

بسم الله الرحمن الرحيم

**Sudan University of Science and Technology  
College of Graduate Studies**

**A comparative Study of Chemical Composition and  
Quality Attributes of fresh and Processed Meat Of  
Calf, Camel and Goat**

دراسة مقارنة التركيب الكيميائي وخصائص جودة لحوم العجول والجمال  
والماعز الطازجة والمصنعة

**By**

**Siham Abdelwhab Alamin Mohammed**

**B. Sc. (2006) and M.Sc. (2008) College of Veterinary  
Medicine and Animal Production, Sudan University  
of Science and Technology**

**A thesis submitted in fulfillment of the  
requirements for the degree of Doctor of Philosophy  
in Animal Production (Meat Science and  
Technology)**

**Supervisor**

**Prof. Daoud Alzubair Ahmed Daoud**

**Department of Meat Science and Technology**

**College of Animal Production Science and  
Technology**

**December 2014**

# بِسْمِ اللَّهِ الرَّحْمَنِ الرَّحِيمِ

لَنْ يَنَالَ اللَّهُ لُحُومُهَا وَلَا دِمَاؤُهَا وَلَكِنْ يَنَالُهُ التَّقْوَىٰ مِنْكُمْ كَذَلِكَ سَخَّرَهَا لَكُمْ لِتُكَبِّرُوا اللَّهَ عَلَىٰ مَا هَدَاكُمْ ۗ وَبَشِّرِ الْمُحْسِنِينَ

صدق الله العظيم

سورة الحج آية (٣٧)

# DEDICATION

To my Family with all my Love

## **ACKNOWLEDGEMENTS**

After giving thanks and prayers to Allah for his great blessing, I would like to express my sincere

appreciation and deep gratitude to my supervisor Prof. Daoud Alzubair Ahmed Daoud for his excellent supervision, invaluable guidance, and valuable advices during the study and continuous interest which have made this work possible.

I would like to express my gratitude and indebtedness to Prof. Shadia A.Alaati Omer for her encouragement and constructive criticism.

I would like to express my gratitude to my family for their encouragement and support during the study.

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## **Abstract**

The study aimed to evaluate the chemical composition and quality attributes of fresh and processed Camel, beef and goat meat. The result showed the chemical composition of camel, beef and goat meat were significantly different ( $P < 0.05$ ). Chemically, camel and goat meat had higher moisture content compared to beef as (77.92, 75.55 and 72.12%) respectively. Beef had higher protein content as (21.07%) compared to camel and goat meat as (19.25 and 20.32%) respectively. Whereas, camel meat had the lowest fat content (1.17%) compared to beef and goat meat as (2.74 and 1.66%). Camel meat had the highest ash content (0.78%) followed by beef (0.47%) and goat meat (0.43%). The present result showed that the camel meat had lowest cholesterol content (59.2 mg/100g) compared to beef and goat meat as (73.6 and 71.2mg/100g) respectively. The present results showed that myofibrillar proteins, sarcoplasmic proteins and non-protein-nitrogen were not significantly ( $P > 0.05$ ) different among the three types of meat. The result showed concentration of myofibrillar protein was similar in the camel, beef and goat meat as (11.24, 11.48 and 11.24% respectively). Also the sarcoplasmic proteins values were (5.50, 5.35 and 5.40%) for camel, beef and goat meat respectively. The non-protein-nitrogen values were (1.35, 1.05 and 1.16%) in camel, beef and goat meat respectively. Results showed that hunter lightness (L) values were highly significant ( $P < 0.001$ ) between three types of meat. Beef and goat meat recorded higher values of lightness compared to camel meat as (33.27, 32.44 and 29.76) respectively. Redness (a) values were not significantly ( $P > 0.05$ ) different between the three types of meat studied, hence goat meat recorded the highest values followed by beef and camel meat as (18.53, 17.69 and 17.04) respectively. The yellowness (b) values were significantly ( $P < 0.001$ ) different between treatments, However, beef recorded the highest values followed by camel and goat meat as (8.82, 7.48 and 5.82)

respectively. In general, camel meat appeared brighter red than beef and goat meat. Water holding capacity (WHC) was highly significant ( $P < 0.01$ ) different among the three types of meat. The WHC values were (1.37, 2.44 and 2.19) for camel, beef and goat meat respectively. Camel meat recorded the lowest values compared to beef and goat meat (camel meat had superior WHC compared to beef and goat meat). The results of cooking loss were highly significant ( $P < 0.01$ ) among the three types of meat. Cooking loss percent of camel meat was the highest values followed by goat meat and beef as (36.3, 34.15 and 31.75%) respectively. The pH values in this study showed no significant ( $P > 0.05$ ) different between the three types of meat. However the pH values were (5.88, 5.77 and 5.68) in camel, beef and goat meat respectively. The moisture content showed significant ( $P < 0.05$ ) different among the three types of sausage. The moisture percent in this study was (73.45, 70.32 and 71.0%) in camel, beef and goat sausages respectively. Camel and goat sausages had higher moisture content compared to beef. Whereas, Beef sausages had higher protein content (18.53%) compared to camel (16.0%) and goat sausages (18%). The fat content was highly significant ( $P < 0.01$ ) among the treatment sausages. However, the fat content of beef sausages was the highest followed by goat and camel sausages as (3.45, 3.0 and 2.31%) respectively. Ash content was highly significant ( $P < 0.01$ ) different among the three types of sausage. Camel sausages had the highest amount of ash followed by beef and goat sausages as (2.0, 1.33 and 1.12%) respectively. The non-protein-nitrogen was not significantly ( $P > 0.05$ ) different among the three type of sausages. Their values were (6.47, 6.23 and 5.89%) respectively. Lightness (L) values were highly significant ( $P < 0.001$ ) between the three types of sausage. Goat sausages recorded the highest values compared to beef and camel sausages as (32.15, 31.8 and 28.5) respectively. Redness (a) values were not significantly ( $P > 0.05$ )

different. Goat sausages recorded higher values followed by beef and camel sausages as (11.56, 11.45 and 10.40) respectively. Similarly, yellowness (b) values were not significant ( $P > 0.05$ ) different. Goat sausages recorded the highest values followed by beef and camel sausages as (8.56, 8.48 and 7.67) respectively. Water Holding Capacity in camel sausages recorded the lowest values (0.48) compared to beef and goat sausages as (1.06 and 0.69) respectively, (camel sausages had the highest water holding capacity compared to beef and goat sausages). Camel sausage had higher cooking loss (24.12%) compared to beef and goat sausages as (21.45 and 22.0%) respectively. The pH values showed no significant ( $P > 0.05$ ) difference between the three types of sausage. pH values were (5.65, 5.73 and 5.66) for camel, beef and goat sausages respectively. Sensory evaluations showed that camel and goat meat were palatable and desirable to panelists. Panelist scores for color were not significant ( $P > 0.05$ ) between the three types of meat. The result indicated that the color was acceptable to panelists. Panelist's scores for tenderness were lower for camel and goat meat compared to beef. Panelist's scores for juiciness were higher for camel meat and beef compared to goat meat. The result of this study showed that Camel meat and beef were more desirable compared to goat meat. However, the goat meat was also desirable to the panelists. Camel and goat sausage resembled beef sausage in taste, appearance and palatability. Sausages made from camel and goat meat were also acceptable to the panelists. Camel sausage recorded higher scores in sensory evaluation compared to beef and goat sausage. Sausages processed by adding sweet potato and bread crumbs were acceptable. However, addition of sweet potato slightly improved the texture and juiciness. The average bacterial load of the fresh and frozen samples for camel meat were ( $3 \times 10^6$  and  $2 \times 10^6$  CFU/gm), for beef were ( $2 \times 10^5$  and  $1 \times 10^5$  CFU/gm) and for goat meat were ( $2 \times 10^6$  and

$1 \times 10^6$  CFU/gm) respectively. The average bacterial load of the fresh and frozen camel sausages were ( $3 \times 10^6$  and  $2 \times 10^6$  CFU/gm), beef sausages were ( $2 \times 10^6$  and  $1 \times 10^6$  CFU/gm) and goat sausages were ( $2 \times 10^6$  and  $1 \times 10^6$  CFU/gm) respectively. In general there was considerable decrease in the bacterial count with increase in storage period. The results indicated that, meat products contamination occurred at various stage of processing. This calls for proper and good manufacturing procedure during processing of meat products. The study also indicated that the mineral concentrations were highly significant ( $P < 0.01$ ) in camel meat compared to that in beef and goat meat.

The study concluded that camel and goat fresh and processed meat have prospective future as a healthy nutritive meat.

## خلاصة الأطروحة

هدفت هذه الدراسة لتقييم التركيب الكيميائي وخصائص الجودة في اللحم الطازج والمصنع للابل والبقر والماعز. حيث أوضحت الدراسة وجود فروق معنوية ( $P < 0.05$ ) في التركيب الكيميائي بين لحم الابل والبقر والماعز. كيميائياً شكل الماء في لحم الإبل أعلى نسبة (77.92%) ويليه لحم الماعز (75.55%) ثم لحم البقر (72.12%) على التوالي. وبلغت نسبة البروتين في لحم البقر أعلى نسبة (21.07%) مقارنة مع لحم الابل ولحم الماعز اللذان كانت النسب (19.25%) و(20.32%) على التوالي. بينما تميز لحم الإبل بانخفاض محتواه من الدهون حيث بلغت نسبته في لحم الإبل بنحو (1.17%) مقارنة مع (2.74%) في لحم البقر و (1.66%) في لحم الماعز. كما تميز لحم الابل بأعلى نسبة رماد ويليه لحم البقر ثم لحم الماعز حيث بلغت نسبته (0.78, 0.47, و 0.43%) على التوالي. أوضحت الدراسة أن لحم الابل يحتوي على نسبة منخفضة من الكلسترول (59.2 ملجم/100 جرام) مقارنة مع لحم البقر (73.6 ملجم/100 جرام) ولحم الماعز (71.2 ملجم/100 جرام). أوضحت الدراسة بأنه لا توجد فروق معنوية ( $P > 0.05$ ) بين لحم الإبل ولحم البقر ولحم الماعز في محتوى بروتينات الساركوبلازم (Sarcoplasmic proteins) وبروتينات الألياف العضلية (Myofibrillar proteins) والنيتروجين اللابروتيني (Non Protein Nitrogen). أوضحت النتيجة أن تركيز بروتينات الألياف العضلية متشابه في لحم الابل ولحم البقر ولحم الماعز (11.24% و 11.48% و 11.24%) على التوالي. وكانت قيم بروتينات الساركوبلازم كالتالي (5.5, 5.35, و 5.4%) في لحم الابل ولحم البقر ولحم الماعز على التوالي. وكانت قيم النيتروجين اللابروتيني (1.35, 1.05% و 1.16%) في لحم الابل ولحم البقر ولحم الماعز على التوالي. أوضحت الدراسة وجود فرق معنوي عالي ( $P < 0.01$ ) في درجة الشفافية في اللون (Lightness -L) بين لحم الابل ولحم البقر ولحم الماعز, بينما سجل لحم البقر ولحم الماعز أعلى قيمة مقارنة مع لحم الابل وكانت القيم (33.27, 32.44, و 29.76) على التوالي. كما لا توجد فروق معنوية ( $P > 0.05$ ) في درجة الاحمرار (Redness- a) بين أنواع اللحم الثلاثة بينما سجل لحم الماعز أعلى قيمة ويليه لحم البقر ثم لحم الابل (18.53, 17.69, و 17.04) على التوالي. يوجد فرق معنوي عالي ( $P < 0.01$ ) في درجة الاصفرار (Yellowness- b) بين أنواع اللحم الثلاثة حيث سجل لحم البقر أعلى قيمة يليه لحم الابل ثم لحم الماعز (8.82, 7.48, و 5.82) على التوالي. أثبتت التجربة أن لون لحم الإبل باهت مقارنة بلحم البقر ولحم الماعز. أوضحت

الدراسة وجود فروق معنوية محسوسة ( $P < 0.01$ ) في خاصية قابلية حمل الماء (WHC) بين لحم الإبل ولحم البقر ولحم الماعز, حيث أظهر لحم الإبل مقدرة عالية على حمل الماء مقارنة بلحم البقر ولحم الماعز (1.37, 2.19 و 2.44) على التوالي. كما أوضحت الدراسة أن الفقد أثناء الطبخ (Cooking Loss) أعلى عند طبخ لحم الإبل مقارنة بلحم البقر ولحم الماعز (36.3, 34.15 و 31.75 %) على التوالي. أوضحت الدراسة عدم وجود فرق معنوي ( $P > 0.05$ ) في قيمة الأس الهيدروجيني (pH) بين الأنواع الثلاثة من اللحم حيث كانت القيم (5.88, 5.77 و 5.68) في لحم الإبل ولحم البقر ولحم الماعز على التوالي. أوضحت الدراسة أن نسبة الرطوبة أظهرت فرق معنوي ( $P < 0.05$ ) بين الأنواع الثلاثة حيث سجل لحم الإبل أعلى نسبة يليه سجق الماعز ثم سجق البقر (73.45, 71 و 70.32 %) على التوالي. سجل سجق البقر أعلى نسبة بروتين ويليه سجق الماعز ثم سجق الإبل (18.53, 18 و 16 %) على التوالي. أوضحت الدراسة وجود فرق معنوي عالي ( $P < 0.01$ ) في نسبة الدهن في الأنواع الثلاثة من السجق كما أظهر سجق الإبل أقل نسبة ويليه سجق الماعز ثم سجق البقر (2.31, 3.0 و 3.45 %) على التوالي. كما أظهر التحليل الكيميائي أن هناك فرق معنوي عالي ( $P < 0.01$ ) في نسبة الرماد في الأنواع الثلاثة, حيث سجل سجق الإبل أعلى نسبة رماد يليه سجق الإبل ثم سجق الماعز (2, 1.33 و 1.12 %) على التوالي. أما النيتروجين اللابروتيني (NPN) أوضحت الدراسة عدم وجود فرق معنوي بين سجق الإبل وسجق البقر وسجق الماعز (6.47, 6.23 و 5.89 %) على التوالي. أما اللون في السجق فقد ثبت أن هناك فرق معنوي عالي ( $P < 0.01$ ) بالنسبة لدرجة الشفافية (Lightness- L) حيث سجل سجق الماعز أعلى قيمة ويليه سجق البقر ثم سجق الإبل (32.2, 31.8 و 28.5) على التوالي. أما درجة اللون الأحمر (Redness-a) أوضحت الدراسة عدم وجود فرق معنوي بين أنواع السجق الثلاثة ( $P > 0.05$ ) كما سجل سجق الماعز أعلى قيمة يليه سجق البقر ثم سجق الإبل (11.56, 11.45 و 10.4) على التوالي. كذلك درجة اللون الأصفر (Yellowness- b) لم تظهر فرق معنوي ( $P > 0.05$ ) وسجل سجق الماعز أعلى قيمة يليه سجق البقر ثم سجق الإبل (8.56, 8.48 و 7.67) على التوالي. وسجل سجق الإبل أقل قيمة (0.48) بالنسبة لخاصية قابلية حمل الماء (WHC) يليه سجق الماعز (0.69) ثم سجق البقر (1.06). مما يدل على أن سجق الإبل له مقدرة عالية على قابلية حمل الماء مقارنة بالأنواع الأخرى. أظهر سجق الإبل نسبة عالية من الفقد أثناء الطبخ (Cooking Loss%) ويليه سجق الماعز ثم سجق البقر (24.12, 22 و 21.45 %) على التوالي. أما قيم الأس الهيدروجيني (pH) كانت (5.65, 5.73 و 5.66) في سجق الإبل وسجق البقر وسجق الماعز على التوالي. عند إجراء التقييم الحسي (Sensory Evaluation) بالنسبة للحم الإبل

ولحم البقر ولحم الماعز أثبتت الدراسة بأن هذه اللحوم الثلاثة مستساغة ومقبولة للمتذوقين . كما أظهرت النتائج أن درجة اللون للحوم الثلاثة كانت مقبولة جدا بالنسبة للمتذوقين. أما بالنسبة للطراوة (Tenderness) سجل لحم البقر طراوة أعلى مقارنة بلحم الإبل ولحم الماعز. أما بالنسبة للعصيرية (Juiciness) فقد أظهرت نتائج التذوق الحسي أن لحم الإبل ولحم البقر أعلى عصيرية مقارنة بلحم الماعز. كما أوضحت نتائج التذوق الحسي بأنه أنواع السجق الثلاثة أظهرت طعم مماثل. كما أظهرت نتائج التذوق الحسي أن سجق لحم الإبل ولحم الماعز تفوق على سجق لحم البقر من حيث المظهر والنكهة، وبما أن الفروق غير محسوسة لذلك يمكن استخدام لحم الإبل والماعز كبديل للحوم البقر. إجمالاً سجل سجق الإبل قيم أعلى في التقييم الحسي بالمقارنة مع سجق البقر وسجق الماعز. خلصت الدراسة إلى أن تصنيع لحوم الإبل والماعز يساعد على تطريتها واستساغتها مما يجعلها سهلة المضغ وجيدة التذوق وعليه يمكن استثمارها كبديل للحوم البقر. كما أوضحت الدراسة بأن إضافة البامبي أو البطاطا (Sweet Potato) والقرقوش (Bread Crumbs) في تصنيع السجق مقبول للمتذوقين. كما أوضحت الدراسة أن إضافة البامبي أو البطاطا يعمل على تحسين الطراوة والعصيرية. تم إجراء العد البكتيري للحوم مباشرة بعد جلبها للمختبر بغرض تحديد درجة التلوث بالباكتيريا وأثره على سلامة وصحة هذه اللحوم في حالة التخزين المجمد في درجة حرارة المجمد (-18°C) في اليوم الأول ثم بعد 7 أيام , 15 يوم , 21 يوم و 28 يوم. وأوضحت الدراسة أن متوسط درجة التلوث البكتيري في عينات لحم الإبل الطازجة والمجمدة كانت ( $3 \times 10^6$  and  $2 \times 10^6$  CFU/gm) ولحم البقر ( $2 \times 10^5$  and  $1 \times 10^5$  CFU/gm) و في لحم الماعز ( $2 \times 10^6$  and  $1 \times 10^6$  CFU/gm). وأوضحت نتائج العد البكتيري لعينات السجق بأن عينات سجق الإبل الطازجة والمجمدة كانت ( $3 \times 10^6$  and  $2 \times 10^6$  CFU/gm) وسجق البقر ( $2 \times 10^6$  and  $1 \times 10^6$  CFU/gm) و سجق الماعز ( $2 \times 10^6$  and  $1 \times 10^6$  CFU/gm) على التوالي . أوضحت الدراسة أن درجة التلوث البكتيري تنخفض بصورة ملحوظة مع زيادة فترة التخزين المجمد. أوضحت الدراسة أن تلوث منتجات اللحوم يحدث أثناء عملية التصنيع، لذا لابد من اتباع الطرق الصحية الصحيحة أثناء عمليات التصنيع لتفادي التلوث. أثبتت الدراسة أن هناك فرق معنوي عالي ( $P < 0.01$ ) في تركيز المعادن بين أنواع اللحم الثلاثة كما تميز لحم الإبل بأعلى تركيز من العناصر المعدنية مقارنة بلحم البقر والماعز.

خلصت الدراسة الى أن لحوم الجمال والماعز الطازجة والمصنعة تعتبر الأجود صحياً والغذاء الأفضل مستقبلاً.



## **CHAPTER ONE**

### **INTRODUCTION**

Sudan is situated in northeast Africa between latitudes 4<sup>0</sup> and 22<sup>0</sup> north and longitudes 22<sup>0</sup> and 38<sup>0</sup> easts. The country is traversed by the River Nile and its tributaries which have varying influences on irrigated agriculture and livestock production systems. There are also number of seasonal rivers and water sources as the Gash and Baraka, which originate from the Ethiopian highlands and form two inland deltas in Sudan. An animal resource in Sudan far exceeds that of the all Arab countries and ranks second in Africa. Livestock production forms an important component of the agricultural sector, which mainly based on traditional pastoral systems. The animal censuses in Sudan according to MARFR (2011) and AAS (2012) were estimated the cattle, sheep, goat and camel population in Sudan as 29.2 million/heads of cattle, 39.3 million/heads of sheep, 30.6 million/heads of goat and 4.7 million/heads of camel's.

Meat consumption in developing countries has been continuously increasing from annual per capita consumption of 10 kg in 1960s to 26 kg in 2000 and expected to reach 37 kg in 2030 according to FAO projections (FAO, 2007). The rising demand for meat in developing countries is mainly consequence of the fast urbanization and technology among the city dweller to spend more on food than rural population. Global meat production in the next decade expected to increase from current annual production of 267 million tons in 2006 to nearly 320 million tons in 2016, (FAO, 2007). Throughout the recorded history consumption of meat has indicated a position of social and economic prestige. People face their economic improvement with increase in meat consumption. Moreover as the social economic status improved their demand for greater quantity and high quality of meat and meat products

increase. AAS (2012) estimated the beef production in the Sudan as (1286400.0 tons/year), the sheep and goat meat were estimated as (1286400.0 tons/year) and the camel meat as (511850.0 tons/year).

Meat is defined as the whole of the carcass of cattle, sheep, goat, camel, buffalo, deer, hare, poultry or rabbit (Williams, 2007). Meat is the one of the most nutritive foods used for human consumption. Quantatively and qualitatively meat and other animal food are better sources for high quality protein than plant food, for its richness in essential amino acids and organic acids that cannot be synthesized in human are available in well balanced proportions and concentration. Meat is especially rich in vitamin B<sub>12</sub> and iron which are important to prevent anemia in children and pregnant women.

In recent years there has been an increased demand for convenience meat and meat products requiring minimal home preparation (Stubbs et al., 2002). Meat processing is the manufacture of meat products from meat, animal fat and certain non meat additives. The additives are used to enhance product flavor, appearance and to increase product volume. The advantage of meat processing is integration of certain animal organs and trimmings that are not usually sold in fresh meat marketing chain as valuable protein rich products. Thus, there are certain economic, dietary and sensory aspects that make meat processing one of the valuable mechanisms for adequate supply of animal protein for human consumption. The demand for camel meat appears to be increasing due to health reasons, as it contains less fat as well as less cholesterol and relatively high poly-unsaturated fatty acids than other meat animal's (Zidan et al., 2000). Recently, more attention has been paid to the nutritional value of camel meat, with the aim of creating additional value for various camel meat products (Ulmer et al., 2004). Generally goat meat is less preferred for its lower in tenderness and

flavor compared to mutton and beef (Webb et al. 2005). Goat meat has been established as a lean meat with favorable nutritional quality and it is considered an ideal choice of the health-conscious consumer (Correa, 2010). Furthermore goat meat is preferred in most African and Asian countries for its taste, higher lean and lower fat content compared to mutton and beef. Meat production from goat in Sudan is gaining new ground, due to the high price of beef and mutton, coupled with low incomes.

The Objectives of this study are:

1. To determine the chemical composition and eating Quality of camel, beef and goat fresh Meat.
2. To evaluate the nutritive value of fresh and processed camel and goat meat compared to beef.
3. To evaluate sensory and hygienic properties of fresh and frozen camel and goat meat compared to beef .
4. To evaluate the addition of sweet potato as a filler in sausage processing as alternative for bread crumbs.
5. To introduce camel and goat meat products as a choice in Sudan.

## CHAPTER TWO

### LITERATURE REVIEW

#### 2.1. General:

Meat is the post-mortem aspect of a complicated biological muscle tissue. Chemical and biochemical constitution of the muscle are affected by a large number of intrinsic factors. The most important of these factors are animal species, breed, sex, age, and anatomical location of muscle, training or exercise, plane of nutrition and inter animal variability (Lawrie, 1991). Shorthose and Harris, (1991) stated that the perceptions of meat quality vary from country to country and between ethnic groups within countries. Williamson, et. al., (2006) reported that lean red meat has a relatively low fat content, moderate in cholesterol, and is rich in protein, essential vitamins and minerals. Moreover, red meat, regardless of feeding regimen, is nutrient dense and regarded as an important source of essential amino acids, vitamins A, B6, B12, D, E, and minerals, as iron, zinc and selenium. According to Peacock, (1985) in the Sudan camels represent an important national resource which is not properly managed for utilization. Sheep and goats comprise a greater proportion of the total wealth of poor families. The dependence of humans on goats was illustrated by Norman (1991) they calculated ratios of humans to goats for various world regions from FAO statistics. The ratio was 3:1 in Africa as a whole and southern Africa 4.05; Asia 10:1 and Latin America 12:1. On a global scale goat provide the least meat per capeta, being 0.5 kg per capeta, compared with beef as 10.1 kg, pork as 12.7 kg, sheep as 1.3 kg and poultry as 7.2 kg. In terms of world regions the provision by goats is the highest in Africa, 1.04 kg per capeta, followed by Asia, 0.47 kg per capeta. Meat is the primary reason for goat

keeping, resulting in meat goats constituting the major proportion of the world goat population (Norman, 1991). Leidner, (1998) and Ringdorfer, (2001) stated that high-quality goat meat produced from kids characterized by high meatiness and low fatness that meets the above requirements, so the demand for this kind of meat is constantly growing both in the EU member states and in the USA.

## **2.2. Camel Meat Consumption in the World:**

According to Camel Newsletter, (1999), the camel meat industry is developing widely throughout Australia and it certain that camel is destined to play a significant role in the meat industry, both in Australia and Overseas. Mansour and Ahmed (2000) reported that the camel meat is used for human consumption in several countries. The acceptability of camel meat products increases with an increase in the duration of processing (smoking, frying and cooking) indicating that the products should be fully processed to gain maximum acceptability. Kadim et al., (2006) stated that the quality of meat from young camels of 3 years old or less is comparable to beef. The amount of mineral elements and protein contents in camel meat are reported to be similar to beef (Dawood and Alkanhal, 1995). However, the meat of camel contains significantly less fat and higher moisture than beef (Dawood and Alkanhal, 1995; El-Faer et.al., 1991; Elgasim and Alkanhal, 1992; Kadim et al., 2006). Camel meat is relatively richer in polyunsaturated fatty acids compared to beef (Rawdah et al., 1994). Mohammad, (2008) stated that camel meat consumption is in an increase in both urban and rural communities of Nigeria. Although, camel meat is considered coarse and tough, it is still consumed in many countries including Nigeria. Shalash, (1979) stated that the percentage of protein, water, fat and ash contents of meat vary with different parts of the animal's body.

Also, the age of animal reflects on the composition of different meat components. Bustinza, (1979) reported that camels younger than 5 years have less protein, fat and ash than older camels. Adim et al., (2008) stated that recently, camel meat has been processed into burgers, patties, sausages and shawarma to add value

### **2.3. Goat Meat consumption in the World:**

Goat meat is one of the most widely eaten red meats in the world (Devendra, 1990). Webb et al., (2005) reported that recently, goat meat has become a component in some Americans' diets. Food preferences vary between different nationalities, cultures, religious and ethnic groups. Goat was widely distributed around the world. Popularity and usage of goat meat varies within and between communities according to a host of criteria. Therefore, the consumer preference of goat meat is almost universal depending on cultural traditions and social and economic conditions. Kannan et al., (2001) reported that goat meat was popular with the greatest production and consumption in Asia and Africa. The consumption of goat meat is mainly increased by ethnic consumers. According to Department of Livestock, (2006), in Thailand, the production of goat meat steadily has increased in recent years especially in the Southern part due to the increment of consumer demand. In addition, the state policy is to increase goat meat production to provide a sufficient supply for the halal food industry. Sande et al., (2005) reported that goat meat, commonly referred to as 'chevon' or 'cabrito', is, however, the most popular meat product in the world and is often served in specialty dishes centered on festival or holiday events. The meat goat business seems to hold new economic potential, particularly for small scale producers who find it easier to raise goats in comparison to the other larger livestock because goats require less land per animal. The US

goat industry is predominantly an infant industry with considerable demand potential. Babiker et al., (1990) stated that goat has won favorable recognition for its quality which matches some consumer preferences for low-fat and consumer concerns on health. When compared to other meat, goat meat is low in calories and fat. According to USDA, (2001) goat meat offers more nutritional value, greater health benefits, and is an ideal choice to be considered as "the other red meat." As the health benefits of goat becomes more widely known among the general population, the demand for alternative low-fat red meat should also continue to increase. AMGA, (2008) stated that Chevon was meat from older goat kids slaughtered when 6 to 9 months of age and weighing from 23 to 34 kg. This type of red meat is usually cut in bite-size or larger pieces to be eaten stewed, baked, or grilled. Gadiyaram and Kannan (2004) stated that goat meat is an ideal source of red meat for the preparation of heart-healthy products because of its lower fat content. McMillin and Brock (2005) reported that goat meat value may be increased through production practices or meat processing by increasing palatable and usable forms or providing meat at times of higher purchaser demand, that usually increase the price of the meat. James and Berry, (1997) stated that goat meat was excellent source of lean in the preparation of low-fat meat products. Kannan et al., (2001) stated that goat meat is popular with the greatest production and consumption in Asia and Africa. Gall, (1982) reported that goat meat is preferentially consumed in the mountainous areas of Turkey. Unlike commonly consumed meats of other species goat meat is mostly consumed in the localities where it is produced. Webb et. al., (2005) reported that popularity and usage of goat meat varies within and between communities according to a host of criteria. Goats are more able to withstand the unfavorable feeding conditions of the arid zones than other

domestic ruminants because of their low feed requirements as regards quality and quantity. Casey, (1982) stated that the poor subcutaneous fat cover on goat carcasses, a positive attribute in other respects, has limited value as a predictor of carcass yield. USDA NASS, (2006) reported that goat meat is one of the most consumed red meats worldwide, except for the United States. According to Wikipedia Foundation, (2006) Goat meat, called chevon (from the French word for the animal chèvre), is considered to be similar in taste to veal or venison, depending on the age of the goat. Goat meat is originally applied to Angora goat meat and emanates from the United States. Casey, (1992) stated that cabrito, a term derived from Spanish refers to goat kid, and is a delicacy in Central and South Americas. USDA, APHIS, (2005) reported that religious preferences, social customs and dietary considerations shape the consumption patterns in the U.S.A. Immigrants from Asia and Africa consume more goat meat than immigrants from Europe, especially developed Europe. Fraser, (2004) stated that Native African-American and Caucasian populations tend to consume goat meat on special occasions such as 4th of July, Easter, and Muslim holidays. Hansen, (2003) reported that the demand for goat meat in the United States is concentrated in areas with ethnic populations that use goat as a traditional staple. According to IBIS World, (2005) urban demographic growth is proportionally related to the urban consumption of goat meat. However, because of low innovation, urban inhabitants prepare goat meat with difficulty. USWM, (1998) reported that the ability of manufacturers to process goats into products, and the capability of the farmers to supply goats consistently influence the availability of products. Total goat meat consumption is a distant fourth globally behind beef, and chicken. Glimp, (1995) stated that the demand for chevon in the United States has increased in the recent year, which is particularly attractive to a health



conscious American consumer due to its lower fat content compared to other types of red meat (Park et al., 1991). James & Berry, (1997) stated that developing value-added products using chevon may mask its characteristic texture and flavor, thus widening the existing market and increasing the number of consumers benefited by this low-fat red meat. Chevon may be an excellent resource in the preparation of low-fat diets, since the fat content of lean meat is significantly less. Rhee et al., (2003) stated that the low consumption rate may be related to the consumers' unfamiliarity with goat meat and its intense and inherent aroma and flavor.

