120</td>
<td>5.56&lt;sup&gt;hi&lt;/sup&gt;</td>
<td>5.34&lt;sup&gt;j&lt;/sup&gt;</td>
<td>5.48&lt;sub&gt;H&lt;/sub&gt;</td>
</tr>
<tr>
<td>168</td>
<td>5.51&lt;sup&gt;i&lt;/sup&gt;</td>
<td>5.29&lt;sup&gt;j&lt;/sup&gt;</td>
<td>5.42&lt;sub&gt;I&lt;/sub&gt;</td>
</tr>
</tbody>
</table>

Muscle effect 6.14<sub>A</sub> 5.98<sub>B</sub>

In this table and subsequent ones, cond.: conditioning, SE: Standard error, and inter.: interaction. A,B means of muscle effect with different letter were significantly different, A,B means of conditioning effect with different subscript letter(s) were significantly different, a,b means of interaction with different superscript letter(s) were significantly different at 5% (P=0.05).
Fig. (1) pH value of camel meat as affected by conditioning time and muscle type
4.2.2 Colorimetric parameters

As seen in table (4) the colour co-ordinate Lightness value (L*) showed a highly significant differences (P=0.01) between conditioning time and between muscle type, although the interaction between the two main factors was significant (P=0.05). There was significant (P=0.05) increase in the (L*) value with the progress of conditioning time; the highest value (31.19) was attained at day 7. ST muscle had significantly greater (L*) value than the DP muscle. The L* value increasing trend was similar for the two studied muscles during the conditioning times fig. (2-a); the pattern of increasing rate between conditioning times 1,3,5, and 7 were 0.5, 0.47 and 0.35 units for ST muscle and 0.66, 0.53 and 0.44 units for DP muscle respectively.

The redness (a*) value showed a highly significant (P=0.01) differences between muscle types and between conditioning times, moreover the interaction values were highly significantly (table 4). The (a*) value decreased significantly (P=0.05) with increasing conditioning time; the lowest value was attained in day 7. The mean (a*) value of ST was significantly (P=0.05) lower compared with DP muscle. ST muscle was lowerst by (11.36%, 10.69%, 8.83% and 0.56% vs day 1, 3, 5, and 7 respectively). The (a*) decreasing trend was similar for the two muscles, but the rate of (a*) value decline was higher in DP muscle 1.56, 1.40 and 1.04 between the conditioning days 1, 3, 5 and 7 while it was 1.28, .99 and .46 units for ST muscle, for the same days (figure 2-b).

With regard to colour co-ordinate yellowness (b*) table (4) showed that, there were highly significant differences (P=0.01) between muscle types and between conditioning times as well as the interaction between the studied factors was significantly (P=0.05) different. The mean (b*) value was decreased significantly (P=0.05) with the progress of conditioning time; the
lowest value was attained at day 7. The mean (b*) in DP muscle was higher significantly (P=0.05) than that of ST muscle. The pattern of (b*) decline was the same in the two studied muscles during conditioning times, but the rate of declining was higher in DP muscle; fig. (2-c). DP muscle had greater (b*) over ST muscle during conditioning time 0.90, 0.77, 0.57 and 0.56 units vs. day 1, 3, 5 and 7 respectively.
Table (4) Effect of conditioning time and muscle type on colorimetric parameters of camel meat

<table>
<thead>
<tr>
<th>Parameters</th>
<th>Muscle type</th>
<th>Conditioning time</th>
<th>Muscle effect</th>
<th>S.E</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>1</td>
<td>3</td>
<td>5</td>
</tr>
<tr>
<td>Lightness</td>
<td>ST</td>
<td>30.90^c</td>
<td>31.40^b</td>
<td>31.87^a</td>
</tr>
<tr>
<td></td>
<td>DP</td>
<td>28.53^f</td>
<td>29.19^e</td>
<td>29.72^d</td>
</tr>
<tr>
<td></td>
<td>cond.effect</td>
<td><strong>29.72_D</strong></td>
<td><strong>30.30_C</strong></td>
<td><strong>30.80_B</strong></td>
</tr>
<tr>
<td>Redness</td>
<td>ST</td>
<td>15.06^c</td>
<td>13.78^d</td>
<td>12.79^e</td>
</tr>
<tr>
<td></td>
<td>DP</td>
<td>16.99^a</td>
<td>15.43^b</td>
<td>14.03^d</td>
</tr>
<tr>
<td></td>
<td>cond. effect</td>
<td><strong>16.03_A</strong></td>
<td><strong>14.61_B</strong></td>
<td><strong>13.41_C</strong></td>
</tr>
<tr>
<td>Yellowness</td>
<td>ST</td>
<td>7.22^b</td>
<td>6.40^c</td>
<td>5.57^de</td>
</tr>
<tr>
<td></td>
<td>DP</td>
<td>8.12^a</td>
<td>7.17^b</td>
<td>6.14^d</td>
</tr>
<tr>
<td></td>
<td>cond. effect</td>
<td><strong>7.67_A</strong></td>
<td><strong>6.79_B</strong></td>
<td><strong>5.86_C</strong></td>
</tr>
</tbody>
</table>
Figue (2-a)

Fig. (2) Colorimetric parameters of fresh camel meat as affected by conditioning time and muscle type.
Figure (2-b)

![Graph showing the relationship between yellowness value (L*) and conditioning time (days) for ST and DP conditions.]

Figure (2-c)
### 4.2.3 Protein fractionation

Table (5) showed that, there was highly significant (P=0.01) differences between conditioning times, between muscle types and due to the interaction between the main factors studied. The myofibrillar protein extractability increased significantly (P=0.05) with increasing the conditioning time for 7 days. ST muscle showed greater myofibrillar protein extractability compared with DP muscle (11.64 vs 10.50 respectively). During conditioning times ST muscle was superior over DP by 0.92, 1.03, 1.21 and 1.32 vs. day 1, 3, 5 and 7 respectively, the rate of increasing was higher in ST 0.35, 0.63 and 0.29 compared with DP muscle 0.24, 0.45 and 0.18 vs. day 3, 5 and 7 respectively; figure (3-a).

Sarcoplastic proteins concentration showed in table (5) there were highly significant (P=0.01) differences between conditioning times and between the two muscles, as well as significant difference due to the interaction between the studied factors. Day 7 of conditioning showed the lowest value of sarcoplastic protein which was 72.13% of day1. The amount of extracted sarcoplastic protein was higher in DP muscle than ST muscle (5.37 vs. 5.01 respectively). During the conditioning times the two muscles showed the same pattern of reduction but they were different in the rate of reduction which was higher in DP muscle 0.66, 0.61 and 0.51 compared with ST 0.62, 0.59 and 0.39 for days 3, 5 and 7. During the studied times ST had the lowest values than the DP by 0.45, 0.41, 0.39 and 0.27 vs. day 1, 3, 5 and 7 respectively; fig. (3-b).

For non-protein-nitrogen, as shown in table (5) there were highly significant differences (P=0.01) among conditioning times and between the two studied muscles (P=0.01), but the interaction between the two studied factors was not-
significant (P>0.05). ST muscle had significantly (P=0.05) greater non-protein-nitrogen compared with the DP muscle. The concentration of non-protein-nitrogen increased significantly (P=0.05) with the progress of conditioning time, with the highest mean attained at day 7.

With regard to connective tissue protein table (5) showed highly significant differences (P=0.01) between the two studied muscles and between conditioning times, moreover, the interaction between the studied factors was highly significant (P=0.01). Connective tissue protein percentage decreased significantly (P=0.05) with the progress of conditioning time, with the lowerst attained at day 7 it was 85.54% of day1. ST muscle had significantly (P=0.05) lower connective tissue content compared with DP muscle (2.04 vs. 2.57). The trend of connective tissue protein decreasing was similar in the two studied muscles; however, it was higher in ST muscle compared with DP muscle (0.15, 0.13 and 0.10 vs. 0.12, 0.11 and 0.09 on day 3, 5 and 7 respectively); figure (3-d).
Table (5) Effect of conditioning time and muscle type on protein fractionation of one-humped camel meat

<table>
<thead>
<tr>
<th>Parameters</th>
<th>Muscle type</th>
<th>Conditioning time</th>
<th>Muscle effect</th>
<th>S.E</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>1</td>
<td>3</td>
<td>5</td>
</tr>
<tr>
<td>Myofibrillar</td>
<td>ST</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>DP</td>
<td>10.98&lt;sup&gt;d&lt;/sup&gt;</td>
<td>11.33&lt;sup&gt;c&lt;/sup&gt;</td>
<td>11.96&lt;sup&gt;b&lt;/sup&gt;</td>
</tr>
<tr>
<td></td>
<td>Cond. effect</td>
<td>10.52&lt;sup&gt;D&lt;/sup&gt;</td>
<td>10.79&lt;sup&gt;C&lt;/sup&gt;</td>
<td>11.36&lt;sup&gt;B&lt;/sup&gt;</td>
</tr>
<tr>
<td>Sarcoplasmic</td>
<td>ST</td>
<td>5.87&lt;sup&gt;b&lt;/sup&gt;</td>
<td>5.24&lt;sup&gt;c&lt;/sup&gt;</td>
<td>4.66&lt;sup&gt;d&lt;/sup&gt;</td>
</tr>
<tr>
<td></td>
<td>DP</td>
<td>6.32&lt;sup&gt;a&lt;/sup&gt;</td>
<td>5.66&lt;sup&gt;b&lt;/sup&gt;</td>
<td>5.05&lt;sup&gt;c&lt;/sup&gt;</td>
</tr>
<tr>
<td></td>
<td>Cond. effect</td>
<td>6.10&lt;sup&gt;A&lt;/sup&gt;</td>
<td>5.45&lt;sup&gt;B&lt;/sup&gt;</td>
<td>4.86&lt;sup&gt;C&lt;/sup&gt;</td>
</tr>
<tr>
<td>NPN</td>
<td>ST</td>
<td>0.53</td>
<td>0.54</td>
<td>0.57</td>
</tr>
<tr>
<td></td>
<td>DP</td>
<td>0.49</td>
<td>0.50</td>
<td>0.51</td>
</tr>
<tr>
<td></td>
<td>Cond. effect</td>
<td>0.49&lt;sup&gt;d&lt;/sup&gt;</td>
<td>0.52&lt;sup&gt;c&lt;/sup&gt;</td>
<td>0.54&lt;sup&gt;B&lt;/sup&gt;</td>
</tr>
<tr>
<td>Conn. tissue</td>
<td>ST</td>
<td>2.24&lt;sup&gt;d&lt;/sup&gt;</td>
<td>2.09&lt;sup&gt;e&lt;/sup&gt;</td>
<td>1.96&lt;sup&gt;f&lt;/sup&gt;</td>
</tr>
<tr>
<td></td>
<td>DP</td>
<td>2.74&lt;sup&gt;a&lt;/sup&gt;</td>
<td>2.62&lt;sup&gt;b&lt;/sup&gt;</td>
<td>2.51&lt;sup&gt;c&lt;/sup&gt;</td>
</tr>
<tr>
<td></td>
<td>Cond. effect</td>
<td>2.49&lt;sup&gt;A&lt;/sup&gt;</td>
<td>2.36&lt;sup&gt;B&lt;/sup&gt;</td>
<td>2.24&lt;sup&gt;C&lt;/sup&gt;</td>
</tr>
</tbody>
</table>

Conn: connective; NPN: non-protein nitrogen
Fig. (3) Protein fractionation of fresh camel meat as affected by conditioning time and muscle type.

Figure (3-a)

Figure (3-b)
Figure (3-c)

Figure (3-d)
4.2.4 Water holding parameters

Table (6) showed that, water-holding capacity (WHC), was highly significant affected by muscle type and conditioning time ($P=0.01$), moreover, the interaction between muscle type and conditioning time was highly significant ($P=0.01$). The mean ratio in ST muscle was significantly ($P=0.05$) lower than that of DP muscle, the mean of water-holding capacity decreased significantly with an increase in conditioning time with the lowerst ratio attained at day 7 which was 84.62% of day1. The response of the two muscles to conditioning differed significantly ($P=0.05$) which was superior in ST over DP throughout the conditioning times; the rates of improvement were (0.15, 0.16 and 0.20 in ST muscle and 0.12, 0.13 and 0.15 in DP vs. day 3, 5 and 7 respectively); figure (4-a).

With regard to cooking loss, as shown in table (6) there were highly significant effects of muscle type and conditioning time ($P=0.01$) on cooking loss, moreover the interaction between muscle type and conditioning time was highly significant ($P=0.01$).The mean of cooking loss decreased significantly with an increase in conditioning time. ST muscle had significantly lower cooking loss compared with DP muscle (31.03 vs. 32.91) respectively. The mean of cooking loss differed significantly due to the interaction between the two studied factors, which was superior in ST muscle over DP muscle throughout conditioning time by (3.22%, 3.86%, 6.57% and 9.88% vs day 1, 3, 5 and 7 respectively), moreover, the rate of reduction in cooking loss was higher inST muscle compared to that of DP muscle 1.91, 2.64 and 3.09 for ST and 1.75, 1.84 and 2.25 for DP vs day 3, 5 and 7 respectively); figure (4-b).

Considering drip loss, table (6) showed highly significant difference between the muscle type ($P=0.01$), and between conditioning time, as well as
significant variation between muscle type and conditioning time interaction (P=0.05). The mean of drip loss decreased significantly with the progress of conditioning times. ST muscle had significantly lower drip loss compared with DP muscle (5.81 vs. 6.61) respectively. ST muscle was superior in drip loss decreasing over DP muscle by (8.57%, 12.75% and 13.92% and 16.45% vs. day 1, 3, 5 and 7 respectively); figure (4-c).

