Physiochemical and sensorial properties of burgers produced from camel meat and beef
(a comparative study)

By

Rawia Ibrahim Mohammed Elhassan AbdelKareem
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Supervisor

Prof: ELgasim Ali ELgasim

Department food science and Technology faculty of Agriculture
University of Khartoum

DETECTION

To my dear supervisor

To my dear parents and family

To my lovely baby and husband

To my dear friends and colleagues,

I dedicate this work, with sincere pleasure and respect

Rawia
Acknowledgment

Thank God Almighty for having helped complete my work. Many thanks and respect to my supervisor Professor Elgasim Ali Elgasim, whose recommendations and untiring efforts helped me a lot in completing this work.

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Physiochemical and Sensorial Properties of Burger Produced from Camel Meat and Beef: a comparative study

M.sc .Dissertation

By

Rawia Ibrahim Mohammed Elhassan AbdelKareem

Abstract: The study was conducted to examine the effect of species and storage period on the physicochemical and sensorial properties of camel and beef burgers. Three Burger types were processed from 100% camel meat, 100% beef meat and 50%camel meat+ 50% beef meat and were packaged and stored refrigerated at 4±1°C for up to seven days. Some subjective and objective measurements were conducted to evaluate the effect of species and storage periods on the quality attributes of burger. Measured parameters included: proximate composition, pH, water holding capacity, storage loss, cooking loss and sensory attribute of burger. The evaluation was made immediately after processing and at 3 and 7 days post processing. The proximate composition of the different burger processed from the two species was very similar (p>0.05) with few numerical differences. The moisture content of the three burger types i.e. camel, beef and camel & beef burger were 73.85%, 72.62% and 72.6% respectively. Camel burger and beef burger had a similar (p>0.05) water holding capacity of 68.05% & 68.26% respectively, while the burger made from the mixture of camel & beef burger had a WHC of 64.5%. Also the three burger types had similar cooking loss, pH and storage loss. Storage period had minor effect on WHC and pH, but significant (P<0.05) effect on storage & cooking losses. The panelist could not detect any significant difference in the sensorial properties of
the burgers made from the different meats particularly in appearance, color, flavor, juiciness and over all acceptability. The possibility of using camel meat in meat burger processing does exist.
النتائج: تم إجراء الدارسة لمعرفة أثر النوع وفترة التخزين على الخواص الفيزيوكيميائية والحسية للبيقر المصنع من لحم الإبل والبقر. تم تصنيع ثلاثة أنواع من البيقر (100% لحم إبل، 100% لحم بقر، 50% لحم إبل + 50% لحم بقر)، تم تخزينها بعد تعبئتها في درجة حرارة 4 ± 1 °C لمدة 7 أيام. تم إجراء بعض الاختبارات لدراسة أثر نوع اللحم وفترة التخزين على عوامل الجودة للمنتج، حيث تم إجراء التحليل الكيميائي التقريبي، قياس الأس الهيدروجيني، سعة مسك الماء، فقد الطبخ وفاقد التخزين والمظاهر الحسية للبيقر. تم إجراء الاختبارات بعد التصنيع مباشرة (صفر/يوم) و بعد 3 أيام و7 أيام. أظهرت نتائج التحليل التقريبي أن هناك تشابه كبير بين الأنواع الثلاثة مع وجود فروقات رقمية بسيطة. المحتوى الرطب للأنواع البيقر الثلاثة إبل والبقر والبيقر المخلوط كان 73.85%، 72.69%، 72.29% على الترتيب. أظهرت النتائج أن للحم الإبل والبقر نفس النسبة من سعة إمساك الماء وكانت 68.02%، 68.26% بينما كانت مقدرة إمساك الماء للبيقر المخلوط 64.50%. كذلك أظهرت النتائج أن العينات الثلاث أظهرت نتائج متشابهة بالنسبة للأس الهيدروجيني وفقد الطبخ والتخزين. فترة التخزين كان لها الأثر القليل على خاصية إمساك الماء والأس الهيدروجيني بينما كان لها أثر معنوي على فاقد التخزين والطبخ. أظهرت النتائج التي تم الحصول عليها من المحكمين أنه لا توجد فروق معنوية في الخواص الحسية للبيقر المصنوع من اللحم المذكورة أعلاه خاصة من حيث المظهر واللون والنكهة والعصيرية والقابلية العام مما يتيح من إمكانية استخدام لحم الإبل في تصنيع البيقر.
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CHAPTER ONE
INTRODUCTION

Meat is defined as those animal tissues, which are suitable for use as food and it is often widened to include, as well as the musculature, organs such as liver and kidney, brains and other edible tissues (Lawrie, 1990). Sudan has a huge livestock population, estimated to be more than one hundred and thirty million head, and classified as follow: 37.1 million head of cattle, 3.18 million camel, 42.8 million sheep and 37.8 million goats; the latest reports indicate a population of about 140 million (FAO, 2000). Therefore, modern aspect of animal production efficiency based on recent scientific development must be considered, especially slaughtering and processing techniques with good control of sanitation and hygiene. These will result in greater yields and higher profits, and would provide incentives for increased population (FAO, 2000). Education and migration have created changes in structure and tradition of society. Increases in population individual income, consumer nutritional awareness, increase in fast food channel and recently, women no longer stay at home to look after their children but are engaged in educational institution, factories and other related sectors in order to improve their social status, created strong demand for fast meal. The export of camels for slaughter mostly to Egypt, Libyan Arab Jamahiriya and other countries is an important source of foreign currency, which is not over looked in a country with few roads and chronic fuel shortage. Sudan is the second largest camel raising country in the Arab world, yet the role of camel meat in the meat industry is underestimated because of
the limited information available concerning camel meat processing potentialities.

This study was initiated to define the quality attribute of camel meat and determine its physiochemical and palatability properties and industrial value.

The specific objectives of the current work are to study:

1- The possibility of utilizing camel meat in burger processing.
2- The physicochemical and sensorial properties of camel burger.
3- The effect of refrigerated storage on camel burger characteristic.
CHAPTER TWO

LITRETURE REVIEW

2-1 Meat definition

Meat is defined as those animal tissues, which are suitable for use as food. All processed or manufactured product, which might be prepared from tissues, are included in this definition. The processed meat products are defined as those in which properties of fresh meat have been modified by use of one or more procedures, such as grinding or chopping, addition of seasoning, alteration of color or heat treatment. Generally, meat processing developed soon after people become hunter. (Judge et al; 1990).

2-2 Nutritional value and chemical composition

2-2-1 Nutritional value

The composition of meat cannot be described simply in terms of the different components and their percentages, since meat includes the entire carcass along muscles, fatty tissues, bones, tendons, edible organs, and glands. Variation in composition results in differences in nutritive value. This is further complicated by the fact that variation in composition is noticed between and within species (Person and Gillett, 1999). Nutritionally; meat is a very good source of essential amino acids, to a lesser extents, of certain minerals. Although vitamins and essential fatty acids are also present, meat also provides calories from protein, fat and limited quantities of carbohydrates (Judge et al., 1990).