#### **2.4. Meat Physiochemical Quality:**

The chemical composition of meat is influenced by different factors such as species, breed, age, sex, anatomical location of muscle and nutrition (Lawrie, 1998). Tornberg, (2005) stated that the muscle consists of 75% water, 20% protein, 3.5% fat and 2% soluble non-protein substances. Mukasa-Mugerwa, (1981) stated that camel meat quality characteristics in general, are comparable to those of beef. Kadim et al., (2006) reported that the chemical composition of camel meat is similar to meat from other species where an inverse relationship existed between the moisture, protein and fat content. The chemical composition of camel meat is an important indicator of meat functionality. Moisture content of camel meat plays an important role in the keeping and eating qualities of meat. Elgasim and Alkanhal, (1992) and Gheisari et al., (2009) reported that the camel meat has relatively lower ash content than beef, lamb and goat meat. Kadim et al. (2006) reported that the chemical composition of camel meat was 71, 21.4, 4.4, and 1.1, for moisture, protein, fat and ash respectively. Mills, et al., (1992) stated that the chemical composition of beef is 71.5, 22.5, 5.5 and 0.9 for moisture, protein, fat and ash

respectively. Nesimi Aktas et al., (2003) reported that the proximate composition of beef was 21.26% protein, 76.56% moisture, and 1-3% fat. Marinova et al., (2001) reported that the chemical composition of goat meat is 76.5, 20.8, 1.6 and 0.87, for moisture, protein, fat and ash respectively. Dhanda, (2001) reported that the goat meat on average consists of 72.3% moisture, 21.0% protein, 4.7% fat and 1.1% ash per 100 g of fresh meat. Johnson et al., (1995a) stated that on comparing the nutritive value of cooked goat meat to that of beef, goat meat has lower fat, similar protein, higher calcium, magnesium, potassium and sodium and similar Iron.

#### **2.4.1. Moisture:**

Camel meat contains (70 – 77%) moisture (Al-Owaimer, 2000, Al-Sheddy et al., 1999, Dawood and Alkanhal, 1995; Kadim et al., 2006 and Siham 2008). Kadim, et al., (2006) reported that the average moisture content in camel meat is about (64.4 % to 77.7%) irrespective of the different muscles or cuts. Babiker and Yosif, (1990) reported that the average moisture % was ranged from (75 - 89%), (75-81 %) and (75-83%) for the muscles, longissimus dorsi, semitendinosus and triceps brachia respectively. Zamel et al., (1992) stated that camel meat had higher moisture content (5-8%) more than beef. Babiker, (1988) and Siham, (2008) reported that camel meat contained more moisture compared to beef. Babiker and Tibin, (1986) reported that camel meat contains more moisture than beef (79.3%). Mohammed, (1993) reported that the chemical composition of camel meat and beef were not significantly different but the camel meat score was higher in moisture (69-73%). Dawood, (1995) reported that camel meat had highest percentage of moisture content (75-78%) while beef meat had lowest % (73-75%).

### **2.4.2. Crude protein:**

Meat and meat products are concentrated sources of high quality protein and they supply easily absorbed iron (Snijders, and Collins, 2004; Lawrie, and Ledward, 2006). Total protein in camel meat was similar to that in beef as (18.9-19.7%) as reported by (Ezekwe et al., 1997). The protein content of camel meat is reported as (20 – 23%) (Al- Owaimer, 2000; Kadim, et al., 2006; Kilgour, 1986 and Dawood and Alkanhal, 1995. Babiker, (1988) and Siham, (2008) reported that the protein content of camel meat was greater than that of beef. In broad sense the composition of meat can be approximate to 75 % water, 18% protein (Lawrie, 1991). Suaad, (1994); Kdima et al., (2006) and Siham (2008) reported that camel meat had protein content as (19.4 - 22.05%).

### **2.4.3 Fat:**

Camel meat is characterized by low fat content and high lean, this is considered as advantages since consumers seek leanness above all meat attributes because animal fats were associated with heart disease in man due to deposition of cholesterol in coronary arteries (Camel Newsletter 2000). Elgasim and Elhag, (1982) reported that the camel meat has a fat content (2.6%) which is less than that of beef (4.7%). In broad sense meat fat is (3%) (Lawrie, 1991). Dawood and Alkanhal, (1995); El-Faer et al., (1991); Elgasim and Alkanhal, (1992); Kadim et al., (2006) and Siham, (2008) reported that the camel meat contains less fat and higher moisture than beef. Fathi-elrhman, (2005) stated that camel meat has a low fat percentage (1.36%) compared to beef as (2.99%). Suaad, (1994) and Kadim et al., (2006) reported that the mean fat percentage of camel meat as (1.1 - 1.5%) therefore it was lean. Williams, (2002) and Siham (2008) stated that fat content in camel meat

was considerably less than beef. NASS, (2005) reported that goat meat is leaner and contains less saturated fat than other red meat. James & Berry, (1997) stated that goat meat is an excellent ingredient in the preparation of low-fat diets, since the fat content of lean meat is significantly less. USDA, (2001) reported that goat meat was established as a lean meat with favorable nutritional qualities, and it's an ideal choice for the health-conscious consumer. A higher fat content in Boer meat crossbred was reported by (Dhanda et. al., 2003 and Stanisz et. al., 2004). According to USDA, (1989) goat meat is 50%-65% lower in fat than similarly prepared beef, but has similar protein content. USDA, (2007) reported that goat meat was low in saturated fat and slightly lower cholesterol than most other red meat, Lower in total fat and cholesterol than traditional meat. Addrizzo, (1994) stated that the nutritive value of goat meat indicated that in the same cuts, goat meat has 50-65% less fat content than beef. USDA, (2007) reported that the goat meat has 50% less fat than beef, 45% less fat than lamb and 15% less fat than veal. James et al., (1990) stated that goat meat has fat content of 50%-65% lower than similarly prepared beef with similar protein content. Gibb et al., (1993) and Hogg et al., (1992) reported that goat meat was leaner than meat from other red meat species.

#### **2.4.4. Ash:**

A number of authors reported ash content of camel meat to range between (1.05 and 1.60%) (Abdelbary and Muhammad, 1995; Paleari et al., 2003). Al- Owaimer, (2000) and Kadim et al., (2006) reported that ash content in camel meat ranged between (1.1% and 1.5%). EL-Gasim, and Alkanhal, (1992) stated that camel meat is lower in ash content than beef and had similar content of the element compared to beef. Mohammed, (1993); Suad, (1994); Kadima et al., (2006) and Siham

(2008) reported that the average mean percentage of camel meat ash content is (1 - 1.1%). Owaimer, (2000) and Kadim et al., (2006) stated that ash content in camel meat was ranged between 1.1% and 1.5%.

#### **2.4.5. Cholesterol concentration:**

Multiple factors affect the cholesterol content of beef, such as gender, animal maturity, degree of marbling, subcutaneous fat thickness, animal breed, dietary energy level, different feeding treatments (restricted diet or ad libitum), and muscle location (type of cut) (Muchenje, et al., 2009). Dinh, et. al., (2011) reported that there are various factors which influence cholesterol content in processed meats: animal species, muscle fiber type, and muscle fat content. Red meat tends to have greater total fat and cholesterol, although differences in the same types of cuts have been reported. Cholesterol concentration of meat has been determined mostly by analytical methods such as colorimetric and chromatography, although the latter has become predominant because of technological advances and method performance. Multiple issues in cholesterol analysis, including sample preparation, detection, and quantification, are evaluated. Kurtu, (2004) stated that camel meat regarded as a high quality food with medicinal value, economically and environmentally adaptable alternative source of meat. Elgasim and Elhag, (1982) stated that the cholesterol concentration in camel meat was noted to be lower than that of beef. Morton, (1984); Fallah et al., (2008) and Kadim et al., (2009) reported that camel meat is in fact leaner than other red meat, has fewer calories and is low in cholesterol. Previous studies have revealed that camel meat is healthy and nutritive as it contains less fat in comparison to other meat especially beef. It also contains a healthy level of minerals. Beserra et. al., (2004) reported that cholesterol concentration of goat meat was affected by goat genotypes. Park et. al., (1991) reported that fat and

cholesterol concentration in goat meat were influenced by dietary calcium, breed and type of tissue. USDA, (2001) reported that goat meat was lower in cholesterol than beef. Rist., (2011) stated that goat meat is a healthy alternative to beef and chicken because of its lower calorie, fat and cholesterol. Pratiwi et. al., (2006) reported that longissimus dorsi muscle of goat meat was contained lower total cholesterol concentration as (55.5mg/100gm). Mourot and Hermier, (2001); Piironen, et. al., (2002); Valsta et. al., (2005); Bragagn, (2009) and Honikel, (2009) reported that cholesterol concentration of raw and cooked meat ranging from (40 to 90 mg/100gm). Klont et. al., (1998). Stated that cholesterol concentration in beef longissimus muscle as (50 - 53mg/100gm). USDA, (1989) reported that the goat meat has low saturated fatty acids and cholesterol, therefore the American Heart Association recommends goat meat to people with heart-related problems. Hasik, et al., (1999) stated that the goat meat has a low cholesterol concentration (48.76 and 56.63 mg/100g). Sikora and Borys, (2006) recorded higher cholesterol levels in meat from kids, while Beserra, et. al., (2004) observed lower cholesterol levels in older kids (8-10 months of age). Kunkle, et. al., (2004) stated that goat meat is leaner and contains less cholesterol and fat than lamb and beef therefore, it requires low-heat; slow cooking to preserve tenderness and moisture. According to the Harvard School of Public Health (2008), saturated fats increase the risk for cardiovascular disease and other chronic conditions, while unsaturated fats improve blood cholesterol levels. Pratiwi et. al. (2007) reported that the cholesterol content of goat meat is associated with its fat content, which means that fattier meat contains more cholesterol than leaner meat. Park et. al. (1991) stated that cholesterol content of goat meat ranging from (58 to 70 mg/100gm).

Pond and Maner, (1984) and Potchoiba et al., (1990) reported that goat meat cholesterol indicates levels of (76mg/100gm) compared to (70 mg/100gm) for beef, fish, and lamb.

#### **2.4.6. Protein Fractionation:**

The protein in muscle can be broadly divided into those which are soluble in water or dilute salt solutions (the sarcoplasmic proteins), those which are soluble in concentrated salt solutions (the myofibrillar proteins) and those which are insoluble in the water or salt (Shimada, et al. 2004). Babiker, (1988); Siham (2008) reported that camel meat had lower sarcoplasmic protein content. In broad sense the composition of meat can be approximate to 3.5% soluble non- protein substance (Lawrie, 1991). Siham, (2008) stated that myofibrillar protein solubility was highly correlated with tenderness as determined by shear and panel measurements. Zaglul and Cassen , (1987) reported that two structural components have been shown to determine the tenderness of meat, namely the collagen of connective tissue and the contractile apparatus of myofibrillar protein. According to Van Laack, (1999) the iso-electric point of myofibrillar proteins is around pH (5.0 to 5.1), readings above and below this pH value was result in myo- filament repulsion due to negative or positive net charges of ions. The rate of pH decline affects the rate of sarcoplasmic protein degradation. The sarcoplasmic proteins were precipitate into the myofibrillar protein fraction and cause a decrease in the myofibrillar protein's ability to bind to water.

#### **2.5. Meat Quality Attributes:**

Quality was defined as the consumer acceptance or preference of food or food product by consumers. Quality has no boundaries and was often described as having a range within many different planes.

Traditionally meat quality is either eating quality or processing quality, therefore quality is directly associated with usage and is a multifaceted concept (Webb et al., 2005). Lawrie, (1991) stated that meat eating quality involves five attributes namely, colour, water holding capacity, tenderness, juiciness and flavour. All attributes are influenced by breed, sex, age, anatomical location, exercise, nutrition and internal variability. Dikeman, (1990); Koohmaraie (1992a); Kerry et al., (2002) and Egena and Ocheme, (2008) reported that meat quality includes tenderness, palatability, flavor, color and juiciness. Kadim et al., (2009); Babiker and Yousif (1990) stated that the quality of camel meat has received little attention for its lower nutritive value and quality than other types of meat. Lawrie, (1991) stated that color, water-holding capacity and odor of meat are detected before and after cooking by the consumer with more prolonged sensation than do juiciness, texture, tenderness, taste and odor. Knoess, (1977); Mukasa Mugerwa, (1981); Elgasim et al., (1987); Dawood and Alkanhal, (1995); Rawdah et al., (1994) stated that the demand for camel meat appears to be increasing due to health reasons, as they produce carcasses with less fat as well as having less cholesterol and relatively high polyunsaturated fatty acids than other meat animals. Siham, (2008) stated that camel meat is palatable and coarser compared to beef, varying in color from raspberry red to brown red and having white fat. El-Faer et al., (1991); Elgasim and Alkanhal, (1992); Dawood, (1995) reported that variation in beef quality is large and is due to many factors, such as differences in genetic background, sex, age, management and nutrition. Verbeke and Viaene, (1999) stated that the consumer's decision to purchase beef is guided by the perception of healthiness and a variety of sensory traits including color, tenderness, juiciness, and aroma or flavor.



### **2.5.1. Meat Color:**

Color is an important criterion of raw or cooked meat and meat products. It reflects the proper composition of the products, particularly in relation of meat to other compounds, freshness of raw materials, texture, taste and proper conditions of storage (Klak et al., 2001; Alberti et al., 2002). Abril et al., (2001); Faustman and Cassens, (1990) reported that the presence of muscle pigments, myoglobin and haemoglobin is the main limiting factor of the meat colour. Factors affecting meat color include muscle fiber type, ultimate pH, and cooling rate. Adegoke and Falade, (2005) reported that the discoloration is related to the amount of the pigments in meat. Glitsch, (2000) reported that color of meat is an important quality attributes that influences consumer acceptance of meat and meat products. Consumers prefer bright-red fresh meat. Adegoke and Falade, (2005) reported that the presence of muscle pigments myoglobin and haemoglobin is the main limiting factor of the meat color. Moloney, (1999) and Milton, (1990) reported that pre –slaughter stress can lead to dark color of beef. Montgomery, et al., (2003) reported that color of meat is influenced by the age, species, sex, diet and exercise. Meat from older animals gets darker in color because the myoglobin level increases with age. Also exercised muscles are always darker in color. Andersen et al., (1989) reported that the gradual change in surface color from red to brown, often encountered during storage and display of fresh and frozen meat. Abdul -Aleem , (1983) stated that muscle color goes darker when the animal moves along distance. Also the color goes darker when the animal temperature arises before slaughtering. Babiker and Tibin, (1985) and Siham (2008) stated that camel meat color was found to be lighter than beef, because the low concentration of camel sarcoplasmic proteins which suggest low myoglobin content in camel muscles

compared to beef. Babiker et al., (1990) stated that goat meat was darker red in colour than lamb. Wilson, (1981) stated that colour loss in sausage is caused partly by oxidation of meat pigment myoglobin to metmyoglobin.

### **2.5.2. Water holding capacity (WHC):**

Water holding capacity is the ability of meat to retain its own or added water during application of external forces such as cutting, heating, grinding, or pressing (Judge et al., 1989) . Trout, (1988) reported that the WHC of meat or meat product was determined the amount of product that can be sold and influence the sensory properties of the product such as juiciness, texture, and flavor. Thomsen and Zeuthen, (1988) stated that the WHC is strongly dependent on the pH of meat and it's minimum at pH 5, corresponding to the iso-electric point of actomyosin. Babiker and Tibin, (1986) and Siham, (2008) reported that the WHC is superior in camel meat than beef and that, superiority explained adaptation ability of camel to its dry habitat. Babiker and Yosif, (1990) stated that the WHC values of Semitendinosus, L.dorsi and Triceps brachii were 2.1, 2.25 and 2.8 respectively. Kafe, (2001) reported that the storage of camel meat for up to seven days resulted in an improvement of the water holding capacity from 5.8 at zero hour to 3.72, 2.82 and 2.12 at 3,5 and 7 days respectively. Fathi, (2005) reported that the water holding capacity of camel meat as (3.25), while beef as (3.65). Ockerman and len, (1987) stated that the WHC increases significantly with the quantity of salt and length of storage time. Nesimi et al., (2003) reported that the increase of water holding capacity caused by application of salt is attributed to the rise in the solubility of meat protein as well as increase in ionic strength. Abdelbary and Muhammed, (1995) stated that the water holding capacity

of meat decreased with heat treatment and varies with species, muscle type and region.

### **2.5.3. Cooking Loss %:**

Cooking loss is one of the most important properties of sausage products as it is related to water holding capacity. There is variation in water holding capacity among different types of meat from different animal and muscles (Lawrie, 1991). Kannan et al., (2001) stated that cooking loss was highest in leg cuts, intermediate in shoulder/arm cuts, and lowest in loin/rib cuts. Siham (2008) reported that cooking loss was lower in camel meat compared to beef. Babiker et al., (1990) reported that chevon had lower cooking loss compared to lamb. James and Berry, (1997) stated that consumer and trained sensory panels found similar juiciness, flavour, and tenderness in patties with less than 40 percentage chevon and more than 60 percentage beef, but increased levels of goat meat in patties decreased cooking loss percentage. Gadiyaram and Kannan, (2004) stated that cooking loss% was lower in chevon sausages (5.5%) compared to beef. Abubaker et al., (1986) reported that tenderness and color scored highest in sausages containing faba-bean and chick pea while color was acceptable in sausages containing lentils and lupine seeds.

### **2.5.4. PH:**

Generally, young animals tend to produce meat with a higher pH than older animals due to lower levels of glycogen (Kannan, et al., 2003). Walker and Betts (2000) reported that ultimate pH of meat was significant for its resistance to spoilage because most bacteria grow optimally at about pH 7 and not below pH 4. Dharmaveer et al., (2007) stated that the microbial load increased with increase in pH of the meat

product. Simela et al., (2004) reported that tenderness and color properties of chevon were high dependent on post-mortem pH and temperature attained by the carcasses, with slow chilling and fast pH decline improving the tenderness and color. Al-Sheddy et al.,(1999); Cristofaneli et al., (2004) and Kadim et al., (2006) reported that the range of the ultimate pH values of dromedary camel meat ranged between 5.7 and 6.0. Breukink and Casey, (1985) reported that the decline of muscle pH followed a pattern typical of red meat carcasses, to stabilize at around pH 5.4. Thomposn, (2002) stated that the ultimate pH value of the meat is a result of combination between many factors including pre-slaughter handling, post-mortem treatments and muscle physiology. Guingnot et al., (1992) stated that the animals which had been rested and well fed before slaughter had large amount of glycogen. Elgamsim and Hag, (1982) stated that the ultimate pH of camel meat was ranged between (5.74 and 5.6). Babiker and Yousif, (1989) reported that the longissimus dorsi, semitendinosus and triceps brachii muscles ultimate pH values were 5.8, 5.7, 5.69 respectively. Kadima et al., (2006) reported that meat from older camel had significantly lower (5.71) pH value than younger animal (5.91) and middle age camels had (5.84). Al-sheddy et al., (1999) ; Cristofaneli et al., (2004) and Kadim et al. (2006) reported that the range of the ultimate PH values of dromedary camel meat ranged between 5.7 and 6.0. Webb et al., (2005) stated that ultimate pH values for goat meat were ranged from (5.55 to 6.33).

#### **2.5.5. Meat Tenderness and texture:**

Of all the attributes of eating quality, the average consumer presently rates texture and tenderness most important (Koochmaraie, 1992a). Mukasa, (1981) defined texture of meat as the sensory manifestation of the structure of the meat and the manner in which the

structure reacts to the force applied during biting. Simela et al., (2003) stated that meat tenderness and flavor are the most important components that determine meat quality. McMillin, (2005) reported that there are two main components of meat tenderness, myofibrillar and connective tissue. The degree of tenderness was related to three categories of protein in muscle, those of the connective tissue, the myofibril and the sarcoplasmic proteins. Age, breed, and diet influence tenderness, juiciness, and flavor. Morgan, (1992) considers tenderness as the single most important component of meat quality. Kadim et al., (2006) stated that, younger animals yield more tender meat than older ones. Mukasa, (1981) stated that the quality of camel meat produced by younger (5 years or less) was comparable to beef in taste and texture. Riley et al., (1989) reported that young goats generally produced more tender meat than older goats. Gaili and Au, (1985) stated that goat muscle fibers are thicker and larger than that of sheep which gives goat meat a characteristic courser grain. Siham, (2008) stated that connective tissue strength measured by shearing along the muscle fiber was higher in camel meat muscle than in beef. Siham, (2008) reported that addition of potato improved the tenderness of sausages compared to bread crumbs and blanched cowpea. Heinze et al., (1986) stated that goat meat is inherently less tender than sheep. Most important palatability attribute to the consumer is meat tenderness to which the texture of the meat may also contribute. Gaili and Au, (1985) stated that goat muscle fibers are thicker and the fiber bundles larger than sheep giving goat meat courser. Siham, (2008) reported that shear force, which measure muscle fiber strength was higher in camel meat compared to beef.

### **2.5.6. Juiciness:**

Juiciness is important to meat texture and palatability. It has two major components; the first is the impression of wetness produced by the release of fluid from the meat during chewing, the second is the more sustained juiciness that apparently results from the stimulating effect of fat on the production of the saliva (Lawrie, 1991 and Moloney, 1999). Lawrie, (1998) stated that juiciness reaches a minimum when the pH level of the meat is about six. Muchenje et al., (2009a, b) reported that the sensation of juiciness in chevon is directly related to the quantity and composition of intramuscular fat. Lawrie, (1991) stated that Juiciness of meat and meat products is affected by the storage conditions and period. Kafe, (2001) stated that camel meat was dry on day one than day seven of storage which was rated juicier. This improvement in juiciness on day seven related to enhancement of water holding capacity. Jan Trela, (2002) reported that low level of intramuscular fat resulted in low values of juiciness. Matlocker et al., (1984) stated that the juiciness of sausage is affected by the level of common salt; higher salt content resulted in higher juiciness. Siham, (2008) stated that sausages became juicier with the addition of potato and that, adding of blanched cowpea compared with bread crumbs and potato reduced juiciness. Panelist scores for juiciness of camel meat were lower than that of beef but there was no significant different between them.; Sen et al., (2004) reported that the goat meat was less tender than sheep meat, although juiciness and overall palatability were not different. Goat meat had the same juiciness, but less tenderness and less overall satisfaction, when compared to pork, beef, and lamb at comparable maturity and fatness. Smith et al., (1974) reported that goat meat and goat meat products were comparable with beef and beef products. Whereas goat meat had the same juiciness, but less

tenderness and less overall satisfaction than other meat products. Smith et al., (1978) reported that the juiciness of goat meat was same in loin chops and leg roasts from Angora and Spanish goats in the same age. Muchenje et al., (2008a) reported that the relationships between juiciness and fat content and composition vary with genotype. Tshabalala et al., (2003) reported that goat meat was less juicy, because goat carcasses had low fat content.

### **2.5.7. Flavor and Aroma:**

Shahidi, (1994) stated that flavor has a great influence on the sensory quality of meat, consequently on its overall acceptability. Milton, (1990) and Moloney, (1999) reported that the flavor of meat is associated with either moisture or fat contents of meat. Therefore, meat from older animals is more intense in flavor than meat from younger animals. Calkins and Hodgens, (2007) reported that flavour is a complex attribute of meat palatability and was determined by the chemical senses of taste and smell. Muchenje et al., (2009a) reported that flavor depends on the quantity and composition of fat in meat. Lawrie, (1991) stated that flavor is a complex sensation that involves odor, taste, texture, temperature and pH. Angelo et al., (1987) reported that the factors that influence the flavor of meat products include animal feed, processing methods, storage condition and sanitation. Mottram, (2002) stated that meat aroma develops from the interaction of non-volatile precursors, including free amino acids, peptides, reducing sugars, vitamins, nucleotides and unsaturated fatty acids, during cooking. Ellard, (2002) stated that camel meat was recognized as having a similar flavor to beef. Babiker and Tibin (1986); Siham (2008) reported that flavor of sausage prepared from camel meat and beef with different fat content (10-15%) was accepted by the panelist. Schönfeldt et al., (1993a, 1993b); Casey et

al., (2003); Sheradin et al., (2003a , b); Webb et al., (2005) reported that goat meat has a distinct flavor and aroma when compared to lamb and mutton. Schonfeldt et al. (1993a) reported that carcasses from younger Angora and Boer goats, had more desirable flavor than carcasses from older ones. Stelzleni and Johnson, (2007) reported that goat meat was characterized by its odor, especially after cooking; therefore, meat flavor was highly affected by animal species and cooking methods. Babiker et al., (1990) stated that goat meat is lower in flavor than lamb and beef. However, Griffin et al. (1992) reported that the flavor of young goat and lamb was not acceptable as the flavor of the older goat and sheep. Alford, (2009) reported that goat has a reputation for strong, gamey flavor, but can be mild depending on how it is raised and prepared.

## **2.6. Meat preservation:**

The main problem with meat, poultry, fish and their products is how to preserve it from microbial spoilage. Since some of methods used for meat preservation depends on removing or limiting the water availability (Belitz, 2004). Grancey, (1981) reported that the preservation of meat usually accomplished by combination of different preservation methods. The principles of all food preservation methods are drying, curing, cold or heat application and chemicals. Bender, (1992) stated that freezing at  $-18^{\circ}\text{C}$  is now a standard method of preserving meat for 1-2 years. The main aims of meat preservation are to prevent loss, autolysis and microbial growth. Dyett et al., (1981) reported that goat meat has been preserved by drying, curing with salts, smoking or manufactured into a reconstituted products, in various regions of the world. Schonfeldt, (1989) reported that the rate of freezing and subsequent thaw drip loss may reduce the nutrient content of meat. Drip losses of longissimus muscles cuts from sheep, Angora and Boer goat frozen at  $-20^{\circ}\text{c}$  and



thawed at 100c<sup>0</sup> for 24 hr were 5.24%, 3.68% and 3.19%, respectively. Judge et al., (2001) stated that heat processing is used to kill spoilage and pathogenic microorganisms in meat and meat products. Judge et al., (1990) reported that preservation is absolutely for prolonging shelf life, and storage of fresh meat and meat products.

### **2.7. Physical and Chemical Changes during Meat Storage:**

Meat is a nutritious, protein-rich food which is highly perishable and has a short shelf-life unless preserved. Shelf life and maintenance of meat quality are influenced by a number of interrelated factors including holding temperature, which can result in detrimental changes in quality attributes of meat (Olaoye, et al., 2010). Grancy, (1981) stated that meat undergoes certain superficial changes as the result of storage. The most of which are shrinkage, sweating and loss of bloom. The major chemical change is breakdown in proteins. Nercellotti et al., (1992) reported that post-mortem factors can influence lipid oxidation and decrease shelf life of the meat products. Mona, (2000) stated that improvement in the water holding capacity, a decrease in cooking loss, shear force and increase of the total bacterial counts occurs with increasing storage time of sausage, burger and minced meat.

### **2.8. Sausage as Meat Product:**

Processing is a mean for extending the product, improving shelf-life and producing an upgraded value added product (Kalalou, et al. 2004; Kalaloui, Zerdani and Faid, 2010). Pearson and Tauber ,(1984) reported that the term sausage is derived from the Latin word "salsas" meaning salt, or literally refers to chopped or minced meat preserved by salting. Mansour and Ahmed (2000) had used advanced technology to process sausage from camel meat and the products showed similar

chemical composition to beef products; however the camel meat products were higher in moisture (73.6%) and ash (4.13%). FAO, (1991) reported that, sausage is meat product in form of especially prepared, ground or chopped meat in which fresh comminuted meat, are modified by various processing methods. Dytte et al., (1981) and Essien, (2003) defined sausages as a comminuted processed meat made from red meat, poultry or a combination of these with water, binders and seasonings. Okerman, (1986) and Jihad et al., (2009) stated that sausages are very common and popular meat products manufactured from lower-value trimmed meat to produce higher value products. Dytte et al., (1981) classified sausage according to the degree of combinations to coarsely comminuted sausage and emulsified sausages. Generally, there are six types of sausages: fresh sausage-uncooked, smoked-cooked, dry or fermented and cooked meat products. Pearson and Gillett, (1996) separated the sausage processing into four basic processes: selecting ingredients, grinding and mixing, stuffing and thermal processing. According to FSIA/ USDA (1995), most sausage, is made by placing the ground ingredients in some type of forming device to give them shape and hold them together for thermal processing (Martin and Julie, 1998). Kerry et al., (2002) reported that fat is an essential component of meat for sensory perception of juiciness, flavor and texture. The water or ice added to the meat mixture provides considerable functional qualities. It chills the meat during the chopping or mixing operations. Essien, (2003) reported that the addition of excessive amounts of water can decrease the quality of sausage, because ice damage fatty tissue which increase fat loss, and lead to uneven salt distribution to the final product. According to Smith, (1988) and Vega et al., (1999) myofibril proteins, are most important during meat processing because of their ability to produce three- dimensional gels upon heating and

subsequent cooling, which has a high influence on the yield and texture properties of processed meat products.

### **2.9.1. Sausages Additives:**

Additive contributes to improving and intensifying some properties of meat, protein, water binding and emulsifying capacities. Meat extenders are improving yields and reduce formulation costs (FAO, 1985 and 1991). FAO, (1991) reported that the salt is the main flavoring agent used in making sausages and it contributes to basic taste characteristics of the final product. Dennis, (2004) stated that salt enhance the flavor of sausages and aids in preserving them against microbial spoilage. Judge et al., (2001); Kerry et al., (2002) reported that salt is the most common and most important additive of sausage. Its function includes flavoring, preservation and production of proper texture by solubilization of meat proteins. Salt is an ingredient of choice to bind restructured meat. Jihad et al., (2009) stated that the food additives are used to accomplish certain functions such as coloring, antimicrobial, preservation, improved nutrition, increased emulsification and altered flavor. Pearson and Gillett, (1996) stated that standardization is often necessary to control seasoning formulation, besides contributing the flavor. Seasonings influence the flavor, appearance or the shelf-life of the product; they are classified as spices, herbs, aromatic vegetables, flavoring enhancers and simulated meat flavors. Toldra, (2002) reported that the characteristics flavor of given type of sausage depends to a large extent on the spices used in its formulation. Lin et al., (1991) reported that the garlic has antibacterial and antioxidant effects on meat products; it is available in three different forms; fresh, dehydrated and extracted. Judge et al., (2001) mentioned that nitrates and nitrites are widely used as

additives in meat products as reddening, preservatives, enhance flavor and reduce oxidative rancidity.