Regarding weep loss there were highly significant differences (P=0.01) between the two types of muscles, and between conditioning times, as well as significant variation (P=0.05) due to muscle type and conditioning time interaction. ST muscle had significantly (P=0.05) lower weep loss compared with DP (1.78 vs. 2.28). Although the weep loss was increased with the progress of conditioning time; the increasing rates were in reduction trend (56%, 26.67%, and 12.15% vs. day 3, 5, 7 respectively). The rate of weep loss increasing during conditioning time was lower in ST muscle compared to that of DP muscle (.65, .50 and .30 in ST, .76, .53 and .36 vs day 1, 3, 5 and 7 respectively); figure (4-d).
Table (6) Effect of conditioning time and muscle type on water holding parameters of camel meat

<table>
<thead>
<tr>
<th>Parameters</th>
<th>Muscle type</th>
<th>Conditioning time</th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>1</td>
<td>3</td>
<td>5</td>
<td>7</td>
<td>Muscle effect</td>
<td>S.E</td>
</tr>
<tr>
<td>W.H.C</td>
<td>ST</td>
<td>2.27&lt;sup&gt;c&lt;/sup&gt;</td>
<td>2.12&lt;sup&gt;d&lt;/sup&gt;</td>
<td>1.96&lt;sup&gt;e&lt;/sup&gt;</td>
<td>1.77&lt;sup&gt;f&lt;/sup&gt;</td>
<td>2.03B</td>
<td>cond.=.04**</td>
</tr>
<tr>
<td></td>
<td>DP</td>
<td>2.60&lt;sup&gt;a&lt;/sup&gt;</td>
<td>2.48&lt;sup&gt;b&lt;/sup&gt;</td>
<td>2.35&lt;sup&gt;b&lt;/sup&gt;</td>
<td>2.20&lt;sup&gt;c&lt;/sup&gt;</td>
<td>2.41A</td>
<td>muscle=.03**</td>
</tr>
<tr>
<td></td>
<td>Cond. effect</td>
<td>2.44&lt;sub&gt;A&lt;/sub&gt;</td>
<td>2.30&lt;sub&gt;B&lt;/sub&gt;</td>
<td>2.16&lt;sub&gt;C&lt;/sub&gt;</td>
<td>1.98&lt;sub&gt;D&lt;/sub&gt;</td>
<td></td>
<td>inter.=.06**</td>
</tr>
<tr>
<td>Cook. loss</td>
<td>ST</td>
<td>34.55&lt;sup&gt;b&lt;/sup&gt;</td>
<td>32.64&lt;sup&gt;c&lt;/sup&gt;</td>
<td>30.00&lt;sup&gt;d&lt;/sup&gt;</td>
<td>26.91&lt;sup&gt;f&lt;/sup&gt;</td>
<td>31.03B</td>
<td>cond.=.25**</td>
</tr>
<tr>
<td></td>
<td>DP</td>
<td>35.70&lt;sup&gt;a&lt;/sup&gt;</td>
<td>33.95&lt;sup&gt;b&lt;/sup&gt;</td>
<td>32.11&lt;sup&gt;c&lt;/sup&gt;</td>
<td>29.86&lt;sup&gt;c&lt;/sup&gt;</td>
<td>32.91A</td>
<td>muscle=.17**</td>
</tr>
<tr>
<td></td>
<td>Cond. effect</td>
<td>35.13&lt;sub&gt;A&lt;/sub&gt;</td>
<td>33.30&lt;sub&gt;B&lt;/sub&gt;</td>
<td>31.06&lt;sub&gt;C&lt;/sub&gt;</td>
<td>28.39&lt;sub&gt;D&lt;/sub&gt;</td>
<td></td>
<td>inter.=.35**</td>
</tr>
<tr>
<td>Drip loss</td>
<td>ST</td>
<td>8.64&lt;sup&gt;b&lt;/sup&gt;</td>
<td>6.57&lt;sup&gt;d&lt;/sup&gt;</td>
<td>4.70&lt;sup&gt;f&lt;/sup&gt;</td>
<td>3.33&lt;sup&gt;h&lt;/sup&gt;</td>
<td>5.81B</td>
<td>cond.=.10**</td>
</tr>
<tr>
<td></td>
<td>DP</td>
<td>9.45&lt;sup&gt;a&lt;/sup&gt;</td>
<td>7.53&lt;sup&gt;c&lt;/sup&gt;</td>
<td>5.56&lt;sup&gt;c&lt;/sup&gt;</td>
<td>4.00&lt;sup&gt;g&lt;/sup&gt;</td>
<td>6.61A</td>
<td>muscle=.07*</td>
</tr>
<tr>
<td></td>
<td>Cond. effect</td>
<td>9.04&lt;sub&gt;A&lt;/sub&gt;</td>
<td>7.05&lt;sub&gt;B&lt;/sub&gt;</td>
<td>5.13&lt;sub&gt;C&lt;/sub&gt;</td>
<td>3.67&lt;sub&gt;D&lt;/sub&gt;</td>
<td></td>
<td>inter.=.14**</td>
</tr>
<tr>
<td>Weep loss</td>
<td>ST</td>
<td>1.12&lt;sup&gt;f&lt;/sup&gt;</td>
<td>1.77&lt;sup&gt;e&lt;/sup&gt;</td>
<td>2.27&lt;sup&gt;c&lt;/sup&gt;</td>
<td>2.56&lt;sup&gt;b&lt;/sup&gt;</td>
<td>1.78B</td>
<td>cond.=.03**</td>
</tr>
<tr>
<td></td>
<td>DP</td>
<td>1.37&lt;sup&gt;f&lt;/sup&gt;</td>
<td>2.13&lt;sup&gt;d&lt;/sup&gt;</td>
<td>2.66&lt;sup&gt;b&lt;/sup&gt;</td>
<td>2.97&lt;sup&gt;a&lt;/sup&gt;</td>
<td>2.28A</td>
<td>muscle=.02**</td>
</tr>
<tr>
<td></td>
<td>Cond. effect</td>
<td>1.25&lt;sub&gt;D&lt;/sub&gt;</td>
<td>1.95&lt;sub&gt;C&lt;/sub&gt;</td>
<td>2.47&lt;sub&gt;B&lt;/sub&gt;</td>
<td>2.77&lt;sub&gt;A&lt;/sub&gt;</td>
<td></td>
<td>inter.=.038</td>
</tr>
</tbody>
</table>

WHC: water holding capacity; Cook: cooking
Fig. (4) Effect of conditioning time and muscle type on water-holding parameters of one-humped camel meat.

Figure (4-a)

Figure (4-b)
Figure (4-c)

Figure (4-d)
4.2.5 Electrophoresis

Table (7) showed approximate molecular weights of the polypeptides protein components of myofibrillar protein and the changes occurred in studied muscles (ST and DP) during conditioning time. Electrophoresis of extracted myofibrillar proteins from ST muscle and DP muscle resolved components with proximately similar degradation, there were 11 bands ranging in molecular weight from (16KDa up to 200KDa). These were, three with low MW (16, 18, and 25KDa), four with moderate MW (30, 33, 35 and 37KDa), two with high MW (45, and 55KDa), and two had very high MW (110 and 200KDa). Protein component represented by a band with molecular weight 55KDa was completely disappeared in ST muscle at 5 and 7 of conditioning, but in DP muscle it was slightly disappeared only day 7. A 37KDa was slightly disappeared in both studied muscles at different conditioning time. The presence of a band with MW (33 KDa) was only appeared in ST muscle at day 5 and 7. A band with approximately 30KDa appeared in ST muscle at day 5 and 7, however it was appeared in DP muscle at day 7 of conditioning time. Protein components of molecular weights 25, 18, and 16KDa appeared at the same conditioning time in the two muscles, figure (5).
**Fig. (5):** SDS-Polyacrylamide gel electrophoresis of myofibrillar protein extracted from Semitendinosus and Deep pectoral muscles of one-humped (Camelus dromedarius) conditioned at 2°C for 7-days. 1 lane: standard protein mixture molecular weight, lanes D1, D3, D5, and D7: correspond to 1\(^{\text{st}}\), 3\(^{\text{th}}\), 5\(^{\text{th}}\), and 7\(^{\text{th}}\) day of conditioning time. ST: Semitendinosus muscle, DP: Deep pectoral muscle.
Table (7): Effect of conditioning time and muscle type on myofibillar protein degradation of camel meat, conditioned at 2°C for (1, 3, 5 and 7 day)

<table>
<thead>
<tr>
<th>Band group</th>
<th>Molecular weight</th>
<th>Muscle type</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td><strong>Muscle type</strong></td>
</tr>
<tr>
<td></td>
<td></td>
<td><em>D1</em></td>
</tr>
<tr>
<td>A</td>
<td>200</td>
<td>+</td>
</tr>
<tr>
<td>b</td>
<td>110</td>
<td>+</td>
</tr>
<tr>
<td>c</td>
<td>55</td>
<td>+</td>
</tr>
<tr>
<td>d</td>
<td>45</td>
<td>+</td>
</tr>
<tr>
<td>e</td>
<td>37</td>
<td>+</td>
</tr>
<tr>
<td>f</td>
<td>35</td>
<td>+</td>
</tr>
<tr>
<td>g</td>
<td>33</td>
<td>-</td>
</tr>
<tr>
<td>h</td>
<td>30</td>
<td>-</td>
</tr>
<tr>
<td>i</td>
<td>25</td>
<td>+</td>
</tr>
<tr>
<td>j</td>
<td>18</td>
<td>+</td>
</tr>
<tr>
<td>k</td>
<td>16</td>
<td>+</td>
</tr>
</tbody>
</table>

+: presence, -: absence and ±: presence or absence

D: day
4.2.6 Sensory evaluation

Table (8) shows the sensorial traits (Tenderness, juiciness, flavour, colour, and over all acceptability) of ST and DP muscles affected by conditioning times (1, 3, 5 and 7 days). Conditioning time and muscle type showed highly significant effects (P=0.01) on tenderness, moreover, the interaction was significant (P=0.05). Tenderness increased significantly (P=0.05) with the progress of conditioning time; with the highest score attained at day 7 it was 31.34% over day 1. The mean score of tenderness was significantly greater (P=0.05) in ST muscle compared with DP muscle (6.41 vs. 5.17). During conditioning time ST muscle was superior over DP muscle by (20.48%, 23.08%, 24.03% and 27.12% vs. day 1, 3, 5 and 7 respectively); figure (6-a).

Regarding juiciness, as shown in table (8), there were highly significant effects (P=0.01) of muscle type and conditioning time, however, muscle type and conditioning time interaction was significant (P=0.05). ST muscle had higher mean score for juiciness than DP muscle (6.02 vs. 5.15). There was a significant (P=0.05) increase in juiciness with an increase of conditioning time with the highest score attained at day 7 it was 31.55% over day 1. During conditioning time the rate of juiciness increasing was greater inST muscle compared with that of DP muscle (0.48, 0.55 and 0.61 in ST; 0.41, 0.47 and 0.56 in DP vs day 3, 5 and 7 respectively); figure (6-b).

With respect to flavour, table (8) showed that, there was highly significant effect (P=0.01) of conditioning time and significant effect (P=0.05) of muscle type, but the interaction between the two main factors was not significant (P>0.05). The favour score increased significantly with the progress of conditioning time; with the highest mean attained at day 7 it was 15.77% over day 1.ST muscle had greater mean compared with DP muscle (5.95 vs.5.26) respectively; figure (6-c).
With regard to sensorial trait acceptability as shown in table (8) there was highly significant variation between conditioning time (P=0.01), as well as significant (P=0.05) differences between the studied muscles and due to the interaction between the main factors. Moreover, the mean acceptability increased significantly (P=0.05) with the progress of conditioning time with the highest score attained at day 7 it was 24.76% over day 1. ST muscle had significantly greater mean score compared with that of DP muscle (6.23 vs 5.44) respectively. During conditioning time the trend of increasing was similar in the two studied muscles; but it was greater in ST muscle compared with DP muscle (0.41, 0.45 and 0.49 in ST and 0.32, 0.42 and 0.43 in Dp vs. day 3, 5 and 7 respectively), moreover ST muscle was superior over Dp muscle by (13.52%, 14.42%, 14.74% and 14.87% vs. day 1, 3, 5 and 7 respectively); figure (6-d).
Table (8) Effect of conditioning time and muscle type on sensory evaluation of one-humped camel meat