Meat is generally a good source of all minerals except calcium. Calcium of meat is present in the bones and teeth (judge et al.1990).
Recent research has demonstrated that meat is not only a rich source of dietary iron but it enhances iron absorption from other sources particularly in the liver than in muscular tissues (Person and Gillett, 1999). Percentages of some minerals in processed meat products are higher than fresh meat because of added salt and seasoning (judge et al.1990). Vitamins occurs in the form of the water soluble B vitamins along with some vitamin A (lipid soluble) and vitamin C (water soluble ascorbic acid ).The level of vitamin in meat is reduced by cooking, the amount depend on temperature and time employed (Gracey, 1986). Meat is generally an-excellent source of the soluble B complex group but is a very poor source of the water-soluble vitamin C, except when ascorbic has been added to processed meat products. It is also a very poor source of the fat-soluble vitamins A, D, E and K that are found primarily in the body fat and variety meat i.e. liver, kidney, heart etc (Judge et al, 1990). Carbohydrates constitutes less than one percent of weight of meat, most of which present as glycogen and lactic acid, thus the liver is a good source of carbohydrates. (judge et al.1990).On nutritional basis alone, meat is vital to the diet, it is one of the few foods which is provides complete protein, as well as being a rich source of such essential nutrients as iron, Niacin and vitamin B12 (National live stock and meat board, 1983). Meat is the most important single item in the diet; primarily because of its palatability and high nutritive value (judge et al.1990).

2-2-2 Chemical composition of meat

The chemical and biochemical content of the muscle are affected by intrinsic factors. The most important intrinsic factors are species, sex,
age, and anatomical location of muscle. The extrinsic factors are nutrition, fatigue, fear, pre-slaughters manipulation and environmental conditions before slaughter. Generally, the composition of meat is 75% water, 18% protein, 3.5% soluble non-protein substances and 3% fat (Lawrie, 1991).

2-3 Quality attributes of meat

Quality like beauty is a very subjective attribute. Various definitions have been put forward over the years, but all have suffered from the lack of any objective approach and have generally concluded that quality meat was that for which the public was prepared to pay the highest price (Cooper and Willis, 1984).

2-3-1 Color

The color of the meat is an important quality attribute, which affects meat consumers. The appearance of fresh meat depends on color, which is defined as the concentration of the pigment myoglobin and by the relative proportions of its three common forms, oxymyoglobin (bright red), myoglobin (purplish red) and hemoglobin (brown). Myoglobin quantity varies with species, sex, muscle and physical activity (Judge et al, 1990). The appearance of the meat surface to the consumer depends on the quality of myoglobin present also on the type of myoglobin molecule. On its chemical state and on it is chemical and physical condition of other components in the meat. In fresh meat, before cooking, the most important chemical form of myoglobin is oxymyoglobin which is known as bloom and it represents the bright red color desired by purchasers. The principle pigment of cooked meat is known as globinhaemichromogen (Lawrie, 1991).
2-3-2Tenderness and texture

According to (Hammond, 1932), texture seen by the eye, is a function of the size of the bundles of fibers into which the perimyseal septa of connective divided the muscle longitudinally. The overall impression of tenderness to the palate includes texture and involves three aspects: firstly, the initial ease of penetration of the meat by the teeth; secondly, the ease with which the meat breaks into fragments; and thirdly, amount of residue remaining after chewing (Weir, 1960).

Tenderness is probably the most important factor considered by the consumer in assessing the eating quality of meat. Two structural components have been shown to determine the tenders of meat, namely the collagen of connective tissue and the contractile apparatus of myofibrilar protein (Zaglul and Cassens, 1987). Kumar et al. (1974) showed that the pre-slaughter and post –slaughter factors effecting meat texture include species, breed, sex, age, feed, pre-rigor factors and processing.

Ihekoronye and Ngoddy (1992) reported that the lesser the amount of connective tissue in meat, more tender is it is. They also reported that when meat is heated in the water, the connective tissue is changed to a sort of tender gelatin and it becomes more palatable. There have been many attempts to device objective physical and chemical methods of assessment by taste panels. Thus, physical methods have included measuring the force in shearing, penetrating, compressing and stretching the meat. Chemical methods have involved determination of connective tissue and enzymes digestion amongst other Criteria (Lawrie, 1991).
2-3-3 Juiciness

The degree of shrinkage on cooking is directly correlated with loss of juiciness to the palate. Juiciness in cooked meat has two organoleptic components; the first is impression of wetness during the first chew produced by rapid release of meat fluids, and the second is sustained juiciness, largely due to stimulatory effect of fat on salivation (Weir, 1990). The principal source of juiciness in meat, as detected by the consumer are intramuscular lipids and water content, the marbling that are present also serves to enhance juiciness during the cooking process when the melted fat apparently become translated along the bands of perimysial connective tissue. This uniform distribution of lipids throughout the muscle may act as barrier to moisture lost during cooking (Judge et al., 1990).

Good quality meat is juicier than poor quality, the deference being at least partly attributable to higher content of intramuscular fat in the former. Also, there are some suggestions that juiciness reaches a minimum where the pH level of meat is about six. This possibly reflects the greater ability of muscle protein to bind water at this pH or level (Howard and Lawrie, 1965).

2-3-4 Flavor

Flavor is a complex sensation. It involves odor, taste, texture, temperature and pH. Of these, odor is the most important. Without it, one of the four primary taste sensations, biter, sweet, sour or saline-predominates (Lawrie, 1991). Lawrie (1979) reported that the evaluation of odor and taste still depends mainly on the taste panel. It is true that, in recent years, gas chromatography has permitted precise measurement of

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the volatiles from foodstuffs, but this has not infrequently confused the tissue. Lawrie (1979).

Judge. et al. (1990) suggested that many constituents of the meat tissue become flavor compounds upon being heated. Some evidence shows that inosinic mono phosphate (IMP) and hypoxanthine enhance flavor or aroma. Since IMP and hypoxanthine is a breakdown product of ATP, it is obvious that muscles with large energy stores would have a more pronounced flavor. Most of the constituents of meat responsible for the meaty flavor are water-soluble components of muscle tissue. They also reported that some undesirable flavor changes that occur during storage could be due to metabolic products.

2-3-5 Water holding capacity (WHC)

The water holding capacity of the meat is of obvious importance. This particularly so in comminuted meat such as burger where the structure of the tissue has been destroyed and is no longer able to prevent the release of the fluid from the portion (Lawrie, 1991). Water holding capacity (WHC) is the ability of meat to retain its water or added water during application of external forces such as cutting, heating, grinding or processing. Many of the physical properties of meat including color, texture and firmness of raw meat, juiciness and tenderness of cooked meat are particularly depended on WHC (Judge et al., 1990).

2-4 Deterioration of meat quality

A number of methods are employed throughout the meat industry to retard deteriorative changes and extend the length of the acceptability period. This depends mainly on preservative method and inherent properties of specific meat items. The post-mortem changes associated
with conversion of muscle to meat, and subsequent storage and hand
linking are caused by microorganism (bacteria, mold and yeast), insect,
indigenous enzymes naturally present in meat, exogenous enzymes
(secreted by microorganisms) and physical effects (freezer burn, drip,
light fading and discoloration). The microbial sources include equipment,
clothing and hands of personnel, air, water, wall and doors (Judge et al.,
1990).

2-4-1 Chemical deteriorative changes

Oxidative rancidity is the production of strong disagreeable odors
and flavor due to exposure of fat to molecular oxygen in air. The
chemical reactions that constitute the oxidative rancidity is described by
the presence of low molecular weight aldehydes, acids and ketone that
formed during oxidation and decomposition of fatty acid molecules. The
rate of auto-oxidation is enhanced by proxidants such as sodium chloride,
some metal ions (e.g. copper, iron), heat ultraviolet light, low PH, and
numerous other substances or agents. Development of rancidity is
retarded by avoidance of the proxidants by storing meat in refrigerated
darkness and minimizing amount of air in container (Judge et al., 1990).