### **2.9.2. Vegetable Protein in sausages:**

Legumes are edible seeds of leguminous plants belonging to the leguminous family. The mature legume seed has three major components: the coat (tester or hull), the cotyledon and the embryo axis, which constitute 8% , 90%, 2% and 15%, 84% , and 1% of soybean and chick peas respectively (Ihekoronye and Ngoddy, 1992). Ahmed and Nour, (1990) stated that the chemical composition of food legumes is governed by the cultivation, geographical location and growth condition. Carnovale et al., (1990) stated that the legumes represent a very interesting class of food because they are a good source of such essential nutrients as protein and some trace elements (iron , zinc), they are rich in compounds that markedly reduce the bioavailability of these nutrients and often contain compounds which are toxic. Siham, (2008) found that camel and beef sausages were not differ in color of the cooked sausages. However, beef sausages with bread received higher scores than the other sausages. Ndupuh and Akobundu , (1984) stated that beef patties extended with maize protein concentrate and defatted groundnut flour were superior in organoleptic quality to those extended with maize flour. Pietrasit and Duda, (2000); Dolata and Piotrowska, (2002) stated that milk proteins can act both as water and fat binders in foods. Siham (2008) found that there was a decrease in flavor score in beef and camel sausages with addition of blanched cowpea.

### **2.9.3. Sausage Casings:**

Casings are special cylindrical containers used to protect sausage, since sausages are comminuted products they must be placed in some type of forming device to give them shape to hold them together during processing and production. Usually the intestine of sheep and goats are used to produce fresh sausage (FAO, 1991). Dennis, (2004) stated that natural casings are from the gastrointestinal tract of animals. Martin and Julie, (1998) reported that casings preserved in salt must be soaked in lukewarm water for at least 30 minutes before use. Flush each casing under cold water, then running cold water through the casing. Unused casings can be drained, covered with salt and frozen. Judge et al., (1990) reported that the types of casings used are: (a) natural (b) manufactured. The natural casings are derived from gastro-intestinal tract of swine, cattle and sheep. The manufactured have four classes: (1) cellulose; (2) inedible collagen; (3) edible collage and (4) plastic.

Botka et al., (2001) stated that beef intestines are used in processing high-quality sausage products (after sorting, calibration and preservation).

### **2.10. Meat Bacteriology:**

Meat and meat products are very perishable. Deterioration begins after exsanguinations, resulting in microbial, chemical and physical changes. The initial microbial load plays a role in the determination of meat product's shelf-life (Olaoye, and Onilude, 2010). Jay, (1996) stated that the important to keep microorganisms at low for reasons of aesthetics, public health and products shelf-life. Ray and Bhunia, (2008) and Pesavento, et al., (2010) reported that the contamination of meat is a continuing possibly from the moment of

Bleeding until consumption. Judge et al., (1990) reported that the spoilage of meat was defined as the state at which meat become unfit for human consumption. Mead, (2004) stated that the aerosols produced during de-hiding, evisceration, and carcass splitting are also important sources of contamination. Bacteriology of meat is depending on the conditions under which animals are reared, slaughtered and processed. Thomas, (2001) reported that microbiology of meat focuses on two areas; keeping quality or shelf life and product safety. Khalifa, (2002) stated that the effect of beef storage on total viable count as ( $5.75 \times 10^{-4}$ ,  $6.2 \times 10^{-4}$ ,  $4.25 \times 10^{-5}$  and  $4.25 \times 10^{-5}$ ) for shade dried beef at zero ,one ,two and three month of storage respectively. According to Paulsen et al., (2006) meat perishable animal product and microbial spoilage of meat has great concern to the food industry. According to AFDO (1999); Huntley, (2000) bacteria, yeast and moulds present on sausage products contribute to spoilage once the product is complete contamination usually occurs during manufacturing processes. Narasimha and Ramesh, (1988) reported that minced meat obtained from retail shops when examined for microbiological quality and shelf-life at higher temperature, have higher total plate count than that processed under hygienic condition. Tibin and Melton, (1990) stated that ground beef is one the most economical popular choice of meat product that offer consumers variety and convenience. SSMO (2008) reported that for fresh sausage the total aerobic plate count should not exceed than  $5.25 \times 10^{-5}$ CFU/gm.

### **2.11. Minerals:**

Nutritionally, meat was a good source of essential amino acids and minerals except calcium. Meat was an important source of iron (Lawrie, 1991). Wan Zabari and Wahid, (1985) reported that lean meat is an excellent source of minerals required for normal growth and good

health and estimated the mean mineral concentration in meat as (Calcium-11, Phosphorous-155.5, Magnesium -19.7, potassium-350, sodium, 64 and Ferrous -4.37 mg/100gm). Doornenbal and Murray, (1982) stated that lean meat has low calcium level which is insufficient to provide the recommended daily allowance. Adim et al., (2008) reported that camel meat like other types of red meat was contained higher level of potassium than the other minerals. Abdon et al., (1980) reported that the mineral concentration in camel meat higher compared to beef, probably due to lower intramuscular fat levels. Doornenbal and Murray, (1982) stated that magnesium was required for normal skeletal development as a constituent of bone. Ferrous (Fe) may be supplied from many different foods. Meat is general adds iron and leafy green vegetables have high iron content. Bender, (1992) reported that meat is a good source of iron and zinc. Dawood and Alkanhal, (1995) stated that camel meat as an excellent source of the trace elements Fe and Zn. Siham, (2008) stated that the camel meat has a higher concentration of calcium, phosphorus, potassium, Sodium, copper, manganese and magnesium compared to beef. Wan Zahari et al., (1985) reported that goat meat has Na concentration as (55 - 77 mg/100gm). USDA, (2001) reported that the goat meat has higher levels of iron (3.2 mg/100gm) when compared to a similar serving size of beef (2.9 mg/100gm), pork (2.7 mg/100gm), lamb (1.4 mg/100g), and chicken (1.5 mg/100g). Comparatively, goat meat contains higher potassium concentration with lower sodium. According to USDA, (2007) goat meat has higher levels in iron and potassium but less sodium than red meat. Abdon et al., (1980) reported that goat meat had iron concentration as 2.1 mg/100gm. Eastridge and Johnson, (1990) reported that goat meat contains comparatively higher levels of iron, potassium associated with a low sodium level.

## **CHAPTER THREE**

### **MATERIALS AND METHODS**

This study was conducted in the laboratory of meat, College of animal Production Science and Technology Sudan University of Science and Technology (SUST) and in meat laboratory in Khartoum University, in the period from September 2012 to October 2013.

#### **3.1 Meat samples:**

Sixty kg of fresh deboned camel, beef and goat meat were obtained. Camel meat was purchased from “Soug Elnaga” local market, west Omdurman, beef from kuku research centre, and goat meat from local market. The meat was trimmed to small pieces and ground through 0.5 cm plate using meat grinder.

#### **3.2 Fillers:** The preparation methods of fillers:

The following fillers were used:

3.2.1. Bread Crumbs: was used after being ground through plate of 0.5 cm diameter.

3.2.2. Sweet Potato: was cooked under pressure for 10 minutes and ground through plate of 0.5 cm diameter.

#### **3.3. Samples for physicochemical analysis:**

Moisture content, crude protein, Fat, Ash, Protein Fractionation and PH were determined according to AOAC (2000). Samples from camel, beef and goat meat were analyzed, (One gm from minced meat was used). Cholesterol level was determined according to (Fenton, 1992).



### 3.3.1. Crude protein:

Kjeldahl method was used to determine nitrogen. The crude protein was determined by multiplying the amount of nitrogen times 6.25. The fresh meat sample was minced and one gm was digested in kjeldahl flask by adding mercury tablets as catalysts and 25 ml conc.H<sub>2</sub>SO<sub>4</sub>. The mixture was heated for 3 hr. The digested samples were cooled and transferred to volumetric flasks. Nitrogen was distilled from the flask in 40% of NaOH solution and received in 4% boric acid. The mixture was titrated against 0.1 N HCl solutions. The formula used for calculation of crude protein was as follows:

Crude protein %=	$T \times 0.1 \times 14 \times 100 \times 6.25$
	Weight of sample x 1000

T= Titration volume

### 3.3.2. Moisture Determination:

Moisture content was based on weight loss of five gm of sample (5 cm length and one cm thickness). The fresh samples were put in an oven at 100°C for 24 hrs. Consequently the samples were cooled in desiccators and their weights were determined. The moisture content was calculated according to the following equation:

Moisture %=	Fresh sample weight – dried sample weight	X 100
	Fresh sample weight	

### 3.3.3 Fat Determination:

Fat was determined by the ether extract. Two gm from the sample were taken to Soxhlet apparatus. The sample was subjected to continuous extraction with ether for 5 hrs. The sample was then removed from the extractor and allowed to dry for 2 hr at 100°C in drying oven till no traces of ether remained. The sample was then cooled and weighed for ether extraction determination as following:

Fat %	Fat weight	X 100
	Sample weight	

### 3.3.4. Ash Determination:

Two grams of fat free sample were placed into dried crucible of known weight. The crucible was placed inside a muffle furnace at 150°C. The temperature was increased gradually till it reached 600°C for 3 hrs. Then the crucible was taken out, cooled into desiccators and weighed. The ash percentage was calculated by the following formula:

Ash %	Weight of crucible before ashing – weight of crucible after drying	X 100
	Sample weight	

### 3.3.5. Determination of cholesterol:

Total cholesterol concentration in the three different types of meat (Camel, beef and goat meat) were quantified using high performance liquid chromatography (HPLC). HPLC has been used to separate cholesterol (Fenton 1992). Cholesterol by HPLC technique with a 25-cm Zorbax RX-Sil. Column (particle size of 5 µm). The compounds

were detected with an ultraviolet (UV) detector at (202nm) for cholesterol. The column was made of ultra-clean porous silica micro particles. The mobile phase was 99% hexane and 1% iso-propanol. Most HPLC methods use the polar stationary phase column made of highly pure, porous silica micro particles (Ponte, et. al., 2004, 2008 and Costa, et. al., 2006).

#### **3.3.5.1. HPLC adjusted to determination the Cholesterol:**

Column : C18  
T : 256  
Solvent : CH<sub>3</sub> OH: H<sub>2</sub>O (the ratio is 98: 2)  
Flow rate : 1.5ml /min.

Cholesterol stock : 0.2 gm cholesterol/ 100ml CH<sub>3</sub>OH

#### **Preparation of cholesterol Standard:**

0.5 mg/100 ml methanol

1.0 mg/100 ml methanol

1.5mg/100 ml methanol

2.0 mg/100 ml methanol

#### **3.3.6. Protein Fractionation:**

Samples for protein fractionation were prepared by trimming off excessive subcutaneous fat and connective tissues then mincing. Five gm from the sample was weighed and fractionated into sarcoplasmic and myofibrillar proteins according to the procedure described by Babiker and Lawrie (1983).All fractionation procedure

was carried at 4°C. The weighed sample was put into a micro-bender jar maintained in an ice-bath and 50 ml of cold 0.03 M potassium phosphate buffer (pH 7.4) was added. The contents of the micro jar were blended at low speed for 5 minutes. After homogenization, the homogenate was transferred to 100 ml centrifuge tubes and centrifuged. The supernatant was kept and the residue was resuspended in another 50 ml of the same potassium phosphate buffer, homogenized and centrifuged as before. The supernatant was decanted and the two solutions obtained were combined and filtered through filter paper (Whatman No. 4) to remove fat and other particulate materials. This combined filtrate contained both sarcoplasmic proteins and non-protein nitrogen fractions. 30 ml sample was mixed with ten ml of Trichloroacetic acid 20% (w/v) for 15 minutes and filtered through filter-paper (Whatman No. 1) to obtain non-protein nitrogen in the filtrate. Kjeldahl semi-micro method was used to determine the nitrogen content of this fraction which was then expressed as a percentage of fresh sample weight. The residue remaining from the extraction with phosphate buffer was extracted once with 50 ml of cold 1.1 M KI in 0.1 M potassium phosphate buffer (pH 7.4) using the same method of sarcoplasmic proteins extraction. After centrifugation at 35000 rpm for 20 min. the supernatant was filtered through glass wool. For determination of non-protein-nitrogen, 30 ml sample from the combined filtrate (containing both sarcoplasmic proteins and none-protein nitrogen fractions) was obtained from the protein fractionation and mixed with 10 ml trichloroacetic acid 20% (w/v), for 15 minute and filtered through filter paper (Whatman No. 1) to obtain non-protein-nitrogen in the filtrate. Kjeldahl semi micro method was used to determine the nitrogen content of this fraction, which was then expressed as a percentage of fresh sample weight.

### 3.4. Quality attributes:

Ten samples from the three types of meat were used for each parameter. Color Measurement was done according to (CIE, 1986). Water Holding Capacity (WHC) was measured according to the modified methods of Jauregui et al., (1981). Cooking Loss % was determined according to (AMSA, 1995). The samples were free of external visible fat and connective tissue and sub sampled for chemical analysis and quality parameters. Samples for quality attributes were allowed to oxygenate for 2 hours at 4°C before use.

#### 3.4.1. Color Measurement:

Color measurements were performed using hunter lab Tristimulus colorimeter model D 25 M-2 Hunter. Lightness (L), redness (a) and yellowness (b) were recorded on muscle sample (CIE, 1986).

#### 3.4.2. Water Holding Capacity (WHC):

One gm from minced meat (LD) was used. Each sample was placed on humidified filter paper (Whatman No. 40) in a desiccators over saturated KCl solution) and pressed between two Plexiglas plates for 3 min. at 25 kg load. The meat film area was traced with a ball pen and the filter paper was allowed to dry. Meat and moisture areas were measured with a compensating Plano-meter (Jauregui et al., 1981). As follows:

Water holding capacity	Loss water area – meat film area
	Meat film area

### 3.4.3. Cooking Loss Determination:

The cooking loss was determined according to (AMSA, 1995). Meat samples were thawed at 5°C for 24 hr. then cut into samples of equal dimensions and weighed. Samples were cooked in plastic bags in a water bath at 80°C for 90 min., cooled in running tap water for 20 min., then dried from fluids and reweighed. The cooking loss % was also determined by oven. Frozen samples randomly selected were used for determining cooking losses and thawed for 24 hours in 4°C refrigerator. Two fingers from each treatment were weighed separately and rapped by aluminum foil, then cooked by oven at 160°C for 25-30min. Samples allowed to cooling at room temperature, then reweighed. Cooking losses were determined by weight difference between raw and cooked sausage. The cooking losses were determined according to (Ziprin et al., 1981). Cooking loss was determined as the loss in weight during cooking and expressed as a percent of pre-cooking weight as follows:

Cooking loss %	Weight before cooking – Weight after cooking	X 100
	Weight before cooking	

### 3.4.4. pH determination:

The pH was performed according to AOAC (1984). One gm of sample was blended with 9 ml of distilled water in a laboratory blender for 2 min, filtered and then pH of the filtrate was determined by digital pH-meter. The meat samples were packed , labeled and kept frozen in - 18 °c (1 g) The procedure at each measurement involved excising of fresh cut surface and sampling it with sterile plate . The area was

covered by polyethylene cover to avoid desiccation. Sample weighing approximately 1 gm was homogenized in 10 ml 5mm iodoacetic acid, 150 mM KCl neutralized to pH 7.0 by dilute NaOH and HCl. The pH was then read on laboratory pH meter, (adjusted with buffer, pH 7.0) at room temperature.

### **3.5. Sausages preparation:**

Three types of sausages were manufactured using two types of fillers (bread crumbs and sweet potato). The ingredients were added equally to the treatments as shown in (Table 1). The Sausage consist of minced meat to which salt (NaCl), garlic, coriander, cinnamon, black pepper, nutmeg, fat, cold water, skim milk and filler 15% were added. The whole mixture was mixed well in a chopper after adding skimmed milk powder to the dough. The mixture was stuffed in sheep casings using piston stuffer, then linked, placed in polythene bags, labeled and frozen at -20°C to wait the following tests.

**Table (1) :**

Ingredients of the sausage recipe:

<b>Ingredient</b>	<b>(%)</b>
Fillers(bread crumbs or sweet potato)	15
Ice water	20
Salt	2
Black pepper	0.5
Coriander	0.5
Sugar	0.5
Garlic	0.3
Skimmed milk powder	0.3
Cinnamon	0.1

(All ingredients are percentage from the formulated products)



### **3.6. Sensory Evaluations:**

#### **3.6.1. Sensory Evaluations of Fresh meat:**

The samples used for sensory evaluation were randomly selected and thawed for 24 hours in 4°C refrigerator prior to cooking. Meat samples were separately cooked in an electric oven at 163 c<sup>0</sup> for 90 minutes as described by Griffin, et al., (1985). A six point hedonic scale was used, where six was extremely desirable while one was extremely undesirable. Tap water was available for the panelists use between testing samples.

#### **3.6.2. Sensory evaluations of sausages:**

Samples for sensory evaluation were conducted in the sensory evaluation facilities of meat laboratory, College of Animal Production Science and Technology Sudan University of Science and Technology (SUST). Ten semi-trained panelists were asked to evaluate the treatment effects on color, texture, flavor and juiciness of the sausage samples. The samples used for sensory evaluation were randomly selected and thawed for 24 hours in 4°C refrigerator prior to cooking. Sausages were separately cooked for 6-10 minutes by deep fat frying in vegetable oil. Sausages were turned every three minutes to prevent excessive browning. Samples were kept warm for evaluation. They were put in coded plates and served warm to the panelists. From each treatment a sample of 6 fingers was randomly placed in a dish divided to six portions under lamb light. Every panelist has one dish to test in each session. A six point hedonic scale was used, where six was extremely desirable while one was extremely undesirable (Appendix 1). Tap water was available for use between testing samples.

### **3.7. Bacteriological Assessment:**

Total viable bacterial counts of fresh and refrigerated samples of camel, beef and goat meat was done after variable periods of storage. Samples were placed in icebox during transport to laboratory and kept in a deepfreeze (-18c°). The thirty grams obtained from LD muscle were excised from the conditioned quarters immediately after 3 and 5 hours postmortem and child for 24hrs. The samples were then blended with 270 ml sterile distilled water by using electric blender (Homogenizer MSE) for 3 minutes. Duplicate samples were taken .Serial dilutions were made for each sample and each dilution was plated in standard plate-count Agar. Duplicates of each sample were incubated at 37 c<sup>0</sup> for 48 hours. Bacterial colony count was expressed as log 10 /10 per gm colony count.

#### **3.7.1. Culture Media: Plate count agar (Difco):**

The medium was in form of dehydrated powder. It was composed of Bacto-tryptone-yeast extract, Dextrose and agar. It was prepared by dissolving 23 gm of medium in one liter of distilled water.

#### **3.7.2. Culture method:**

Ten gram of each sample was taken aseptically, cut into small pieces and blended with 90 ml sterile cooled normal saline for 3–4 minutes at high speed. The homogenized suspension was allowed to stand for 10 minutes to allow the foam to subside and heavy particles to settle.

#### **3.7.3. Total viable counts:**

Using sterile pipette 1.0 ml of the supernatant was transferred to a test tube containing 9.0 ml sterile normal solution. The contents were mixed by another sterile pipette and 1.0 ml of the mixture was transferred

to a second tube until the fifth tube thus decimal serial dilutions up to  $10^{-6}$  were prepared. Using sterile pipettes 1.0 ml of the dilutions  $10^{-2}$ ,  $10^{-3}$ ,  $10^{-4}$  and  $10^{-5}$  was transferred into duplicate sterile Petri dishes. Fifteen to twenty milliliters of molten plate count agar cooled to  $42-45^{\circ}\text{C}$ , in a water bath, were poured into each plate containing the inoculums. Plates were then rotated from side to side and then left to dry and incubated in inverted position (Cruickshank, 1975). The dilutions  $10^{-3}$ ,  $10^{-4}$  and  $10^{-5}$  were used for samples stored.

### **3.8. Determination of minerals in camel, beef and goat meat:**

For the determination of minerals concentration, the samples were initially homogenized in a food processor and dried in a drying oven at  $100^{\circ}\text{C}$ . The meat samples subjected to complete digestion in muffle furnace with a maximum temperature of  $450^{\circ}\text{C}$  to constant weight. A mixture of concentrated  $\text{HNO}_3$  and 30%  $\text{H}_2\text{O}_2$  was used for the complete digestion of samples. A Spectrometer (Optima 3000 DV, Perkin Elmer – 1350 W) was used with the specific wavelengths.

#### **3.8.1. Calcium determination in meat samples:**

The concentration of calcium in meat was determined according to the method of Trinder, (1960). A stock solution was prepared by dissolving 0.25 gm of calcium carbonate in 0.1 N HCl (hydrochloric acid) and made up to 100 ml with the acid. The standard was prepared by diluting 4 ml of the stock solution with 100 ml distilled water (D.W). 0.5 ml of standard was added to 1.0 ml of 0.5% chloronillic acid in a tube, used as standard. 0.5 ml of sample was placed in a centrifuge tubes, 1.0 ml of 0.5% chloronsillic acid was added. All tubes were allowed to stand for 15 minutes, and centrifuged at 3000 rpm for 5 minutes. The supernatant was decanted, and tubes were drained on a filter paper. The

precipitate was washed with 0.5 ml D.W., and centrifuged again, the supernatant decanted and the tubes drained on a filter paper. The precipitate was dissolved in 4 ml of 4% ferric nitrate and allowed to stand for 5 minutes and then read at wave length 500 nm, ferric nitrate was used as blank.

Calcium concentration in the meat sample was calculated as follows:

Reading of unknown – reading of blank	X 100= mg/100 gm
Reading of standard – reading of blank	

### 3.8.2. Phosphorus determination in meat samples:

Phosphorous concentration was determined by the method described by Varley (1967). 0.2197 gm of potassium dehydrogenate phosphate was dissolved in distilled water and made up to 1 liter. Few drops of chloroform were then added to 0.5 ml of the solution. 4.5 ml of 10% trichloroacetic acid (TCA) was added and used as standard. Five ml of 10% TCA was used as a blank. One ml of the sample was added to 9 ml of 10% TCA and the mixture was filtered, then 5 ml from the supernatant was taken in a test tube. One ml of ammonium molybdate solution was added to all samples and mixed then one ml of metal solution added, mixed and allowed to stand for 3 minutes at room temperature, finally read in a colorimeter at wave length 680 nm. Meat inorganic phosphate was calculated as follows:

Reading of unknown	X 5 = mg/100 g
Reading of standard	

### 3.8.3. Magnesium determination in meat samples:

Magnesium concentration was determined by the method described by Norbert (1982). 8.358 gm of analytic grade magnesium chloride were dissolved in D.W. and made up to 1.0 liter. 1 ml of this solution was diluted in D.W. up to 200 ml and used as standard. Two concentrations of standard were made low standard by diluting 1.0 ml of standard with 2 ml D.W and high standard was made by adding 1.0 ml D.W. to 2 ml working standard. For the blank 3.0 ml D.W. was used. 0.2 ml of meat samples were diluted with 2.8 ml of D.W. To all tubes 0.5 of polyvinyl alcohol, 0.5 ml titan yellow and 1.0 ml 7.5 w/v sodium hydroxide solutions were added in the above stated order with mixing after each addition. All tubes were allowed to stand for 5 minutes, the absorbance of unknown and standard were read at wave length 540 nm and the zero absorbance was set by blank. The meat samples magnesium level was calculated as follows:

Reading of unknown x 2.5	mg/100 gm
Reading of high standard	

### 3.8.4. Determination of sodium (Na) and potassium (k) in meat samples :

Sodium and potassium concentration in meat samples were determined by a flame photometer (Corning 400) as described by Wootton (1974). Low Na and K standard solution were prepared by dissolving (8.1 and 0.373g) of Na and K in D.W to 1.0 liter respectively. High Na and K standard solution were prepared by dissolving (9.35 and 0.522g) in D.W respectively. One ml of sample was diluted with distilled

water (9.9 ml) in stopper dematerialized test tube and mixed. The knob of light filter was adjusted to Na or K, then the power was connected and the Galvanometer light switched on, the gas switch was ignited. The high standard was adjusted to 100 (full scale), then the diluted sample and the low standard were read. Meat sodium (Na) concentration was calculated as follows:

Reading of the diluted meat sample	X140 = mg/100gm
Reading of the low Na standard	

Meat K concentration was calculated as follows:

Reading of the diluted meat sample	X 5 = mg/10gm
Reading of the low K standard	

### 3.8.5. Ferrous determination (Fe):

Ferrous concentration was determined according to the method described in atomic absorption methods Pyunicam Sp. 90 using an atomic absorption spectrophotometer.

### 3.9. Statistical analysis:

The data collected were subjected to statistical analysis by using complete randomized design used to analyze the results obtained from this study and subjected to ANOVA followed by Least significant difference test (LSD) using the (SPSS, Version 17.0, 2008).

## CHAPTER FOUR

### RESULTS

#### 4.1 Chemical Composition of camel, beef and goat meat:

Table (2) and figure (1) shows the mean values ( $\pm$ SD) of chemical composition of camel, beef and goat meat. The moisture content showed significant ( $P < 0.05$ ) different among the treatment muscles. Camel and goat meat had higher moisture content than beef. Protein content was highly significant ( $P < 0.01$ ) different among the three types of meat. Beef had higher protein content compared to camel and goat meat. Fat content was not significantly ( $P > 0.05$ ) different among the treatment muscles. However, the fat content of beef was the highest followed by goat and camel meat. Ash content was highly significant ( $P < 0.01$ ) different among the three species meat studied. Camel meat had the highest amount of ash followed by beef and goat meat respectively. The cholesterol content of the three species was highly significant ( $P < 0.01$ ) among the treatment muscles. Camel meat had significantly lower cholesterol content than beef and goat meat. Myofibrillar proteins were not significantly ( $P > 0.05$ ) different among the three species. Sarcoplasmic proteins were not significantly ( $P > 0.05$ ) different among the three species. Non-protein-nitrogen was not significantly ( $P > 0.05$ ) different among the three treatments.

**Table (2): Mean values ( $\pm$ SD) of chemical composition of camel, beef & goat meat:**

<b>Meat type Parameters</b>	<b>Camel meat</b>	<b>Beef</b>	<b>Goat meat</b>	<b>Significant level</b>
<b>Moisture %</b>	77.92 $\pm$ 0.60 <sup>a</sup>	72.12 $\pm$ 0.95 <sup>c</sup>	75.55 $\pm$ 0.70 <sup>b</sup>	*
<b>CP %</b>	19.78 $\pm$ 0.77 <sup>b</sup>	21.07 $\pm$ 0.44 <sup>a</sup>	20.32 $\pm$ 0.71 <sup>b</sup>	**
<b>Fat %</b>	1.17 $\pm$ 0.26 <sup>b</sup>	2.74 $\pm$ 0.80 <sup>a</sup>	1.66 $\pm$ 0.17 <sup>b</sup>	NS
<b>Ash %</b>	0.78 $\pm$ 0.47	0.47 $\pm$ 0.03	0.43 $\pm$ 0.02	**
<b>Cholesterol(mg/100gm)</b>	59.20 $\pm$ 4.66 <sup>b</sup>	73.60 $\pm$ 6.73 <sup>a</sup>	71.20 $\pm$ 5.81 <sup>a</sup>	**
<b>Myofibriller protein%</b>	11.24 $\pm$ 0.27	11.48 $\pm$ 0.06	11.36 $\pm$ 0.25	NS
<b>Sarcoplasmic protein%</b>	5.50 $\pm$ 0.35	5.35 $\pm$ 0.21	5.40 $\pm$ 0.32	NS
<b>NPN %</b>	1.35 $\pm$ 0.26	1.05 $\pm$ 0.16	1.16 $\pm$ 0.11	NS

**N.B.** : For this table and other subsequent tables:

NS = No significant difference between the two means.

\* = (P < 0.05)

\*\* = (P < 0.01)

a, b and c = Means within the same row with different superscripts differ P < 0.05).



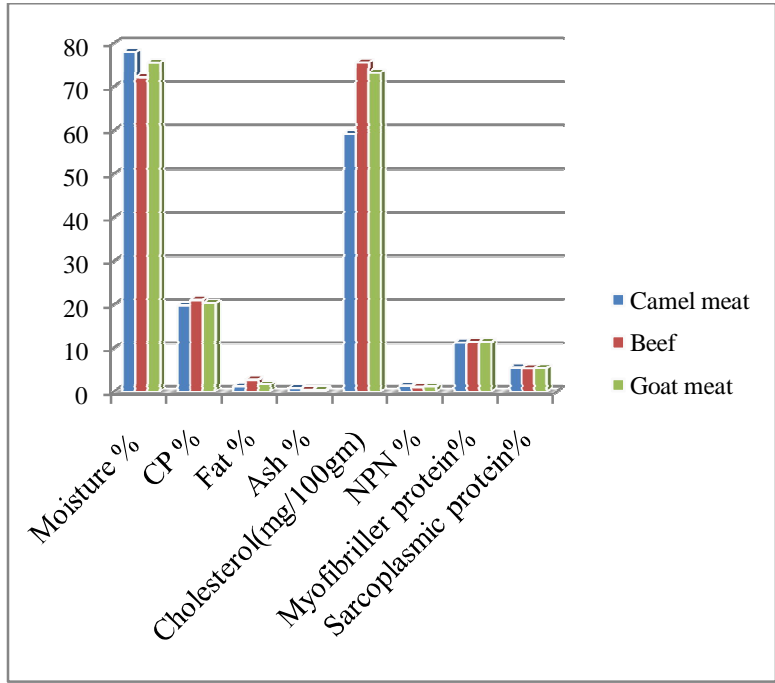


Figure (1): Proximate analysis of camel, beef and goat meat

**4.2. Meat quality attributes:**

Table (3) and figure (2) shows mean values ( $\pm$ SD) of some quality attributes of camel, beef and goat meat. Hunter lightness (L) values were highly significant ( $P < 0.001$ ) between three muscles studied. Beef and goat meat recorded higher values than camel meat. Redness (a) values were not significant ( $P > 0.05$ ) different. Goat meat recorded higher values

followed by beef and camel meat. Yellowness (b) values were significantly ( $P < 0.001$ ) different. Beef recorded higher value followed by camel and goat meat. Water holding capacity (WHC) was highly significant ( $P < 0.01$ ) different among the three types of meat studied. Camel meat recorded low values compare to beef and goat meat (That mean camel meat have highest water holding capacity compared to beef and goat meat). Cooking loss was highly significant ( $P < 0.01$ ) different among the three types of meat. Cooking loss percent of camel meat was higher followed by goat meat and beef respectively. There was no significant ( $P > 0.05$ ) different between the three types of meat in PH values.