<table>
<thead>
<tr>
<th>Parameters</th>
<th>Muscle type</th>
<th>Conditioning time</th>
<th>Muscle effect</th>
<th>S.E</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>1</td>
<td>3</td>
<td>5</td>
</tr>
<tr>
<td>Tenderness</td>
<td>ST</td>
<td>5.47&lt;sup&gt;c&lt;/sup&gt;</td>
<td>6.08&lt;sup&gt;d&lt;/sup&gt;</td>
<td>6.71&lt;sup&gt;b&lt;/sup&gt;</td>
</tr>
<tr>
<td></td>
<td>DP</td>
<td>4.54&lt;sup&gt;c&lt;/sup&gt;</td>
<td>4.94&lt;sup&gt;d&lt;/sup&gt;</td>
<td>5.41&lt;sup&gt;c&lt;/sup&gt;</td>
</tr>
<tr>
<td></td>
<td>Cond. effect</td>
<td><strong>5.01</strong>&lt;sup&gt;D&lt;/sup&gt;</td>
<td><strong>5.51</strong>&lt;sup&gt;C&lt;/sup&gt;</td>
<td><strong>6.06</strong>&lt;sup&gt;B&lt;/sup&gt;</td>
</tr>
<tr>
<td>Juiciness</td>
<td>ST</td>
<td>5.23&lt;sup&gt;c&lt;/sup&gt;</td>
<td>5.71&lt;sup&gt;c&lt;/sup&gt;</td>
<td>6.26&lt;sup&gt;b&lt;/sup&gt;</td>
</tr>
<tr>
<td></td>
<td>DP</td>
<td>4.47&lt;sup&gt;d&lt;/sup&gt;</td>
<td>4.88&lt;sup&gt;cd&lt;/sup&gt;</td>
<td>5.35&lt;sup&gt;c&lt;/sup&gt;</td>
</tr>
<tr>
<td></td>
<td>Cond. effect</td>
<td><strong>4.85</strong>&lt;sup&gt;D&lt;/sup&gt;</td>
<td><strong>5.30</strong>&lt;sup&gt;C&lt;/sup&gt;</td>
<td><strong>5.81</strong>&lt;sup&gt;B&lt;/sup&gt;</td>
</tr>
<tr>
<td>Flavour</td>
<td>ST</td>
<td>5.62&lt;sup&gt;c&lt;/sup&gt;</td>
<td>5.82&lt;sup&gt;bc&lt;/sup&gt;</td>
<td>5.95&lt;sup&gt;b&lt;/sup&gt;</td>
</tr>
<tr>
<td></td>
<td>DP</td>
<td>4.79&lt;sup&gt;f&lt;/sup&gt;</td>
<td>5.12&lt;sup&gt;e&lt;/sup&gt;</td>
<td>5.51&lt;sup&gt;d&lt;/sup&gt;</td>
</tr>
<tr>
<td></td>
<td>Cond. effect</td>
<td><strong>5.20</strong>&lt;sup&gt;D&lt;/sup&gt;</td>
<td><strong>5.47</strong>&lt;sup&gt;C&lt;/sup&gt;</td>
<td><strong>5.73</strong>&lt;sup&gt;B&lt;/sup&gt;</td>
</tr>
<tr>
<td>Acceptability</td>
<td>ST</td>
<td>5.54&lt;sup&gt;c&lt;/sup&gt;</td>
<td>5.95&lt;sup&gt;c&lt;/sup&gt;</td>
<td>6.46&lt;sup&gt;b&lt;/sup&gt;</td>
</tr>
<tr>
<td></td>
<td>DP</td>
<td>4.88&lt;sup&gt;d&lt;/sup&gt;</td>
<td>5.20&lt;sup&gt;cd&lt;/sup&gt;</td>
<td>5.62&lt;sup&gt;c&lt;/sup&gt;</td>
</tr>
<tr>
<td></td>
<td>Cond. effect</td>
<td><strong>5.21</strong>&lt;sup&gt;D&lt;/sup&gt;</td>
<td><strong>5.58</strong>&lt;sup&gt;C&lt;/sup&gt;</td>
<td><strong>6.04</strong>&lt;sup&gt;B&lt;/sup&gt;</td>
</tr>
</tbody>
</table>
Figure (6-a)
Fig. (6) Effect of conditioning time and muscle type on sensory evaluation of one-humped camel meat.

Figure (6-b)
Figure (6-c)

Figure (6-d)
4.2.7 Microbiological properties

Table (9) shows that, there were highly significant differences (P=0.01) between conditioning time and between the two studied muscles, the interaction between the two studied factors was significant (P=0.05), the mean of the total viable count increased significantly with the progress of conditioning times; with the highest mean attained on day 7. DP muscle had significantly (P=0.05) higher mean of total viable count compared with that of ST muscle (4.96 vs. 5.60) respectively. Although the mean of TVC increased significantly in both muscles during conditioning time, the rate of increasing was higher in DP muscle 0.32, 0.53 and 0.86 in DP muscle vs. 0.23, 0.30 and 0.39 in ST muscle for day 3, 5 and 7 respectively); figure (7-a).

With regard to Psychrophilic bacteria, as seen in table (9) there were highly significant (P=0.01) difference between conditioning times, and significant (P=0.05) differences between the two muscles and due to the interaction between the two factors. The mean of Psych. bacteria increased with increasing conditioning time; the highest mean was (4.24 log/g ) attained on day 7. DP muscle had significantly (P=0.05) higher mean compared to that of ST muscle. During conditioning time the increasing rate of psysh. Bacteria growth was significantly higher in DP muscle than ST muscle (0.20, 0.26 and 0.34 in DP vs. 0.18, 0.22 and 0.28 in ST for day 3, 5 and 7 respectively); figure (7-b).

As seen in table (9) for Pseudomonas spp counted , there were highly significant (P=0.01) differences between conditioning time and between the two studied muscles, as well as significant variation due to the interaction between the two studied factors (P=0.01). The mean of Pseudomonas spp increased significantly (P=0.05) with the progress of conditioning time; the highest mean was recorded in day 7. The mean counted for DP muscle was
significantly (P=0.05) higher than that of ST muscle. Although the bacreia growth was increased in the two muscles during conditioning time; but the rate of increasing was greater in DP 0.17, 0.20 and 0.26 in DP vs 0.14, 0.16 and 0.20 in ST for day 3, 5 and 7 respectively; figure (7-c).

With respect *Listeria monocytogene*, as seen in table (9) there was higher significant difference (P=0.01) between conditioning times and significant (P=0.05) difference between muscle types, however, the muscle type and conditioning time’s interaction was significance (P=0.05). During conditioning times the growth of *Listeria monocytogene* was varied significantly (P=0.05) the highest count was attained at day 7. The mean counted of *Listeria monocytogenes* was significantly higher (P=0.05) in DP muscle compared with that in ST muscle. Moreover, the rate of growth increasing was significantly higher in DP (0.14, 0.18 and 0.19 in DP vs. 0.12, 0.12 and 0.17 in ST for day 3, 5 and 7 respectively); figure (7-d).

Considering *Streptococcus spp*, table (9) shows that, there was highly significant (p=0.01) difference between conditioning time, significant (p=0.05) differences between the muscle types (p>0.05) and due to the interaction between the two main factors. The mean counted of *Streptococcus spp* was increased significantly (P=0.05) during the conditioning time; the highest mean attained on day 7. DP muscle had significant (p=0.05) greater mean compared to that of ST. The means counted of *Streptococcus spp* differe significantly in both studied muscles during conditioning time; the rate of growth increasing was greater in DP muscle (0.11, 0.16 and 0.19 in DP vs. 0.09, 0.13 and 0.14 in ST for day 3, 5 and 7 respectively); figure (7-e).

With regarding *staphylococcus aureus*, as shown in table (9), there were highly significant differences among the conditioning time and between muscle types (P=0.01), as well as between muscle type and conditioning time
interaction. The mean counted of *staphylococcus aureus* decreased significantly (P=0.05) with increasing conditioning time; the highest mean counted was attained on day 1. DPMuscle had significantly higher mean counted compared to that of ST muscle.
### Table (9) Effect of conditioning time and muscle type on microbiological properties on camel meat

<table>
<thead>
<tr>
<th>Parameters</th>
<th>Muscle type</th>
<th>Conditioning time</th>
<th>Muscle effect</th>
<th>S.E</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>1</td>
<td>3</td>
<td>5</td>
</tr>
<tr>
<td>T.V.C</td>
<td>ST</td>
<td>4.54&lt;sup&gt;e&lt;/sup&gt;</td>
<td>4.77&lt;sup&gt;f&lt;/sup&gt;</td>
<td>5.07&lt;sup&gt;de&lt;/sup&gt;</td>
</tr>
<tr>
<td></td>
<td>DP</td>
<td>4.88&lt;sup&gt;ef&lt;/sup&gt;</td>
<td>5.20&lt;sup&gt;d&lt;/sup&gt;</td>
<td>5.73&lt;sup&gt;b&lt;/sup&gt;</td>
</tr>
<tr>
<td>Cond. effect</td>
<td>4.71&lt;sup&gt;D&lt;/sup&gt;</td>
<td>4.99&lt;sup&gt;C&lt;/sup&gt;</td>
<td>5.40&lt;sup&gt;B&lt;/sup&gt;</td>
<td>6.03&lt;sup&gt;A&lt;/sup&gt;</td>
</tr>
<tr>
<td>Psych.</td>
<td>ST</td>
<td>3.43&lt;sup&gt;f&lt;/sup&gt;</td>
<td>3.61&lt;sup&gt;ef&lt;/sup&gt;</td>
<td>3.83&lt;sup&gt;c&lt;/sup&gt;</td>
</tr>
<tr>
<td></td>
<td>DP</td>
<td>3.57&lt;sup&gt;f&lt;/sup&gt;</td>
<td>3.77&lt;sup&gt;ce&lt;/sup&gt;</td>
<td>4.03&lt;sup&gt;b&lt;/sup&gt;</td>
</tr>
<tr>
<td>Cond. effect</td>
<td>3.50&lt;sup&gt;C&lt;/sup&gt;</td>
<td>3.69&lt;sup&gt;C&lt;/sup&gt;</td>
<td>3.93&lt;sup&gt;B&lt;/sup&gt;</td>
<td>4.24&lt;sup&gt;A&lt;/sup&gt;</td>
</tr>
<tr>
<td>Pseud.</td>
<td>ST</td>
<td>3.22&lt;sup&gt;e&lt;/sup&gt;</td>
<td>3.36&lt;sup&gt;de&lt;/sup&gt;</td>
<td>3.52&lt;sup&gt;cd&lt;/sup&gt;</td>
</tr>
<tr>
<td></td>
<td>DP</td>
<td>3.41&lt;sup&gt;cd&lt;/sup&gt;</td>
<td>3.58&lt;sup&gt;c&lt;/sup&gt;</td>
<td>3.78&lt;sup&gt;b&lt;/sup&gt;</td>
</tr>
<tr>
<td>Cond. effect</td>
<td>3.32&lt;sup&gt;C&lt;/sup&gt;</td>
<td>3.47&lt;sup&gt;C&lt;/sup&gt;</td>
<td>3.65&lt;sup&gt;B&lt;/sup&gt;</td>
<td>3.89&lt;sup&gt;A&lt;/sup&gt;</td>
</tr>
<tr>
<td>Listeria.</td>
<td>ST</td>
<td>3.11&lt;sup&gt;c&lt;/sup&gt;</td>
<td>3.23&lt;sup&gt;de&lt;/sup&gt;</td>
<td>3.35&lt;sup&gt;bc&lt;/sup&gt;</td>
</tr>
<tr>
<td></td>
<td>DP</td>
<td>3.32&lt;sup&gt;cd&lt;/sup&gt;</td>
<td>3.46&lt;sup&gt;bc&lt;/sup&gt;</td>
<td>3.64&lt;sup&gt;ab&lt;/sup&gt;</td>
</tr>
<tr>
<td>Cond. effect</td>
<td>3.22&lt;sup&gt;C&lt;/sup&gt;</td>
<td>3.35&lt;sup&gt;B&lt;/sup&gt;</td>
<td>3.50&lt;sup&gt;B&lt;/sup&gt;</td>
<td>3.63&lt;sup&gt;A&lt;/sup&gt;</td>
</tr>
</tbody>
</table>

T.V.C: Total viable count; Psych: Psychrophilic; Pseud: Pseudomonas spp; Listeria: Listeria monocytogene
Fig. (7-a)
Effect of conditioning time and muscle type on microbiological growth on one-humped fresh camel meat.

Fig. (7-b)
Fig. (7-c)

Figure (7-d)
During conditioning the growth of staphylococcus aureus decreased significantly (P=0.05) in both studied muscles, but the decreasing rate was higher in ST muscle compared to that in DP muscle (0.13, 0.13 and 0.10 in ST and 0.11, 0.10 and 0.09 in DP muscle vs. day 3, 5 and 7 respectively); figure (7-e).

With regard to total coliform bacteria, table (9) stated that, there were highly significant differences (P=0.01) among the conditioning times and between the studied muscles, moreover the interaction between the two studied factors was significant (P=0.05). The mean of total coliform bacteria decreased significantly (P=0.05) with the progress of conditioning time; with the lowest mean attained at day 7. DP muscle had significantly higher mean counted of total coliform bacteria than ST muscle. During conditioning time the growth of total coliform bacteria decreased significantly (P=0.05) in both studied muscles, but the decreasing rate was higher in ST muscle compared to that in DP muscle (0.20, 0.17 and 0.16 in ST and 0.17, 0.16 and 0.14 in DP muscle vs. day 3, 5 and 7 respectively); figure (7-f).

With respect to E. coli, table (9) revealed that, there were highly significant differences (P=0.01) between conditioning times and between muscle types, as well as significant difference (P=0.05) due to the interaction between conditioning time and muscle type. The mean of E. coli was decreasing significantly (P=0.05) with the progress of conditioning time, DP muscle had significantly (P=0.05) higher mean counted compared to that of ST muscle. The rate decreasing was significantly higher in ST muscle compared to DP muscle among conditioning time (0.07, 0.07 and 0.05 in ST muscle and 0.05, 0.04 and 0.04 in DP vs. day 3, 5 and 7 respectively); figure (7-g).