2-4-2 Physical deteriorative changes

Dehydration is the loss of moisture from meat surface that
concentrate pigments and due to loss of intracellular water, reduces light
reflection, the meat appear dark in color. Loss of moisture from meat
surface during storage produces a dried state, course textured appearance
that adversely affects eye appeal and acceptability. Severe dehydration
usually results in very dry products following cooking, and thus affects
palatability. An excessive loss of moisture from meat surfaces result in
freezer burn which is characterized by cork–like texture and gray to tan color (Judge et al. 1990). The loss weight that results is due to losses of meat moisture from its surface during refrigerated storage and is known as shrinkage. Physical change accompanying shrinkage during prolonged refrigerated storage includes surface dehydration and discoloration (Judge et al. 1990) off-flavors may occur when meat is stored in the presence of aromatic compounds such as apples or onions due to high susceptibility of meat to absorb the volatile materials (Judge et al. 1990).

2-5 Storage of meat

Meat is one of the perishable foods containing good culture media i.e. high in moisture, nearly neutral pH and high in nutrient. For these reasons, the pH and microbial contamination must be controlled. Vanden Berg (1961) reported that change in pH during freezing and subsequent storage might be caused by the increase in concentration of soluble material in liquid phase as a direct consequence of ice formation by the subsequent precipitation and probably the interaction of proteins with ionic substances in the unfrozen phase of frozen foods. Precipitation of salts would appear to be the cause of large pH change. (Judge et al. 1990), mentioned that the initial microbial load of meat result from introduction of microbiological contamination into vascular system or subsequent contamination that occur on meat surface during slaughtering, cutting, processing storage and handling of meat.

2-6 Processed meat products

Those are products in which properties of fresh meat have been modified using one or more procedures such as alteration of color, grinding or chopping, addition of seasoning or heat treatment. The
original purpose of meat processing was preservation by inhibiting microbial decomposition as well as processing that result in flavorful and nutritious products. Increased price for lean meat has also altered processing practices and has encouraged the incorporation of increased percentage of less expensive fat (Judge et al. 1990). The processed products should be uniform in color, texture and fat distribution and suitable to be conveniently and accurately cut into portion size with the minimum of waste to consumer. Also reduced cooking loss and improved tenderness and texture and increased shelf life are some of the most important characteristics of processed meat (Price and Schweigert, 1987).

Comminuted products are those made from raw meat materials that have been reduced into small meat pieces, chips, or flakes. Some comminuted products may be classed as sausage and others are not. Two main advantages are gained from all comminuted processes, i.e. improved uniformity of product due to more uniform particle size and distribution of ingredients, and increased in tenderness, as the meat is subdivided into smaller particles. Equipment commonly used for comminution includes the meat grinder, bowl chopper, emulsion mill and flaking machines. Grinders are usually employed for the first step in comminution of meat and some restructure products (Judge et al. 1990). Many commercial products being as ground meat, chunks pieces flakes, slices or fillets that are formed into roast, steak, patties or nuggets. These often are marketed as burger, steaks, and many even be breaded and precooked (Judge et al. 1990).
2-7 Burger

The word is derived from hamburger, a large beef sausage which is cut into slices before cooking but the term is now applied more commonly to product of similar organoleptic properties made as flat slices. It was common practice in Germany to name food products especially sausage, after the town where they are manufacture. In UK the same products are referred to beef burger possibly due to the misapprehension that burger are named according to their meat constituent. Such as bacon burger, lamb burger and hamburger, or according to basic ingredient for example cheese burger, microwave burger which is usually intended to be fully cooked in microwave oven (Varanam and Sutherland, 1995).

The basic ingredient of burger is lean meat of suitable quality due to its role in water holding and determining the organoleptic properties of burger. Good quality frozen meat is best used since it has superior water binding properties.

Fat is added as separate ingredient it plays the same role as lean meat in determining the organoliptic properties. Burger normally contains some amount of extender like powder milk dried for binding or reduces cooking loss of the product (Rust, 1976). Bread crumbs contribute to the mouth feel and texture of burger and absorbs any free moisture present. Bread crumb is made from wheat dough which is backed and ground to specified particle size (Varanam and Sutherland, 1995).
2-7-1 *Ice/ water in burger production*

Many products would be dry and unpalatable if only the moisture contained in the meat ingredient were present in the final product. Additional water improves their tenderness and juiciness. Ice water added to keep product temperature down during emulsification. It is added to the burger formulations also serves to replace water that will be lost during processing operations. Thus, by adding water, the yield of finished product can be improved (Forrest et al., 1975).

2-7-2 *Seasonings*

Like sugar, salt and spices is used in meat product, sugar for flavoring, also play a role on browning of burger during cooking. Also, they are used to improved color and as preservative (Rust, 1976). Salt play an important technological role in solubilization of proteins and increasing water holding capacity. Beside their role as flavor enhance and serves as preservative. Spices are used to impart unique flavor and also has preservative role (Rust, 1976).

2-7-3 *Vegetables proteins as meat extenders*

There is a wide variety of non-meat products. These products are refereed to as binder extenders and less frequently as fillers. They are added to meat formulations to reduced formulation cost, to improved cooking yield, to improved slicing characteristic, to improve flavor, to increased protein content, to improve emulsion stability, to improve fat binding (person and Gillett, 1999).
2-7-4 Soya Bean as meat extenders

Soya protein extenders are three main classes of products namely Soya flour, Soya protein concentrate and Soya protein isolate. All three products are used in processed meat burger (Pearson and Gillett, 1999.)

2-8- Sudan Livestock resources

Sudan has the second largest animal population in Africa. In 1997, the contribution of livestock to was estimated at 20%, representing 42% of the contribution of the agricultural sector (Ministry of Finance and National Economy 1997). Earnings from the export of live animals and meat in 1996 were 135.7 million US$.Western Sudan has the most livestock (40%), followed by southern Sudan (27%) and central Sudan (23%). The majorities of breeds are raised within tribal groups and often carry the name of the tribe. They are well adapted to the harsh environment and often trek long distances in search of feed and water. Productivity is low but can be improved with good management in more favorable conditions. Cattle are mainly descended from Bos Taurus, or zebu. In central Sudan, they are generally kept for milk, and in western Sudan for meat production. Sheep are of the Sudan Desert type, with live weights up to 70 kg and excellent meat and carcass characteristics. Goats, mostly of the large, black Nubian type, are found in central Sudan and are kept for milk. There are two types of the single-humped camel, one kept for riding and the other as a pack or baggage animal. Camels are exported mainly for meat.

2-8-1 Camel breeds of the Sudan

Sudan has the second largest camel population in the world, estimated at nearly 3m and the country is home to some of the most well
known camel nomads, the Kababish, Shukria, Hadendowa and others. Tribal groups in Sudan breed distinctive types of camels (Mason and Maule, 1960). Well-known among these are the Anafi and Bishareen, prized for their racing and riding capacities, the Rashaidi, a sturdy transport camel with superior drought resistance, and the large whitish Lahaween, which gives high meat yields. The Arab breed of camel is well suited for meat production and transportation. Camel meat is important at the subsistence level but is rarely marketed. The export of camels for slaughter – mostly to Egypt, but also to the Libyan Arab Jamahiriya and other countries, is an important source of foreign currency.
Table (1) Total meat consumption (x1000 ton (between 2000-2004) in Sudan

<table>
<thead>
<tr>
<th>Year</th>
<th>Sheep</th>
<th>Goats</th>
<th>Cattle</th>
<th>Camel</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>2000</td>
<td>138</td>
<td>115</td>
<td>653</td>
<td>19</td>
<td>930</td>
</tr>
<tr>
<td>2001</td>
<td>142</td>
<td>115</td>
<td>701</td>
<td>19</td>
<td>977</td>
</tr>
<tr>
<td>2002</td>
<td>154</td>
<td>116</td>
<td>746</td>
<td>19</td>
<td>1035</td>
</tr>
<tr>
<td>2003</td>
<td>222</td>
<td>128</td>
<td>858</td>
<td>46</td>
<td>1254</td>
</tr>
<tr>
<td>2004</td>
<td>225</td>
<td>129</td>
<td>860</td>
<td>35</td>
<td>1249</td>
</tr>
</tbody>
</table>