**Table (3): Mean values ( $\pm$ SD) of some quality attributes of the camel, beef and goat meat:**

<b>Parameters</b>	<b>Camel meat</b>	<b>Beef</b>	<b>Goat meat</b>	<b>Significant level</b>
<b>Lightness (L)</b>	29.76 $\pm$ 0.54 <sup>b</sup>	33.27 $\pm$ 1.21 <sup>a</sup>	32.44 $\pm$ 1.02 <sup>a</sup>	**
<b>Redness (a)</b>	17.04 $\pm$ 0.57	17.69 $\pm$ 1.45	18.53 $\pm$ 0.57	NS
<b>Yellowness (b)</b>	7.48 $\pm$ 1.52 <sup>a</sup>	8.82 $\pm$ 0.67 <sup>a</sup>	5.82 $\pm$ 0.27 <sup>b</sup>	**
<b>Water holding capacity (WHC)</b>	1.37 $\pm$ 0.20 <sup>b</sup>	2.44 $\pm$ 0.24 <sup>a</sup>	2.19 $\pm$ 0.30 <sup>a</sup>	**
<b>Cooking loss %</b>	36.30 $\pm$ 0.86 <sup>a</sup>	31.75 $\pm$ 1.20 <sup>c</sup>	34.15 $\pm$ 0.85 <sup>b</sup>	**
<b>PH</b>	5.88 $\pm$ 0.31	5.77 $\pm$ 0.34	5.68 $\pm$ 0.19	NS

N.B. :

L = Degree of lightness at hunter lab color

a = Degree of redness at hunter lab color

b = Degree of yellowness at hunter lab color

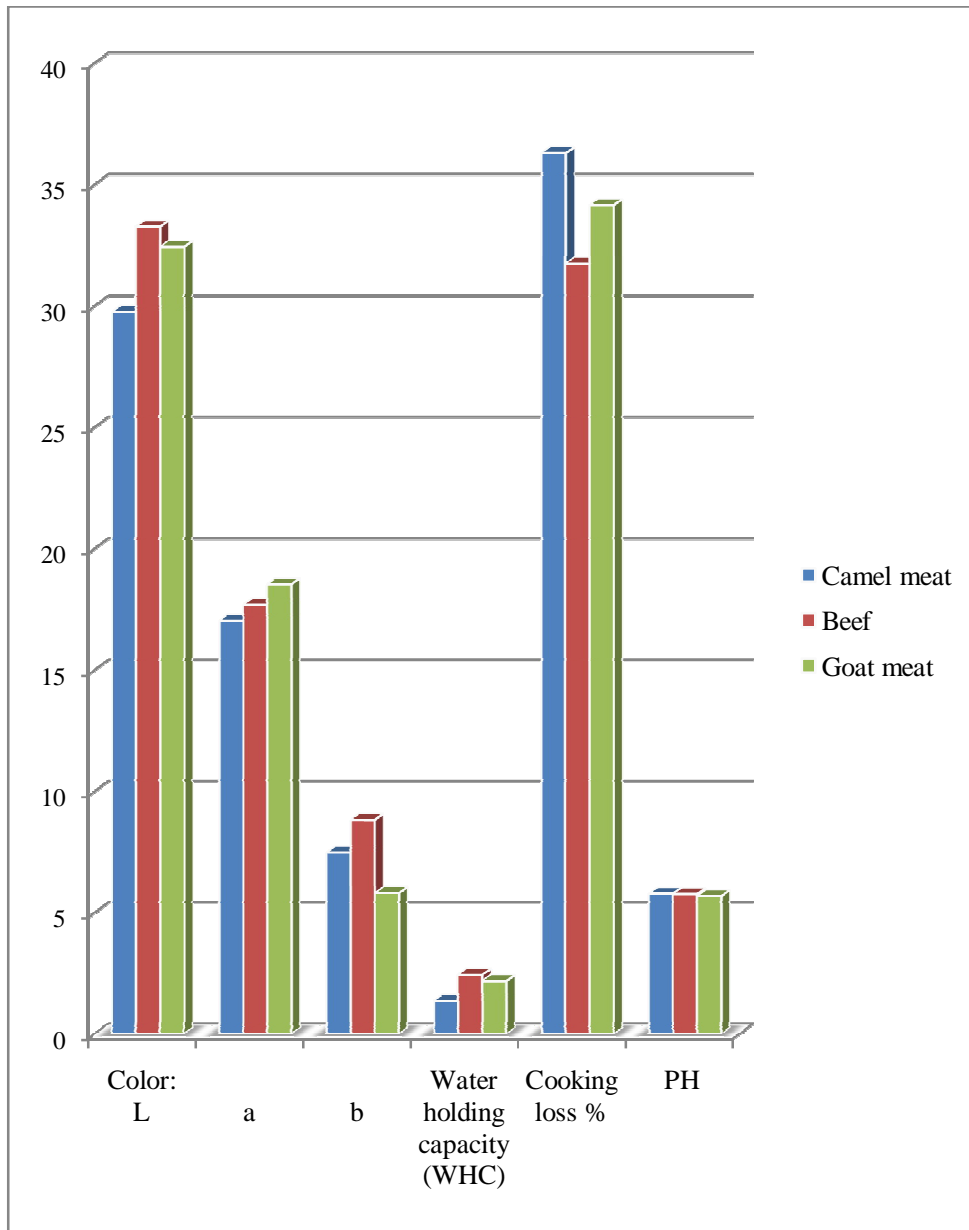


Figure (2): Some quality attributes for different types of meat

#### 4.3. Chemical Composition of camel, beef and goat sausages:

Table (4) and figure (3) shows the mean values ( $\pm$ SD) of chemical composition of camel, beef and goat sausages. The moisture content showed significant ( $P < 0.05$ ) different among the treatment sausages. Camel and goat sausages had higher moisture content than beef. Protein content was highly significant ( $P < 0.01$ ) different among the three types of sausages. Beef had higher protein content compared to camel and goat sausages. Fat content was highly significant ( $P < 0.01$ ) different among the treatment sausages. However, the fat content of beef sausages was the highest followed by goat and camel sausages. Ash content was highly significant ( $P < 0.01$ ) different among the three sausages type. Camel sausages had the highest amount of ash followed by beef and goat sausages respectively. Non-protein-nitrogen was not significantly ( $P > 0.05$ ) different among the three type of sausages.

**Table (4): Mean values ( $\pm$ SD) of chemical composition of camel, beef**

**&goat sausages:**

<b>Meat type Parameters</b>	<b>Camel sausages</b>	<b>Beef sausages</b>	<b>Goat sausages</b>	<b>Significant level</b>
<b>Moisture %</b>	73.45 ± 0.71 <sup>a</sup>	70.32±1.12 <sup>b</sup>	71.0 ± 1.0 <sup>b</sup>	*
<b>CP %</b>	16.0 ± 0.30 <sup>c</sup>	18.53±0.25 <sup>b</sup>	18.0 ±0.41 <sup>a</sup>	**
<b>Fat %</b>	2.31± 0.22 <sup>c</sup>	3.45±0.23 <sup>a</sup>	3 ± 0.20 <sup>b</sup>	**
<b>Ash %</b>	2.0 ± 0.20 <sup>a</sup>	1.33 ± 0.35 <sup>b</sup>	1.12±0.20 <sup>b</sup>	*
<b>NPN %</b>	6.47 ±0.45	6.23 ±0.40	5.89±0.11	NS

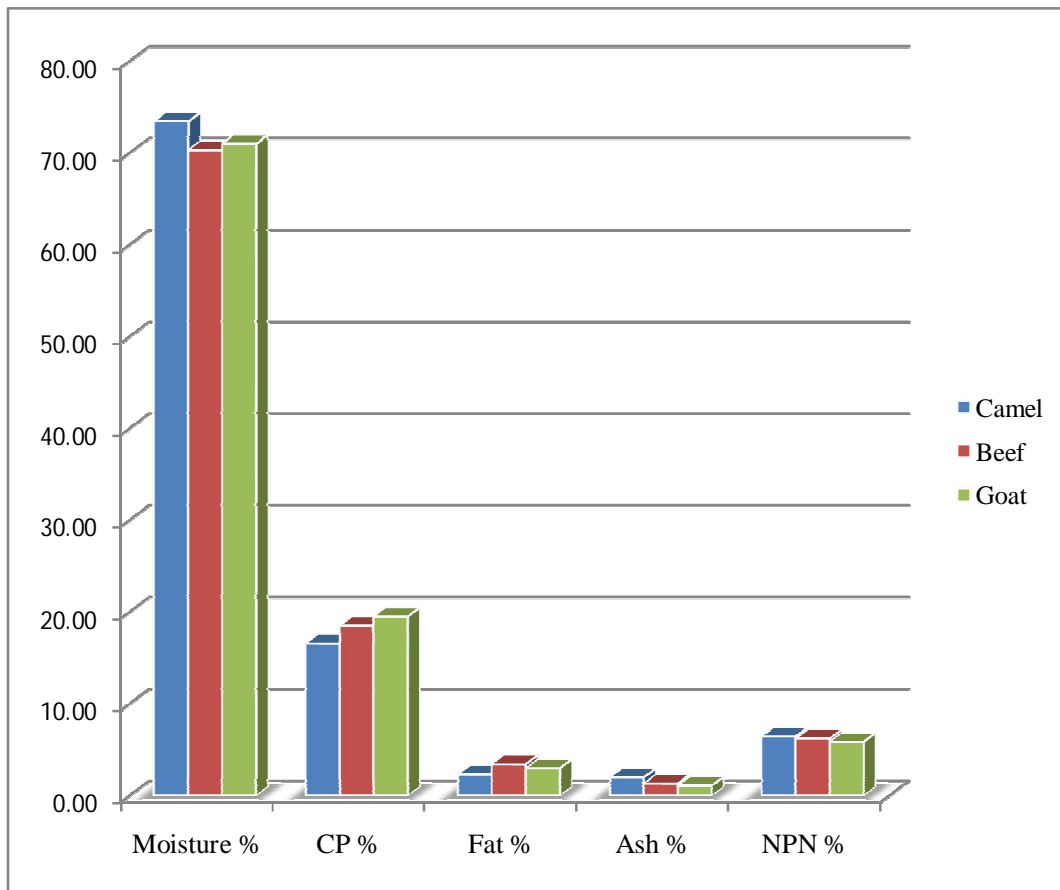


Figure (3): Proximate analysis of camel, beef and goat sausages

#### **4.4. Sausages Some Quality Attributes:**

Table (5) and figure (4) shows mean values ( $\pm$ SD) of some quality attributes of camel, beef and goat sausages. Hunter lightness (L) values were highly significant ( $P < 0.001$ ) between three types of sausages studied. Beef and goat sausages recorded higher values than camel sausages. Redness (a) values were not significant ( $P > 0.05$ ) different. Goat sausages recorded higher values followed by beef and camel sausages. Yellowness (b) values were no significant ( $P < 0.001$ ) different. Goat sausages recorded higher value followed by beef and camel sausages. Water holding capacity (WHC) was highly significant ( $P < 0.01$ ) different among the three types of sausage studied. Camel sausages recorded low values compare to beef and goat sausages (That mean camel sausages have highest water holding capacity compared to beef and goat sausages). Cooking loss was highly significant ( $P < 0.01$ ) different among the three types of sausage. Cooking loss percent of camel sausage was higher followed by goat meat and beef respectively. There was no significant ( $P > 0.05$ ) different between the three types of meat in pH values.



**Table (5): Mean values ( $\pm$ SD) of some quality attributes of the camel, beef and goat sausages:**

<b>Parameters</b>	<b>Camel sausages</b>	<b>Beef sausages</b>	<b>Goat sausages</b>	<b>Significant level</b>
<b>Lightness (L)</b>	28.5 $\pm$ 0.50 <sup>c</sup>	31.80 $\pm$ 0.26 <sup>b</sup>	32.15 $\pm$ 1.03 <sup>b</sup>	**
<b>Redness (a)</b>	10.40 $\pm$ 0.50	11.43 $\pm$ 0.51	11.56 $\pm$ 0.51	NS
<b>Yellowness (b)</b>	7.67 $\pm$ 0.31	8.48 $\pm$ 0.50	8.56 $\pm$ 0.59	NS
<b>Water holding capacity (WHC)</b>	0.48 $\pm$ 0.17 <sup>b</sup>	1.06 $\pm$ 0.21 <sup>a</sup>	0.69 $\pm$ 0.17 <sup>b</sup>	*
<b>Cooking loss %</b>	24.12 $\pm$ 0.83 <sup>a</sup>	22.02 $\pm$ 0.03 <sup>b</sup>	21.2 $\pm$ 0.78 <sup>b</sup>	**
<b>pH</b>	5.65 $\pm$ 0.21	5.73 $\pm$ 0.11	5.66 $\pm$ 0.07	NS

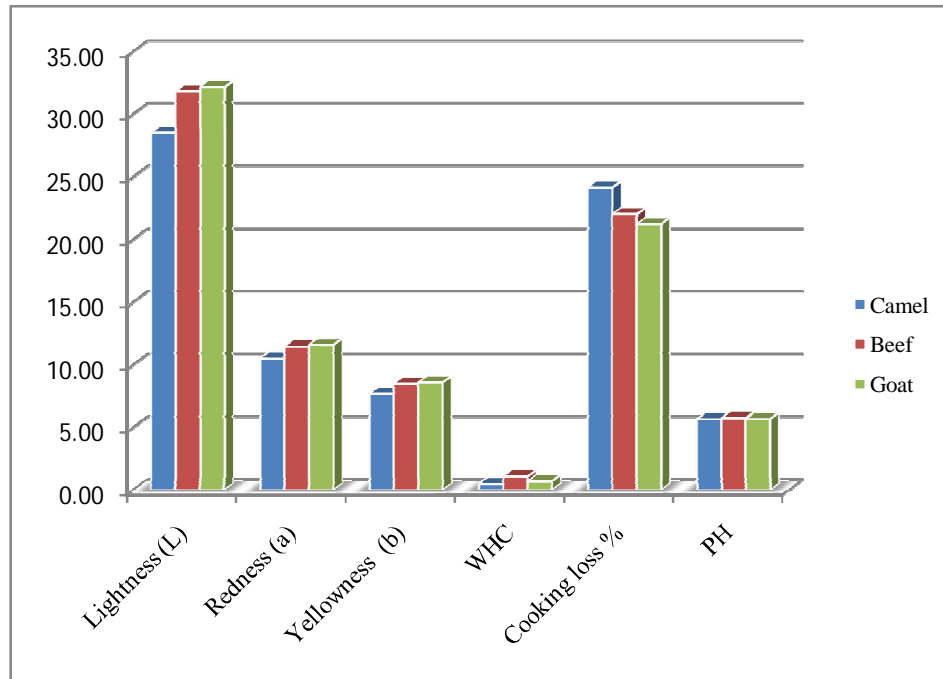


Figure (4): Some quality attributes for different types of sausage

#### 4.5. Sensory Evaluation:

##### 4.5.1 Sensory Evaluation of camel, beef and goat meat:

Meat type Parameters	Camel meat	Beef	Goat meat	Level of significant
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Table (6) and figure (5) shows the panel rating of cooked camel, beef and goat meat. The treatments differ significantly ( $P < 0.05$ ) in the parameters measured except color and all scores obtained were above moderately desirable (Appendix 1). Panelists scores for juiciness of camel meat and beef were higher than that of goat meat and there was significant ( $P < 0.05$ ) different between them. Panelist scores for color were not significant ( $P > 0.05$ ) different between them. There was significant ( $P < 0.05$ ) different between them in tenderness. Panelists scores for tenderness of camel and goat meat were lower than that of beef. There was highly significant ( $P < 0.01$ ) different between treatment in flavor. The scores for flavor of camel and goat meat were lower than that of beef. Overall acceptance showed significant ( $P < 0.05$ ) different between them. Camel meat and beef more desirable than goat meat.

<b>colour</b>	4.60±0.70	4.80±0.42	4.30±0.48	NS
<b>Tenderness</b>	4.50±0.71 <sup>b</sup>	5±0.67 <sup>a</sup>	4.20±0.63 <sup>b</sup>	*
<b>juiciness</b>	5.10±0.57 <sup>a</sup>	5.10±0.74 <sup>a</sup>	4.10±0.57 <sup>b</sup>	**
<b>Flavor</b>	4.40±0.52 <sup>b</sup>	4.60±0.70 <sup>a</sup>	3.70±0.67 <sup>b</sup>	**
<b>Overall acceptance</b>	4.80±0.63 <sup>a</sup>	5,0±0.67 <sup>a</sup>	4.20±0.63 <sup>b</sup>	*

**Table (6): Mean values (± SD) of meat quality attributes (sensory evaluations) of camel, beef and goat meat cooked by boiling:**

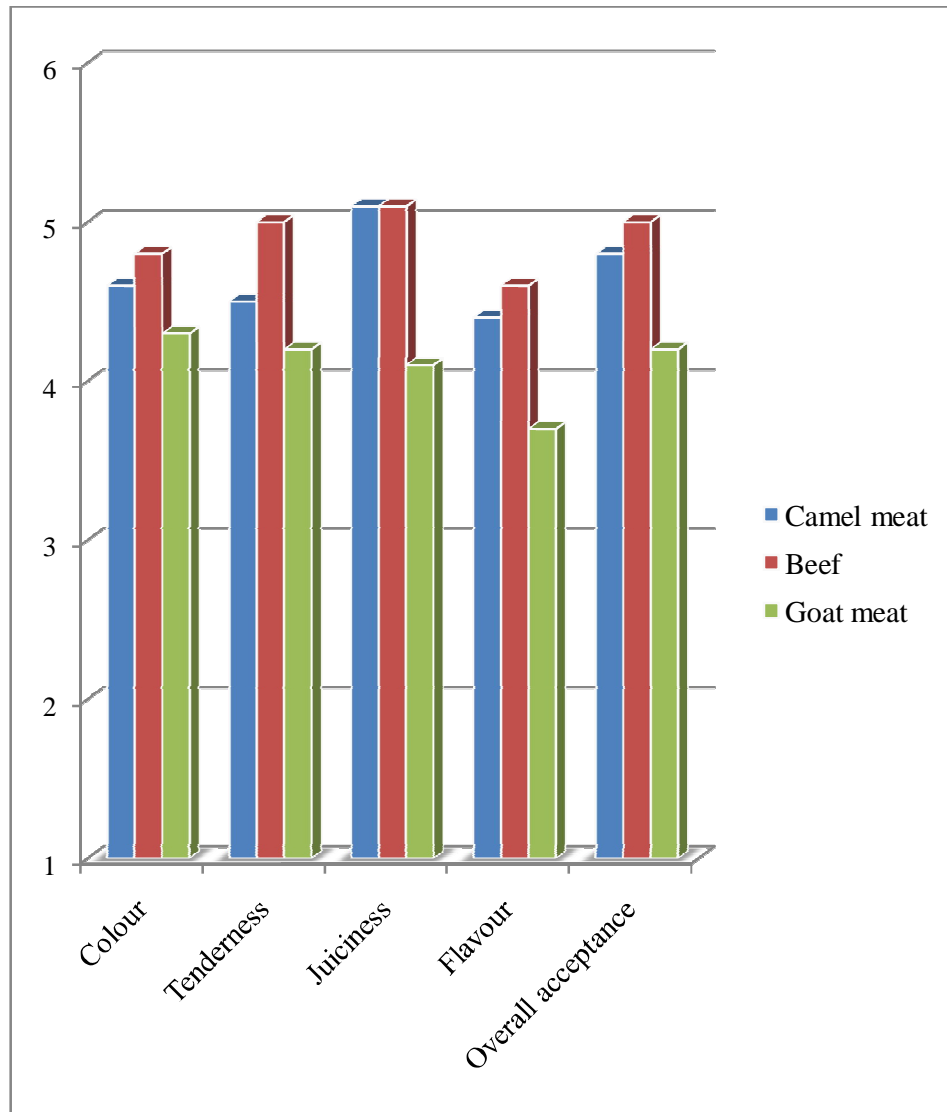


Figure (5): Sensory evaluation of different types of meat

**4.5.2. Sensory evaluation of camel, beef and goat sausages:**

Sensory results and the acceptability of sausages of different types of meat and fillers were shown in table (7) and figures (6, 5 and 7), all the scores obtained were ranged between (3.0 - 6.0) and there was no significant ( $P>0.05$ ) different treatments in any of the parameters measured. Sensory results of sausages with different types of fillers were shown in table (5), all the scores obtained ranged between (4.0-6.0).The statistical analysis showed high significant ( $P < 0.01$ ) different among parameters measured.

#### **4.5.2.1. Color:**

Camel, beef and goat sausages were not significantly different ( $P> 0.05$ ) in color of the cooked sausages. However, camel and beef sausages with sweet potato received higher scores compared to goat sausages.

#### **4.5.2.2. Tenderness:**

There was no significant different ( $P> 0.05$ ) among treatments in tenderness. Most noticeably sausages of camel meat containing sweet potato had higher tenderness scores followed by beef sausages and goat sausages.

#### **4.5.2.3 Juiciness:**

As shown in table (7), the juiciness of different sausages showed no significant ( $P>0.05$ ) different among treatments. Sausages of camel meat with sweet potato received the highest score ( $5.5 \pm 0.53$ ). Also it was noticed that sausages became juicier with the addition of sweet potato compared to bread crumbs.

#### **4.5.2.4. Flavor:**

As shown in table (7), there was no significant ( $P>0.05$ ) different among treatments in flavor. The camel and goat sausages with sweet potato were received the highest scores in flavor, where as the flavor scores of different sausages (camel, beef or goat sausages) with bread crumbs showed decreased values.

#### **4.5.2.5. Overall acceptance:**

As shown in table (7), there was no significant ( $P>0.05$ ) different among treatments in overall acceptance, while the camel sausages with sweet potato received higher scores followed by beef and goat sausages. Generally it was observed that most of the scores of color, tenderness, juiciness, flavor and overall acceptance were above moderately desirable (Appendix 1). These results indicated that the sweet potato improved the characteristics of sausages and influence on the overall acceptance scores. The overall acceptability results indicated that sausages made with camel, beef and goat meat with different types of fillers were differed in the overall acceptability scores but all were accepted. Results also indicate that camel, beef and goat sausages made with sweet potato were preferred by the panelists group and received the highest acceptability scores compared with others, while sausages made with bread crumbs received the least acceptability scores. The results showed that textural attributes of goat sausages are comparable to those of other types of sausages, since several important attributes were not influenced by sausage type.

**Table (7): Mean values ( $\pm$  SD) of sensory attributes of sausages made of different types of meat and fillers cooked by (deep fat Frying):**

Factors		Parameters				
Sausage type	Filler type	Color	Juiciness	Tenderness	Flavor	Overall acceptance
Camel sausage	Bread crumbs	4.70 $\pm$ 0.95	3.70 $\pm$ 1.06	4.40 $\pm$ 0.97	4.40 $\pm$ 0.70	4.30 $\pm$ 0.67
	Sweet potato	5.40 $\pm$ 0.70	5.50 $\pm$ 0.53	5.30 $\pm$ 0.95	5.30 $\pm$ 0.82	5.40 $\pm$ 0.70
Beef sausage	Bread crumbs	4 $\pm$ 0.94	4.10 $\pm$ 1.45	4.60 $\pm$ 1.17	3.80 $\pm$ 1.32	4.20 $\pm$ 1.14
	Sweet potato	5.30 $\pm$ 0.67	4.80 $\pm$ 0.92	4.70 $\pm$ 1.06	4.50 $\pm$ 0.85	4.90 $\pm$ 0.74
Goat sausage	Bread crumbs	5 $\pm$ 1.05	4.40 $\pm$ 1.07	4.60 $\pm$ 0.97	3.90 $\pm$ 1.10	4.70 $\pm$ 0.95
	Sweet potato	4.90 $\pm$ 0.57	4.60 $\pm$ 0.52	4.50 $\pm$ 0.85	5.10 $\pm$ 0.57	4.90 $\pm$ 0.32
<b>Main effect</b>						
Sausage type	Camel sausage	5.05	4.60	4.85	4.85	4.85
	Beef sausage	4.65	4.45	4.65	4.15	4.55
	Goat sausage	4.95	4.50	4.55	4.50	4.80
<b>Standard Error</b>		0.19	0.22	0.22	0.21	0.18
<b>Significant level</b>		NS	NS	NS	NS	NS
Filler type	Bread crumbs	4.57	4.07	4.53	4.03	4.40
	Sweet potato	5.20	4.97	4.83	4.97	5.07
<b>Standard Error</b>		0.15	0.18	0.18	0.17	0.15
<b>Significant level</b>		**	**	NS	**	**
<b>Sausage type <math>\times</math> Filler type</b>						
<b>Significant level</b>		*	*	NS	NS	NS

Notes = [1] Based on a scale of 1-6 with six the highest score

[2] Means (10 panelists)



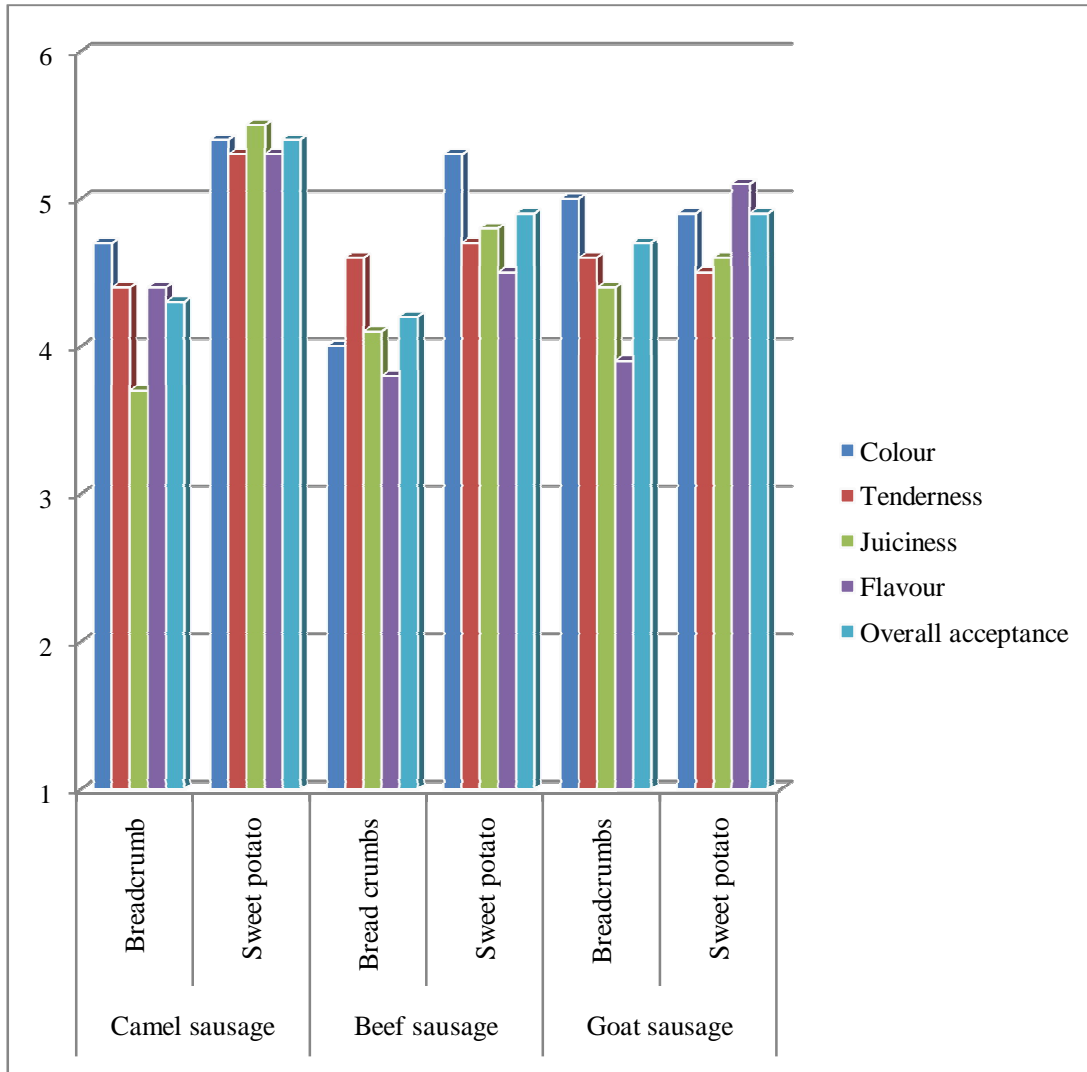


Figure (6) : Sensory evaluation of different types of meat and fillers.