For Salmonella spp, samples were completely free from Salmonella spp, 100% absence.
<table>
<thead>
<tr>
<th>Parameters</th>
<th>Muscle type</th>
<th>Conditioning time</th>
<th>Muscle effect</th>
<th>S.E</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>1</td>
<td>3</td>
<td>5</td>
</tr>
<tr>
<td>Strepto.</td>
<td>ST</td>
<td>1.94&lt;sup&gt;c&lt;/sup&gt;</td>
<td>2.03&lt;sup&gt;de&lt;/sup&gt;</td>
<td>2.16&lt;sup&gt;d&lt;/sup&gt;</td>
</tr>
<tr>
<td></td>
<td>DP</td>
<td>2.20&lt;sup&gt;cd&lt;/sup&gt;</td>
<td>2.31&lt;sup&gt;c&lt;/sup&gt;</td>
<td>2.47&lt;sup&gt;b&lt;/sup&gt;</td>
</tr>
<tr>
<td></td>
<td>Cond. effect</td>
<td><strong>1.97&lt;sup&gt;d&lt;/sup&gt;</strong></td>
<td><strong>2.17&lt;sup&gt;c&lt;/sup&gt;</strong></td>
<td><strong>3.32&lt;sup&gt;b&lt;/sup&gt;</strong></td>
</tr>
<tr>
<td>Staph.</td>
<td>ST</td>
<td>2.84&lt;sup&gt;b&lt;/sup&gt;</td>
<td>2.71&lt;sup&gt;b&lt;/sup&gt;</td>
<td>2.58&lt;sup&gt;c&lt;/sup&gt;</td>
</tr>
<tr>
<td></td>
<td>DP</td>
<td>3.00&lt;sup&gt;a&lt;/sup&gt;</td>
<td>2.89&lt;sup&gt;b&lt;/sup&gt;</td>
<td>2.79&lt;sup&gt;c&lt;/sup&gt;</td>
</tr>
<tr>
<td></td>
<td>Cond. effect</td>
<td><strong>2.92&lt;sup&gt;A&lt;/sup&gt;</strong></td>
<td><strong>2.80&lt;sup&gt;B&lt;/sup&gt;</strong></td>
<td><strong>2.69&lt;sup&gt;C&lt;/sup&gt;</strong></td>
</tr>
<tr>
<td>Total coliform ST</td>
<td>ST</td>
<td>2.36&lt;sup&gt;b&lt;/sup&gt;</td>
<td>2.16&lt;sup&gt;b&lt;/sup&gt;</td>
<td>1.99&lt;sup&gt;b&lt;/sup&gt;</td>
</tr>
<tr>
<td></td>
<td>DP</td>
<td>2.61&lt;sup&gt;a&lt;/sup&gt;</td>
<td>2.54&lt;sup&gt;b&lt;/sup&gt;</td>
<td>2.38&lt;sup&gt;b&lt;/sup&gt;</td>
</tr>
<tr>
<td></td>
<td>Cond. effect</td>
<td><strong>2.49&lt;sup&gt;A&lt;/sup&gt;</strong></td>
<td><strong>2.38&lt;sup&gt;B&lt;/sup&gt;</strong></td>
<td><strong>2.32&lt;sup&gt;B&lt;/sup&gt;</strong></td>
</tr>
<tr>
<td>E. coli</td>
<td>ST</td>
<td>1.40&lt;sup&gt;b&lt;/sup&gt;</td>
<td>1.33&lt;sup&gt;c&lt;/sup&gt;</td>
<td>1.25&lt;sup&gt;cd&lt;/sup&gt;</td>
</tr>
<tr>
<td></td>
<td>DP</td>
<td>1.54&lt;sup&gt;a&lt;/sup&gt;</td>
<td>1.49&lt;sup&gt;ab&lt;/sup&gt;</td>
<td>1.45&lt;sup&gt;b&lt;/sup&gt;</td>
</tr>
<tr>
<td></td>
<td>Cond. effect</td>
<td><strong>1.47&lt;sup&gt;A&lt;/sup&gt;</strong></td>
<td><strong>1.41&lt;sup&gt;B&lt;/sup&gt;</strong></td>
<td><strong>1.35&lt;sup&gt;C&lt;/sup&gt;</strong></td>
</tr>
</tbody>
</table>

Strepto.: *Streptococcus, feacal.* Staph.: *Staphylococcus aureus,* E.: *Escherichia.*
Figure (7-e)

Figure (7-f)
Figure (7-g)

Figure (7-h)
4.3.1 Physical analysis

Table (10) shows that, there was highly significant (P=0.01) effect of conditioning time, but there were not-significant (P>0.05) effects of freezing periods and due to the interaction between conditioning time and freezing period on the pH value of fresh camel sausage. The sausage made from unconditioned meat had significantly ((P=0.05) greater pH value compared to that made from 5 days conditioned meat.

With respect to (WHC) and cooking yield; as Shown in table (10) there were highly significant differences (P=0.01) between conditioning time and between freezing period, but the interaction between the studied factors was not significant (P>0.05), the means of water-holding-capacity of the sausage made from unconditioned meat was lower compared to that made from conditioned meat, and the sample that had been frozen for 1 days was lower significantly (P>0.05) in ratio compared to that frozen for 30 days. Sausage manufactured from unconditioned meat had significantly (P=0.05) greater cooking yield than that made from conditioned camel meat, and freezing for 1 day (P=0.05) had significantly superior cooking yield compared to 30 days.

As shown in table (10) conditioning time and freezing period had significant effect (P=0.05) on lightness (L*) and redness (a*) colours of fresh camel sausage, but the interaction between the two factors was not significant (P>0.05). Fresh sausage had been frozen for one day had significantly (P=0.05) lower lightness and greater redness values compared to that frozen up to 30 days, moreover the sausage that manufactured from unconditioned camel meat had significantly lower lightness and greater redness values compared to that made from 5 days conditioned camel meat. Consedering yellowness (b*) colour; never conditioning time nor freezing period had significant effect on co-ordinate yellowness value of fresh camel sausage. Also the interaction betweenthe main factors was not significant (P>0.05).
<table>
<thead>
<tr>
<th>Parameters</th>
<th>Cond.time</th>
<th>Freezing period</th>
<th>Cond. effect</th>
<th>S.E.M</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>1</td>
<td>30</td>
<td></td>
</tr>
<tr>
<td>pH value</td>
<td>0</td>
<td>6.25</td>
<td>6.17</td>
<td>6.21A</td>
</tr>
<tr>
<td></td>
<td>5</td>
<td>5.29</td>
<td>5.27</td>
<td>5.28B</td>
</tr>
<tr>
<td></td>
<td></td>
<td><strong>Freezing effect</strong></td>
<td><strong>5.77_A</strong></td>
<td><strong>5.72_A</strong></td>
</tr>
<tr>
<td>W.H.C</td>
<td>0</td>
<td>1.03</td>
<td>1.60</td>
<td>1.32B</td>
</tr>
<tr>
<td></td>
<td>5</td>
<td>1.34</td>
<td>2.01</td>
<td>1.67A</td>
</tr>
<tr>
<td></td>
<td></td>
<td><strong>Freezing effect</strong></td>
<td><strong>1.19_B</strong></td>
<td><strong>1.81_A</strong></td>
</tr>
<tr>
<td>Cooking yield</td>
<td>0</td>
<td>95.81</td>
<td>94.91</td>
<td>95.36A</td>
</tr>
<tr>
<td></td>
<td>5</td>
<td>93.87</td>
<td>93.30</td>
<td>93.59B</td>
</tr>
<tr>
<td></td>
<td></td>
<td><strong>Freezing effect</strong></td>
<td><strong>94.84_A</strong></td>
<td><strong>94.12_B</strong></td>
</tr>
</tbody>
</table>

*Please purchase PDFcamp Printer on http://www.verypdf.com/ to remove this watermark.*
<table>
<thead>
<tr>
<th>Parameters</th>
<th>Cond. time</th>
<th>Freezing period</th>
<th>Cond. effect</th>
<th>S.E</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>1</td>
<td>30</td>
<td></td>
</tr>
<tr>
<td>Lightness</td>
<td>0</td>
<td>32.93</td>
<td>34.21</td>
<td>33.58B freez.=.34**</td>
</tr>
<tr>
<td></td>
<td>5</td>
<td>33.01</td>
<td>35.03</td>
<td>34.03A cond.=.34*</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Freezing effect</td>
<td></td>
<td>inter.=.48ns</td>
</tr>
<tr>
<td></td>
<td>32.98B</td>
<td>34.62A</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Redness</td>
<td>0</td>
<td>12.26</td>
<td>12.12</td>
<td>12.19A freez.=.20*</td>
</tr>
<tr>
<td></td>
<td>5</td>
<td>11.60</td>
<td>11.40</td>
<td>11.50B cond.=.20*</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Freezing effect</td>
<td></td>
<td>inter.=.28ns</td>
</tr>
<tr>
<td></td>
<td>11.92A</td>
<td>11.76B</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Yellowness</td>
<td>0</td>
<td>7.16</td>
<td>6.59</td>
<td>6.88A freez.=.17ns</td>
</tr>
<tr>
<td></td>
<td>5</td>
<td>6.93</td>
<td>6.49</td>
<td>6.74A cond.=.17ns</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Freezing effect</td>
<td></td>
<td>inter.=.24ns</td>
</tr>
<tr>
<td></td>
<td>7.05A</td>
<td>6.54A</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
4.3.2 Proximate chemical compositions

Moisture content table (11) shows that, chemical compositions of fresh camel sausages were highly significant (P=0.01) affected by conditioning time and freezing period, but the interaction between the two factors was not-significant (P>0.05). Fresh camel sausage made from unconditioned meat had significantly (P=0.05) higher moisture and protein contents but lower fat and ash contents compared to that made from 5 days conditioned meat. Moreover, sausage had been frozen for one day had significantly (P=0.05) greater moisture, protein and fat contents but significantly (P=0.05) lower ash content compared to that frozen for 30 days.

4.3.3 Sensory evaluation

Table (12) shows that, there was highly significant (P=0.01) effect of conditioning time and significant (P=0.05) effects of freezing period and due to the interaction between conditioning time and freezing period on colour. The mean for sensorial trait colour of sausage made from unconditioned meat significantly (P=0.05) had higher score compared to that made from conditioned meat. Sausage frozen for 1 day had significantly (P=0.05) higher score compared with frozen for 30 days. The mean colour of the sausage of the two studied conditioning times were significant (P=0.05) decreased with the progress of freezing period, moreover the rate of decreasing was higher in the sausage that made from conditioned camel meat (0.34 vs. 0.28), sausage made from unconditioning meat was superior in colour over sausage made from conditioned meat during freezing period by (17.83% and 19.96% vs. day 1 and 30 respectively).
Table (11) Effect of conditioning time and freezing period on proximate chemical composition of camel sausage

<table>
<thead>
<tr>
<th>Parameters</th>
<th>Cond. time</th>
<th>Freezing period</th>
<th>Cond. effect</th>
<th>S.E</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>1</td>
<td>30</td>
<td></td>
</tr>
<tr>
<td>Moisture</td>
<td>0</td>
<td>69.68</td>
<td>68.74</td>
<td>68.71A</td>
</tr>
<tr>
<td></td>
<td>5</td>
<td>67.68</td>
<td>65.76</td>
<td>66.72B</td>
</tr>
<tr>
<td>Freezing effect</td>
<td>68.68\textsubscript{A}</td>
<td>66.75\textsubscript{B}</td>
<td></td>
<td>inter.=.5ns</td>
</tr>
<tr>
<td>Protein</td>
<td>0</td>
<td>15.42</td>
<td>14.09</td>
<td>14.76A</td>
</tr>
<tr>
<td></td>
<td>5</td>
<td>15.00</td>
<td>14.06</td>
<td>14.53B</td>
</tr>
<tr>
<td>Freezing effect</td>
<td>15.21\textsubscript{A}</td>
<td>14.08\textsubscript{B}</td>
<td></td>
<td>inter.=.21ns</td>
</tr>
<tr>
<td>Fat</td>
<td>0</td>
<td>13.71</td>
<td>13.16</td>
<td>13.44B</td>
</tr>
<tr>
<td></td>
<td>5</td>
<td>13.98</td>
<td>13.48</td>
<td>13.74A</td>
</tr>
<tr>
<td>Freezing effect</td>
<td>13.85\textsubscript{A}</td>
<td>13.32\textsubscript{B}</td>
<td></td>
<td>inter.=.47ns</td>
</tr>
<tr>
<td>Ash</td>
<td>0</td>
<td>2.21</td>
<td>2.29</td>
<td>2.25\textsubscript{B}</td>
</tr>
<tr>
<td></td>
<td>5</td>
<td>2.28</td>
<td>2.37</td>
<td>2.32\textsubscript{A}</td>
</tr>
<tr>
<td>Freezing effect</td>
<td>2.25\textsubscript{B}</td>
<td>2.33\textsubscript{A}</td>
<td></td>
<td>inter.=.02ns</td>
</tr>
</tbody>
</table>
Considering tenderness, as shown in table (12) there was highly significant differences (P=0.01) between conditioning time and between freezing period, as well as significant (P=0.05) variation of the interaction between conditioning time and freezing period. Tenderness of camel sausage decreased significantly (P<0.05) with increasing freezing period of the products and conditioning the raw camel meat, the rate of decreasing was lower in sausage made from unconditioned meat compared with that made from conditioned meat (0.14 vs. 0.18 respectively). Sausage made from unconditioned meat was superior in tenderness over that meat from conditioned meat during freezing period by (9.67% and 10.59% vs. day 1 and 30 respectively).

With regard to juiciness as shown in table (12), there was highly significant (P=0.01) effect of conditioning time, although freezing period and the interaction between conditioning time and freezing period were significant (P=0.05), sausage made from unconditioned meat had significantly (P=0.05) greater mean score for juiciness compared to that made from conditioned meat, also sausage had been frozen for 1 day had significantly (P=0.05) greater mean score for juiciness compared to that frozen for 30 days. Inspite of juiciness score decreased with increasing freezing period for both sausages, but sausage made from unconditioned meat was superior over that made from 5 days conditioned meat during freezing period by (12.88% and 14.48% vs. day 1 and 30 respectively).