Table (2) live animals export number between (1995-2004) in Sudan

<table>
<thead>
<tr>
<th>Year</th>
<th>Sheep</th>
<th>Goats</th>
<th>Cattle</th>
<th>Camel</th>
</tr>
</thead>
<tbody>
<tr>
<td>1995</td>
<td>578677</td>
<td>820</td>
<td>8709</td>
<td>50583</td>
</tr>
<tr>
<td>1996</td>
<td>100795</td>
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<td>30940</td>
<td>72071</td>
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<td>1997</td>
<td>1074576</td>
<td>3595</td>
<td>16891</td>
<td>77741</td>
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<td>1998</td>
<td>1586193</td>
<td>3686</td>
<td>48891</td>
<td>131570</td>
</tr>
<tr>
<td>1999</td>
<td>1616363</td>
<td>435</td>
<td>40501</td>
<td>132009</td>
</tr>
<tr>
<td>2000</td>
<td>731242</td>
<td>315</td>
<td>61599</td>
<td>132009</td>
</tr>
<tr>
<td>2001</td>
<td>15417</td>
<td>-</td>
<td>13883</td>
<td>185500</td>
</tr>
<tr>
<td>2002</td>
<td>1602638</td>
<td>2655</td>
<td>53164</td>
<td>155710</td>
</tr>
<tr>
<td>2003</td>
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</tr>
<tr>
<td>2004</td>
<td>1703562</td>
<td>750</td>
<td>101899</td>
<td>132602</td>
</tr>
</tbody>
</table>

2-8-2 Camel

The camel (Camelus dromedaries) is an important livestock species uniquely adapted to hot arid environments. It is most numerous in the arid areas of Africa, particularly in the arid lowlands of Eastern Africa namely, Somalia, Sudan, Ethiopia, Kenya and Djibouti. Approximately 11.5 million animals in this region represent over 80% of the African and two thirds of the world’s camel population. Compared to other livestock, the camel is unique in having an exceptional ability to survive and thrive under adverse climatic conditions such as high ambient temperatures, low rainfall, and feed scarcity. Therefore, it offers an ideal option for animal production in arid and semi-arid regions of the world. The camel is a good source of meat in areas where the climate adversely affects other animal’s production efficiency (Kadim et al., 2006).

2-8-2-1 Taxonomy

The family Camelidae includes two subfamilies: Camelinae (Old World Camelids) and Laminae (New World Camelids). There are two species of camel within the genus Camelus. The Dromedary one-humped camel (Camelus Dromedaries) is most widely distributed in the hot arid areas of the Middle East and Africa, whereas the Bacterian two-humped camel (Camelus Bactrianus) is found in parts of central Asia and China (Dorman, 1986). Four species of the New World camelids are found in South America: the guanaco (Lama guanacoe) and the vicuna (Vicugna vicugna) are wild, whereas the Llama (Lama glama) and the alpaca (Lama pacos) are domesticated (Murray, 1989 and Skidmore, 2005). The Llama and Alpaca are mainly used for meat and fiber production. Camels
are multipurpose animals with females used primarily as milk producers, the males for transport or providing milk and both sexes providing meat as tertiary product. The genetic diversity and relationships amongst the dromedary populations are poorly documented. Phylogenetic analysis (micro-satellite loci) showed that dromedary breeds can be classified according to countries (Mburu et al., 2003).

2-8-2-2 Camel meat

Camel meat consumption in the Arab world is not impressive. This can be attributed to the fact that camel meat is the least studied type of meat and is wrongly believed to be of lower nutritive value and quality than other type of red meat.

Few scientific studies have been devoted to camel meat (Khatami, 1970; Knoess, 1977; Williamson and Payne 1978; Elgasim & Elhag, 1992 and Elgasim et al., 1987) concluded that the carcass characteristics of the Arabian camel are comparable to those of other red meat animal species.

In spite of its potential, the contribution of camel meat to the per capita meat consumption in the world is not impressive (Elgasim and Alkanhal, 1992). Carcass characteristics of the camel are comparable to those of the other red meat animal species. The meat of young camels (below 3 years) is comparable in taste and texture to beef (Dawood, 1995).

A camel carcass can provide a substantial amount of meat for human consumption with certain parts of the carcass such as the hump and liver considered a delicacy that is favored in Middle Eastern markets. Although the marketing systems for camel meat are not well organized,
there is evidence of a high demand for fresh camel meat and for camel meat to be used in blended meat products even among societies not herding camels (Morton, 1984; Pérez et al., 2000 and Shalash, 1979a). Camel meat could be a cheap option to meet the growing needs for meat in developing countries especially for low income population groups (El-Mossalami et al.; 1996; Saparov and Annageldiyev, 2005).

However, camels are generally raised in less developed countries and research for improving their reproductive and productive characteristics has been limited (Skidmore, 2005). The average birth weight of the dromedary camels is about 35 kg (Wilson, 1978), but it varies widely between regions, breeds and within the same breed. Reports on camel birth weights range between 27 and 39 kg, which is comparable with that of tropical cattle breeds. For instance, reports of birth weights include 26–28 kg for Somali camels (Field, 1979, Ouda, 1995 and Simpkin, 1983); 27 kg for Tunisian camels (Hammadi et al., 2001) and 39 kg for Indian camels (Bissa, 1996).

The geographical location affects camel birth weights, possibly due to genetic differences or nutritional factors such as the availability of natural grazing which is the major feed source under traditional systems. For example, in India, the birth weight of the camel calves varied from 26.3 to 51.2 kg, with a mean of 37.3 kg (Bhargava et al., 1965). In Tunisia and Kenya calves were smaller (Hertrampf, 2004), weighing an average of 25.8 and 30.9 kg, respectively (Burgemeister, 1975), whereas Sudanese camels had birth weights between 30 and 40 kg (El-Amin, 1979). The weight of the newborn camels in Australia ranged between 30 and 40 kg under normal and healthy condition (Central Australia Camel
Industry Association, 1997). Kurtu, (2004) reported that the weight of male camel carcasses was greater than that of carcasses from females by 48%. Wilson (1978) reported an average dressing-out percentage of 48% in Sudanese camels with it being higher for males (51%) than females (47%). Babiker & Yousif, (1987) reported dressing-out percentages of 54.4% for cold carcasses and 55.9% for hot carcasses in Male Sudanese camels. Higher values were reported for sexes by Babiker&Tibin, (1989), 57% and 63.8% dressing-out percentages, respectively.

The camel is a good source of meat in areas where climate adversely affects other animals. The male dromedary carcass can weigh 400 kg or more Knoess, (1977). The carcass of a male Bactrian can weigh up to 650 kg. The carcass of a female camel weighs between 250 and 350kg. Data collected from a herd numbering about 4300 animals showed that the body weight of slaughtered animals averaged between 439 -484 kg Keikin,(1976). This was more than the weigh of 400kg previously given Knoess,(1977) . The total meat production of the herd was 530-650 metric tons It is obvious that the meat yields depends on the age ,sex ,feeding condition and general health of animal (El-Amin,1979). Not only the yield ,but also the taste of the meat determined by these parameters. In old animals the meat is tough and not tasty (El-Amin,1979). The cut of meat also determines its tenderness (Abdal-Baki, et al.,1957), the hump being eaten raw ,while still warm, but after it cools down it is boiled before it is eaten (Hartely,1979).