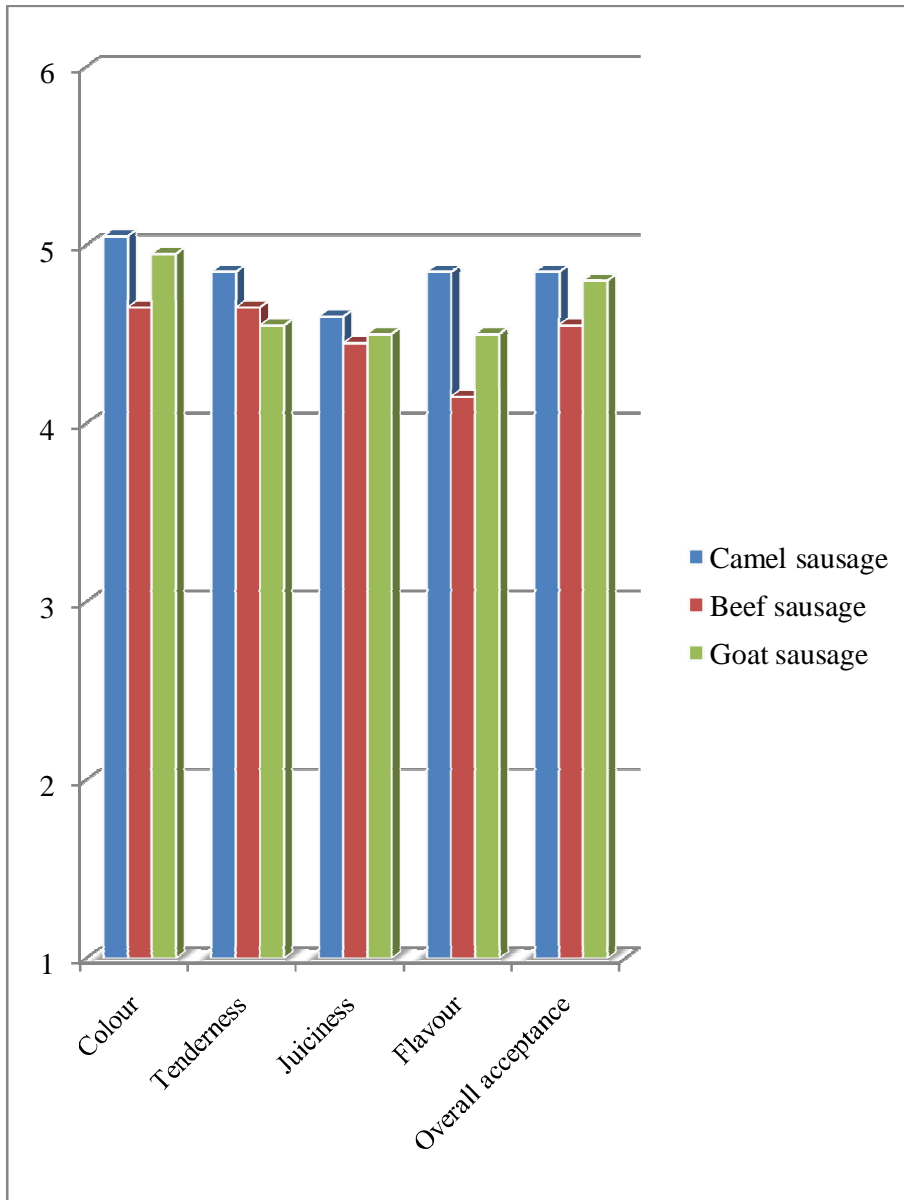


Figure (7): Sensory evaluation of different types of meat sausages

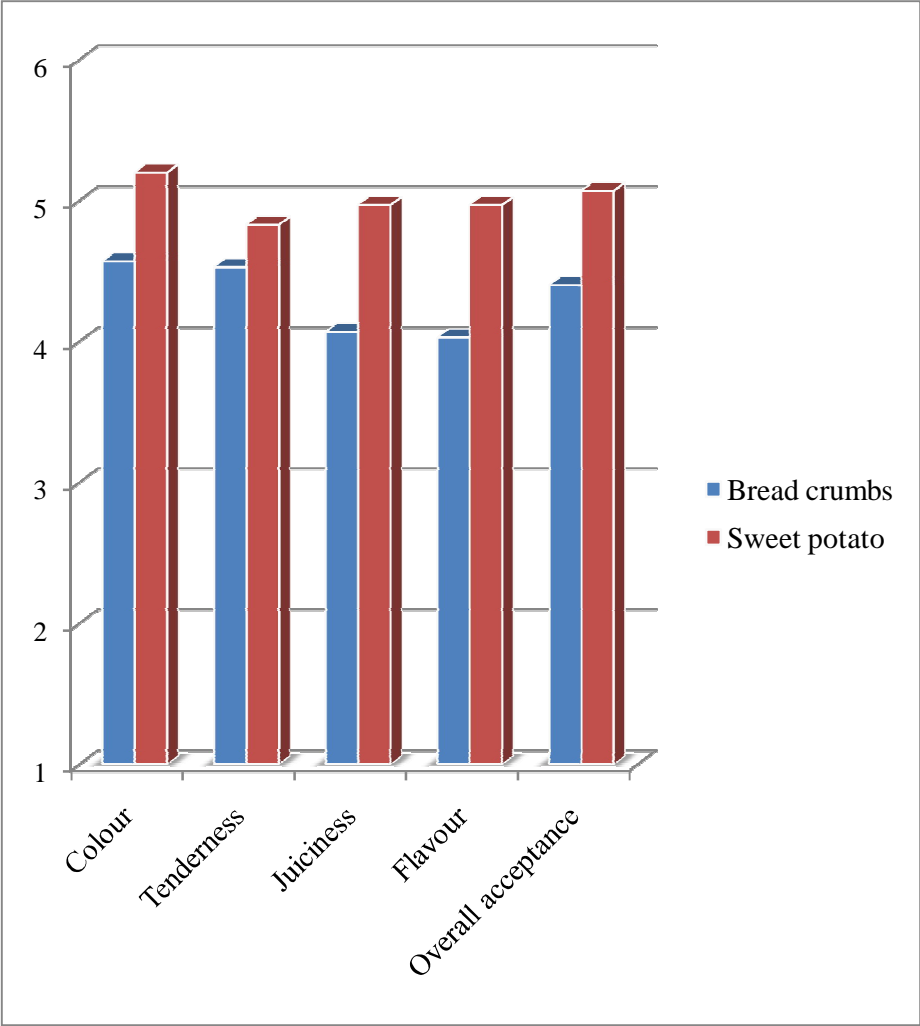


Figure (8): Sensory evaluation of different types of fillers

#### **4.6. Cooking losses:**

##### **4.6.1. Cooking loss of camel, beef and goat meat:**

As shown in table (8) and figures (9, 10 and 11). The mean values of the effect of type of cooking methods on cooking loss of meat are represented. Results showed no significant different ( $P > 0.05$ ) among the treatments for cooking losses. Similarly the type of meat not affected on cooking loss.

**Table (8): Mean values ( $\pm$ SD) of cooking loss (%) of camel, beef and goat fresh meat cooked in vegetable oil (deep fat frying) and in oven (160 C° for 25-30min):**

<b>Factors</b>		<b>Parameter</b>
<b>Meat type</b>	<b>Cooking method</b>	<b>Cooking loss %</b>
Camel meat	Deep fat frying	38.52 $\pm$ 6.10
	Oven	39.36 $\pm$ 3.81
Beef	Deep fat frying	32.96 $\pm$ 5.13
	Oven	28.71 $\pm$ 2.98
Goat meat	Deep fat frying	38.99 $\pm$ 6.70
	Oven	32.78 $\pm$ 8.71
<b>Main effect</b>		
<b>Meat type</b>		
Camel meat		38.94
Beef		30.84
Goat meat		35.88
<b>Standard Error</b>		2.4
<b>Significant level</b>		N.S
<b>Cooking method</b>		
Deep fat frying		36.83
Oven		33.62
<b>Standard Error</b>		1.96
<b>Significant level</b>		NS
<b>Meat type <math>\times</math> Cooking method</b>		
<b>Significant level</b>		NS

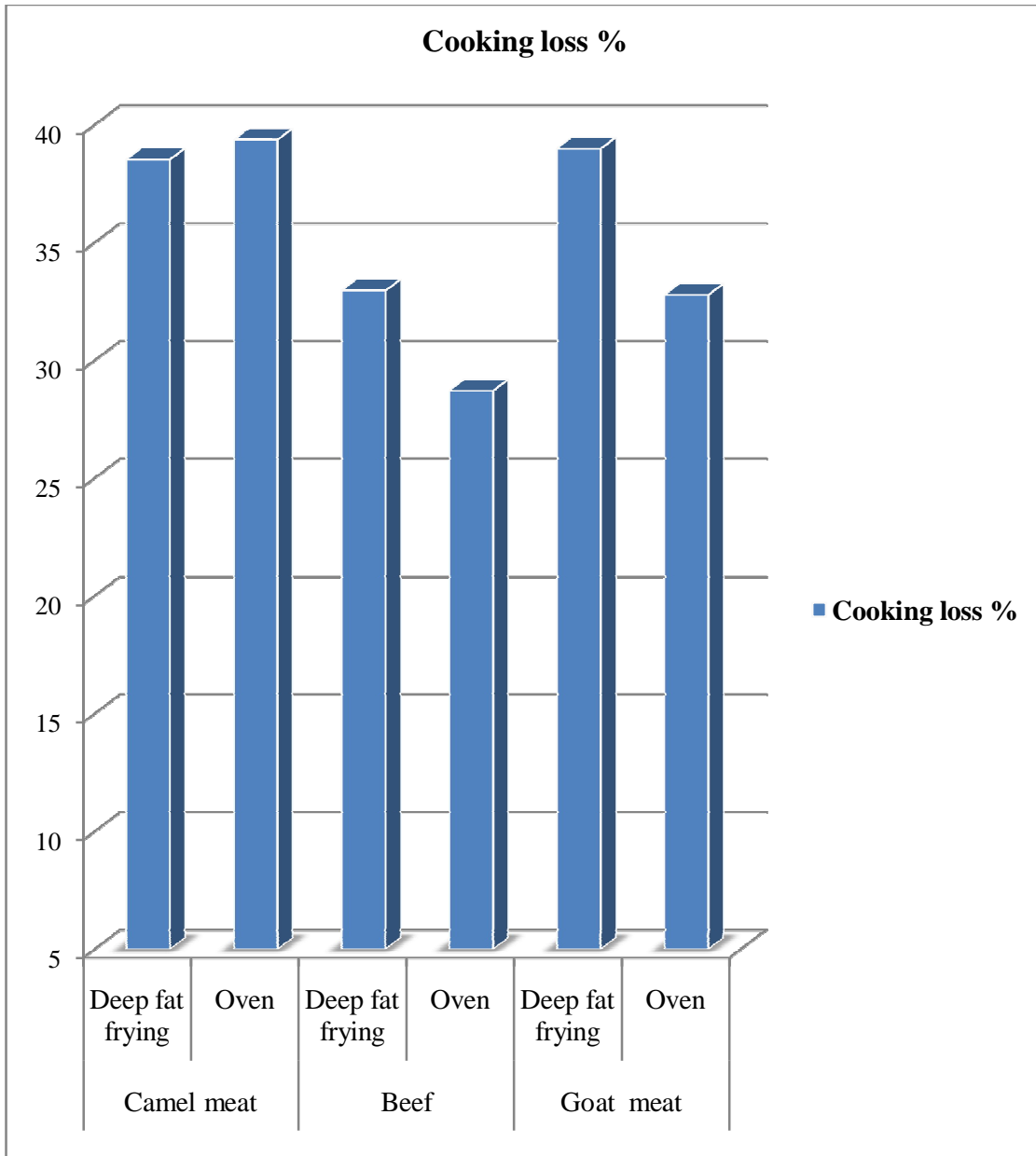


Figure (9): Cooking loss percentage for different types of meat using different cooking methods.

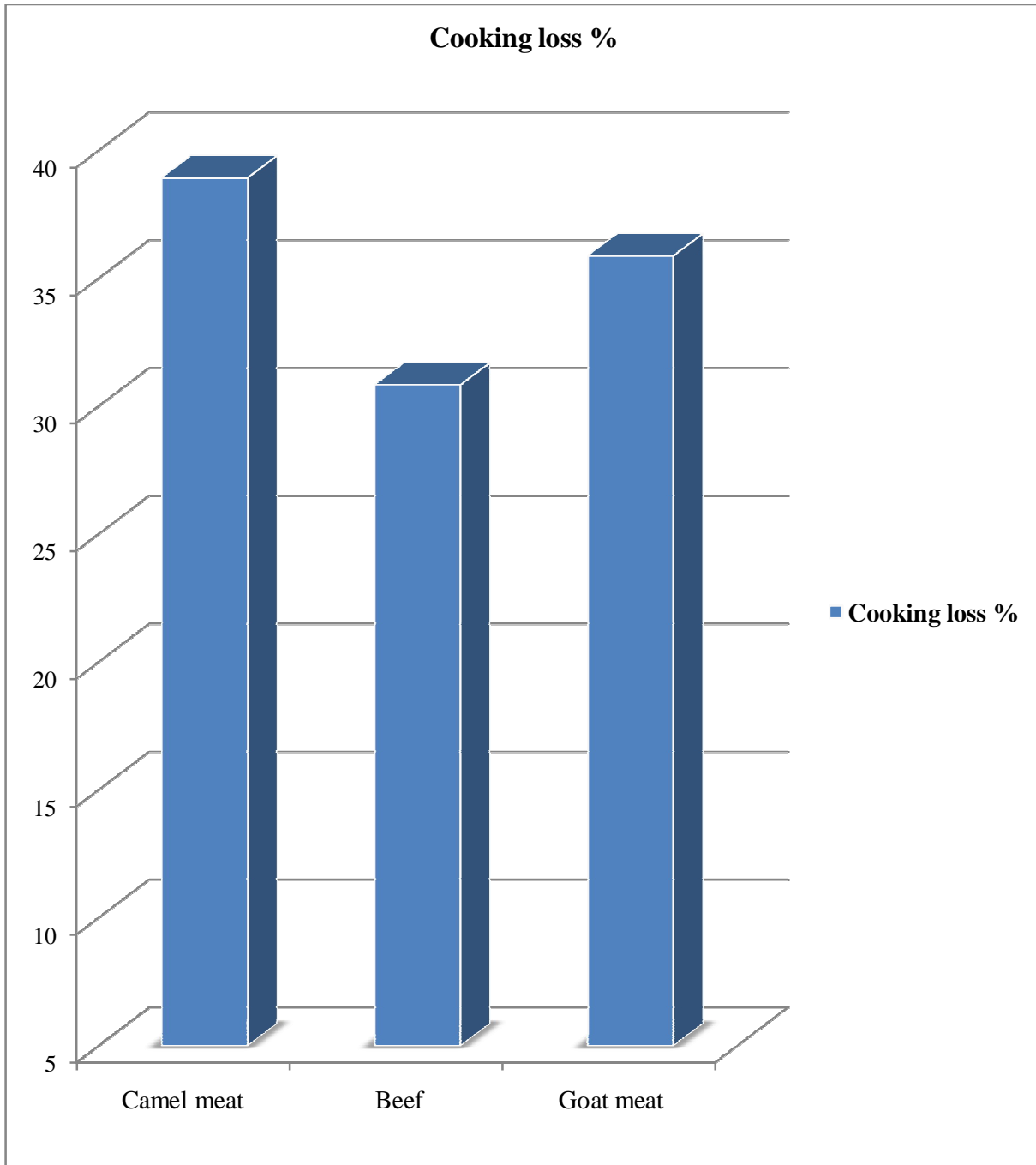


Figure (10): Cooking loss percentage for different types of meat.

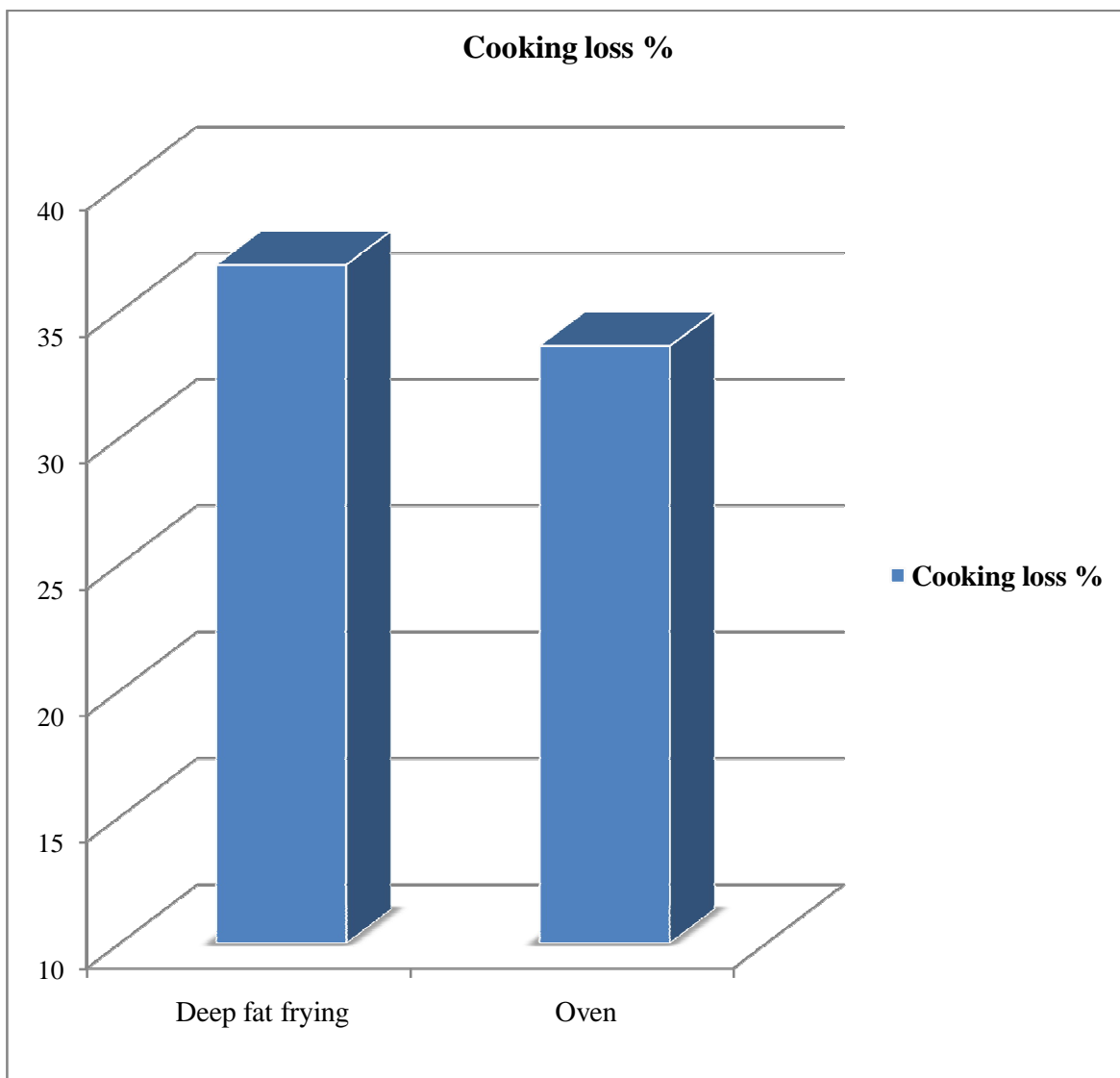


Figure (11): Cooking loss percentage for different cooking methods.



#### **4.6.2. Cooking loss of camel, beef and goat sausages:**

As shown in table (9) and figures (12, 13 and 14) the mean values of the effect of type of cooking methods on cooking loss % of sausages are presented. Results showed types of meat were not significantly different ( $P > 0.05$ ) among the treatments for cooking loss. The type of fillers affected significantly ( $P < 0.01$ ) on cooking loss %. These results indicated that, sweet potato showed high percent of cooking loss compared to bread crumbs. Using sweet potato which leads to reduced the size of sausage fingers and diminished the weight. As a result these findings affected economically on sausage sale.

**Table (9): Mean values ( $\pm$  SD) of cooking loss (%) of camel, beef and goat sausages (with bread crumbs and sweet potato) Cooked in oil (deep fat frying for 3-5 min):**

<b>Factors</b>		<b>Parameter</b>
<b>Sausage types</b>	<b>Filler type</b>	<b>Cooking loss %<math>\pm</math> SD</b>
Camel sausage	Bread crumbs	28.29 $\pm$ 5.45
	Sweet potato	43.45 $\pm$ 0.51
Beef sausage	Bread crumbs	26.71 $\pm$ 5.40
	Sweet potato	38.2433 $\pm$ 3.20
Goat sausage	Bread crumbs	28.86 $\pm$ 6.19
	Sweet potato	39.8767 $\pm$ 0.93
<b>Main effect</b>		
<b>Meat type</b>		
Camel sausage		35.87
<b>Beef sausage</b>		32.48
<b>Goat sausage</b>		34.37
<b>Standard Error</b>		1.74
<b>Significant level</b>		NS
<b>Filler type</b>		
Bread crumbs		27.95
Sweet potato		40.52
<b>Standard Error</b>		1.42
<b>Significant level</b>		**
<b>Sausage type <math>\times</math> Cooking method</b>		
<b>Significant level</b>		NS

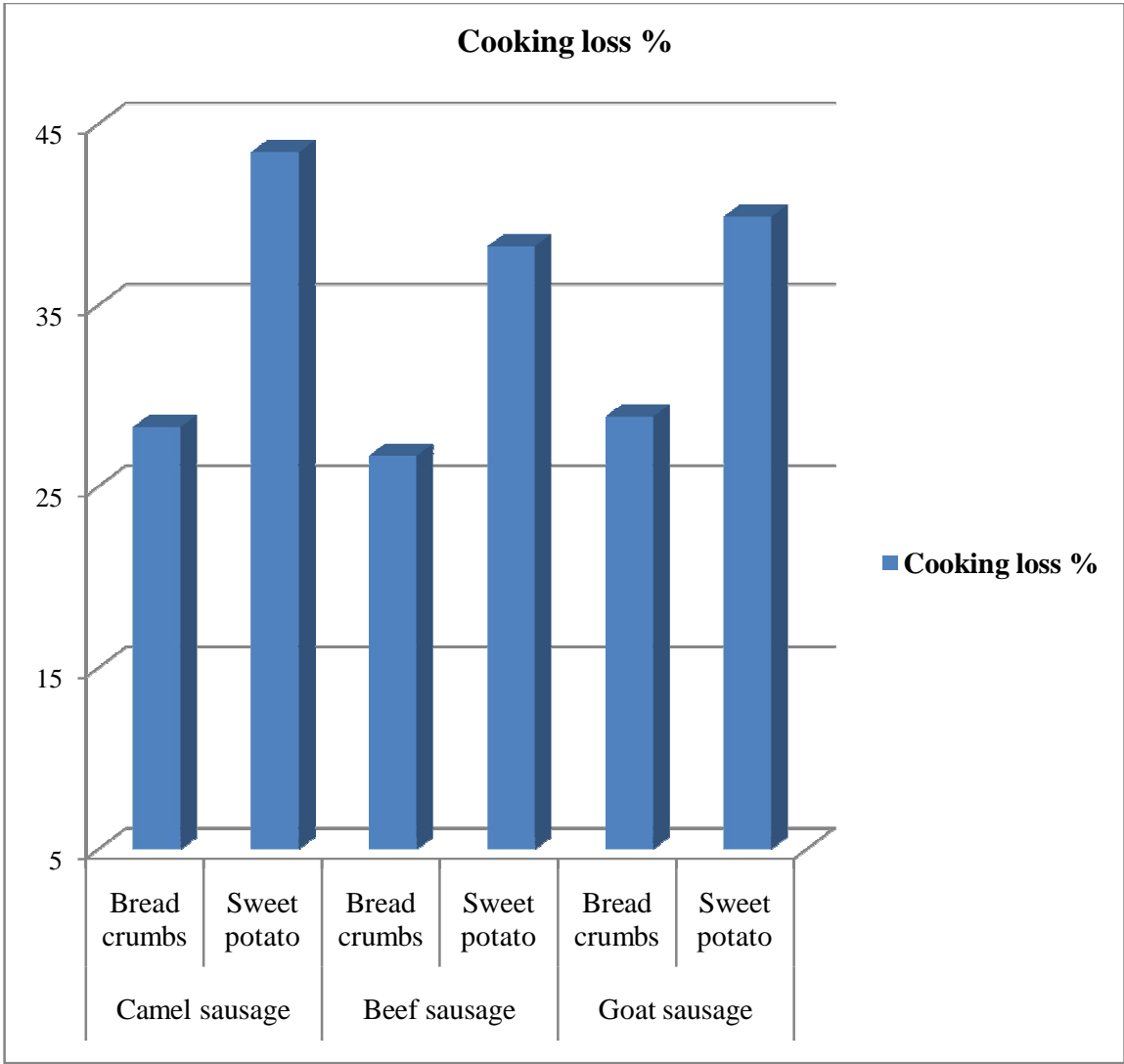


Figure (12): Cooking loss percentage for different types of sausage using different fillers.

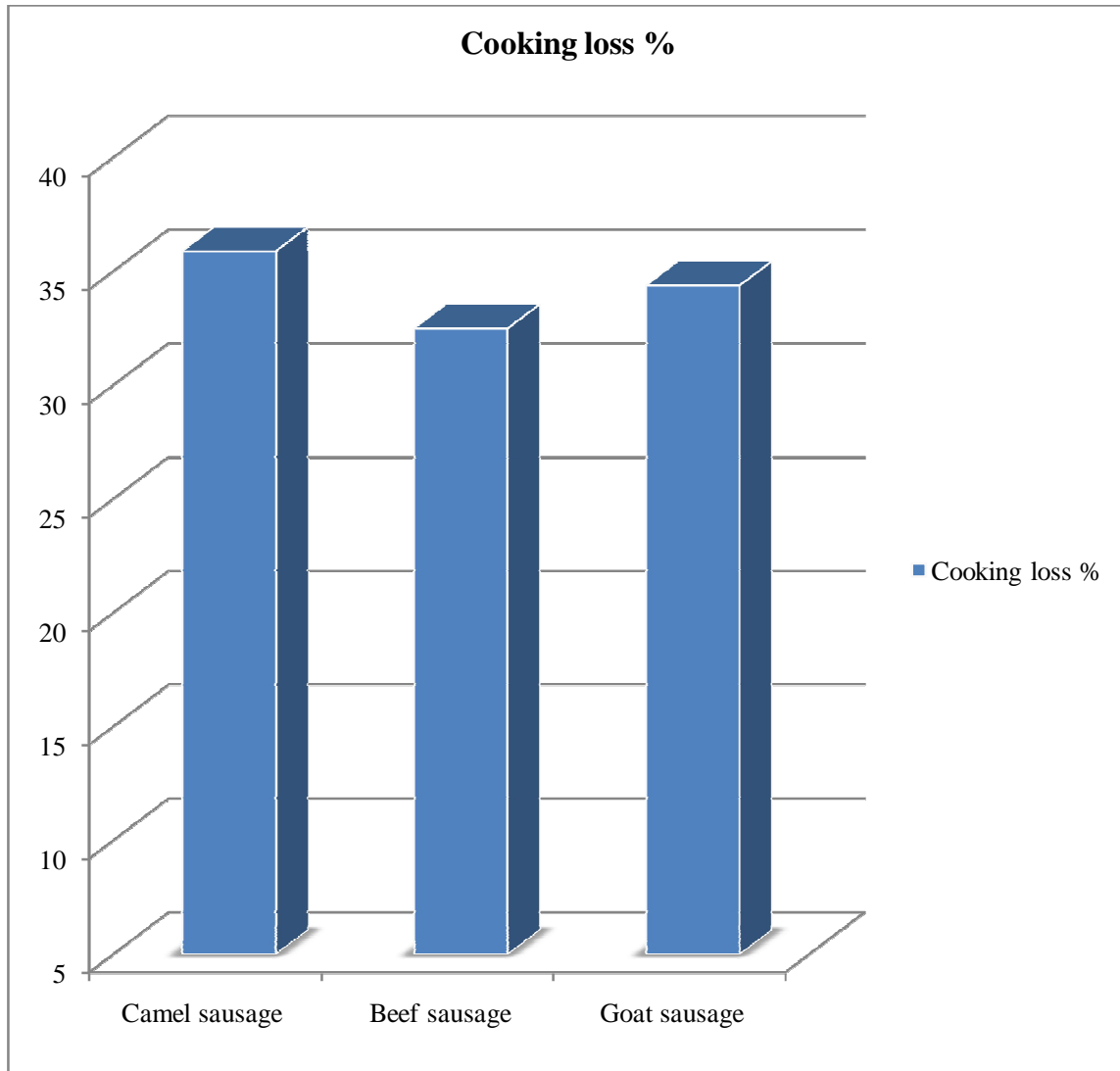


Figure (13): Cooking loss percentage for different types of sausage

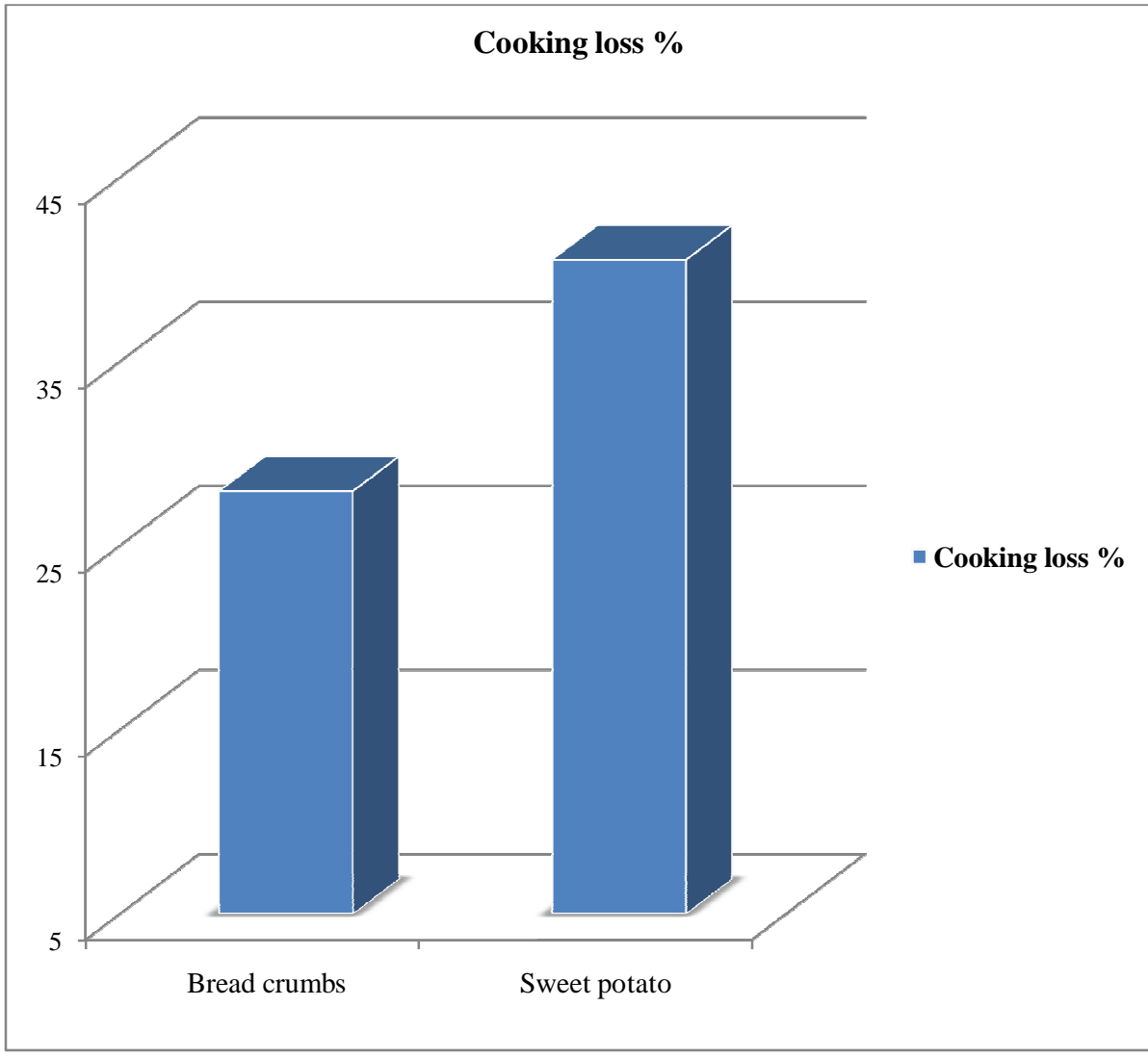


Figure (14): Cooking loss percentage for different type of fillers.