With respect to flavour as shown in table (12) there were significant differences (P=0.05) between conditioning time and between freezing period, however the interaction between freezing period and conditioning time was not-significant (P>0.01), sausage made from conditioned meat had significantly higher (P=0.05) score compared to that made from unconditioned meat, moreover freezing camel sausage for 1 day result in higher flavour score compared with 30 days.
The sensorial trait acceptability was shown in table (12) there were highly significant differences (P=0.01) between conditioning time and between freezing period, as well as the interaction between the two factors was significant (P=0.05), sausage made from unconditioned meat had significantly (P=0.05) higher score compared to that made from conditioned meat, and freezing for 1 day significantly (P=0.05) had greater score mean compared to that frozen to 30 days. During freezing period acceptability score decreased for both sausage, but the rate of decreasing was lower in the sausage that made from unconditioned meat compared with the other (0.23 vs. 0.31 respectively). Moreover, sausage made from unconditioned meat was superior in acceptability over that made from 5 days conditioned meat during freezing period by (5.66% and 7.22% vs. day 1 and 30 respectively).
**Table (12) Effect of conditioning time and freezing period on sensory evaluation of fresh camel sausages**

<table>
<thead>
<tr>
<th>Parameters</th>
<th>Muscle Cond. time</th>
<th>Sausage Freezing period</th>
<th>Cond. effect</th>
<th>S.E</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>1</td>
<td>30</td>
<td></td>
</tr>
<tr>
<td>Colour</td>
<td>0</td>
<td>7.07&lt;sup&gt;a&lt;/sup&gt;</td>
<td>6.79&lt;sup&gt;b&lt;/sup&gt;</td>
<td>6.88&lt;sup&gt;A&lt;/sup&gt; inter.=.17*</td>
</tr>
<tr>
<td></td>
<td>5</td>
<td>6.00&lt;sup&gt;c&lt;/sup&gt;</td>
<td>5.66&lt;sup&gt;d&lt;/sup&gt;</td>
<td>5.93&lt;sup&gt;B&lt;/sup&gt; cond.=.12**</td>
</tr>
<tr>
<td>Freezing effect</td>
<td></td>
<td><strong>6.54&lt;sub&gt;A&lt;/sub&gt;</strong></td>
<td><strong>6.28&lt;sub&gt;B&lt;/sub&gt;</strong></td>
<td></td>
</tr>
<tr>
<td>Tenderness</td>
<td>0</td>
<td>7.03&lt;sup&gt;a&lt;/sup&gt;</td>
<td>6.89&lt;sup&gt;a&lt;/sup&gt;</td>
<td>6.96&lt;sup&gt;A&lt;/sup&gt; inter.=19*</td>
</tr>
<tr>
<td></td>
<td>5</td>
<td>6.41&lt;sup&gt;b&lt;/sup&gt;</td>
<td>6.23&lt;sup&gt;b&lt;/sup&gt;</td>
<td>6.34&lt;sup&gt;B&lt;/sup&gt; cond.=.13**</td>
</tr>
<tr>
<td>Freezing effect</td>
<td></td>
<td><strong>6.72&lt;sub&gt;A&lt;/sub&gt;</strong></td>
<td><strong>6.58&lt;sub&gt;B&lt;/sub&gt;</strong></td>
<td></td>
</tr>
<tr>
<td>Juiciness</td>
<td>0</td>
<td>7.10&lt;sup&gt;a&lt;/sup&gt;</td>
<td>6.80&lt;sup&gt;b&lt;/sup&gt;</td>
<td>6.91&lt;sup&gt;A&lt;/sup&gt; inter.=.19*</td>
</tr>
<tr>
<td></td>
<td>5</td>
<td>6.29&lt;sup&gt;c&lt;/sup&gt;</td>
<td>5.94&lt;sup&gt;d&lt;/sup&gt;</td>
<td>6.21&lt;sup&gt;B&lt;/sup&gt; cond.=.13**</td>
</tr>
<tr>
<td>Freezing effect</td>
<td></td>
<td><strong>6.70&lt;sub&gt;A&lt;/sub&gt;</strong></td>
<td><strong>6.42&lt;sub&gt;B&lt;/sub&gt;</strong></td>
<td></td>
</tr>
<tr>
<td>Flavour</td>
<td>0</td>
<td>6.81</td>
<td>6.67</td>
<td>6.54&lt;sup&gt;B&lt;/sup&gt; inter.=.17ns</td>
</tr>
<tr>
<td></td>
<td>5</td>
<td>7.00</td>
<td>6.87</td>
<td>6.96&lt;sup&gt;A&lt;/sup&gt; cond.=.12*</td>
</tr>
<tr>
<td>Freezing effect</td>
<td></td>
<td><strong>6.88&lt;sub&gt;A&lt;/sub&gt;</strong></td>
<td><strong>6.62&lt;sub&gt;B&lt;/sub&gt;</strong></td>
<td></td>
</tr>
<tr>
<td>Acceptability</td>
<td>0</td>
<td>6.91&lt;sup&gt;a&lt;/sup&gt;</td>
<td>6.68&lt;sup&gt;b&lt;/sup&gt;</td>
<td>6.71&lt;sup&gt;A&lt;/sup&gt; inter.=.16*</td>
</tr>
<tr>
<td></td>
<td>5</td>
<td>6.54&lt;sup&gt;b&lt;/sup&gt;</td>
<td>6.23&lt;sup&gt;c&lt;/sup&gt;</td>
<td>6.53&lt;sup&gt;B&lt;/sup&gt; cond.=.14**</td>
</tr>
<tr>
<td>Freezing effect</td>
<td></td>
<td><strong>6.71&lt;sub&gt;A&lt;/sub&gt;</strong></td>
<td><strong>6.54&lt;sub&gt;B&lt;/sub&gt;</strong></td>
<td></td>
</tr>
</tbody>
</table>
4.3.4 Microbiological properties

As shown in table (13), there was highly significant (P=0.01) variation between freezing period, the mean of total viable count decreased significantly (P=0.05) with the progress of freezing period, and sausage frozen for 30 days had the lowest mean counted compared to that counted immediately after processing. There were not-significant differences between conditioning time and between the interaction between conditioning time and freezing period (P>0.05).

Psychrophilic bacteria table (13) shows that, there were highly significant differences (P=0.01) between conditioning time and significant difference (P=0.05) between freezing period, but the interaction between the two factors was not-significant (P>0.05). Sausage made from conditioned meat had significantly (P=0.05) higher mean Psychrophilic count compared to that manufactured from unconditioned camel meat, also the mean of Psychrophilic bacteria was significantly (P=0.05) greater immediately after preparation and decreased with the progress of freezing period.

Considering *Staphylococcus aureus*, table (13) shows highly significant difference (P=0.01) between conditioning time, and between freezing period, but the interaction between conditioning time and freezing period was not-significant (P>0.05). Sausage made from conditioned meat had significantly (P=0.05) higher mean counted for *Staphylococcus aureus* compared to that made from unconditioned meat, the mean of *Staphylococcus aureus* counted differed significantly (P=0.01) during freezing period, with the highest mean counted immediately after processing.

The total coliform bacteria as shown in table (13), there were highly significant (P=0.01) differences between freezing period and due to the interaction between conditioning time and freezing period, but there was not-significant variation (P>0.05) between conditioning time. Sausage made from conditioned meat had
higher total coliform count immediately and after freezing for 1, but at day 30 there was not detection of total coliform.

With respect *E. coli*, table (13) shows that, there were highly significant difference (P=0.01) between conditioning time and between freezing periods, also the interaction between conditioning time and freezing period was highly significant (P=0.01). The mean of *E. coli* counted for sausage made from conditioned meat was significantly (P=0.05) greater compared to that made from unconditioned meat, the mean count of sausage immediately after processing was significantly (P=0.05) greater compared to that had been frozen.
Table (13) Effect of conditioning time and freezing period on microbiological properties of camel sausage

<table>
<thead>
<tr>
<th>Parameters</th>
<th>Muscle type</th>
<th>Conditioning time</th>
<th>Muscle effect</th>
<th>S.E</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>0</td>
<td>1</td>
<td>30</td>
</tr>
<tr>
<td>T.V.C</td>
<td>0</td>
<td>5.21</td>
<td>3.54</td>
<td>2.32</td>
</tr>
<tr>
<td></td>
<td>5</td>
<td>6.81</td>
<td>4.36</td>
<td>2.76</td>
</tr>
<tr>
<td>Freezing effect</td>
<td></td>
<td><strong>6.01_A</strong></td>
<td><strong>3.95_B</strong></td>
<td><strong>2.54_C</strong></td>
</tr>
<tr>
<td>Psych</td>
<td>0</td>
<td>3.41</td>
<td>2.42</td>
<td>2.13</td>
</tr>
<tr>
<td></td>
<td>5</td>
<td>4.02</td>
<td>2.95</td>
<td>2.18</td>
</tr>
<tr>
<td>Freezing effect</td>
<td></td>
<td><strong>3.72_A</strong></td>
<td><strong>2.69_A</strong></td>
<td><strong>2.15_C</strong></td>
</tr>
<tr>
<td>Staph</td>
<td>0</td>
<td>2.41\textsuperscript{b}</td>
<td>0.00\textsuperscript{c}</td>
<td>0.00\textsuperscript{c}</td>
</tr>
<tr>
<td></td>
<td>5</td>
<td>2.79\textsuperscript{a}</td>
<td>0.00\textsuperscript{c}</td>
<td>0.00\textsuperscript{c}</td>
</tr>
<tr>
<td>Freezing effect</td>
<td></td>
<td><strong>2.60_A</strong></td>
<td><strong>0.00_B</strong></td>
<td><strong>0.00_B</strong></td>
</tr>
<tr>
<td>total coliform</td>
<td>0</td>
<td>2.23\textsuperscript{a}</td>
<td>0.00\textsuperscript{b}</td>
<td>0.00\textsuperscript{b}</td>
</tr>
<tr>
<td></td>
<td>5</td>
<td>2.44\textsuperscript{a}</td>
<td>0.00\textsuperscript{b}</td>
<td>0.00\textsuperscript{b}</td>
</tr>
<tr>
<td>Freezing effect</td>
<td></td>
<td><strong>2.34_A</strong></td>
<td><strong>0.00_B</strong></td>
<td><strong>0.00_B</strong></td>
</tr>
<tr>
<td>E. coli</td>
<td>0</td>
<td>1.33b</td>
<td>0.00c</td>
<td>0.00c</td>
</tr>
<tr>
<td></td>
<td>5</td>
<td>1.60a</td>
<td>0.00c</td>
<td>0.00c</td>
</tr>
<tr>
<td>Freezing effect</td>
<td></td>
<td><strong>1.47_A</strong></td>
<td><strong>0.00_B</strong></td>
<td><strong>0.00_B</strong></td>
</tr>
</tbody>
</table>
CHAPTER FIVE
DISCUSSION

5.1 Meat chemical composition

Camel meat chemical composition gave in (table 2), there were highly significant differences between the two studied muscles Semitendinosus (ST) and Deep pectoral (DP); ST muscle had significantly higher protein, fat and slightly higher ash contents but lower moisture, these were because there was a negative correlation between moisture and fat in muscles. Semitendinosus muscle was classified as intermediate tender, while Deep pectoral as tough muscle, tough muscles had higher moisture content than tender ones, although tender muscles had great protein, fat, and ash (Smith et al., 1988). Since the striated muscles of mammalian body were each designed for a specific role in the living animal, it would be expected that their composition would vary, just as the great differences in their size, shape and anatomical complexity would reflect the wide range of tasks they were required to perform (Laweire, 1991). In general the results agreed and conflicted with previous researches (Nasr et al., 1965; Abdel Baki, 1957) whom found that, the shoulder muscles of camel had 19.8% protein, 78.3% moisture, 3.8% fat, and 1.1% ash, while round muscles had 22.3% protein, 76.1% moisture, 0.95% fat and 0.79%. Babiker and Tibin,(1986) found that, camel meat had significantly greater total protein than cattle, they stated that, camel meat had 74.37% moisture, 21.6% protein, 2.79% fat, and 1.31% ash. Babiker & Yousif (1990) found that Semitendinosus muscle had 75.8% moisture, 21.41% protein, 1.4% fat, and 1.38% ash content. Saliha, (2001) found that Sudanese desert camel meat had 79.01% moisture, 20.19% protein, 2.94% fat and 1.31% ash. Kadium et al., (2006) found that, Omani camels had 76.7%
moisture, 18.6% protein, 1.1% fat and 1.4% ash, while Dalia, (2008) found that, Sudanese camel had 77.75% moisture, 21.05% protein, 0.92% fat, 0.84% ash.

5.2.1 pH determination
Table (3) shows that, pH value decreased with the progress of conditioning time and DP muscle had significantly lower pH value and greater rate of pH decline compared with ST muscle. These might be due to the fact that during cold storage of meat, the lactic acid content increased due to breakdown of glycogen to lactic acid, and pH decreased. Moreover, DP muscle has deep location, greater glycogen and greater sarcoplasmic proteins, so it will be hotter and less temperature losing, greater glycolitic enzymes and higher lactic acid accumulation. The present study generally agree with Gonzalez et al., (2008) who evaluated pH in two muscles (Semitendinosus and longissimus thoraces) during an ageing period of 10 days, and found that, the initial pH (ST = 5.67 vs LT =5.66) on day one, and fell faster on ST than on LT, although both reached the same value after 5 days (5.58). Soltanizadeh et al., (2008) demonstrated that, camel meat reached their ultimate pH after 48hr post-mortem, the pH values were 6.5, 6.1, 5.8, 5.7, and 5.6 for 6, 12, 24, 48, and 72hr respectively for Semitendinosus muscle. The pH decline of meat is related to the glycogen content of the muscle at slaughter, where lower glycogen content may result in decreased rates of glycolysis, hence, a slower accumulation of lactic acid and a slower rate of post-slaughter pH decline. The amount of enzymes in the camel glycolytic pathway is, therefore, less than cattle causing slower glycogen degradation and pH decline (Immonen & Puolanne, 2000); these may be linked to increased protease activity of camel meat. Camel usually transported for a long distance pre-slaughter, so it had higher level of cortisol which lead to an increases in hepatic glycogenolysis.
and gluconeogenesis. Thus, a decrease in level of glycogen during rigor mortis was obtained which lead to a decrease in level of lactic acid and increase in pH of the meat (Salem, 2004). Our results were in conflict with Kotczak et al., (2003) who stated that pH increased significantly during 12-day post-mortem ageing of Psoas major and minor, and Semitendinosus muscles of cow.

5.2.2 Colorimetric parameters
The colorimetric parameters indicated that meat lightness (L*) value increased significantly with an increase in conditioning time, with significant variation between the two studied muscles, where ST muscle had greater (L*) value and lower rate of lightness increasing. These was expected because lower temperature of conditioning promote increased penetration of oxygen into the surface layer of the meat as well as the amount of oxygen dissolved in tissue fluids, both of which factors can assist in maintaining myoglobin and haemoglobin in their oxygenated forms. Also ST muscle has more white fibres, less myoglobin, lower glycogene in compared with DP muscle. The result was in agreement with (Renerre & Bonhmme, 1991; Klont et al., 2000) who stated that L* value increased significantly during conditioning period. Guignot et al., (1992) concluded that the relative influence of the pigment content and rate of pH fall on colour traits was dependent on muscle type. Meat colour is dependent upon the quantity and oxidation states of muscle pigment myoglobin, so different between muscle types were generally significant for colour value during and after oxygenation and due to difference in total pigment concentration (Matsumoto et al., 1983); the concentration of the total pigment is a factor inherent to the type of muscle. Our result was in conflict with (Chambaz et al., 2003; Vieira et al., 2006) they found no effect of ageing on any of the colorimetric parameters.
The present study found that the (a*) and (b*) values decrease significantly with increasing conditioning time, with significant variation between the two studied muscles (ST& DP). This was similar with (Renerre & Bonhmme, 1991) they found that the (a*) and (b*) values decreased during conditioning time (1, 2, 3, 4 days), but with non significant differences. Klont et al., (2000) stated that (a*) and (b*) of veal carcasses be stable or constant during ageing period of (2, 3, 4, 7 and 14 days). Nour, (2003) found that, a* and b* values decrease significantly during ageing period of (1, 5, 10, 15 days). Gonzalez, et al., (2008) measured colorimetric traits (a*) and (b*), they found that the red and yellow indices maintained a constant trend during conditioning.