2-8-2-3 Camel meat composition

Camel meat varies in composition according to breed type, age, sex, condition and site on the carcass. Water content differs only slightly
between species, while differences in fat content are more marked (Sales, 1995). Camel meat contains 70–77% moisture (Al-Owaimer, 2000, Al-Sheddy et al., 1999, Dawood and Alkanhal, 1995 and Kadim et al., 2006). These levels are higher than those in meat of other farm animal species. It is also a good source of protein containing about 20–23% (Al-Owaimer, 2000, Kadim et al., 2006 and Kilgour, 1986). This level is similar to those in other farm animals (table 3). These protein contents are similar to values reported by (Dawood and Alkanhal 1995), but are lower than values reported by (Elgasim & Alkanhal, 1992). This level of protein in camel meat makes it a good source of high quality protein in arid and semi-arid regions. Camel meat protein may increase with age. Ash content in camel meat, ranges between 1.1% and 1.5% (Al-Owaimer, 2000 and Kadim et al., 2006). Chemical composition of camel meat varied between the shoulder, topside and loin (Herrman & Fischer, 2004). The humps, together with the fat of the prenephric areas are an important supplement to the human diet. As the animals get older, the moisture and ash content of hump fat and around the kidneys increases, while the crude fat content decreases (Shalash, 1979). It was found that there was more crude fat in the fat tissues around the kidneys than the hump. The brisket, ribs and lion are other preferred parts of the carcass (Hartley, 1979). There is difference percentages protein, water, fat and ash of meat from various parts of the body (Shalash, 1979). The age of animal also affects the component of the meat. Camels younger than 5 year have less protein, fat and ash than older camels.

The meat is easy cured, and the high protein content provides good caloric value. They are also cheaper than sausage made from other meat. (Hartley, 1979).
Table (3) Comparison between camel meat chemical composition with other species

<table>
<thead>
<tr>
<th>Species</th>
<th>Moisture (%)</th>
<th>Protein (%)</th>
<th>Fat (%)</th>
<th>Ash (%)</th>
<th>Muscle</th>
</tr>
</thead>
<tbody>
<tr>
<td>Camel</td>
<td>71.0</td>
<td>21.4</td>
<td>4.4</td>
<td>1.1</td>
<td>Longissimus</td>
</tr>
<tr>
<td>Beef</td>
<td>71.5</td>
<td>21.5</td>
<td>5.5</td>
<td>0.9</td>
<td>Longissimus</td>
</tr>
<tr>
<td>Goat</td>
<td>76.5</td>
<td>20.8</td>
<td>1.6</td>
<td>0.87</td>
<td>Longissimus</td>
</tr>
</tbody>
</table>

source: a Kadim, et al. (2006), b Mills et al. (1992), c Marinova et al. (2001)
2-8-2-4 Moisture, protein and fat content of camel & beef meat

The moisture content of camel meat was higher than that of beef. The importance of moisture in meats lies in its pronounced effect on the shelf life of meat, its processing potential and sensory characteristic. Usually consumers prefer (juicy) over (dry) mouth-feeling meats. Camel has slightly higher (M/P) than beef. The M\P ratio is reflection of suitability of meat for sausage manufacturing (Forrest et al, 1975). Camel meat has a protein content that is slightly less than that of beef. Camel meat has a fat content (2.6%) that is less than that of beef (4.7%). In addition the Cholesterol content of camel meat was noted to be lower than that of beef (Elgasim and Elhag, 1992).

2-8-2-5 Camel meat quality

Camel meat quality characteristics in general, are comparable to those of beef (Fischer, 1975; Kadim et al., 2006; Knoess, 1977; Leupold, 1968; Mukasa-Mugerwa, 1981) and (Shariatmadari and Kadivar, 2006ab). Camel meat is described as raspberry red to dark brown in color with a sweet taste due to the high glycogen content. The fat of the camel meat is white (Leupold, 1968) An increase in meat toughness and a reduction in the palatability and quality are reported with increasing age (Dahl and Hjort, 1979; El-Amin, 1979 and Kadim et al., 2006). The range of the ultimate pH values of dromedary camel meat ranged between 5.7 and 6.0 (Al-Sheddy et al., 1999; Cristofaneli et al., 2004 and Kadim et al., 2006). Generally, young animals tend to produce meat with a higher pH than older animals due to lower levels of glycogen (Kannan, et. al, 2003). The ultimate pH of meat is influenced by many factors including pre-slaughter handling, post mortem treatments and muscle
physiology (Marsh, 1977; Thompson, 2002). Tenderness of meat is rated as the most important quality attribute by the average consumer and appears to be sought at the expense of flavor or color (Lawrie, 1979). Meat from 6–8 years old camels was darker (lower L*) and redder (higher a*) than that of 1–3 years camels in the study of (Kadim et al., 2006), probably because of higher concentrations of myoglobin.

Other factors affecting meat color include muscle fiber type, ultimate pH, and cooling rate (Abril et al., 2001; Faustman and Cassens, 1990). Expressed juice is an important meat quality characteristic because of its influence on nutritional value, appearance and palatability, (Kadim et al., 2006). The dromedary camel meat contains higher expressed juice than other camelidae such as the Llama and alpaca probably because of the lower fat content (Cristofaneli et al., 2004).

**2-8-2-6 Camel meat nutritive value**

Methods of improving the intake of nutrients is especially important in developing countries, and in this respect the high content of protein and other nutrients in camel meat means that it could provide a valuable complement to low-protein diets particularly for vulnerable groups like children and pregnant woman. The nutrient content of camel meat can be affected by age, sex, carcass weight, fatness, packaging and storage conditions, and time (Dawood and Alkanhal, 1995; Schweigert, 1987). Moreover, camel meat is believed by Somali and Indian people to have remedial effects for as many as 13 different diseases, including hyperacidity, hypertension, pneumonia and respiratory diseases and also to be an aphrodisiac (Kurtu, 2004). Further research is needed to substantiate or disprove these beliefs. Processing of camel meat such
drying, curing and smoking have taken place in Arabia for many years. Zegeye, (1999) suggested that the acceptability of camel meat products increases with an increase in the duration of smoking, frying and cooking, indicating that such products should be fully processed to gain acceptability. Recently Australian processed camel meat has been accepted as an international traded meat product. It is now exported to Saudi Arabia, throughout Asia, Canada, United States and Europe. Camel is available in carcass form or as fresh or frozen vacuum-packed cuts. 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 (Omer et al., 2004).

2-8-2-7 Camel meat processing

Thermal processing, curing and smoking are the three most common methods used for camel meat preservation and processing Kalalou et al., 2004; Zegeye, 1999). As consumers may have different reactions to products, overall acceptance must be determined by sensory evaluation. 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 (Mansour and Ahmed 2000) and (Omer et al., 2004).

Minced camel meat provides an excellent basis for various manufactured and cured forms of meat such as sausages and pastrima. Sausages can form a highly acceptable cooked camel meat and it has highly desirable features as a sausage component. The prepared camel sausage is similar in chemical composition to that of beef Shalash, (1979b). Advanced technology was used by Mansour & Ahmed (2000)
to process burger and sausages from camel meat. The products showed similar chemical composition to beef processed products, but the camel products were higher in moisture (73.6%) and ash (4.13%). The sensory evaluation tests indicated that the camel burger gained higher scores in overall acceptability than the other products.
CHAPTER THREE
MATERIAL AND METHODS

3-1 Food materials

Camel meat was obtained from Alkabashi market (Khartoum north) and beef meat was obtained from Bahary center markets. The camel and beef meat was stored frozen at -10 °C.

The additional materials needed in the formulation spices, salt and sugar, potatoes, onion, garlic, Soya bean, skim milk, Bread crumb and starch were obtained from Bahry local market.

3-2 Methods

3-2-1 Raw material preparation

3-2-1-1 Meat preparation

Stored camel and beef meat were thawn at-3°C over night, sliced and ground using a meat grinder.

3-2-1-2 Soya bean preparation:

Half kg of Soya bean was soaked for one hour in 1L of cold water.