#### **4.7. Organoleptic Tests:**

Results of organoleptic tests are given in table (10). All samples qualified as good by the panelists according to criteria given in materials and methods.

**Table (10): Affect of storage period on results of some organoleptic characteristics of fresh and frozen camel, beef and goat samples:**

Samples	State of samples	Organoleptic Test			
		Off odor	Color	Texture	Judgment
<b>Samples of camel, beef and goat meat</b>	Fresh	None	Red	Normal	Good
	After 7 days of freezing	None	Red	Normal	Good
	After 15 days of freezing	None	Red	Normal	Good
	After 21 days of freezing	None	Red	Normal	Good
	After 28 days of freezing	None	Red	Normal	Good

#### **4.8. Total viable bacterial count:**

##### **4.8.1. Total viable bacterial count of camel, beef and goat meat samples:**

Bacterial counts of fresh and frozen samples from camel, beef and goat meat were presented in tables (11 and 12) and figures (15, 16, and 17). The average bacterial load of the fresh and frozen samples of camel meat were  $3 \times 10^6$  and  $2 \times 10^6$  respectively. The average bacterial loads of the fresh and frozen samples of beef were  $2 \times 10^5$  and  $1 \times 10^5$  respectively. Whereas, the average bacterial loads of fresh and frozen samples of goat meat were  $2 \times 10^6$  and  $1 \times 10^6$ . The fresh samples have the higher bacterial count compared to samples stored at deep-freeze temperature ( $-18^\circ\text{C}$ ). The statistical analysis showed high significant difference ( $P < 0.01$ ) between treatments in bacterial load. The storage time has high significance different ( $P < 0.01$ ) on total bacterial count between treatments.



**Table (11): Mean values ( $\pm$  SD) of total bacterial count (TBC) of fresh and frozen Samples of camel, beef and goat meat after variable periods of storage (0-4 weeks) at  $-18^{\circ}$ :**

Type of meat	No. of samples	Average total count in gram (CFU/g) Meat (TBC) in $10^{-5}$				
		Fresh samples	After one week of storage	After two weeks of storage	After three weeks of storage	After four weeks of storage
Camel meat	3	$3 \times 10^{-6}$	$3 \times 10^{-6}$	$1 \times 10^{-6}$	$1 \times 10^{-6}$	$2 \times 10^{-6}$
Beef	3	$2 \times 10^{-5}$	$2 \times 10^{-5}$	$3 \times 10^{-6}$	$3 \times 10^{-6}$	$1 \times 10^{-5}$
Goat meat	3	$2 \times 10^{-6}$	$2 \times 10^{-6}$	$1 \times 10^{-6}$	$2 \times 10^{-6}$	$1 \times 10^{-6}$

CFU/gm = Colony forming unit per gram

**Table (12): Mean values ( $\pm$  SD) of total bacterial count (TBC) of fresh and frozen samples of camel, beef & goat meat after variable periods of storage (0- 4 weeks) at  $-18\text{C}^{\circ}$  :**

<b>Factors</b>		<b>Parameters</b>
<b>Meat type</b>	<b>Storage period</b>	<b>Meat TBC <math>\times 10^{-5}</math></b>
<b>Camel meat</b>	1 <sup>st</sup> day	250 $\pm$ 53.74
	7 days	25 $\pm$ 4.24
	15 days	10 $\pm$ 2.83
	21 days	0
	28 days	5 $\pm$ 1.41
<b>Beef</b>	1 <sup>st</sup> day	50 $\pm$ 22.63
	7 days	15 $\pm$ 1.41
	15 days	10 $\pm$ 1.41
	21 days	5 $\pm$ 1.41
	28 days	0
<b>Goat meat</b>	1 <sup>st</sup> day	150 $\pm$ 7.07
	7 days	20 $\pm$ 2.83
	15 days	10 $\pm$ 1.53
	21 days	0
	28 days	5 $\pm$ 1.41
<b>Main effect</b>		
<b>Meat type</b>		
<b>Camel meat</b>	59 <sup>a</sup>	
<b>Beef</b>	19 <sup>c</sup>	
<b>Goat meat</b>	37 <sup>b</sup>	
<b>Standard Error</b>	4.83	
<b>Level of Significant</b>	**	
<b>Storage time</b>		
<b>1<sup>st</sup> day</b>	150 <sup>a</sup>	
<b>7 days</b>	18.33 <sup>b</sup>	
<b>15 days</b>	6.67 <sup>b</sup>	
<b>21 days</b>	8.33 <sup>b</sup>	
<b>28 days</b>	8.33 <sup>b</sup>	
<b>Standard Error</b>	6.23	
<b>Level of Significant</b>	**	
<b>Meat type <math>\times</math> Storage time</b>		
<b>Level of Significant</b>	**	

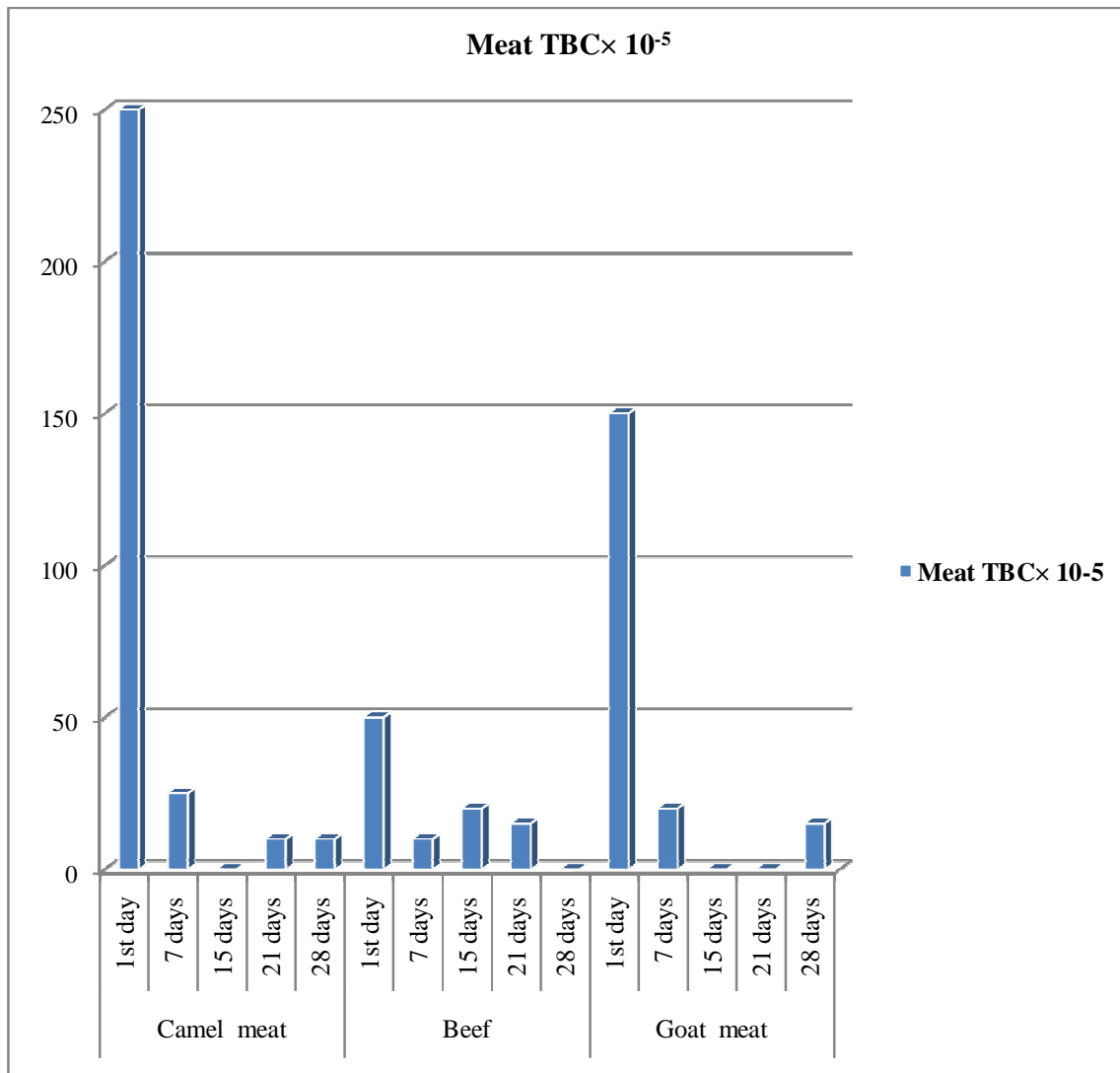


Figure (15): Total bacterial counts (CFU/gm) for different types of meat in different storage periods.

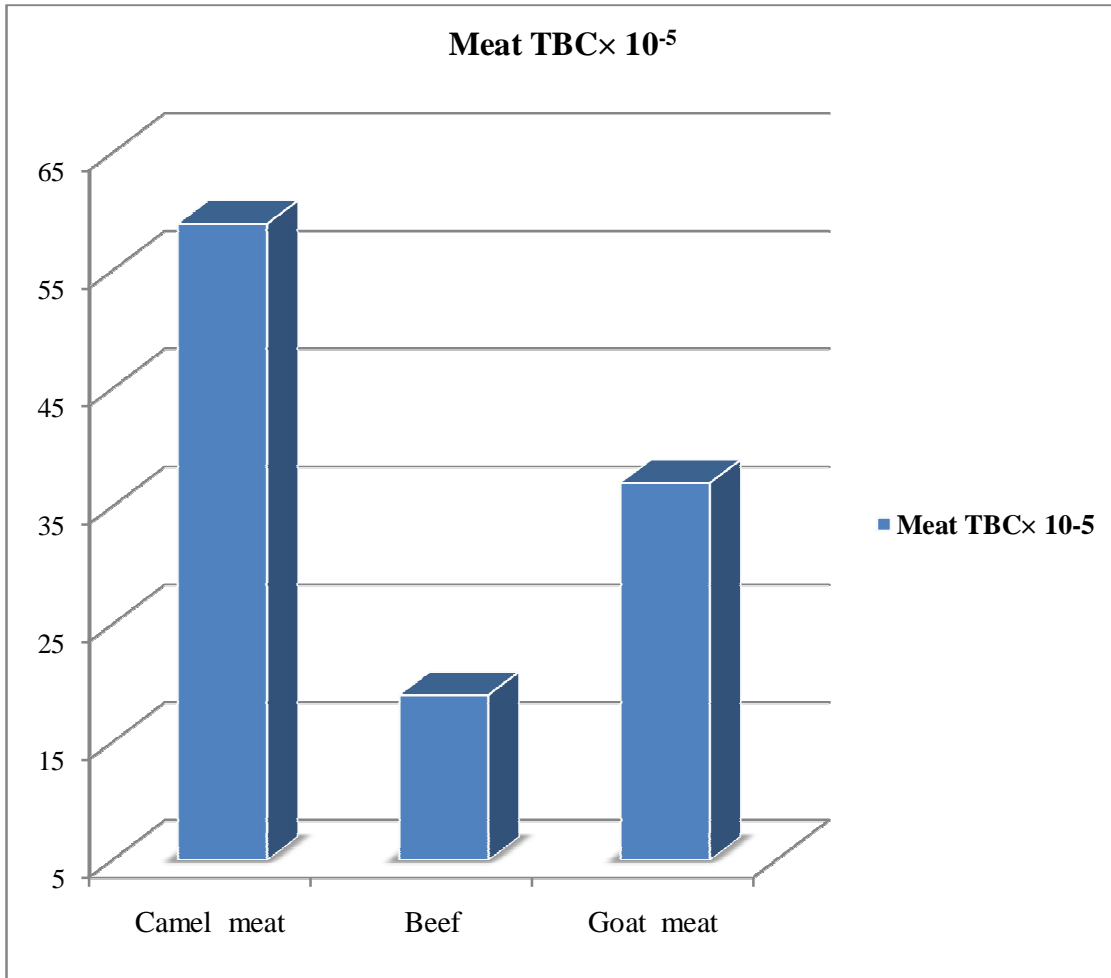


Figure (16): Total bacterial counts (CFU/gm) for different types of meat.

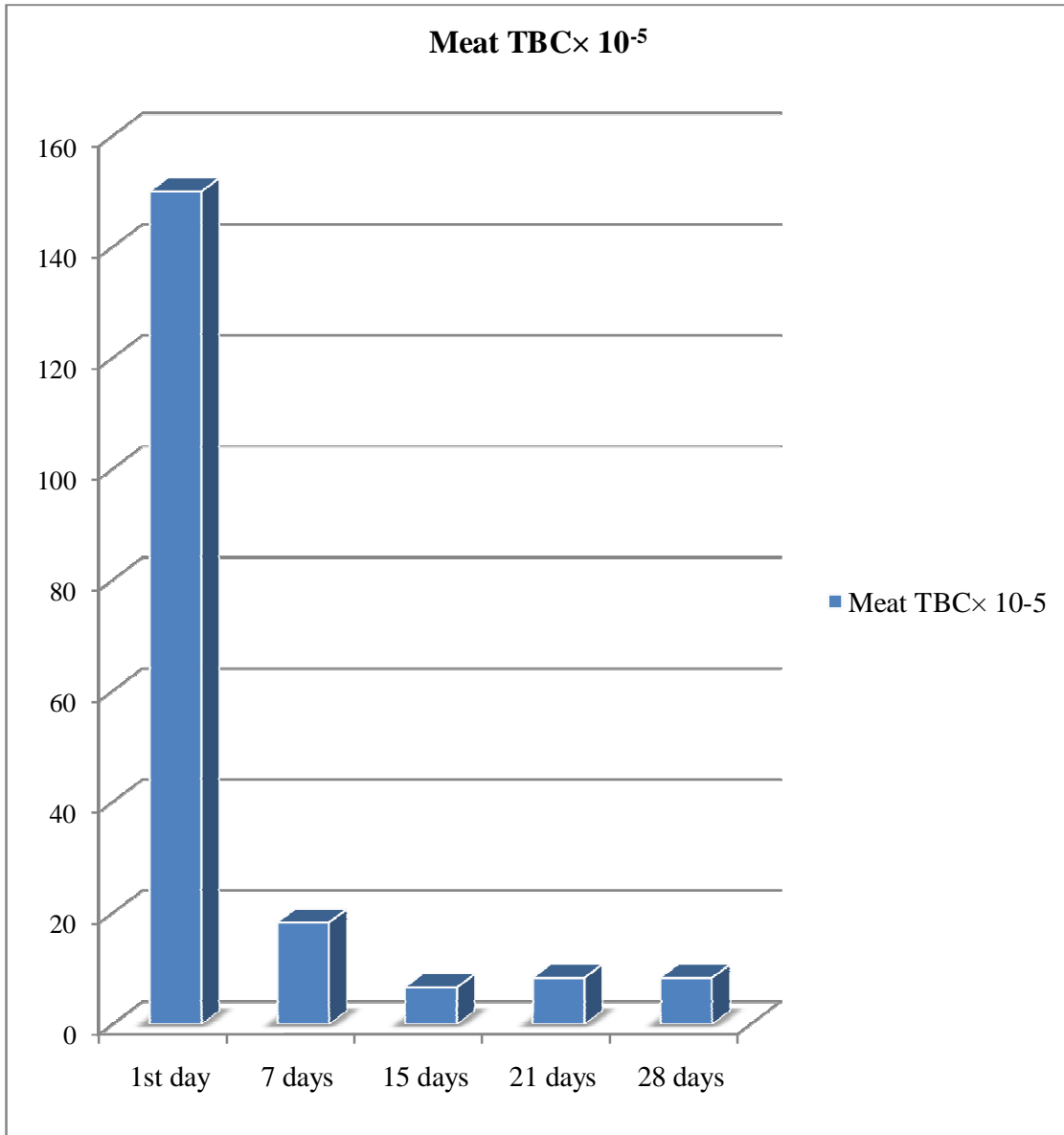


Figure (17): Total bacterial counts (CFU/gm) for meat in different storage periods.

#### **4.8.2. Total viable bacterial count of camel, beef and goat sausage**

##### **samples:**

Bacterial count of fresh and frozen samples from camel, beef and goat sausages were presented in table (13 and 14) and figures (18, 19 and 20). Initially on first day, TBC for the samples were significantly higher ( $P < 0.05$ ) compared to treatments on week 4. The average bacterial loads of the fresh and frozen samples of camel sausages were  $3 \times 10^6$  and  $2 \times 10^6$  respectively. The average load of the fresh and frozen samples of beef sausage was  $2 \times 10^6$  and  $1 \times 10^6$  respectively. Whereas, the average load of fresh and frozen samples of goat sausage was  $2 \times 10^6$  and  $1 \times 10^6$  respectively. In general, there was decreased in the bacterial count in sausage with increase of the freezing time. The fresh samples have the higher bacterial count compared to samples that stored at deep-freeze temperature ( $-18\text{c}^\circ$ ). In general, total bacterial count (TBC) decreased for all treatments as storage time increased.

**Table (13): Mean values ( $\pm$  SD) of total bacterial count (TBC) of fresh and frozen samples of camel, beef & goat sausages after variable periods of storage (0-4 week) at  $-18\text{ C}^{\circ}$ :**

Factors		Parameters
Sausages type	Storage period	Sausage TBC $\times 10^{-5}$
Camel sausages	1 <sup>st</sup> day	15 $\pm$ 2.83
	7 days	15 $\pm$ 1.41
	15 days	5 $\pm$ 2.83
	21 days	5 $\pm$ 2.83
	28 days	10 $\pm$ 1.41
Beef sausages	1 <sup>st</sup> day	10 $\pm$ 2.83
	7 days	5 $\pm$ 1.41
	15 days	15 $\pm$ 4.24
	21 days	0
	28 days	0
Goat sausages	1 <sup>st</sup> day	10 $\pm$ 1.41
	7 days	10 $\pm$ 1.41
	15 days	0
	21 days	5 $\pm$ 0
	28 days	10 $\pm$ 2.83
<b>Main effect</b>		
<b>Sausages type</b>		
Camel sausages	10 <sup>a</sup>	
Beef sausages	6 <sup>b</sup>	
Goat sausages	7 <sup>b</sup>	
<b>Standard Error</b>		0.67
<b>Level of Significant</b>		**
<b>Storage time</b>		
1 <sup>st</sup> day	11.67 <sup>a</sup>	
7 days	10 <sup>a</sup>	
15 days	6.67 <sup>b</sup>	
21 days	3.33 <sup>c</sup>	
28 days	6.67 <sup>b</sup>	
<b>Standard Error</b>		0.87
<b>Level of Significant</b>		**
<b>Meat type <math>\times</math> Storage time</b>		
<b>Level of Significant</b>		**

**Table (14): Mean values ( $\pm$  SD) of total bacterial count (TBC) of fresh and frozen Samples of camel, beef and goat sausage after variable periods of storage (0-4 weeks) at  $-18^{\circ}$ :**

Site of collection	No. of samples	Average total count in gram (CFU/g) Sausages (TBC) in $10^{-5}$				
		Fresh samples	After 7 days of storage	After two weeks of storage	After three weeks of storage	After four weeks of storage
Camel sausage	3	$3 \times 10^{-6}$	$3 \times 10^{-6}$	$1 \times 10^{-6}$	$1 \times 10^{-6}$	$2 \times 10^{-6}$
Beef sausage	3	$2 \times 10^{-6}$	$1 \times 10^{-6}$	$3 \times 10^{-6}$	$1 \times 10^{-6}$	$1 \times 10^{-6}$
Goat sausage	3	$2 \times 10^{-6}$	$2 \times 10^{-6}$	$1 \times 10^{-6}$	$1 \times 10^{-6}$	$1 \times 10^{-6}$

CFU/g = Colony forming unit per gram



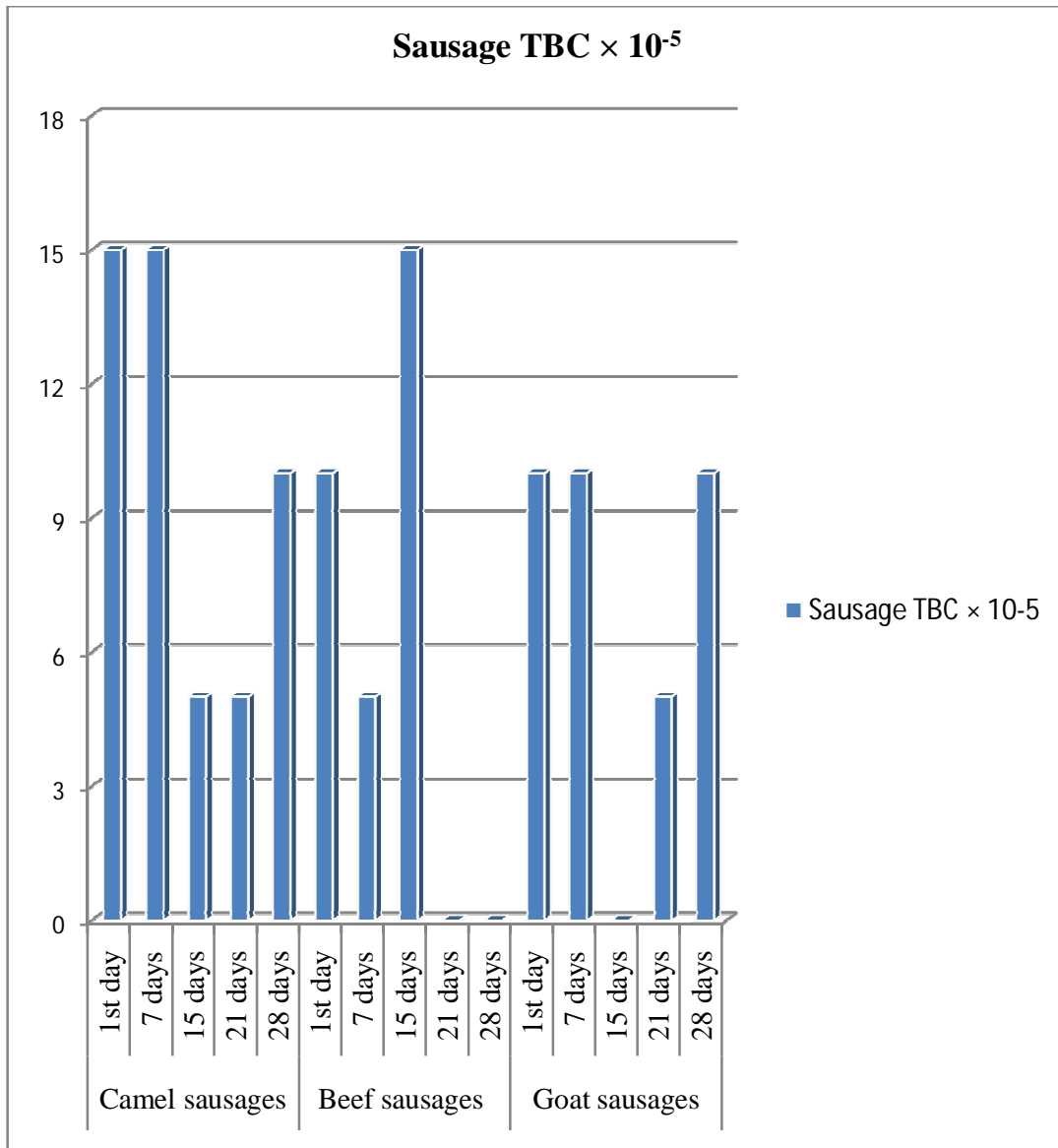


Figure (18): Total bacterial counts (CFU/gm) for different types of sausage in different storage periods

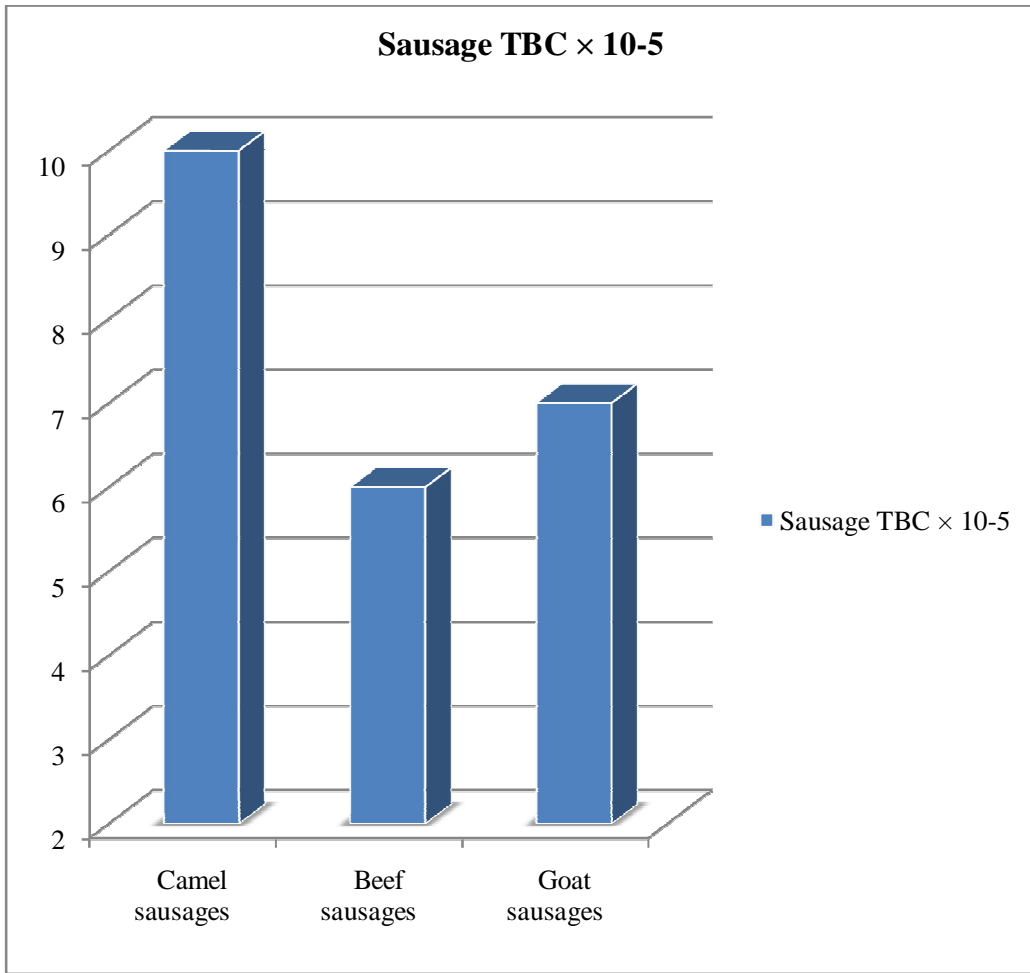


Figure (19): Total bacterial counts (CFU/ml) for different types of sausage

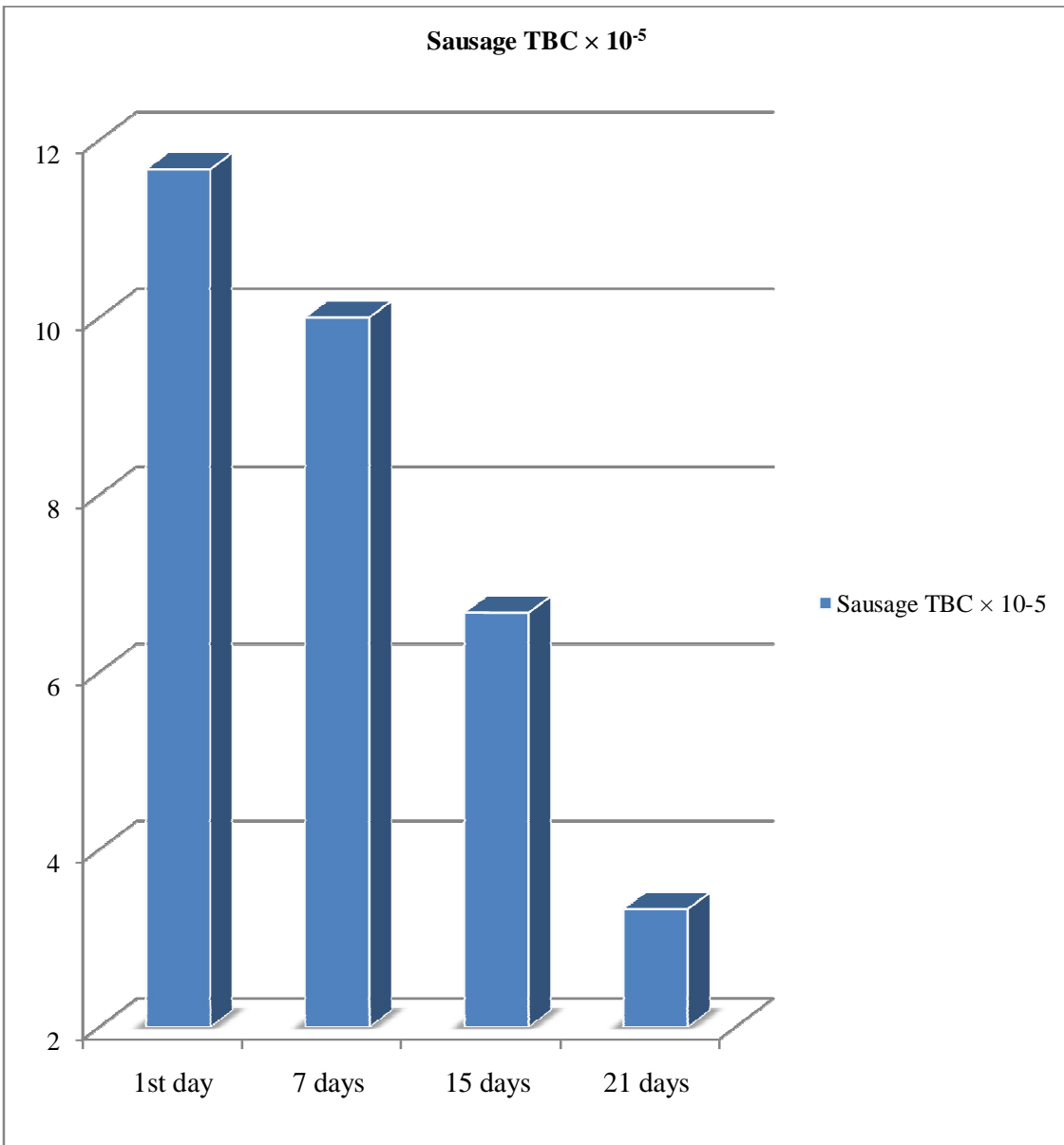


Figure (20): Total bacterial counts (CFU/gm) for different storage periods

#### **4.9. Minerals concentration in camel beef and goat meat:**

Calcium (Ca), phosphorous, sodium (Na), magnesium (Mg), potassium (K) and Ferrous (Fe) concentration in camel, beef and goat meat were shown in table (15) and figure (21).