5.2.3 Protein fractionation
In this study myofibrillar proteins extractability increased significantly with increasing conditioning periods, ST muscle had greater mean of myofibrillar protein than DP muscle, the rate of increasing in myofibrillar protein value was greater in ST muscle compared with DP muscle. ST muscle had greater total protein, may be it had more proteases activity than DP muscle, low pH caused disruption of the lysosomal membranes; allowed the lysosomal enzymes to become free within the cytoplasm and to gain access to the myofibrillar proteins. There was strong evidence that lysosomal proteases were released during conditioning, once the muscle pH had fallen to pH 5.50 (Wu et al., 1981; Yates et al., 1983). The extractability at high ionic strength of total myofibrillar protein rose up to and even beyond the initial level on subsequent storage at 2°C (Lawrie, 1991). Myofibrillar protein degradation highly influenced by the length of ageing period (Palka, 2003) and by the studied muscle (Strandine et al., 1949). It is well accepted that during conditioning proteolytic changes occur in the myofibrillar proteins leading to
their increased fragility (Penny, 1980; Etherington, 1984). This was in agreement with Nour, (2003) who found that myofibrillar protein increased significantly during ageing periods, with varying degree between different muscles; Gonzalez et al., (2008) reported that, myofibrillar degradation increased significantly during ageing time for both Semitendinosus muscle and longissimus thoracis with no variation between the two muscles. Goll et al., (1964) studied the Longissimus dorsi and Semitendinosus muscles and found that myofibrillar proteins were least extractable at 24h post-mortem, but their solubility was significantly higher at 168-336h than at 24h post-mortem. Considering Sarcoplasmic proteins, their extractability was significantly affected by conditioning time and muscle type. The amount of extractability was decreased with increasing conditioning time; moreover, DP had significantly greater sarcoplasmic protein and higher reduction rate compared with ST muscle. The decrease of sarcoplasmic proteins extractability during conditioning time could be due to their proteolysis to amino acids, DP muscle had significantly lower pH value and higher myoglobin content than ST muscle; thus these might enhance the proteolysis of sarcoplasmic proteins. this was in agreement with Nour, (2003) who stated that, sarcoplasmic protein decreased significantly with increasing ageing period of (1, 5, 10 and 15 days). Goll et al., (1964) studied the L.dorsi and Semitendinosus muscles and found that sarcoplasmic protein was most extractable immediately after death and that its solubility decreased during post-mortem ageing of 168-336hs. Abdel Baki et al., (1957) observed that in camel meat during cold storage, the coagulable protein and alkali insoluble protein decreased gradually. Deatherage and Fujimaki, (1964) stated that, the considerable increment in the soluble products of protein breakdown must arise from sarcoplasmic protein.
Sarcoplasmic proteins during post-mortem ageing undergo large changes in composition during storage at temperature of 5°C or lower (Lawrie, 1991).

Regarding non-protein-nitrogen; there was significant increase with the progress of conditioning time and ST muscle had significantly greater non-protein nitrogen. Denatured proteins are particularly liable to attack by proteolytic enzymes, leading to an increase in water-soluble nitrogen, due to the production of peptides and amino acids from protein. The increases in n-p-n may also be due to hydrolysis of meat proteins by the endogenous proteolytic enzymes of the muscle and those synthesized by the psychrophilic microflora of the natural contamination of meat. Our result was inline with previous result by (Babiker and Yousif 1990), who found that, non-protein-nitrogen, was 0.56 for L.dorsi, 0.52 for Semitendinosus and 0.53 for Triceps brachii muscle with highly significant difference (P=0.01) between the three muscles. Saliha, (2001) stated that, non-protein-nitrogen of camel meat increased significantly during conditioning times, 0.48, 0.52, 0.57, and 0.61 for day 1, 3, 5, and 7 respectively. Nour, (2003) found that non-protein-nitrogen percentage increased significantly with increasing ageing period. Souble non-protein-nitrogen increased significantly during post-mortem ageing; denatured proteins are particularly liable to attack by proteolysis enzymes, leading to an increase in water-soluble nitrogen, due to the production of peptides and amino acids from protein (Lawrie, 1991). The rest of non-protein-nitrogen, being composed of peptides with smaller molecular mass. The increase of non-protein fraction improves both the tenderization and the degree of nitrogenous compounds of the meat (Warris, 2000; Ionescu et al., 2008).

Considering connective tissue protein; the percentage decreased continuously and varying in accordance with applied treatments. Connective tissue protein
was greater in DP muscle, also the rate of reduction was lower compared to ST muscle; these were expected, because DP was in the chest; so it had been exposed to high training and exercise due to respiration, the flat shape and large size in compared to ST muscle which had round shape and small size; so the distribution and amount of connective tissue protein will be greater in DP muscle. Connective tissue properties, had been reported to be highly influenced by the length of the ageing period (Palka, 2003), and by the studied muscle (Strandine et al., 1949). Gonzalez, et al., (2008) reported that, total collagen decreased during ageing period (2, 5, 8, and 10 days at 4°C) for both Semitendinosus and Longissimus thoracis muscles. The increase in collagen solubility during ageing was found to be highly significantly different between muscles (Kotczak et al., 1992). During ageing it takes place a limited process of proteolysis which leads to ultrastructural changes in skeletal muscle and to the improvement of meat tenderness (Koohmaraie, 1992). It is possible that during post-mortem ageing of meat a part of intramuscular collagen turns into soluble form, exo-endopeptidases of which may degrade to amino acids. During ageing significant changes occur in the properties of intramuscular collagen, causing an increase in its solubility (Koohmaraie and Geesink, 2006). The changes in properties of intramuscular collagen might be responsible for an increase in spaces between adhering muscle fibres (Kotczak et al., 2003), and weakening of intramuscular connective tissue (Nishimura et al., 1995; 1996). The lysosomal proteases capable of cleaving native insoluble collagen to soluble fragments are cathepsins B, L and N (Lawrie, 1991).

5.2.4 Water holding parameters
Considering water-holding capacity, the present study showed that, water-holding-capacity increased with time, and Semitendinosus muscle was
superior over Deep pectoral. ST muscle had slight higher ash content, greater myofibrillar protein extractability and degradation, so it could released greater Ca and Na ions and greater K ions which might lead to more change in osmotic pressure induced more reactive group of protein to link with water, so it expected that (WHC) be greater compared with DP muscle. The improved (WHC) could be due to the proteolytic degradation of cytoskeletal proteins, which had subsequently caused swelling of the myofibrils and allowed the meat to retain water (Huff-lonergan & Lonergan, 2005). Degradation of the cytoskeletal proteins during conditioning would increase (WHC) of meat by removing inter-myofibrillar and costameric connections and thereby reduce or remove the linkage between the rigor-induced lateral shrinkage of the myofibrils and shrinkage of the whole muscle fibre. This finding was similar to previous reports Arnold et al., (1956) who found that sodium and calcium ions were continuously released into the sarcoplasm by the muscle proteins during conditioning, and potassium ions were absorbed after the first 24 hrs. Large excess of potassium ions on the muscle protein lead to increase the net charge, thereby, the water-holding capacity increased. On subsequent conditioning of the meat, (WHC) tends to increase; this might be due to an increased osmotic pressure, caused by the breakdown of protein molecules to small units; much intramuscular rearrangement, causing changes in the electrical charges on the protein, might also be responsible (Lawrie, 1991).

With respect to cooking loss, there was significant effect of conditioning period on cooking loss and a significant effect of muscle type. In this study ST was superior over DP muscle; this might be due to the fact that during cooking, the liquid comes from constitutive water and from the fat melted during heating, so the difference between muscles is expected (Mandell et al.,
1997; King et al., 2003). Cooking induces structural changes, which decrease meat water holding capacity, and thermal shrinkage causes loss of protein immobilizing water (Tornberg, 2005); so the difference between muscles was expected. Our study was in agreement with many researchers (Klont et al., 2000; Nour, 2003; Gonzalez et al., 2008). They found that cooking loss decreased significantly during ageing period. Cooking loss decreased with increasing storage time. Abdul Rahim et al., (2006) concluded that the percentage of cooking loss differed significantly between different muscles, and the effect of conditioning on cooking loss was found to be independent of the muscle type and this was statistically evident by the absence of interaction between conditioning and muscle type. And this was in conflict with our study. Also Al-Owaimer (2002) noted that conditioning had little effect on cooking loss of camel meat. Vieria et al., (2006) reported no effect on cooking loss during ageing period.

Considering drip loss, it was decreased significantly during conditioning period and Semitendinosus muscle was superior over Deep pectoral. This was in agreement with Abdul Rahim et al., (2006) they demonstrated that the percentage of drip loss decline throughout the 7 days of conditioning. The highest percentage was exhibited by the unconditioned samples and this could be explained by improvement in water-holding capacity during the conditioning as reported earlier by (Boakye & Mittal 1993). Maria and Alfredo (1980) noted that the percentage of exudates obtained from freezing meat those aged before decline when time post-mortem increase (12.44%, 9.52%, 7.8% for day 2, 4, and 6 respectively). Some conflicting researches results were found; Vieria et al., (2006) observed no significant difference of
drip loss during ageing period. Al-Owaimer (2002) stated that conditioning had little effect on drip loss in camel meat.

With respect to weep loss in this study there were significant difference between the two types of camel muscles, and significant effect of conditioning period, and over all significant variation of interaction. The improvement in weep loss was successively achieved during conditioning time, although the weep loss increased with time; the increasing rate was in reduction rate; probably due to accentuated proteolysis, with consequent reduction of ionic stretch (Huff-lonergan and lonergan, 2005). These results were in agreement with earlier researches (Klont et al., 2000) who studied weep loss in three groups of veal carcasses selected on the basis of their pH fall and found that weep loss increased significantly within each group during the ageing period of (2, 3, 4 and 14 days). Gonzalez et al., (2008) studied weep loss in Semmitendinosus and Longissimus thoracis muscles, of beef during (1, 2, 5, 8 and 10 days) of ageing, they found that, weep loss increased during ageing period for both muscles (2.85% for ST and 1.89% for LT respect to 8 days value).

5.2.5 Electrophoresis

Table (6) shows the appearance of 200 KDa which corresponds to myosin heavy chains (MHC), this was similar to the result by Vasileva et al., (2010) they stated that, due to its molecular weight, the band of (MHC) was located close to the top of the gel. Iwanowska et al., (2010) claimed that, during the 10–day period of cold storage, a continuous increase in the content of 200 KDa, protein was observed from 45 min, and 48, 96 and 240 hrs. post slaughtered (14% to 16.07%). These changes indicate that, in the place of the
band, which usually corresponds to myosin heavy chains (MHC), appeared also products of high-molecular protein degradation.

There was appearance of 105KDa, during the ageing period for both studied muscles, this finding is in agreement with Iwanowska et al., (2010) that, the storage time did not affect change in 105KDa protein, which corresponds to a-actinin, the main element of the Z-disk. This observation confirms suggestion of Taylor et al., (1995), that the protein in question does not undergo rapid degradation. The most likely candidate is a-actinin, but it has been shown (Penny, 1980) that, the a-actinin content does not change during ageing nor does its property of binding to F-actin. The amount of the band of a-actinin decreases during cold storage period from 1 to 14 days, but not significant (Vasileva et al., 2010). The data for the resistance of degradation of a-actinin was stated by Goll et al., (1991).

Table (6) shows the slight appearance of 55KDa which correspond to desmin. Toylar et al., (1995) revealed that over a half of desmin of the Semitendinous muscle was degraded between day 1 and 3 of cold storage, leading to rapid increase in meat tenderness. Iwanowska et al., (2010) revealed that, within the protein of 42–200KDa it is possible to observe the desmin degradation change. In the second and fourth day of cold storage the content of products of desmin degradation increased intensively, whereas the desmin band was conspicuous and disappeared only on day 10 storage. Hwan and Bandman, (1989), showed that desmin is easily degraded detected at 4°C during ageing process. They also stated that further storage at 4°C results in an increase of proteolytic fragments and concomitant loss of intact desmin by 3 weeks postmortem, little un-degraded desmin remains in the muscle. Desmin is a secondary filament, surrounding the Z-disk of the myofibrils. It is located in
the periphery of the Z-disk and connects the closely situated myofibrils on the level of their Z-lines, thus connecting the myofibrils with other cell structures including sarcolema (Robson, et al., 1995) and preserving the structural integrity of the muscle cells. Rowe et al., (2004) prove that the postmortem alteration of desmin due to its role location influence the tenderness of meat. Vasileva et al., (2010) stated that the part of the desmin band changed from 1.10% to 0.88% at the end of storage (14 days) but the quantity of the separated of it 38KDa fragment was significantly increased (P=0.05) during refrigerated storage. While investigating the changes in desmin band in the same muscle (L. darsi), Ho et al., and (1997) reported that, it’s slow fading till 28th day of the refrigerated storage.

Table (6) shows appearance of 45KDa, this in agreement with recent study by Iwanowska et al., (2010). They revealed that, the process of degradation of proteins of the range 42-200KDa proceeded similarly to the degradation of 200KDa and some proteins constitute degradation products of higher molecular protein. Moreover, the appearance of these bands correlated (R² = 0.82) with meat tenderness on day 7 of cold storage. The 43KDa corresponds to actin. Vasileva et al., (2010) revealed that, the part of the main protein fractions actin and myosin decreased during the storage time (1 to 14 days). The data for the resistance of degradation of actin by the calpain during refrigerated storage was reviewed by Goll et al., (1991). Koohmaraie, (1996) revealed that, myosin, actin, and alpha-actinin do not affect the processes of increasing of the meat tenderness.