3-2-1-3 Potatoes preparation:

Potatoes were blanched then ground.

3-2-1-4 Spices preparation:

Spices were cleaned and ground.
3-2-2 Burger formulation:

The experiment designed to produce burger with the following specification:- lean meat 60%, fat 10%, ice water 6.5%, added starch 4%,soya bean 3.5% , Bread crumb5.5%, skim milk 2%,potatoes 5%, onion 0.3%,salt 1.5%,sugar 0.3%and spices 1.4%.

Calculation/ 1kg of burger

Meat required = 60*1000/100=600g
Fat required = 10*1000/100=100g
Water required = 6.5*1000/100=65g
Starch required = 4*1000/100=40g
Soya bean = 3.5*1000/100=35g
Skim milk required = 2*1000/100=20g
Bread crumb required = 5.5*1000/100=55g
Potatoes required = 5*1000/100=50g
Salt required = 1.5*1000/100=15g
Sugar required = 0.3*1000/100=3g
Onion required = 0.3*1000/100=3g
Spices required = 1.4*1000/100=14g
**Table (4) burger formula**

<table>
<thead>
<tr>
<th>Components</th>
<th>%</th>
<th>Weigh in gram</th>
</tr>
</thead>
<tbody>
<tr>
<td>Meat</td>
<td>60%</td>
<td>600g</td>
</tr>
<tr>
<td>Fat</td>
<td>10%</td>
<td>100g</td>
</tr>
<tr>
<td>Water</td>
<td>6.5%</td>
<td>65g</td>
</tr>
<tr>
<td>Starch</td>
<td>4%</td>
<td>40g</td>
</tr>
<tr>
<td>Soya bean</td>
<td>3.5%</td>
<td>35g</td>
</tr>
<tr>
<td>Bread crumb</td>
<td>5.5%</td>
<td>55g</td>
</tr>
<tr>
<td>Skim milk</td>
<td>2%</td>
<td>20g</td>
</tr>
<tr>
<td>Potatoes</td>
<td>5%</td>
<td>50g</td>
</tr>
<tr>
<td>Onion</td>
<td>0.3%</td>
<td>3g</td>
</tr>
<tr>
<td>Salt</td>
<td>1.5%</td>
<td>15g</td>
</tr>
<tr>
<td>Sugar</td>
<td>0.3%</td>
<td>3g</td>
</tr>
<tr>
<td>Spices</td>
<td>1.4%</td>
<td>14g</td>
</tr>
</tbody>
</table>
3-2-3 Production of burger

Frozen meat was thown & cut into small pieces.

↓

The meat pieces were ground using a meat grinder.

↓

The ground meat was mixed with salt, sugar, spices, fat and half of ice water in Hobart chopper and chopped for about 3 mints.

↓

The other ingredients etc starch, Soya bean, Bread crumb, skim milk, potatoes, onion were added to the mixture and mixed until or ingredients are homogenously

↓

The homogenous mixture was transferred to a muld.

↓

The muld was pressed to obtain patty of approximately 55g.

↓

The patties were placed in a stack of 10 with plastic liner in-between. The patties were over wrapped in a plastic tray and stored in a refrigerator at 4±1°C.

↓

The evaluation of refrigerated patties was performed immediately (day 0) at3 &7 days post processing
3-2-4 Analytical methods

3-2-4-1 Proximate analysis

3-2-4-1-1 Moisture Content Determination

Moisture content of raw samples and final products were determined according to AOAC, (1995) as follows:

Three gram of sample was weighed accurately on pre-cleaned, pre-dried, pre-weighed steel moisture dishes. Transferred to Air-Oven at 130°C for 2 hours, cooled in desicator until it reaches room temperature and weighed, Transferred to the oven again for one hour. Samples were cooled and weighed again. Moisture content of the samples calculated as formula as follows:

\[
\text{Moisture content (\%) } = \frac{W_2 - W_3}{W_2 - W_1} \times 100
\]

Where:

\[
W_1 = \text{weight of dish.}
\]

\[
W_2 = \text{weight of dish + sample before dry}
\]

\[
W_3 = \text{weight of dry sample + weight of dish}
\]

3-2-4-1-2 Crude Protein Content Determination:

Crude protein content was determined by Kjeldahl method according to the AOAC, (1995), using Semiautomatic Distilling Unit for Organic Nitrogen Determination by Kjeldahl (PRO-NITRO11, 4000851, J.P. SELECTA, Barcelona, Spain). As follow:

In Kjeldahl method flask, 3 g of sample were placed followed by addition of Kjeldahl tablets. Twenty five milliliters of concentrated
Sulphuric acid (density 1.86 g/ml) were added to samples. The flasks were placed on the digestion apparatus, heated firstly at low heat, and then heating was continued with increase heat until the mixture was colorless (3 hours). The flasks were removed and left to cool. The digested samples were poured in volumetric flasks (100 ml) and diluted to 100 ml with distilled water. Five milliliters were taken and neutralized using 10 ml of 40% NaOH. The distillate was received in a conical flask containing 25 ml of 2% Boric acid plus 3 drops of indicator (bromocresol green plus methyl red). The distillate was continued until the volume in the flask was 75 ml. the flask was then removed from the distillator. The distillate was then titrated against 0.1 N HCl until the end point was obtained (red color).

Protein content was calculated as follows:

\[
\text{C N} \, (\%) = \frac{T \times N \times 0.014 \times 100}{W}
\]

Crude protein (%) = C N (%) × 6.25

Where:

T = Titration figure.

N = Normality of hydrochloric acid.

W = Weight of sample (g).

0.014 = Atomic wt of N2/1000.

3 = weight of dried sample + dish.
3-2-4-1-3 Fat Content Determination:

Fat content was determined according to AOAC, (1995). Using Solvent Recovery Extractor for the Determination of fat and Oil (DET-GARS, 6 Units, J.P. SELECTA, and Barcelona, Spain) as follows:

Three grams of sample was weighed into extraction thimble Placed to (DET-GARS) unit. Flat bottom flasks were cleaned, dried, and weighed. 50 ml of petroleum ether (40-60 °C) were added to each one, continuous extraction powered on for one hour (heating, raising, solvent recovering). Bottom flasks were placed to dry in oven at 103 ± 2°C to removed solvent residue. Crude fat content of samples were calculated from the difference of weights of flask and the weight of samples as follows:

\[
\text{Oil} \, (\%) = \frac{W_2 - W_1}{W_0} \times 100
\]

Where:

\(W_1\) = weight of flask with fat.

\(W_2\) = weight of flask.

\(W_0\) = weight of sample.

3-2-4-1-4 Ash Content Determination:

Ash content was determined according to AOAC, (1995). As follow:

Crucibles were dried in an oven at 100 ± 5°C, cooled to room temperature and placed in desicator until they were ready to use. Three grams of the sample were weighed accurately into prepared, a pre-
weighed crucibles. The samples were placed in a muffle furnace regulated at 450-550 °C for three hours until a light grey or white ash remained. Finally, the crucibles were removed from the furnace, cooled in a desicator and then reweighed. The ash was calculated according to the following formula:

$$\text{Ash (\%)} = \frac{\text{weight of residue (g)}}{\text{Weight of sample (g)}} \times 100$$

3-2-4-2 pH measurement

Ten gram of the samples was placed in blender gar and 100 ml of distilled water were added the mixture was blended at high speed for 1min; the PH of the mixture was measured by using a precalibraled pH meter model. This has been calibrated with two standard buffers (6.8 and 4.0).