##### **4.9.1. Calcium (Ca):**

Calcium concentration was not significantly ( $P>0.05$ ) different among camel, beef and goat meat. The camel meat has a highest concentrate of calcium compared to beef and goat meat.

##### **4.9.2 Phosphorus (P):**

Phosphorus concentration was highly significant different ( $P<0.001$ ) between camel, beef and goat meat. Phosphorous concentration high in camel meat compared to that of beef and goat meat.

##### **4.9.3. Sodium (Na):**

Sodium concentration was highly significant ( $P<0.01$ ) different among the three types of meat. Camel meat contained slightly higher concentration of sodium than the beef and goat meat.

##### **4.9.4. Potassium (K):**

Potassium concentration was highly significant ( $P<0.001$ ) among the three types of meat. But no significant different ( $P>0.05$ ) in the potassium concentration between beef and goat meat. Potassium concentration was more in camel meat than that of beef and goat meat.

##### **4.9.5. Magnesium (Mg):**

Magnesium concentration was highly significant ( $P<0.01$ ) between the three types of meat studied. There was no significant difference ( $P>$

0.05) in magnesium concentration between beef and goat meat. Magnesium concentration was high in camel meat compared to that of beef and goat meat.

#### **4.9.6. Ferrous (Fe):**

Ferrous concentration was highly significant ( $P < 0.01$ ) between the three types of meat. Ferrous concentration was high in camel meat compared to beef and goat meat. In general ferrous content in red meat showed small amount compared to other mineral content.

**Table (15):** Mean values ( $\pm$ SD) of minerals content of camel, beef and goat meat in Mg/ 100gm:

<b>Parameters</b>	<b>Camel meat</b>	<b>Beef</b>	<b>Goat meat</b>	<b>Level of significant</b>
<b>Calcium (Ca)</b>	12.56 $\pm$ 1.78	11.36 $\pm$ 0.35	11.21 $\pm$ 0.35	NS
<b>Phosphorus (P)</b>	176.0 $\pm$ 4.30 <sup>a</sup>	155.0 $\pm$ 5.79 <sup>b</sup>	154.5 $\pm$ 3.82 <sup>b</sup>	**
<b>Sodium (Na)</b>	114.40 $\pm$ 4.98 <sup>a</sup>	89.08 $\pm$ 6.40 <sup>b</sup>	76.0 $\pm$ 3.54 <sup>c</sup>	**
<b>Potassium (K)</b>	411 $\pm$ 29.89 <sup>a</sup>	323.2 $\pm$ 12.44 <sup>b</sup>	310.2 $\pm$ 8.76 <sup>b</sup>	**
<b>Magnesium (Mg)</b>	90.16 $\pm$ 5.03 <sup>a</sup>	37.6 $\pm$ 11.01 <sup>b</sup>	27.31 $\pm$ 4.57 <sup>b</sup>	**
<b>Ferrous (Fe)</b>	5.0 $\pm$ 0.49 <sup>a</sup>	2.96 $\pm$ 0.32 <sup>b</sup>	3.50 $\pm$ 0.45 <sup>b</sup>	**

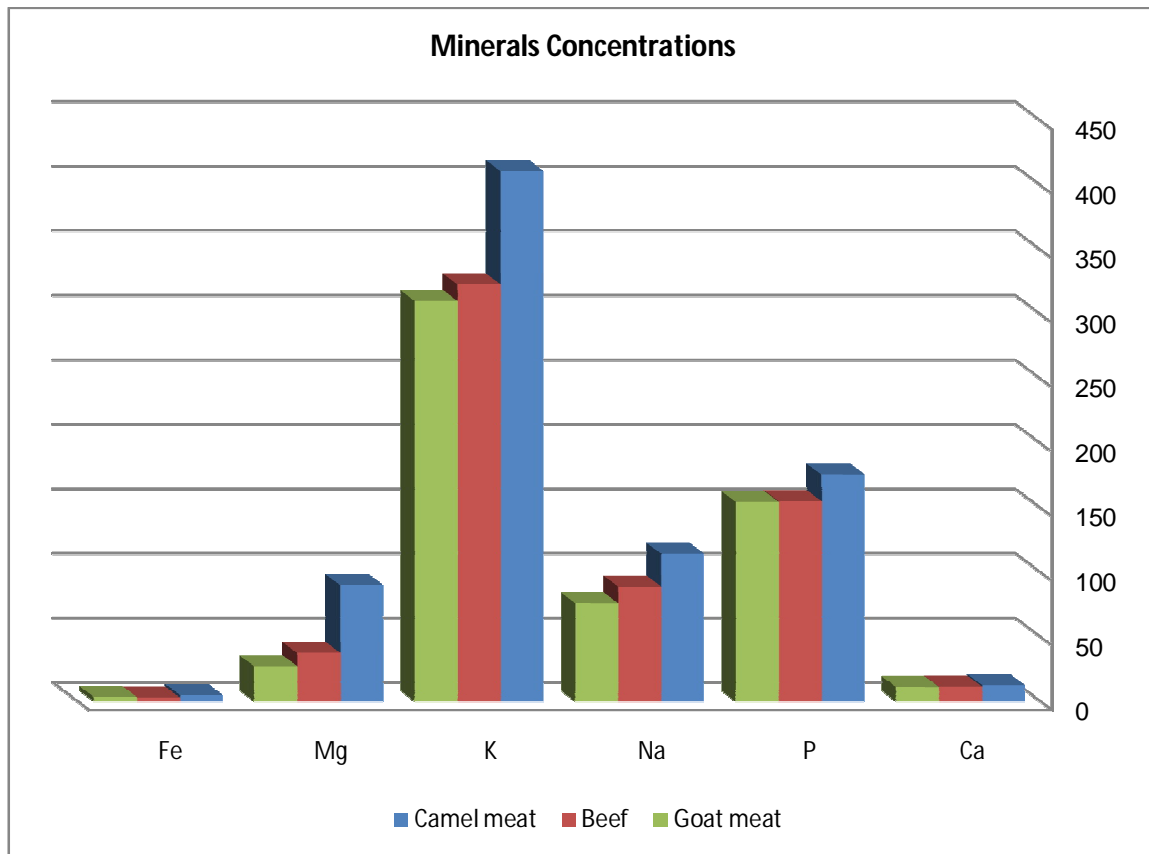


Figure (21): Minerals content in camel, beef and goat meat.

## CHAPTER FIVE

### DISCUSSION

#### 5.1. Chemical Composition of camel, beef and goat meat:

In the present study the chemical composition of camel, beef and goat meat were significantly differed ( $P < 0.05$ ).

##### 5.1.1 Moisture:

The present results showed that the moisture content was significantly ( $P < 0.05$ ) different among different meat. Camel and goat meat had higher moisture content compared to beef. The moisture content of camel meat was (77.92 %) and this agreed with the results of Dawood and Alkanhal, (1995), Al-Sheddy et al., (1999), Al-Owaimer, (2000); Kadim et al., (2006), and Siham (2008) who reported a value ranging between (70 and 77%). The moisture content in this study was higher than that reported by Mohammed, (1993) who reported moisture content of (69 - 73%). Also the result of the present study showed slightly lower value than that reported by Adim et al. (2008) who reported the moisture content in camel meat as (78%). The present result was higher than the value reported by Gulzhan et al., (2013) who reported the moisture% in camel meat as (72.1%) and higher than the findings of Shehata (2005) who reported that Longissimus thoraces of camel meat had moisture content of (69.2%) and also more than the result of Tariq Mahmud et al., (2011) who reported that moisture in camel meat as (72.03%). The present result was in line with the result reported by Kilgour, (1986); El-Faer et al., (1991); Al-Ani, (2004); Cristofaneli et al., (2004) and Kadim et al (2009) who reported the camel meat had (70-77%) moisture content. Also the present result was in line with the result of El-Faer et al. (1991); Elgasim and Alkanhal, (1992) who reported the mean moisture content of



camel meat as (76.82%). Also the result of this study agreed with the result of Mohammad and Abubakar, (2011) who mentioned moisture content in camel meat as (77.42%). The results of this study were slightly higher than that reported by IJFSN, (2010) who reported that moisture in camel meat as (76.7%) and higher than the result stated by Lawrie, (1979) as (75%). Similarly the result of this study was higher than the result of Abdelbaki, (1957) and Hamman et al., (1962) as (76.2%) and higher than the result of Fakolade et al., (2006) who reported a moisture content value as (74.55%) for camel meat. The present result agreed with the findings of Nasr et al. (1965) who recorded the moisture in camel meat as ranging between (76.2-78.3%). The moisture content in this study was higher than the result recorded by Abdelbary and Muhammed, (1995) as (68.8 - 76.0%) for camel meat.

The moisture content of beef in this study was (72.12%). This finding was lower than the value reported by Arganosa and Bandian, (1978) who reported the moisture content of beef as (74.24%). However, the present result was lower than the result found by (IJFSN, 2010) as (75.7%) and Lee, (2012) as (78.07%). The present result was similar to the result reported by Sadler, et. al., (1993) ; Sinclair et. al., (1999) and Williams, et. al., (2007) as (73.1%). The present result was higher than the value of Siham, (2008) who reported the moisture content of beef as (70.47 %).

The moisture content of goat meat was (75.55%). This result was higher than the findings of Schonfeldt, (1989) as (64.6- 65.4 %). Also the present result was higher than the result of Shija et. al., (2013) who reported that moisture in goat meat as (70.65%) and higher than the result of Dhanda, (2001) who reported the moisture content of goat meat as (72.3%). On the contrary, the present result was lower than the findings

of Arguello et.al., (2004) who reported the moisture content in goat meat was (76.63%) and Wattanachant, et al, (2008) who reported a value of (76.61%) in goat meat. Also similar low value was reported by Mohammad, et al. (2010) who found that the moisture content of goat meat as (78%) and Songklanakarin J. Sci., (2008) as (76.61 -78.6%).The result in the present study in line with the result reported by Mohammad, et al., (2010) who found the moisture content in goat meat ranging between (72.20 and 80.02). The present result agreed with the result of USDA, (2007) as (75.84%) and Agranosa and Bandian, (1978) as (75.34%).

The moisture content of camel meat in this study was higher compared to beef and goat meat; these results were in conformity with the findings of Gheisari, et. al., (2009). The results of this study were in line with corresponding value reported by Dawood, (1995) who reported that the camel meat had highest moisture content as (75-78%) where beef had lowest value as (73-75%). This may be due to the lower intramuscular fat of camel meat compared to beef and goat meat. This was similar to the statement of Stankov et al. (2002) who reported that the decrease in moisture content in meat has been due to increase in fat content. The higher moisture content of camel meat compared to beef and goat meat were in conformity with those reported by Dawood and Alkanhal, (1995); El-Faer et al., (1991); Elgasim and Alkanhal, (1992); Kadim et al., (2006) and Siham, (2008).

### **5.1.2 Protein:**

The protein content showed high significant ( $P < 0.01$ ) different among the three types of meat. Beef had higher protein content as (21.07%) compared to camel and goat meat as (19.25 and 20.32%)

respectively. The crude protein content in camel meat was (19.78%). This result was almost in line with the findings of Mohammad and Abu-Bakr, (2011) that reported protein in camel meat as (19.25%), and also was in line with the findings of Adim et al., (2008) who mentioned a value of (19%). Also the present result agreed with the value reported by Lawrie (1979) as (19%). The present result was also similar to the result of Kadim, et. al., (2006) who reported the protein content of camel meat ranged from (18.6% to 25.0%). The protein content of camel meat was agreed with the value reported by Abdelbaki (1957) and Hamman et. al., (1962) as (19.4%) and also was in line with the findings of Ezekwe et al., (1997) who recorded the protein content in camel meat as (18.9- 19.7%). The result in this study was slightly less than that reported by Suaad, (1994) who stated value of (20%) and Nasr et al., (1965) who reported value of (20.07 and 25.2%). The present result was less than the value reported by Dawood and Alkanhal, (1995) as (21.36%) and the results of IJFSN, (2010) as (21.4%). The result in this study was higher than the finding of Gulzhan et al., (2013) who reported that protein content as (17%) in camel meat.

In the present study the protein content in beef was (21.07%). This result was less than that stated by (USDA, 2001) as (25%). Also slightly less than the result of IJFSN, (2010) as (22.6%), and also less than the result of Sadler, et. al.(1993) ; Sinclair et. al., (1999) and Williams, et. al., (2007) who reported value of (23.2%). The protein content of beef in this study was higher than the findings of Lee, (2012) who reported a value as (17.38%).

In the present study the protein content was (20.32%) in goat meat, this result was in line with the findings of Arguello et. al., (2004) who reported value of (20.07%) and the result of Wattanachant, et al., (2008)

as (20.39%). Also the result of this study was in line with the value reported by USDA, (2007) as (20.60%). The result of this study was in agreement with the result of Songklanakarin J. Sci., (2008) who reported value ranged between (17.5 and 20.4%) in goat meat and Henryk, et al., (2008) as (19.44%). The present result lower than that reported by USDA, (2001) as (23%), and the result of Shija et. al., (2013) as (23.45%). This result was lower than that reported by Dhanda, (2001) as (21%), and the value of Schonfeldt, (1989) as (26.6 and 27.2%). Also the result in this study was higher than the value reported by Mohammad, et al., (2010) who stated that the protein content in goat meat as (13.12-17.50%).

In general the present study showed that the protein content in camel meat was lower than that of beef and goat meat. This result disagreed with that reported by Gheisari, et. al., (2009) who stated that camel meat had similar protein content compared to that of beef and goat meat. The result in this study showed camel meat less protein content than beef, this result disagreed with the result of Siham, (2008) who stated that camel meat had less protein compared to beef. The differences of protein content in this studies compared to previous studies may be due to breed and age differences as stated by (Gulzhan et al., 2013).

### **5.1.3. Fat:**

The fat content of this study showed no significant different ( $P>0.05$ ) between camel, beef and goat meat. Fat content was (1.17%) in camel meat which was in line with the findings of Zamil El-Faer et al., (1991) as (1.2 - 1.8%). The fat content in camel meat of this study was agreed to the result of Nasr et al. (1965) as (0.92 and 1.01%). The result in this study was lower than that reported by Adim et al., (2008) as (3%).

The fat content of camel meat in this study was similar to the value reported by Babiker and Yousif (1989) as (1.4%), but lower than the value reported by Elgasim and Elhag, (1992) as (2.6%). The present result was in agreement with the result of Kadim et al., (2006) who reported that the fat content of camel meat as (1.1 - 10.5%). The result in this study was lower than the value reported by Gulzhan et al., (2013) as (10 %) and less than that reported by Mohammad and Abu-Bakr, (2011) as (18.99%). The present result was higher than the result of IJFSN, (2010) who reported fat % in camel meat as (0.7 %) but was lower than the findings of Tariq, et al., (2011) as (5.79%) and the value of Lawrie, (1979) as (2.5%). Also the value stated by Abdelbaki, (1957) and Hamman et al., (1962) as (2.6%).

The fat content in beef was (2.74%). This result agreed with the result reported by (Sadler, et. al., 1993; Sinclair et. al., 1999 and Williams, et. al., 2007) as (2.8%). The fat content in beef of this study was lower than the value reported by USDA, (2001) as (3%) and Lee, (2012) as (3.2%). The present result was higher than the findings of IJFSN, (2010) who reported a value of (0.9%).

The fat content of goat meat in the present study result showed that fat content was (1.66%). This result was in line with the findings of Arguello et. al., (2004) as (1.54 %) and also in line with the result of Mohammad, et al., (2010) and Henryk, et. al., (2008) as (1.77%). The present result was in line with the result of Songklanakarin, (2008) as (1.14% - 3.16%). This result was also in line with the finding of Wattanachant, et al, (2008) as (1.14%). The fat content in this study was lower than that reported by Elkhidir, et al., (1998) as (2.8%) and the result reported by Shija et. al. (2013) as (2.49 %), and finding of Schonfeldt, (1989) as (2.6 - 7.1%). The fat content of this study was

lower than the result of USDA, (2001) as (5%) and value reported by USDA, (2007) as (2.31%). Similar lower value was reported by Dhanda, (2001) as (4.7%).

In general results of this study indicated that camel meat had less fat, compared to beef and goat meat, these results were in conformity with those reported by Dawood and Alkanhal, (1995); El-Faer et al., (1991); Elgasim and Alkanhal, (1992) and Siham, (2008) as (1.63% and 4.8%) for camel meat and beef respectively. In the present study goat meat recorded lower fat content than beef as (1.66 and 2.74%) respectively. These results were in agreement with the findings of Park et al., (1991) who reported that goat meat is 50%-65% lower in fat than beef. Also these results agreed with the result reported by USDA, (2001) who stated that goat meat contain less fat than beef. Meat vary greatly in their fat content according to the animal species, age, plan of nutrition and part of the carcass used Valsta et al., (2005). The result of this study agreed with the findings of Gheisari, et. al., (2009) who indicated that the camel meat had less fat content than beef and goat meat.

#### **5.1.4 Ash:**

In this study the ash content was revealed high significant ( $P < 0.01$ ) among the three types of meat. Camel meat had the highest ash content (0.785) followed by beef (0.47%) and goat meat (0.43%) respectively. In the present study the ash content of fresh camel meat was (0.78%) which was in line with the result found by Gulzhan et al., (2013) who reported the ash% in camel meat as (0.9%) and similar to the findings of Nasr et al., (1965) as (0.76 - 0.86%). The ash content in the present study slightly lower to that reported by Babiker and Yousif, (1990) as (1.05%) and Abdelbaki, (1957) and Hamman et al. (1962);

Owaimer, (2000); Kadim, et. al., (2006) and Siham, (2008) who reported value ranged between (1.0% and 1.4%). The present result was slightly lower than that reported by Adim et al., (2008) as (1.2%); Suaad, (1994) as (1.17%) and Abdelbary and Muhammad, (1995) and Paleari et al., (2003) as (1.05-1.60%). The present result was also lower than that reported by IJFSN, (2010) as (1.1%) and the value reported by Tariq et al., (2011) as (4.45%). The ash content in camel meat in this study was lower than that reported by Mohammad, and Abu-bakr, (2011) as (2.99%) and Abdelbary and Mohammad, (1995) and Paleari et al., (2003) as (1.05- 1.6%).

In this study results showed the ash content of beef was (0.47%), this result was agreed with the findings of IJFSN, (2010) as (0.9%). Also the present result was in line with the findings of Ezekwe et al., (1997) who reported that the ash content in beef ranged between (0.98 and 1.6%). The present result showed that camel meat had higher ash content compared to beef.

The ash content in goat meat in this study was (0.43%), which agreed with the result of Wattanachant, et al., (2008) as (0.45%) and Songklanakarin, (2008) as (0.45%). The ash content in goat meat was lower than the findings of Schonfeldt, 1989 and Henryk, et. al., (2008) as (1.06 - 1.08%); USDA, (2007) as (1.11%) ; Shija et. al., (2013) as (4.40 %) ; Arguello et. al., (2004) and Dhanda, (2001) as (1.17%). Also the result in the present study was higher than the findings of Mohammad, et al., (2010) as (0.06%). This result showed that camel meat was higher ash content than beef and goat meat, this result in line with the results of Siham, (2008) who reported values as (1.35 and 0.92%) in camel meat and beef respectively.

### **5.1.5. Cholesterol:**

The result in this study showed the cholesterol concentration in the three types of meat was highly significant ( $P < 0.01$ ). The present result showed that the camel meat had lower cholesterol concentration (59.2 mg/100gm) compared to beef and goat meat as (73.6 and 71.2 mg/100gm) respectively. These results were similar to the statement reported by Elgasim and Elhag, (1982); Fallah et al., (2008); Kadim et al., (2009) who found that the camel meat was in fact leaner than beef and goat meat. The present result indicated that goat meat had lower cholesterol concentration than beef. This result was in line with the findings of USDA, (2001) who reported that the goat meat was lower in cholesterol concentration than beef as value of (73.1mg/100gm and 63.8mg/100gm) for beef and goat respectively. The present result were not matching with the findings of Pond and Maner, (1984); Potchoiba, et al., (1990) who reported that the cholesterol level in goat meat was (76 mg/100gm) compared to (70 mg/100gm) in beef. The present result was in line with the result reported by USDA, (2001) as (73.1 mg/100gm) and higher than the result reported by Sadler, et. al., (1993); Sinclair et. al., (1999) and Williams, et. al., (2007) as (50 mg/100gm).

The present result showed cholesterol concentration in goat meat was (71.2mg/100gm) which was slightly similar to that findings of Park et al., (1991) as (57.8 to 70 mg/100gm) and was higher than the values reported by Hasiket al., (1999 ) as (48.76 - 56.63 mg/100gm); Henryk, et. al.,( 2008) as (48.76 mg/100gm); Beserra et al., (2004) as (69.4 mg/100gm); Rhee et al., (1982) as (51.7 to 65.8 mg/100gm); Pratiwi et al., (2006) as (55.5mg/100gm); USDA, (2007) as (57 mg/100gm) and USDA (2001) as (63.8 mg/100gm) for goat meat.



The cholesterol concentration of meat was significantly affected by goat genotypes, Beserra et al., (2004). Multiple factors affect the cholesterol content of beef, such as sex, maturity, degree of marbling, breed, dietary energy level and different feeding as stated by Muchenje, (2009).

## **5.2. Protein fractionation:**

In the present study the results showed that myofibrillar proteins, sarcoplasmic proteins and non-protein-nitrogen were not significantly ( $P > 0.05$ ) different among the three types of meat. The result of protein fractionation showed concentration of myofibrillar protein was similar in the camel, beef and goat meat as (11.24, 11.48 and 11.24% respectively). Also the present results showed the sarcoplasmic proteins values was (5.50, 5.35 and 5.40%) for camel, beef and goat meat respectively. The non-protein-nitrogen values were (1.35, 1.05 and 1.16%) in camel, beef and goat meat respectively. The result in this study was in line with the findings of Nafiseh, et. al. (2010) who reported that there was no significant difference between myofibrillar proteins in camel meat and beef as (10.89 and 10.58%) respectively. The present results were similar to the results reported by Siham, (2008) who reported that the myofibrillar protein content as (11.64 and 11.5%) in camel meat and beef respectively. These results were in agreement with the finding of Lawri, (1979) who reported that the camel meat had similar sarcoplasmic proteins and non-protein-nitrogen compared to beef and goat meat. The present result in line with the findings of Siham, (2008) who reported that the camel meat had less sarcoplasmic proteins compared to beef as (6.11 and 26%) respectively. The concentration of sarcoplasmic proteins was significantly ( $P < 0.001$ ) higher in beef than that of camel and goat meat, this may be a reflection of species differences in chemical composition of

the muscles. The present result was in agreement with the findings of Siham, (2008) who reported that non-protein-nitrogen in camel meat (1.48%). However, the present result was lower than the result found by Lawrie, (1991) who reported a value of (3.5%) in camel meat and beef.

### **5.3. Meat Quality Attributes:**

#### **5.3.1. Color:**

Objective color measurements of fresh camel, beef and goat meat were studied. Results showed that hunter lightness (L) values were highly significant ( $P < 0.001$ ) between the types of meat. Beef and goat meat recorded higher values compared to camel meat as (33.27, 32.44 and 29.76) respectively. Redness (a) values were not significant ( $P > 0.05$ ) different between the three types of meat. Goat meat recorded higher values followed by beef and camel meat as (18.53, 17.69 and 17.04) respectively. The yellowness (b) values were significantly ( $P < 0.001$ ) different between treatments. Beef recorded higher values followed by camel and goat meat as (8.82, 7.48 and 5.82) respectively. Results showed that camel meat appeared brighter red than beef and goat meat. This result was supported by results by Fox, (1966); Saffle, (1968) and Bennion, (1980) who reported that the camel meat is lighter in color compared with that of beef and goat meat. Results were also in conformity with the statement of Babiker and Yousif, (1990) who reported that camel meat color varied from raspberry red to brown. The goat meat which recorded highest value in redness compared to beef and camel meat was comparable to those reported by Babiker et al., (1990) who stated that goat meat was dark red in color. The present result also in line with the findings of Adim et al., (2008) who reported that the camel meat has been described as raspberry red to dark brown in color. Whereas, the present

result disagreed with the finding of Wattanachant, et al., (2008) who reported that goat meat color values as (50.83, 3.82 and 8.06) for (L, a and b) respectively and also disagreed with the findings of Songklanakarin, (2008) who reported that goat meat had color values as (L, 50.83; a, 3.82 and b, 8.06). The present results were in line with the results of Kadim et al., (2006) who reported camel meat color values as lightness (L) ranged from (27.86 to 43.21), redness (a) ranged from (10.46 to 22.81) and yellowness (b) ranged from (4.63 to 10.11). The present results showed value as (32.44) for lightness color in goat meat, these values were lower than that found by Arguello et. al., (2004) who reported the lightness value in goat meat color was (50.79) and Arguello et al., (1998) as (50 – 56). The present results were inconformity with the result reported by Siham, (2008) who reported the camel meat color lightness (29.56) and redness (16.45). The present results were almost similar to the results reported by Siham, (2008) as (19.6) for redness and (7.78) for yellowness in beef.

### **5.3.2. Water holding capacity (WHC):**

Water holding capacity (WHC) was highly significant ( $P < 0.01$ ) for the three types of meat. Camel meat recorded low value compared to beef and goat meat (That mean camel meat had superior water holding capacity compared to beef and goat meat). In the present result the water holding capacity was (1.37, 2.44 and 2.19) for camel, beef and goat meat respectively. The present results were lower than the values reported by Kafe, (2001) in camel meat as (5.8) and results of Henryk, et. al., (2008) who reported that the WHC in goat meat as (7) and Arguello et. al., (1998) as (9.7 - 11.8). The results of this study were in line with the findings of Elkhidir et. al., (1998) who reported that the goat meat had WHC of (2.14). Whereas, the present results disagreed with the result of

Arguello et. al., (2004) who reported that the WHC in goat meat (0.59). Lower water holding capacity of meat increased cooking loss in final products as stated by Lawrie, (1991). The present results were in line with the findings of Siham, (2008) who reported that the WHC in beef as (2.67). Differences in water holding capacity of camel meat compared to beef and goat meat might be due to differences in pH level.

### **5.3.3. Cooking loss %:**

In the present study results showed that the cooking loss was highly significant ( $P < 0.01$ ) among the three types of meat. Cooking loss percent of camel meat was higher followed by goat meat and beef as (36.3, 34.15 and 31.75%) respectively. However these different may be due to moisture content differences in different meat studied.

The cooking loss in camel meat in this study as (36.3%) which was higher than the findings of Kadim et al., (2006) as (13.18 - 29.88). The present result was in agreement with the findings of Siham, (2008) who reported that cooking loss % in camel meat as (35.6%).

Cooking loss in beef in this study (31.75%) which was lower than the result reported by Siham, (2008) as (38.6%). Cooking loss was lower in beef muscle than camel meat, probably due to the lower content of intra-muscular fat of camel meat as stated by Kadim, et al., (2006).

The goat meat in this study was higher cooking loss (34.15%) than the findings of Songklanakarin, (2008) and Wattanachant, et al., (2008) who reported that the cooking loss percent in goat meat as (27.77%) and Lee et al., (2008) as (16.95%) and also the result of Madruga et al., (2008) who reported values ranged from (26.5 to 29.2%). The cooking loss percentage in goat meat in this study was in line with the result reported by Elkhidir et al., (1998) as (34%).

Cooking loss depends also on water-holding capacity as stated by Henckel et al., (2000). These differences are due to molecular differences or to a variation in the architectural distribution of the connective tissue in different meats as reported by Dawood, (1995). Such differences in cooking loss due to several factors including the rate of thawing as reported by Uttaro and Alhus, (2007) and cooking temperature as reported by Jeremiah and Gibson, (2003). Cooking loss was affected by many factors such as surface and internal temperature of meat as stated by Panea et al., (2008).

#### **5.3.4. PH**

There was no significant ( $P > 0.05$ ) difference between the three types of meat in pH values. The pH values in this study were (5.88, 5.77 and 5.68) in camel, beef and goat meat respectively. In the present study, the camel meat recorded higher value of pH compared to beef and goat meat. The pH of camel meat in this study agreed with values found by Al-Sheddy et al., (1999); Cristofaneli et al., (2004) and Kadim et al., (2006) who reported values of pH in camel meat ranged from (5.7 to 6.0). The pH value of camel meat in this study (5.88) was in conformity with the result of Babiker and Yousif, (1990) who reported that the pH values of camel meat as (5.8). Also the present result was in line with the findings of Kadim et al., (2006) and Siham, (2008) who reported that the ultimate pH of camel meat ranged from (5.46 to 6.64). The pH value of beef in this study was (5.77) which slightly similar to that reported by Lee, (2012) as (5.64) and Siham, (2008) as (6.0). In the present study the pH value in goat meat which was in conformity with the result of Zhong et al., (2009) and Arguello et. al., (1998) who reported that the goat meat has pH value of about (5.6) and was in line with the findings of Madruga et al., (2008) as (5.5 - 5.6) and Henryk, et. al., (2008) as (5.78).

The result in this study agreed to the result reported by Arguello et. al., (2004) who found the pH in goat meat as (5.49). The findings in this result was lower than the result reported by Wattanachant, et al., (2008) and Songklanakarin, (2008) as (6.57) pH in goat meat. This result agreed with that reported by Simela et al., (2004 a, b) as (5.88 - 6.03) pH in goat meat.

The differences in pH affected by several factors including the rate of thawing Uttaro and Alhus, (2007). The present result in line with the findings of IJFS N, (2010) and Snell, (1996) who reported that the values of pH in the meat after chilling were ranged between (5.49 and 5.82). The differences in pH level might be due to the changes that occurred after slaughter owing largely to the differences in the amount of glycogen available as reported by Guingnot et al., (1992). High ultimate pH values in meat can indicate stressed animals during pre-slaughter handling Simela et al., (2004 a, b).

#### **5.4. Chemical Composition of camel, beef and goat sausages:**

##### **5.4.1. Moisture %:**

In the present result the moisture content showed significant ( $P < 0.05$ ) difference among the three types of sausage. The moisture percent in this study was (73.45, 70.32 and 71.0%) in camel, beef and goat sausages respectively. This result showed that the camel and goat sausages had higher moisture content compared to beef. The moisture percent in beef sausage in this study was (70.32%) where as was higher than the value reported by Agnihotri and Pal, (2000) as (66.71%) and Nafiseh, et. al., (2010) as (48.7%). Moisture in camel sausage in this study was (73.45%) higher than the findings of Nafiseh, et. al., (2010) as (51.3 %).