Below actin was corresponding to T-troponin with MW 37KDa. Many investigators reported about degradation of T-troponin during cold storage, i.e. in a number of studies Troponin–T is determined as a regulatory protein.
without direct influence on the meat tenderization but its changes during postmortem might indirectly improve the tenderness of meat by breaking the thin filaments and the interaction between the thin and the thick filaments (Ho et al., 1994; Huff-lonergan et al., 1996; Negishi et al., 1996). However, George et al., (1980) failed to find any correlation between the loss of Troponin-T and the decrease in shear force during ageing.

Below the T-troponin there was appearance of tropomyosin with MW 35 and 33KDa. This was in agreement with finding by Vasileva et al, (2010) they stated that, the tropomyosin is visualized under T-troponin band and changes its relative part with 0.61% during the time of storage. Matsumato et al., (1983) demonstrated that tropomyosin was degraded to 33, 20 and 11KDa fragments during cold storage.

In the present study there was appearance of 30KDa from day 3 in ST muscle, but only at day 7 in DP muscle. Penny and Dransfield, (1979) consider the appearance of 30KDa polypeptide as an indicator of proteolysis and meat tenderness, related to Troponin-T. Soares et al., (1995) observed light weakening of Troponin-T during cold storage up to 9 day at 2ºC of buffalo meat. Penny, (1980) noticed the appearance of protein band with molecular masses of about 30KDa in aged meat. Okitani et al., (1981) suggested that, the origin of 30KDa band is a proteolytic fragment of myosin. Koohmaraeie et al., (1984) observed the appearance of a 30KDa band concomitantly with the disappearance of desmin and Troponin-T. These indicate that desmin might be the source of the 30KDa band. Regardless of the source, a parallel increase in tenderness with the increase in intensity of the 30KDa peptide has been reported by many researchers. O’Halloman et al., (1997) relate the process of meat ageing to proteolysis of troponin-T and appearance of fragments of
molecular weight of 30KDa. This protein is often accepted as a good indicator of meat tenderization process. Vasileva et al., (2010) revealed that, the amount of T-Troponin decreased for all period of storage (1, 6, 14 days) which was related to the increase of 30KDa polypeptide during ageing. Parrish et al., (1981) failed to find differences in the 30KDa band between tender and tough maturity (old beef).

The low molecular weights components represented by 25KDa, 18KDa, and 16KDa which corresponding to myosin light chain1 (MLC1), I-Troponin, myosin light chain2 (MLC2), and myosin light chain3 (MLC3) respectively. These findings are in agreement with many previous results, Lowey et al., (1969); Seller and Goodson, 1995) Stated that, one-dimensional Sodium dodecyl sulphate (SDS-page) of purified skeletal muscle myosin showed three light chain bands in addition to the heavy chain band, the light chain bands were called LC1, LC2, and LC3 with decreasing molecular weight, 25KDa, 18KDa, and 16KDa respectively.

They also, claimed that, the sub- fragment of heavy meromyosin, with molecular weight about 110KDa can be further split by protedytic enzymes, into three fragments: 25 KD (terminal), 50KDa (Central) and 20KDa (terminal) fragment. Vasileva et al., (2010) stated that, two more bands of the myosin light chain (MLC) located in the lower part of the gel, the parts of the MLC1 (25) and MLC2 (18KDa) are increased at the end of the refrigerated storage (14 days) they also stated that I-troponin identified between the two MLC components. As pointed by (Ho et al., 1996) its distance of migration increases.
5.2.6 Sensory evaluation

Considering tenderness, with time there was successively improvement in tenderness, the maximum improvement was achieved at day 7 was 36% compared with day one. ST muscle was superior over DP muscle. This might be expected because ST muscle had more protein degradation, greater protease activity and less connective tissue protein compared with DP muscle. Moreover, during conditioning there was extensive proteolysis of the collagen and elastin of connective tissue might appear to be the most likely change causing increased tenderness. Collagen fibres appear to swell during conditioning, a feature which may signify that cross-links are, in fact, being broken. The result was in agreement with Al-Owaimer, (2002) who concluded that the optimum ageing time for improving camel meat was 7 days. Goll et al., (1983) stated that, the improvement in tenderness during conditioning is the result of proteolytic degradation by proteases endogenous to the skeletal muscle cell. Goll et al., (1997) postulated that early post-mortem tenderization can be explained by changes in the actin/myosin binding state, where as increases in tenderness after 3 days of ageing are more related to post-mortem protein denaturation.

Regarding juiciness, as sited in table (7), there was great improvement in juiciness with the progress of conditioning time; ST muscle was superior over DP muscle. This may be due to the improvement in WHC which result in reducing cooking loss during conditioning time, therefore improved meat juiciness. The difference between muscles was expected; as juiciness is the impression of wetness produced by release of meat fluid and due to the stimulatory effect of fat on salivation. This was in agreement with Vieria et al., (2006) found that in Morucha pure breed, the scores of juiciness increased
significantly until 10 days of ageing, where as in Charolais cross breed juiciness did not increase significantly after 7 days. Lawrie, (1991) noted that during roasting of meat, coagulation of the proteins on the surface inhibits loss of fluids; and the more rapid the heating, the faster the formation of this layer and the lower the shrink; and increased in juiciness.

With respect to flavour, table (7) shows significant increase in flavor score with the progress of conditioning time, not-significant effect between the two studied muscles. Research by (Campo et al., 2003) indicated that the delayed increase in flavour intensity is a result of the accumulation of the products, which can be considerable as flavour precursors, derived from proteolysis that occur during ageing. During conditioning period flavour tend to increase; there are high MW hydrocarbons, benzenoid components and pyrazines. Moreover changes in free fatty acids during ageing contribute, to the flavour changes. Thus, the level of Oleic acid in the intramuscular fat has been observed to be increased during storage of beef at 2°C (Lawrie, 1991).

Regarding colour, there was non-significant difference among conditioning times, as well as non-significant variation between muscle types. This was in agreement with (Nour, 2003) who noted that, there was not significant difference among ageing period (1, 5, 10 and 15 days) on colour trait. lower temperature promote increased penetration of oxygen into the surface layer of the meat as well as the amount of oxygen dissolved in tissue fluids, both of which factors can assist in maintaining myoglobin and haemoglobin in their oxygenated form; so when the meat cooked there was not significant difference on cooked colour (Lawrie, 1991).
5.2.7 Microbiological properties studied

In Sudan some problems of slaughter-houses are due to poor waste disposal systems and environmental sanitation, lack of workers training and understanding of the importance of sanitation (Ibrahim, 1989). So in the present study a total viable count was determined on the different muscles at different conditioning periods to include mesophiles and psychrotrophs. Such counts are usually determined because they provide the most useful index of overall hygienic quality.

The results given in (Table 8) declare that, total viable count differs significantly for all the variables studied, and that, the mean counts were generally higher at muscle (DP) than (ST) among all the different periods examined. These were expected, because the (DP) muscle had higher myoglobin and glycogen contents compared to (ST) muscle. Abdel Karium, (1992) who studied spoilage bacteria of beef during refrigeration storage, found that, the total bacteria count increased with progress in refrigeration time. The results also confirmed the statement by Robert, (1980), that bacterial numbers at different sites on the same carcass, may differ significantly. Foda et al., (1978) found that, total bacteria count of camel meat stored at 4°C for 2 days was 110.0×10^3/gm, and 11.30×10^5/gm at day 14. Fallah et al.,(2008), demonstrated that, fresh camel meat under refrigeration temperature ( 3±1°C) had about 5.58, 5.96, 6.90 as aerobic plate count on day 0, 3, and 6 respectively, and the meat spoiled by day 9.

Nortje et al., (1989a) studied total aerobic count of beef retail cuts ( from chuck and rump) stored for 0, 2 and 4 days at 5°C, they found that, the total count on meat cuts was highest, followed by the psychrotrophs, the pseudomonadaecae, the increase in total viable mean counts were significantly
different throughout storage time, and between the studied cuts. Mona, (2000); Nazik, (2007) found that, total bacteria count of minced meat increased with highly significant difference during refrigeration storage at (4±2°C).

The higher bacterial counts obtained during this work may be due to surface contamination of meat, which came from different sources, mainly hides, air, water, equipment, intestinal content, slaughter floor and hand and clothes of the workers.

Regarding psychrotrophic bacteria, since fresh meat was subjected to continuous refrigeration during slaughter processing and throughout retail display, spoilage organisms must be able to survive and grow at low temperature.

In the present study, statistical analysis showed that, all the variables studied had a significant influence on the psychrotrophic count of the camel meat. The mean psychrotrophic counts on the different conditioning periods for the two studied muscles closely approximate the viable mean count, although these were slightly lower. These findings were in agreement with many previous researches, Nortje et al., (1989a) found that, psychrotrophs counts increased significantly with increasing storage time, with significant variation between the two studied cuts. Mona, (2000); Bohaychuk and Greer (2003); Nazik, (2007) found that, the psychrophiles growth increased significantly during refrigeration storage. Fallah et al., (2008), found about 4.81, 5.11, 6.01, the means count of Psycrophilic bacteria on day 0, 3, and 6 respectively.

The contamination of camel meat with psychrotrophic bacteria in the present study may be due to the fact that, psychrotrophic bacteria which include
potential spoilage organisms of chilled meat were common in soil, water and vegetation (Duree and Thomas, 1970).

Pseudomonas species are widely distributed in nature, in soil and water and because of its wide occurrence it is a frequent contaminant (Monica, 2000).

In the present study, a comparison of counts shows the *Pseudomonas spp* counts closely resembled that of the psychrophic and total viable counts. There was highly significant difference of mean counts among conditioning period. The mean counts were higher on deep pectoral muscle compared with that of semitendinosus. These results confirm the statement by (Gill & Newton, 1980), that the composition of the microbial population of meat will depend on the time and conditions of storage, while Pseudomonas spp. have a marked advantages in growth rates as compared with other genera under aerobic conditions. Furthermore, this advantage tends to increase with decreasing temperatures. Nortje *et al.*, (1989b), they revealed that, both storage time, and meat cuts had highly significant effect on Pseudomonadaceae count. Fallah *et al.*, (2008) found that, *Pseudomonas spp* in camel meat increased significantly (*P* < 0.05) with increasing storage period at refrigeration temperature, they found about, 3.33, 5.86, and 8.08 for day 0, 3, 6, and spoiled at day 9.

Listeria is widely distributed in nature and be found in decaying vegetation and in soils, animal feces, silage and water. As a result of its wide spread in the environment, it is able to survive to long periods of time under adverse conditions, and has ability to grow at refrigeration temperature. Listeria is now recognizes as an important food-borne pathogen (Wagner and Jr., 2000).

The present study shows a significant variation among conditioning time, and between the two studied muscles on *Listeria monocytogene* growth, the mean
Listeria monocytogene counts increased with progress of conditioning time, 3.528, 3.707, 4.000, and 4.283 for day 1, 3, 5, and 7 respectively, (the mean counts were taken as log_{10} cfu/g). These findings proximately inline with Fallaha et al., (2008), they studied the microbial growth on camel meat at (3±1°C), demonstrated that, the mean log values of Listeria monocytogenes increased significantly during storage time, 3.91, 4.30, 4.81, for day 0, 3, 6, respectively and the meat spoiled at day 9. Elmalti and Amarouch, (2008) found that, the growth and survival of Listeria monocytogenes on whole pieces of camel meat storage at 4°C for 10 days increased significantly, 3.02, 3.90, 4.27, 4.80 and 5.74 for day 1, 3, 5, 7, and 10 days respectively.

Streptococcus faecalis, is the main pathogen in the genus Enterococcus, causing about 95% of enterococcal infections (Monica, 2000). Nasr, (2003) isolated Streptococci from nasal cavity, trachea lung tissue and bronchial lymph nodes of the one-humped camel slaughtered in Khartoum State.

In this work, Streptococcus faecalis growth influenced significantly during conditioning time, the mean Streptococcus count increased with increasing refrigeration storage. These results were inline with previous findings by Bently et al., (1987) and Kotula et al., (1987), they studied the microbial properties of different types of meat and meat products during refrigeration storage, and they found an increase in Streptococci count frequently with progress in refrigeration time. Husssein (1987) found that, Streptococci count increased with progress of refrigerated beef storage. Mona, (2000) found that Streptococcus faecalis growth increased significantly during refrigeration storage.

With respect to Staphylococcus aureus. The presence of this organism could be indicative of contamination of meat from skin, mouth and nose of workers
and this is in agreement with other workers who reported that *Staphylococcus aureus* was found on the interior of nasal mucosa of 40–50% of healthy adults and in the thorax of many of them (Duerden *et al.*, 1992). Also Wagner and Jr, (2000) reported that Staphylococci exists in air, dust, sewage, water and food or on food equipment, environmental surface, human and animal. Staphylococci in raw meat may originate from handlers who were the main source of meat contamination. Selma, (2000), isolated Staphylococci from intestinal tract of one-humped camel in Khartoum State. Nasr, (2003), isolated Staphylococci from nasal cavity, trachea, lung tissue and bronchial lymph nodes of the one-humped camel in Khartoum State.

In the present study, there was significant influence of both conditioning period and muscle type on *Staphylococcus aureus*. Deep pectoral had higher count over semitendinosus. Our results agree with (Abdel Karium, 1992) who studied spoilage bacteria of beef during refrigeration storage, found that, the Staphylococci count decreased with increasing times. Conflicting results were found by (Mona, 2000) who stated that *Staphylococcus aureus* increased significantly during refrigeration storage at (4±2°C) and Fallah et al., (2008) who studied the microbial properties of camel meat stored at (3±1°C) for 9days, recorded about 3.80, 4.01, 4.44 for day 0, 3, 6, respectively and the meat spoiled at day 9.