3-2-4-3 Water holding capacity (WHC)

One gram of burger was placed between two pieces of the nylon cloth (to allow separation of the meat from the filter paper) which in turn was placed between two filters (Whatman No11). The whole system was placed between glassy plates firmly for two minutes the pressed meat was removed and weighed .WHC was express as the following equation:

Water holding capacity = 100 – water index

Water index = (Loss in weight\ Original weight) × 100

3-2-4-4 Storage loss

Sample was taken from processed burger and weighed at 0day then stored refrigerated and weighted again on the third and seventh day.
Storage loss % = (weight loss / weight of sample before storage) \times 100

3-2-4-5 Cooking loss

Burger samples were deep-fried then the cooking loss was calculated as follows:

Cooking loss % = (Weight loss / Original weight) \times 100

3-2-4-6 Sensory Evaluation

Ten member sensory panel consisting of M.Sc. and B.Sc. student of food science and technology Department, Faculty of Agriculture, University of Alzaeem Alazhari, semi-trained according to the procedure of Cross et al. (1978). The panel evaluated the cooked burger samples of species for appearance, color, flavor, taste, odor, juiciness, tenderness, over all acceptability. By the mean of scale (10 extremely like, 1 extremely dislike). Panelists received samples which were randomly numbered.

3-2-4-7 Statistical Analysis

The data collected from the different treatments was subjected to analysis of variance and whenever appropriate the mean separation procedure of Duncan was employed (Steel and Torrie, 1980). The SAS program (SAS, 2002), was used to perform the general linear model (GLM) analysis.
CHAPTR FOUR
RESULT AND DISCUSSION

4-1 Proximate composition

Chemical composition of burgers from different species was shown on Table (5). Although there were significant differences (p<0.05) between the moisture contents of the burgers made from the two species or from the mixture of their meats, however, numerically the difference was so small. Beef and camel burger had moisture content of 72.62% and 73.85% respectively. Camel burger moisture content finding agree with the values reported by Al-owaimer, (2000), Alshedy et al, (1999) and (Dawood and Alkanhal, 1995) while that of beef burger was lower than that reported by Mills et al, (1992). Protein content of beef and camel burger were 18.57% and 17.45% respectively. Camel burger protein content was lower than those values reported by Al-owaimer, (2000), Kadim et al, (2006) and Kilgour, (1986). Beef burger protein content was lower than that reported by Mills et al, (1992). Camel burger had the highest moisture content and the lowest protein content compared to beef burger, such finding are in agree with those reported by Elgasim et.al, (1987). On the other hand, meat mixture burger had the lowest moisture content and the highest protein content. Ash content for the different burger i.e. beef, camel and their mixture were found to be 2.86%, 2.82% and 2.95% respectively, Camel burger ash content was higher than that reported by Al-owaimer, (2000) and Kadim et al, (2006) and it was lower than that reported by Monsour& Ahmed, (2000). Beef burger ash content was higher than that reported by Mills et al, (1992). Camel burger, beef burger and camel& beef had similar ash content (p>0.05).
Table (5) Chemical composition of burger processed from camel meat, beef meat and their mixture.

<table>
<thead>
<tr>
<th>Item</th>
<th>Camel</th>
<th>Beef</th>
<th>Camel &amp; Beef</th>
</tr>
</thead>
<tbody>
<tr>
<td>Moisture%</td>
<td>73.85&lt;sup&gt;a&lt;/sup&gt;</td>
<td>72.62&lt;sup&gt;b&lt;/sup&gt;</td>
<td>72.29&lt;sup&gt;c&lt;/sup&gt;</td>
</tr>
<tr>
<td>Protein%</td>
<td>17.45&lt;sup&gt;c&lt;/sup&gt;</td>
<td>18.57&lt;sup&gt;b&lt;/sup&gt;</td>
<td>18.79&lt;sup&gt;a&lt;/sup&gt;</td>
</tr>
<tr>
<td>Fat%</td>
<td>4.12&lt;sup&gt;b&lt;/sup&gt;</td>
<td>4.28&lt;sup&gt;a&lt;/sup&gt;</td>
<td>4.26&lt;sup&gt;a&lt;/sup&gt;</td>
</tr>
<tr>
<td>Ash%</td>
<td>2.82&lt;sup&gt;a&lt;/sup&gt;</td>
<td>2.86&lt;sup&gt;a&lt;/sup&gt;</td>
<td>2.95&lt;sup&gt;a&lt;/sup&gt;</td>
</tr>
</tbody>
</table>

a-c = Means in the same row bearing different superscript letter are significantly different (p<0.05)

*(n=6)
Elgasim et al. (1987) had a similar finding working with camel burger. Camel burger had a fat content of 4.12% Table (5) which lower than the values reported by Kadim et al. (2006), but it was higher than that reported by Elgasim and Elhag, (1992). Beef burger had a fat content of 4.28% which lower than that reported by Mills et al. (1992). It was concluded that the burgers made from the meat of each species are statistically significantly differente (p< 0.05) in fat contents, Elgasim et al., (1987) had a similar finding working with camel burger.

Generally, beef meat had higher on protein, fat and ash contents compared to the camel meat Such conclusion is similar to that of Elgasim and Elhag, (1992).The effect of the storage period on the chemical composition of the burger processed from the meat: of beef, camel and their mixture is shown on Table (6). Apparently storage period had no effect (p>0.05) on moisture, protein, fat and ash contents. Irrespective of the species, Table (6).Such a finding indicates that the chemical composition of the burger was constant throughout the storage period tested i.e 7 days. According it is to be expected that the sensorial or physical properties of the burger will be acceptable qualities to the consumers, of particular importance are juiciness and coherence or firmness.

4-2 Water holding capacity, pH, storage and cooking losses

Water holding capacity, pH, storage and cooking losses of burger processed from pure camel & beef meat and from a mixture of camel & beef meat is shown on Table (7). The results revealed that burger made from 50% camel meat & 50% beef meat had slightly lower (p<0.05)
Table (6) Effect of storage period on the Chemical Composition of burger processed from camel meat, beef meat and their mixture

<table>
<thead>
<tr>
<th>Item</th>
<th>Storage period (days)</th>
<th>0 day</th>
<th>3\textsuperscript{rd} day</th>
<th>7\textsuperscript{th} day</th>
</tr>
</thead>
<tbody>
<tr>
<td>Moisture%</td>
<td>72.92 \textsuperscript{a}</td>
<td>72.87 \textsuperscript{a}</td>
<td>72.89 \textsuperscript{a}</td>
<td></td>
</tr>
<tr>
<td>Protein%</td>
<td>18.25 \textsuperscript{a}</td>
<td>18.26 \textsuperscript{a}</td>
<td>18.29 \textsuperscript{a}</td>
<td></td>
</tr>
<tr>
<td>Fat%</td>
<td>4.21 \textsuperscript{a}</td>
<td>4.19 \textsuperscript{a}</td>
<td>4.22 \textsuperscript{a}</td>
<td></td>
</tr>
<tr>
<td>Ash%</td>
<td>2.87 \textsuperscript{a}</td>
<td>2.89 \textsuperscript{a}</td>
<td>2.87 \textsuperscript{a}</td>
<td></td>
</tr>
</tbody>
</table>

\textsuperscript{a}= Means in the same row bearing similar superscript letter are not significantly different (p>0.05).

*(n=6)
WHC than that made from pure (100%) beef or camel meat Table (7). It is to be noticed that burger processed from a mixture of camel& beef meat had the highest (p<0.05) storage loss (5.72%), while the lowest storage loss (4.78%) was reported for the camel burger. On the other hand the cooking loss of the burger processed from the different species under investigation were similar (p>0.05). The pH of the burger was not affected by species differences as the three types of burger had similar pH values (Table 7) and it falls within the pH range reported in the literature for processed burger, Alsheddy et al. (1999), Cristofaneli et. al, (2004) and Kadim et al., (2006). Generally, irrespective of the burger type Table (8) the WHC decreased numerically with the increase in storage period up to the 3rd day of storage. The lowest WHC was reported on the 7th day of storage. Both storage & cooking loss increased with the increase in storage period, the highest storage & cooking losses were reported on the 7th day of storage. The pH of the burger showed significant (p<0.05) change with the storage period Table (8).