#### **5.4.2. Protein %:**

Protein content in the present study was highly significant ( $P < 0.01$ ) among the three types of sausage. Beef sausage had higher protein content compared to camel and goat sausages. In the present study protein percent in camel sausage was (16.0%) which was similar to the findings of Nafiseh, et. al., (2010) as (15.9%). The protein percent in beef sausage as (18.53%) which was in line with the result reported by Nafiseh, et. al., (2010) as (18.8 %). Protein percentage of goat sausage was (18.0 %) which similar to the findings of Dharmaveer et al., (2007) as (18.36%). The protein values were 18.53 and 18.0% for beef and goat sausages respectively, which was less than the result reported by Gadiyaram, and Kannan, (2004) as (20.00 and 20.47%) in goat and beef sausages respectively.

#### **5.4.3. Fat %:**

Fat content in this study was highly significant ( $P < 0.01$ ) among the treatment sausages. However, the fat content of beef sausages was the highest followed by goat and camel sausages as (3.45, 3.0 and 2.31%) respectively. Fat content in camel sausage was (2.31%) which was lower than the value reported by Nafiseh, et. al., (2010) as (13 %). The fat percent in beef sausage was (3.45%) which far lower than the findings of Nafiseh, et. al., (2010) who reported value as (16.8%). The fat content of goat sausage in this study was (3.0%) which was far less than that reported by Dharmaveer et al., (2007) as (17.05%) and Jihad et al., (2009) as (16.7%) that might be due to the added fat. The fat percent in goat sausage was in agreement with the result of Gadiyaram and Kannan, (2004) that reported the fat level as (2.29%) in goat sausages but disagreed with their result in beef sausage as (7.07%) in beef sausages. In

this study the low fat content in goat sausage compared to beef sausage was in line with the findings of Gadiyaram and Kannan, (2004).

#### **5.4.4. Ash %:**

Ash content in the present study was highly significant ( $P < 0.01$ ) among the three types of sausage. Camel sausage had the highest ash content followed by beef and goat sausages as (2.0, 1.33 and 1.12%) respectively. The ash content in the present study in goat sausage as (1.12%) which was lower than that reported by Dharmaveer et al., (2007) as (2.27%) and Jihad et al., (2009) as (3%).

#### **5.4.5. None Protein Nitrogen (NPN) %:**

The present result showed the non-protein-nitrogen was not significantly ( $P > 0.05$ ) different in the three type of sausages. The NPN in this study was (6.47, 6.23 and 5.89%) for camel, beef and goat sausage respectively. This result agreed with the findings of Ali, (2012) who reported that the NPN of beef sausage was (6%) and slightly lower value reported of goat sausage as (4%).

### **5.5. Some Quality Attributes of camel, beef and goat sausages:**

#### **5.5.1. Color:**

In the present study the results showed that the Hunter lightness (L) values were highly significant ( $P < 0.001$ ) between three types of sausage studied. Goat sausages recorded higher values compared to beef and camel sausages as (32.15, 31.8 and 28.5) respectively. Also Redness (a) values were not significant ( $P > 0.05$ ) different. Goat sausages recorded higher values followed by beef and camel sausages as (11.56, 11.45 and 10.40) respectively. Similarly yellowness (b) values were not significant ( $P < 0.001$ ) different. The goat sausages recorded higher value followed



by beef and camel sausages as (8.56, 8.48 and 7.67) respectively. The value of lightness in camel and beef sausages in this study were (28.5 and 32.15) respectively which was less than the values reported by Nafiseh, et al., (2010) as (66.6 and 68.6) for camel and beef sausages respectively. These results are comparable to the statement of Babiker et al., (1990) who stated that goat meat was darker red in color. The result of redness in this study was slightly less than the value reported by Nafiseh, et. al., (2010) who reported that the redness value in camel sausage was (13.9) and in beef sausage was (9.2), where as the yellowness value in camel sausage was (15.8) and in beef sausage as (15.6).

#### **5.5.2. Water holding capacity (WHC):**

In the present study water holding capacity (WHC) was highly significant ( $P < 0.01$ ) among the three types of sausage studied. Camel sausages recorded low value (0.48) compared to beef and goat sausages as (1.06 and 0.69) respectively. (Which means camel sausage had highest water holding capacity compared to beef and goat sausages). The goat sausage had WHC of (0.69) which was higher to that reported by Babiker et al., (1990) as (0.27) and slightly higher value reported of beef sausage as (0.80).

#### **5.5.3. Cooking loss %:**

In the present study the result showed that cooking loss was highly significant ( $P < 0.01$ ) among the three types of sausage (camel, beef and goat sausages). Cooking loss percent of camel sausage was higher compared to beef and goat sausages as (24.12, 21.45 and 22.0%) respectively. Camel sausage in this study recorded cooking loss percent as (24.12%) which was in line with the result reported by Nafiseh, et. al., (2010) as (24%). Beef sausage in this study had cooking loss percent as

(21.45%) which was slightly similar to that reported by Ali, (2012) as (22%). The present result showed that camel and goat sausages were recorded higher cooking loss compared to beef sausage which was disagreed with the findings of Ali, (2012) who reported that goat sausage had lower cooking loss as (16.64%) compared to beef sausage which showed (22.07%). The value of goat cooking loss in this study was higher than the findings of Gadiyaram and Kannan, (2004) as (5.52%) and in beef sausage as (19.88%). The present result disagreed with the findings of Nafiseh, et. al., (2010) who reported that the camel sausage had lower cooking loss than beef sausage as 24.2 and 30.2% respectively. The difference in cooking loss could be attributed to the denaturation temperature of protein and the difference in chemical properties and types of meat as stated by Dawood, (1995) and Nafiseh, et. al., (2010). The type of fillers affected significantly ( $P < 0.01$ ) on cooking loss %. The sweet potato showed high cooking loss compared to bread crumbs. However, using of sweet potato leads to reduced size of sausage fingers and diminished weight. Therefore, these findings affected economically on sausage marketing.

#### **5.5.4. PH :**

There was no significant ( $P > 0.05$ ) different between the three types of sausage in pH values. In this study the pH values were (5.65, 5.73 and 5.66) for camel, beef and goat sausages respectively. The pH value in camel sausage (5.56) was agreed with the findings of Nafiseh, et. al., (2010) who reported the pH value in camel sausage as (5.7). The pH result in this study was in line with the result of Wensvoort et al., (2004) who reported the pH in camel and beef sausages was (5.5). Also similar result was reported by Nafiseh, et. al., (2010) as (5.6) in beef sausage. In this study goat sausage had similar pH (5.66) as beef sausage (5.73),

similar findings was recorded by Dharma veer et al., (2007) as (6.44) and Abbas, (2009) as (5.61) for goat and beef sausages.

## **5.6. Sensory evaluation:**

### **5.6.1. Sensory Evaluation of camel, beef and goat meat:**

The present study showed that the treatments differ significantly ( $P < 0.05$ ) in the sensory parameters measured (tenderness, juiciness, flavor and overall acceptance) except color and all scores obtained were above moderately desirable. In this study Panelist scores for color were not significant ( $P > 0.05$ ), whereas, significant ( $P < 0.05$ ) differences were observed in tenderness. Panelist's scores for tenderness of camel and goat meat were lower than that of beef, which was in line with the findings of Sen et al., (2004); Schonfeldt et al., (1993b); Griffin et al., (1992) who reported that goat meat was less tender than other types of red meat and the findings of Sen et al., (2004) who reported that goat meat was less tender compared to beef. The present result was in line with the findings of Smith et al., (1974) who compared sensory characteristics of goat meat with beef and stated that the goat meat had the same juiciness, but was less tenderness compared to beef. In this result tenderness of camel meat was less than beef, this result disagreed with the result stated by Adim et al., (2008) who found that the camel meat was similar in taste and texture to beef and Williams, (2002) who reported that camel meat was similar in taste and texture to beef. In the present result the panelist's scores for juiciness of camel meat and beef were higher compared to goat meat. Differences in juiciness related primarily to the ability of muscles to hold water during cooking as reported by Aberle et al., (2001). The present results disagreed with the result of Sen et al., (2004) who stated that goat meat had the same juiciness to beef. The scores for flavor of camel and

goat meat were lower than beef, which agreed with the statement of Babiker et al., (1990) who reported that the goat meat was lower in flavor compared to lamb and beef. This was also similar to the findings of Schönfeldt et al., (1993a, 1993b); Casey et al., (2003); Sheradin et al., (2003a,b); Webb et al., (2005) who reported the goat meat has a distinct flavor and aroma compared to beef and mutton. Some evidence stated by Nelson et al., (2004) who suggested that goat meat fares favorably in palatability when compared with lamb and beef. In this study the goat meat was desirable to the panelists; this result was in conformity with the findings of Degner, (1991); Griffin et al., (1992) and Miller, (1999). The present result was in line with the findings of Smith et al., (1974) who compared sensory characteristics of goat meat with beef and reported that the goat meat had less overall satisfaction when compared to beef. Overall acceptance showed significant ( $P < 0.05$ ) different. Camel meat and beef were more desirable compared to goat meat hence the goat meat was also desirable, which was agreed with the findings of Henryk, et al., (2008) who reported that the sensory evaluation confirmed good eating quality of goat meat. The present study showed the goat meat had less overall satisfaction compared to camel meat and beef, which was in agreement with the findings of Sen et al., (2004) who stated the goat meat recorded less overall satisfaction compared to beef.

#### **5.6.2 Sensory evaluation of camel, beef and goat sausages:**

Sensory results and the acceptability of sausages of different types of meat and fillers were showed all the scores obtained were ranged between (3.0 and 6.0) and there was no significant ( $P > 0.05$ ) different between treatments in any of the parameters measured. The present results showed no significant differences between camel, beef and goat sausages, but camel sausage recorded higher scores in sensory evaluation

than beef and goat sausage. This finding was in line with that of James and Berry, (1997) who mentioned that the trained sensory panelist found similar juiciness, flavor, and tenderness in patties of goat and beef. Textural attributes of goat sausages are comparable to those of beef sausages Gadiyaram and Kannan, (2004). Results of sensory evaluation of sausages manufactured with camel, beef and goat meat, showed that panel scores for color, flavor, juiciness and overall acceptability were significantly different ( $P < 0.05$ ) among treatments. Results obtained from this study showed that sausages made from either camel meat or goat meat was acceptable to the Sudanese palate. This indicates that meat from beef or camel meat, or goat meat can replace each other in sausage manufacturing, These results being in agreement with Kulaeva (1964) who reported that camel meat resembled beef in taste and Khatami (1970) who noted that camel meat closely resembled beef in appearance, color, texture and palatability. This finding was in line with that of James and Berry, (1997) who mentioned that the trained sensory panelist found similar juiciness, flavor, and tenderness in patties of goat meat and beef. The present results also showed that sausage manufactured by using sweet potato and bread was acceptable. The camel meat with its superior processing properties and low fat content furnishes a good raw material for comminuted meat and healthy food commodities. The result in this study in line with the findings of Ellard, (2000) who reported that the camel meat had similar flavor to beef. Camel, beef and goat sausages were not significantly different ( $P > 0.05$ ) in color of the cooked sausages. However, camel and beef sausages with sweet potato received higher color measurement scores compared to goat sausages. These results indicated that using sweet potato with meat to manufactured sausages improved characteristics of camel and beef sausages and made them acceptable to panelists compared with bread. The overall acceptability

results indicated that sausages made with camel, beef and goat meat with different types of fillers were differed in the overall acceptability scores but all were accepted. These findings are supported by the results of Babiker and Tibin, (1986), who evaluated overall organoleptic properties of sausages made from either beef or camel meat, they observed that all sausages were acceptable to the panelist group. Results also indicate that camel, beef and goat sausages made with sweet potato were preferred by the panelists group and received the highest acceptability scores compared with others, while sausages made with bread crumbs received the least acceptability scores.

#### **5.7. Total viable bacterial count of camel, beef and goat (meat and sausages):**

In the present results the average bacterial load of the fresh and frozen samples of camel meat was ( $3 \times 10^6$  and  $2 \times 10^6$  CFU/gm) respectively. The average bacterial loads of the fresh and frozen samples of beef were ( $2 \times 10^5$  and  $1 \times 10^5$  CFU/gm) respectively. Whereas, the average bacterial loads of fresh and frozen samples of goat meat were ( $2 \times 10^6$  and  $1 \times 10^6$  CFU/gm) respectively. Also the present result showed that the fresh samples had the higher bacterial count compared to samples stored at deep-freeze temperature at ( $-18c^0$ ). Results of the total viable bacterial counts obtained in the present study were agreed with standards suggested by Oregon Department of Agriculture, (1973) who reported that the total aerobic plate count of fresh and refrigerated meat should not exceed as ( $5 \times 10^6$  CFU/gm). Also at the end of the storage periods no organoleptic changes were detected. Also these results were similar to that stated by Rajkumar et al., (2004) who reported low bacterial count in goat meat patties under freezing. This lower bacterial count with storage

period may be due to lower water activity during freezing. Also the results in this study were in line with the findings of Khalifa, (2002) who reported that the effect of storage of beef on total viable count was as follows ( $5.75 \times 10^{-4}$  CFU/gm) at first day and ( $4.25 \times 10^{-4}$  CFU/gm) at month for beef. These results were similar to that stated by Rajkumar et al., (2004) who reported low bacterial count in goat meat patties under freezing. The present results showed that the total bacterial count decreased significantly ( $P < 0.01$ ) with storage period as the average bacterial load of the fresh and frozen samples of camel sausages were ( $3 \times 10^6$  and  $2 \times 10^6$  CFU/gm) respectively. The average load of the fresh and frozen samples of beef sausage was ( $2 \times 10^6$  and  $1 \times 10^6$  CFU/gm) respectively. Whereas, the average load of fresh and frozen samples of goat sausage were ( $2 \times 10^6$  and  $1 \times 10^6$  CFU/gm) respectively. In general, there was decreased in the bacterial count in sausage with increase of the freezing time. The fresh samples have the higher bacterial count compared to samples that stored at deep-freeze temperature ( $-18^\circ\text{C}$ ). This result was matching to that reported by Abass, (2009) as ( $3.9 \times 10^{-1}$  CFU/gm) and ( $3.78 \times 10^{-1}$  CFU/gm) in zero and 7 days respectively. In general, results in this study showed that the total viable count for the fresh sausage was ranged between ( $2 \times 10^6$  and  $3 \times 10^6$  CFU/gm), these results in line with the findings of SSMO, (2008) who reported that for fresh sausage the total aerobic plate count should not exceed than ( $5.25 \times 10^5$  CFU/gm). The present results showed that total bacterial count decreased significantly ( $P < 0.01$ ) with storage period, this result is matching with that reported by Abass (2009) as ( $3.9 \times 10^{-1}$  CFU/gm) in the first day and ( $3.78 \times 10^{-1}$  CFU/gm) in day7. The contamination comes from different sources, mainly hides, hoofs, air, water, equipments, intestinal contents and slaughtering floor as reported by Empey and Scott, (1939). Results indicated that storage at ( $-18^\circ\text{C}$ ) for four weeks

significantly decreased bacterial counts. This may be due to the freezing condition. Freezing is known to injure bacterial cells and it is known to decrease the number of viable bacterial cells. Very few bacterial genera can thrive under freezing conditions Judge et al., (1989).

### **5.8. Minerals Concentration in camel, beef and goat meat:**

In the present study the mean concentration of minerals mg/100gm was highly significant different ( $P < 0.01$ ) in the three types of meat except calcium. In general, minerals concentration in camel meat was higher compared to that in beef and goat meat. The present results disagree with the findings of Gheisari, et. al., (2009) who reported that camel meat has similar mineral concentrations to beef (K, Ca, Fe, P and Mg).

#### **5.8.1. Calcium (Ca):**

In the present result camel meat has a highest concentration of calcium (12.56mg/100gm) compared to beef and goat meat as (11.36 and 11.21mg/100gm) respectively. The result in this study slightly more than the findings of Wan Zahari and Wahid, (1985) and Siham, (2008), who stated that Calcium concentration in camel meat, was (11mg/100gm) and more than the result of Mohammad and Abubakar (2011) who reported that the calcium concentrations of camel meat were ranged between (5.59 and 8.27 mg/100gm). The present result in line with the result of Kadim, et. al., (2006) who reported that the calcium concentrations in camel meat ranged from (9.2 to 46.6 mg/100gm). Also the result in this study in line with the findings of Faer et al., (1991); Elgasim and Alkanhal, (1992); Dawood and Alkanhal, (1995); Rashed, (2002); Badiei et al., (2006); El- Kadim et al (2009) who reported that the calcium concentrations in camel meat ranged from (1.33 to 11.48 mg/100gm). The result in this study more than the result of Gulzhan et al., (2013) who



reported that the calcium concentration in longissimus dorsi of camel meat was (5 mg/100gm). The present result less than the values reported by Tariq, et. al., (2011) who reported that camel meat has calcium concentration as (27mg/100gm). This study showed that the calcium concentration in beef was (11.36 mg/100gm), this result more than the result of Sadler, et. al., (1993); Sinclair et. al., (1999) and Williams, et. al., (2007) who reported that calcium concentration in beef was (4.5mg/100gm) and (Siham, 2008) as (8 mg/100gm) and McCance and Widdowson, (1960) as (5.4 mg/ 100gm). The present result less than the findings of Abdon et. al., (1980) who reported that the calcium concentration in beef (96 mg /100 gm). In this study calcium concentration in goat meat was (11.21mg/100gm), this result in line with the findings of Wan Zahari et al., (1985) who reported that the calcium concentration in goat meat was (11mg/100gm) and Abdon et. al., (1980) as ranged from (11 to 12 mg/100 gm). The result in this study less than the findings of USDA, (2007) who reported that the calcium concentration in goat meat was (13 mg/100gm).

### **5.8.2. Phosphorus (P):**

In the present study phosphorous concentration higher in camel meat as (175.6 mg/100gm) compared to that of beef and goat meat as (155 and 154.5 mg/ 100gm) respectively. The result in this study more than the findings of Wan Zahari and Wahid, (1985), who stated that phosphorous concentration in camel meat, was (155.5 mg/100gm). The result in this study less than the findings of Kadim, et. al., (2006) who reported that the phosphorous concentrations in camel meat ranged from (249.9 to 584 mg/100gm) and Gulzhan et al., (2013) as (229.0 mg/100gm) as reported by. The result in this study less than the findings of Tariq, et. al., (2011) who reported that the phosphorus concentration in

camel meat was (549 mg/ 100gm). The result in this study in line with the findings of Siham, (2008) who stated that the phosphorus concentration in camel meat was (176 mg/100gm). The present result showed that the phosphorus concentration in beef was (155mg/100gm), this result slightly more than the result stated by Siham, (2008) as (150mg/100gm) and less than the findings of Mc Cance et. al., (1960) who reported that the phosphorus concentration in beef was (334 mg/100 gm) and less than the result of Sadler, et. al., (1993); Sinclair et. al., (1999) and Williams, et. al., (2007) who reported that the Phosphorus concentration in beef was (215mg/100gm). In the present result the phosphorous concentration in goat meat was (154.5mg/100gm), this result in line with the findings of Wan Zahari et al., (1985) who reported that the phosphorous concentration in goat meat was (155.5 mg/100gm). The result in this study less than the findings of USDA, (2007) who reported that the phosphorus concentration in goat meat was (180mg/100gm).

### **5.8.3. Sodium (Na):**

The present result showed that camel meat was contained slightly higher concentration of sodium as (114.4 mg/100gm) compared to beef and goat meat as (89.08 and 76 mg/100gm) respectively. The result in this study in line with the findings of Kadim, et. al., (2006) who reported that the concentration of sodium in camel meat ranged from (104.7 to 257 mg/100gm). The result in this study far than the findings of Wan Zahari and Wahid, (1985), who stated that sodium concentration in camel meat, was (64 mg/100gm) and less than the findings of Tariq, et.al., (2011) who reported that the sodium concentration in camel meat was (252mg/100gm) and less than the result of Siham, (2008) as (198mg/100gm). In this study the sodium concentration in beef was (89.08 mg/100gm), this result more than the result reported by McCance

et al., (1960) as (69 mg/ 100 gm) and more than the findings of Sadler, et. al., (1993) ; Sinclair et. al., (1999) and Williams, et. al., (2007) who reported the sodium concentration in beef was (51 mg/100gm) and Mc Cane et. al., (1960) as (69 mg/100gm). The present result less than the result reported by Siham, (2008) who stated that the sodium concentration in beef was (165mg/100gm). In this study goat meat has sodium concentration of (76 mg/100gm), this result similar to that mentioned by Wan Zahari et al., (1985) who reported that goat meat has sodium concentration ranged between (55 and 77 mg/ 100gm). The result in this study in line with the findings of Wan Zahari et al., (1985) who reported that the sodium concentration in goat meat ranged from (55to 77 mg/ 100gm). The present result less than the result reported by USDA, (2007) as (82 mg/100gm) and USDA, (2001) as (92mg/100gm).This study showed that goat meat contain less sodium compared to camel meat and beef, this result in line with the result mentioned by USDA, (2007) who reported that goat meat less sodium than beef.

#### **5.8.4. Potassium (K):**

In the present study the Potassium concentration higher in camel meat as (411mg/100gm) compared to beef and goat meat as (323.2 and 310.2 mg/100gm) respectively. The result in this study in line with the result of Kadim, et. al., (2006) who reported that the potassium concentration in camel meat ranged from (471.4 to 1053mg/100gm). The result in this study more than the findings of Wan Zahari and Wahid, (1985) who stated that potassium concentration in camel meat was (350 mg/100gm) and Gulzhan et al., (2013) who reported that the potassium concentration in longissimus dorsi of camel meat was (369 mg/100gm). The present result less than the findings of Tariq, et.al., (2011) who reported that the potassium concentration in camel meat was

(1008mg/100gm) and less than the findings of Muhammad and Abu-bakr, (2011) who reported that the potassium concentrations in camel meat was ranged from (559 to 827 mg/100gm) and Siham, (2008) as (560mg/100gm). the result in this study showed that the Potassium concentration in beef was (323.2mg/100gm) this result slightly similar to that reported by McCance et al., (1960) as (334 mg/100 gm) and Sadler, et. al., (1993); Sinclair et. al., (1999) and Williams, et. al., (2007) as (363 mg/100gm) and Siham, (2008) as (350mg /100gm). This study showed that the potassium concentration in goat meat was (310.2mg/100gm), this result slightly less than the findings of Wan Zahari et al., (1985) who reported that the potassium concentration in goat meat was ( 350 mg/100gm) and USDA, (2007) who reported that the Potassium concentration in goat meat was (385 mg/100gm). The present result showed that the potassium concentration in goat meat less than in beef, this result disagree with the findings of USDA, (2007) who reported that goat meat higher potassium concentration than beef. The present result less than the result reported by USDA, (2001) as (436 mg/100gm).

#### **5.8.5. Magnesium (Mg):**

In the present study result showed that the magnesium concentration was higher in camel meat as (90.16 mg/100gm) compared to that of beef and goat meat as (37.6 and 27.31mg/100g) respectively. The result in this study more than the findings of Wan Zahari and Wahid, (1985), who stated that magnesium concentration in camel meat, was (19.7 mg/100g) and more than the findings of Kadim, et. al., (2006) who reported that the magnesium concentration in camel meat ranged from (24.7 to 57.3 mg/100gm) and Tariq, et.al., (2011) as (56.7 mg /100gm) and Siham, (2008) as (28 mg/100g). The present result less than the result reported by Gulzhan et al., (2013) who stated that the magnesium

concentration in longissimus dorsi of camel meat was (251.0mg/100gm). This result slightly more than the result of Muhammad and Abu-Bakr (2011) who reported that the magnesium concentrations in camel meat were ranged from (79.4 to 80.6 mg/100gm). The present study showed that the magnesium concentration in beef was (37.6mg/100gm), this result more than the findings of Sadler, et. al., (1993); Sinclair et. al., (1999) and Williams, et. al., (2007) as (25 mg/100gm) and Siham, (2008) as (24 mg/100gm). The present result showed that the magnesium concentration in goat meat was (27.31mg/100gm), this result more than the result reported by Wan Zahari et al., (1985) who stated that the magnesium concentration in goat meat was (19.7 mg/100gm).

#### **5.8.6. Ferrous (Fe):**

In the present study result showed that the ferrous concentration was higher in camel meat as (5.0 mg/100gm) compared to beef and goat meat as (2.96 and 3.5mg/100gm) respectively. The result in this study in line with the findings of Wan Zahari and Wahid, (1985), who stated that ferrous concentration in camel meat, was (4.37 mg/100gm). Also this result agreed with the findings of USDA, (2001) who mentioned that goat meat has higher levels of iron (3.2 mg/100gm) when compared to beef as (2.9 mg/100gm). This result in line with the findings of Gulzhan et al., (2013) who reported that the iron concentration in longissimus dorsi of camel meat was (5 mg/100gm). The present result disagrees with the result reported by Tariq, et. al., (2011) who stated that the iron concentration of camel meat was (16 mg/100gm). The result in this study more than the result reported by El-Faer et al., (1991); Dawood and Alkanhal, (1995) and Rashed, (2002) as value ranged from (1.16 to 3.39 mg/100gm), which was expected that due to the different physiological requirements of myoglobin of different muscles. The present result less

than the findings of Mohammad and Abubakar, (2011) who reported that the ferrous concentrations of camel meat were ranged between (78 and 156 mg/100gm). This result more than the result of Dawood and Alkanhal, (1995) that measured the iron concentration of camel meat and reported a value of (3.24 mg/100gm). The present result in line with the findings of Siham, (2008) who reported that the iron concentration in camel meat was (5.6mg/100gm). The present result showed that the iron concentration of beef was (2.96mg/100gm), this result in line with the result reported by Siham, (2008) who stated that the iron concentration in beef was (2.8 mg/100gm) and in line with the result of USDA Composition of Foods, (1986) as (2.72 mg/100gm). The present result more than the result reported by Sadler, et. al., (1993); Sinclair et. al., (1999) and Williams, et. al., (2007) as (1.8 mg/100gm). The present result showed that the camel meat contain more iron than beef, this result agreement with the result of Nafiseh, et. al., (2010) who reported that the amount of iron was significantly higher in camel meat, therefore camel meat better source of iron compared to beef. The present result showed that the iron concentration in goat meat was (3.5mg/100gm), this result more than the result reported by Abdon et al., (1980) as ( 2.1 mg/100gm) and USDA, (2007) as (2.83 mg/100gm). The present result less than the result of Wan Zahari et al., (1985) who reported that iron concentration in goat meat (4.37mg/100gm). The present result showed that the iron concentration in goat meat higher than that in beef, this result agreement with the result found by USDA, (2007) who reported that goat meat higher iron concentration than beef. In general ferrous concentration in the three types of meat studied showed small amount compared to other mineral content. The differences in these results may be due to the differences in species of animal, genetic factors, environmental factors and nutritional.

## CHAPTER SIX

### CONCLUSION AND RECOMMENDATIONS

#### CONCLUSION:

In this study the chemical composition and some eating quality attributes of camel, beef and goat meat were evaluated. Chemically camel meat had low fat content (1.17%) and cholesterol concentration (59.2 mg/100gm) which makes it an ideal healthy meat and coupled with high nutritive value. Results also showed that camel meat could be utilized in comminuted meat products with reduced fat and cholesterol content in the final product. Goat meat has been established as a lean meat with favorable nutritional quality. However, goat meat contains low fat (1.66%) and cholesterol concentration (71.2mg/100gm) compared to beef which had (2.74%) fat and (73.6mg/100g) cholesterol.

Camel, beef and goat sausages were not significantly ( $P > 0.05$ ) different in juiciness, tenderness, flavor and color. Camel and goat sausages were organoleptically acceptable to Sudanese panelists and did not differ significantly ( $P > 0.005$ ) from beef sausages. The cooking loss of the treatment sausages was not significantly different. The results indicated that the textural property of goat sausages were similar to camel and beef sausages. Bacteriological assessment were done on camel, beef and goat meat to evaluate the level of contamination and its effect on the keeping quality of the meat after storage at  $-18^{\circ}\text{C}$  for 1, 7, 15, 21 and 28 days. The average bacterial count for fresh and frozen camel meat were ( $3 \times 10^6$  and  $2 \times 10^6$  CFU/gm), beef were ( $2 \times 10^5$  and  $1 \times 10^5$  CFU/gm) and goat meat were ( $2 \times 10^6$  and  $1 \times 10^6$  CFU/gm), which decreased with storage period at 1, 7, 15, 21, and 28 days. Whereas, the average bacterial load of the fresh and frozen samples of camel sausages were ( $3 \times 10^6$  and

$2 \times 10^6$  CFU/gm), of beef sausage were ( $2 \times 10^6$  and  $1 \times 10^6$  CFU/gm) and goat sausage were ( $2 \times 10^6$  and  $1 \times 10^6$  CFU/gm) respectively. In general there was a decrease in the bacterial load with increase in storage period.

Minerals concentration was highly significant ( $P < 0.01$ ) in camel meat compared to beef and goat meat. In this study the concentration of Ca, P, Na, K, Mg and Fe was high in camel meat compared to beef and goat meat.

This study concluded that camel and goat meat have prospective future as a healthy nutritive meat.

### **Recommendations:**

It is necessary to continue such researches to develop new approaches in camel and goat meat processing technology. Therefore, further researches on the following topics are suggested:

1. The wholesomeness of using camel and goat meat compared to the meat of other animals.
2. Study of quality and nutritive value of camel and goat meat compared to meat of other animals.
3. The prospective of using camel and goat meat products by using different technologies and additives.



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## **Appendix 1**

### **Grading chart for meat and sausage**

<b>Sample code</b>	<b>Color</b>	<b>Flavor</b>	<b>Tenderness</b>	<b>Juiciness</b>	<b>Acceptance</b>
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A					
B					
C					
D					
E					
F					

Evaluate these samples for color, texture, flavor and juiciness – for each sample, use appropriate scale to show your attitude by checking at the point that best describe the feeling about the sample. If you have any question please ask, thanks for your cooperation.

**Key:**

<b>Color</b>		<b>Flavor</b>		<b>Tenderness</b>		<b>Juiciness</b>	
6	Extremely desirable	6	Extremely intense	6	Extremely desirable	6	Extremely juicy
5	Very desirable	5	Very intense	5	Very desirable	5	Very juicy
4	Moderately desirable	4	Moderately intense	4	Moderately desirable	4	Moderately juicy
3	Moderately undesirable	3	Moderately un intense	3	Moderately desirable	3	Moderately juicy
2	Very undesirable	2	Very un intense	2	Very undesirable	2	Very dry
1	Extremely undesirable	1	Extremely un intense	1	Extremely bland	1	Extremely dry