Positive reaction in fecal coliform test may indicate fecal contamination (Fishbein *et al.*, 1976). Mervat, (2003) reported that coliform mean count cfu/g of fresh beef collected from Omdurman central slaughterhouse was 2.6×10^4, while samples from Khartoum North retail meat market had 2.7×10^5 and from Hilat-Kuku retailed meat market had 5×10^4 cfu/g at day zero.
In the present study conditioning period had significant influence in total coliform bacteria, although muscle types had no-significant effect. The mean total coliform bacteria counted were 1.4 MPN/g, 2.4, 2.7 and 3.7MPN/g for day 1, 3, 5 and 7 respectively. These results were in agreement with some researchers, Mona, (2000) found that total coliform increased significantly during refrigeration storage, the mean coliform counts were 392 MPN/g, 1531 MPN g and 7042 MPN/ g for day 1, 5 and 10 respectively. Nazik, (2007) studied total coliform in beef meat, she found that, the total coliform increased significantly with increased refrigeration storage time, the mean total coliform counts were 2.4 MPN/g, 2.8 MPN/g, 4.8MPN/g and 11.20MPN/g at 0, 3, 7 and 10 days respectively. Fallah et al., (2008) studied the total coliform bacteria in camel meat stored at (3±1°C) for 9days, they recorded about, 3.61, 4.23, 5.11, for day 0, 3, 6, and the meat spoiled at day 9 (the means taken as log cfu/g). Some conflict results were obtained by Anil et al., (1995) studied the microbiological quality of sausage; the samples were analyzed after 1, 3, 7, 14 and 21 days after refrigeration storage. They found that the total number of microorganisms increased significantly, but coliform bacteria decreased.

Considering Escherichia coli, (Wagner and Jr., 2000) reported that E. coli is an indicator bacteria of fecal contamination, Entero pathogenic E. coli is a significant cause of diarrhea in developing countries and localities of poor sanitation. Mansour, Linda and Dalia, (1993) showed that E. coli was an important and common human enteric pathogen which causes diarrhea and haemorrhagic colitis.

Lawrie, (1991) found that the organisms derived from infected personnel or healthy carriers include E. coli, Staphylococcus aureus, Streptococcus spp. and Colistridium spp. Pathogenic bacteria, such as E. coli and Lestreia
*monocytogenes*, are commonly found in fresh meats and represent a safety hazard when under cooked meat, are consumed Gants, (1996). Nasr, (2003) isolated *E. coli* from nasal cavity, trachea lung tissue and bronchial lymph nodes of the one-humped camel slaughtered in Khartoum State.

In the present study, conditioning time and muscle type had significant effect on *E. coli*, and so the interaction between conditioning time and muscle type. The means *E. coli* counts were 0.26, 0.31, 0.37 and 0.44 MPN/g for 1, 3, 5 and 7 days, these results was inline with Nazik, (2007) recorded the mean count of *E. coli* on refrigerated beef as 0.20, 0.29, 0.45 and 0.65 MPN/g at day 0, 3, 7 and 10 respectively. Fatima, (1985) reported that, the most frequent coliform bacteria present in meat was *Escherichia coli*. Fallah et al., (2008) stated that *Escherichia coli* were detected in all samples of camel meat during 6 days at cold storage (3±1°C).

Salmonella is found in soil, water, sewage, animals, contaminated poultry flocks, wild birds, insects, flies, processing equipment feed and intestinal tract of human and animals (Banwart, 1989). The gastrointestinal tracts of animal and man are common sources of Salmonella while high protein foods such as meat and meat products are most frequently associated with Salmonella food poising (Wanger and Jr., 2000; Monica, 2000).

Inspite of, the wide spread of Salmonella sources, the present study showed completely absence 100% of *Salmonella spp* on both studied muscles during conditioning periods. This result was confirmed with many studies, Mohamed (1990) showed no presence of Salmonella spp during refrigeration storage of processed meat. Nazik, (2007) observed that, Salmonella spp was not detected throughout any refrigerated storage period tested, (0, 1, 3, 7, and 10 days). Some conflict results by Abdel Karium (1992) reported that Salmonella was
isolated at the rate of 6.2%, 2.7% from beef samples refrigerated for 7 and 10 days respectively. Elmalti and Amarouch, (2008) stated that, Salmonella was found only at day zero, it was Salmonella dubolin at refrigeration storage of camel meat (3±1°C). Mona, (2000) showed, the presence of *Salmonella spp* at a rate of 14.25% at 1 and 10 days of minced meat at refrigeration storage.

5.3.1 Physical analysis
The pH value of sausage made from unconditioned camel meat was significantly higher compared with that made from 5 days conditioned meat. The water – holding – capacity of sausage prepared from unconditioned meat was superior over that formulated from conditioned meat. Dzudi and Okubanjo (1998) stated that WHC and pH value of emulsions prepared from pre-rigor meat were significantly (P<0.05) higher than those made from post-rigor. Thomas et al., (2008) demonstrated that, sausage made from hot-boned meat had higher pH compared with those made from cold – boned. Elizabeth et al., (1988) revealed that, pre-rigor grinding and salting reduced the post-mortem pH decline and extent of meat discoloration. The W.H.C. of pre-rigor mince meat deteriorated during prolonged storage (Salder & Swan, 1997). Hot–boned or pre–rigor meat known to have superior binding properties when used as raw materials in comminuted meat products. Pre-rigor beef has a higher water-holding capacity (W.H.C.) and better fat-emulsifying properties than post-rigor beef, which makes it more suitable for making comminuted meat products such as sausage and patties (Salder & Swan 1997).

With regarding cooking yield, sausage made from unconditioned meat had significantly higher cooking yield compared to that made from conditioned meat. The use of pre-rigor meat significantly reduced cooking loss (Dzudi and Okubanhor, 1998). Thomas et al., (2008) found that hot-boned sausage result
in significantly higher cooking yield compared with cold-boned. Hot-boned meat generally results in higher processing yields than does cold-boned meat (Boles & Swan, 1996; Claus & Sorheim, 2006; Gariepy et al., 1994), due to its higher pH value.

Considering colour, results by Elizabeth et al., (1988) demonstrated that, pre-rigor grinding and salting of beef produces a more stable bright red colour, which appears to be associated with a lower percentage of met-myoglobin and a higher ultimate pH in the pre-rigor salted meat. An increase in redness value of unconditioned processed sausage appears to be associated with its lower met-myoglobin content (Salder & Swan, 1997) due to its more intensive respiratory action (Pisula & Tyburcy, 1996). Mendenhall (1989) reported that, patties from pre-rigor ground beef had more redness but lower yellowness and lightness.

5.3.2 Chemical composition of fresh camel sausage
In our study sausage made from unconditioned camel meat had significantly higher moisture and protein contents but lower fat and ash contents compared with that made from 5 days conditioned meat. These findings were in agreement with many researchers, Berry et al., (1999) reported higher moisture and fat retention in Patties made from hot-processes beef. But Claus and Sorheim (2006) observed lower percentage of moisture and protein and higher fat in patties made from pre-rigor beef. Thomas et al., (2008) stated that proximate analysis revealed slightly higher moisture and protein contents and a significantly higher fat percent in sausage made from hot-boned meat. Dzudic and Okubanjot (1998) found that, the moisture content of the sausage prepared from pre-rigor meat was significantly higher ($P<0.05$) than those prepared from post-rigor, and the fat content was lower in sausage that made
or formulated from pre-rigor meat – Elizabeth et al., (1988) demonstrated that, the extent of lipid oxidation was not significantly different for pre-rigor and post-rigor ground salted meat samples, although salt accelerated oxidation during storage. The increase in moisture could be attributed to the better binding properties resulting from increased solubility and thus extractability of actin and myosin in hot-boned meat (Salder & Sawan, 1997). This may be expected because permanent cross bridges between actin and myosin would not have formed in hot-boned meat at the time of processing and muscle will be in a more relaxed state due to their still higher ATP level (Thomas et al., 2008).

5.3.3 Sensory Evaluation
As seen before, the colour of sausage made from unconditioned meat had significantly higher (P<0.01) colour score, higher juiciness, higher overall acceptability compared with sample made from 5 days conditioned raw materials, while sausage formulated from conditioned meat only had higher tenderness score for juiciness, and colour than those from post-rigor Dzudi and Okuban jot (1998). Thomas et al., (2008) stated that hot-boned sausage had significantly better (P<0.05) appearance on the day of processing, the bright red appearance on the day of processing, could be attributed to their lower met-myoleb in content as a result of more intensive respiratory action (Salder & Swan, 1997). Flavour score was significantly higher for cold – processed sausage, juiciness, texture had no significant difference, Thomas et al., (2008) did not find differences in sensory characteristics of patties prepared from hot-boned and cold-boned ground beef. In addition several researchers have found no significant differences among the overall acceptability of hot and cold – processed pork (Pisula & Tyburcy, 1988; Rhee
et al., 1988). Moreover Bentley et al., (1988) reported that sensory panel evaluation scores of firmness, flavour and overall desirability for Luncheon loaves exhibited no significant differences as affected by hot or cold processed meat and fat.

5.3.4 Microbiological properties of camel sausage

In general our results were in agreement with many previous researches. Borgstrom, (1955) reported that, cells which were still viable immediately after freezing died gradually on storage in the frozen state. Woodburn and Strong, (1960) observed a significant decrease in number of viable bacterial cells stored at -11°C and -30°C over ten weeks period.

Ann Ma-lin and Becuat (1980) reported that, cells of bacteria which had been exposed to temperature of 2°C for periods of time as short as 30 minutes, showed signs of damage and death rate of approximately 50% when frozen. Despite the great benefit of freezing to food industries, a number of workers had observed that many pathogenic bacteria survived prolonge storage in various kinds of frozen foods.

Conflicting report by Woodburn and Strong (1960) reported that at -30°C, the viable numbers of S. aureus and Strep. Faecalis did not decrease significantly after 10-weeks of frozen storage.
CHAPTER SIX
CONCLUSIONS AND RECOMMENDATIONS

- Chemical composition of camel Semitendinosus and Deep pectoral muscles differed significantly.
- The differences in colorimetric traits during meat conditioning time and between the studied muscles were due to the relative difference of pigment myoglobin content.
- The rate of pH fall in camel meat is slow due to the slow rate of glycogen degradation. An elevated pH early post-mortem while muscle temperature is still high favors Calpains degradation activity on myofibrillar proteins.
- ST muscle had a slower pH decline than DP, which might be due to lower glycogen content and that could suggest an increased Calpains enzymes activity and early tenderness achieved by this muscle.
- During conditioning times, proteolytic changes occur in the myofibrillar proteins leading to their increased fragility. The sarcoplasmic protein decreased and the non-protein-nitrogen increased during ageing due to hydrolysis of meat proteins by the endogenous proteolytic enzymes of the muscle and those synthesized by the psychrophilic microflora of the natural contamination of meat. These Changes were associated of increased muscle tenderness and flavor.
- Water-holding-capacity improved during ageing possibly due to, an increased osmotic pressure, caused by the breakdown of protein molecules to small units, the change in the electrical charges on the protein, and the proteolytic degradation of cytoskeletal proteins, which caused swelling of the myofibrils and allowed the meat to retain water. The improvement on
cooking loss, drip loss, weep loss mostly depended on the improvement of (WHC).

- Ageing provided changes in the banding pattern of myofibrillar proteins on SDS-page (SDS-polyarrcrylamide gels). These changes included the well documented loss in the intensity of the desmin and troponin-T bands with the concomitant appearance of protein bands at the 30Kilodaltons (KDa) region.

- There was successively improvement in tenderness, juiciness, and flavor and over all palatability with the progress of conditioning time and the ST muscle was superior over DP muscle.

- Total bacterial count, psychrophilic bacteria count as well as specific bacteria as Pseudomonas spp, Listeria monocytogene, Streptococcus feacalis, increased significantly with the progress of conditioning time. But counts were within the allowed limits of bacterial meat loads. While Staphylococcus aureus, total coliform, and Escherichia coli decreased. Increased slaughter house hygiene and personnel health education and implementation of HACCP systems would reduce initial bacterial contamination of meat. The observed increase in bacterial count due to storage at refrigeration temperature (2°C) denoted that, despite the fact that, this temperature was generally known to retard or stabilize bacterial growth yet; multiplication of some bacteria was not completely inhibited. Even below the minimum growth temperature it was well established that metabolism did not cease completely.

- Physical and chemical properties, sensorial traits and microbiological parameters of fresh camel sausage were affected by conditioning time and freezing period.
Recommendations

- By the formation of the cross-links between the collagen molecules, the meat of old animals becomes harder. In order to obtain tender meat at industrial level, it proceeds either to the slaughter of young animals, or to the storage of meats for ageing at low temperature (0-4°C).

- Further investigation is needed into earlier post-mortem muscle protease activity in different muscles to explain the difference in myofibrils degradation.

- Pre-rigor meat had superior water-binding characteristics than post-rigor meat, so processed meat products with improved quality could be produced if pre-rigor meat was used.

- Pre-rigor meat for processing must be used shortly after slaughter, or its superior functionality will be lost. Therefore only processors that have their own slaughtering facilities or with such facilities close by can use pre-rigor meat in processing.

- Meat used for sausage production must has the least possible bacterial contamination this could be achieved by keeping meat thoroughly chilled and handling it in the most hygienic way possible.

- The risks of very considerable bacterial contamination from sausage ingredients can largely be avoided by using refined grades of spices (particularly by using the extracted oleoresins and essential oils in one of the various forms commercially available), and by using so-called sterilized (i.e. heat-treated) cereals or cereals blends.

- Product handling increase product contamination from hands, surfaces, and air. Since this will in turn lead to a shortening of shelf life, handling must be limited.
CHAPTER SEVEN

REFERENCES


128


Bendall, J. R. and Resrall, D. L. (1983). The cooking of single myofibrils, small myofibril bundles and muscle strip from beef *M. psoas* and
M. sternomandibularis muscles at varying heating rate and temperatures. J. Meat Sci. 8:93.


Ghada, I. A. (2008) Physical and chemical properties of burgers manufactured with different levels of camel meat. M.Sc thesis, University of Khartoum,


Monica, Ch. (2000). District Laboratory Practice in tropical countries. Part 2 Cambridge University Press.