Allowing for discrepancies in the cooking reigms employed by the different investigators, the cooking loss is similar to that reported in the literature by Ali (2003), and Elgasim et al, (1987).

### 4.3. Sensory evaluation

The effect of species and storage period on the sensory characteristics of burger Processed from camel, beef or camel &beef meats are shown on Table (9&10).The panelists could not detect any significant difference (p>0.05) of the burgers from the different types of meat in (appearance, color, flavor, juiciness and overall acceptability Table (9), however the panelists rated the juiciness of beef burger to be
Table (7) Water holding Capacity, pH, Storage loss and cooking loss of burger processed from camel meat, beef meat and their mixture.

<table>
<thead>
<tr>
<th>Item</th>
<th>Camel</th>
<th>Beef</th>
<th>Camel &amp; Beef</th>
</tr>
</thead>
<tbody>
<tr>
<td>W.H.C%</td>
<td>68.02 a</td>
<td>68.26 a</td>
<td>64.50 b</td>
</tr>
<tr>
<td>PH</td>
<td>5.67 a</td>
<td>5.67 a</td>
<td>5.67 a</td>
</tr>
<tr>
<td>Storage loss%</td>
<td>4.78 a</td>
<td>5.18 a</td>
<td>5.72 a</td>
</tr>
<tr>
<td>Cooking loss%</td>
<td>19.47 a</td>
<td>9.96 a</td>
<td>19.98 a</td>
</tr>
</tbody>
</table>

a-b =Means in the same row bearing different superscript letter are significantly different (p<0.05)

*(n=6)
Table (8) Effect of storage period on water holding capacity, pH, storage loss and cooking loss of burger processed from camel meat, beef meat and their mixture.

<table>
<thead>
<tr>
<th>Item</th>
<th>Storage period (days)</th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>0 day</td>
<td>3\textsuperscript{rd} day</td>
<td>7\textsuperscript{th} day</td>
<td></td>
</tr>
<tr>
<td>W.H.C%</td>
<td>66.16 \textsuperscript{a}</td>
<td>66.08 \textsuperscript{a}</td>
<td>58.45 \textsuperscript{a}</td>
<td></td>
</tr>
<tr>
<td>pH</td>
<td>5.72 \textsuperscript{a}</td>
<td>5.66 \textsuperscript{b}</td>
<td>5.63 \textsuperscript{c}</td>
<td></td>
</tr>
<tr>
<td>Storage loss%</td>
<td>0.016 \textsuperscript{c}</td>
<td>6.54 \textsuperscript{b}</td>
<td>9.22 \textsuperscript{a}</td>
<td></td>
</tr>
<tr>
<td>Cooking loss%</td>
<td>13.84 \textsuperscript{c}</td>
<td>18.59 \textsuperscript{b}</td>
<td>26.97 \textsuperscript{a}</td>
<td></td>
</tr>
</tbody>
</table>

\[a-c = \text{Means in the same row bearing different superscript letter are significantly different (p<0.05)}\]

\[*(n=6)\]
lower than that of camel and camel & beef burgers.

Knoess, (1977); Fisher, (1975), and Khatimi, (1970) reported that camel meat is comparable in palatability and texture to beef meat. Direct comparison between camel burger and beef burger suggested that camel burger had numerically higher score in flavor, tenderness, juiciness and over all acceptability than the beef burger while the latter had numerically higher scores in appearance and color than camel burger. Mansour & Ahmed (2000) reported that camel burger gained higher score in over all acceptability than other product.

With the exception of flavor, apparently storage period had no effect (p>0.05) on the sensorial properties of processed burger evaluated. Till the 3rd day of storage the flavor scores decreased with the increase in storage period (p<0.05). There after (7th day of storage), the flavor score was similar to that on the 3rd day and significantly lower than that on the 1st storage period (0 day), Table (10).
Table (9) Sensory characteristics of burger processed from camel meat, beef meat and their mixture.

<table>
<thead>
<tr>
<th>Item</th>
<th>Camel</th>
<th>Beef</th>
<th>Camel &amp; Beef</th>
</tr>
</thead>
<tbody>
<tr>
<td>Appearance</td>
<td>7.11(^a)</td>
<td>7.19(^a)</td>
<td>7.13(^a)</td>
</tr>
<tr>
<td>Color</td>
<td>7.00(^a)</td>
<td>7.14(^a)</td>
<td>7.13(^a)</td>
</tr>
<tr>
<td>Flavor</td>
<td>7.14(^a)</td>
<td>6.83(^a)</td>
<td>7.10(^a)</td>
</tr>
<tr>
<td>Juiciness</td>
<td>7.13(^a)</td>
<td>6.63(^b)</td>
<td>7.12(^a)</td>
</tr>
<tr>
<td>Tenderness</td>
<td>7.81(^a)</td>
<td>7.51(^a)</td>
<td>7.62(^a)</td>
</tr>
<tr>
<td>Overall acceptability</td>
<td>7.58(^a)</td>
<td>7.08(^a)</td>
<td>7.52(^a)</td>
</tr>
</tbody>
</table>

\(^a-b\) = Means in the same row bearing different superscript letter are significantly different (p<0.05)
*(n=6)
Table (10) Effect of storage period on sensory characteristics of burger processed from camel meat, beef meat and their mixture.

<table>
<thead>
<tr>
<th>Items</th>
<th>0 day</th>
<th>3\textsuperscript{rd} day</th>
<th>7\textsuperscript{th} day</th>
</tr>
</thead>
<tbody>
<tr>
<td>Appearance</td>
<td>7.28\textsuperscript{a}</td>
<td>7.17\textsuperscript{a}</td>
<td>6.66\textsuperscript{a}</td>
</tr>
<tr>
<td>Color</td>
<td>7.3\textsuperscript{a}</td>
<td>7.06\textsuperscript{a}</td>
<td>6.9\textsuperscript{a}</td>
</tr>
<tr>
<td>Flavor</td>
<td>7.61\textsuperscript{a}</td>
<td>6.93\textsuperscript{b}</td>
<td>6.53\textsuperscript{b}</td>
</tr>
<tr>
<td>Juiciness</td>
<td>6.76\textsuperscript{a}</td>
<td>6.66\textsuperscript{a}</td>
<td>6.48\textsuperscript{a}</td>
</tr>
<tr>
<td>Tenderness</td>
<td>6.77\textsuperscript{a}</td>
<td>7.19\textsuperscript{a}</td>
<td>7.26\textsuperscript{a}</td>
</tr>
<tr>
<td>Overall acceptability</td>
<td>7.63\textsuperscript{a}</td>
<td>7.59\textsuperscript{a}</td>
<td>6.69\textsuperscript{a}</td>
</tr>
</tbody>
</table>

\textsuperscript{a-b} = Means in the same row bearing different superscript letter are significantly different (p<0.05) *(n=6)
CHAPTER FIVE

CONCLUSION AND RECOMMENDATION

5-1 Conclusion

- Camel meat is acceptable for human consumption and in some communities it could replace meat from other species.
- Camel meat had a chemical composition similar to beef.
- It is possible to use camel meat to dilute beef meat for burger making for its healthy and sensory benefits.
- Processing of camel meat increased the tenderness, taste and palatability of the products. Camel meat can be processed in similar ways to beef, producing similar products with similar acceptability.

5-2 Recommendations

- It is strongly recommended to use camel meat for burger processing.
- Promotion programs are needed to make camel meat products more acceptable to consumers.
- Further investigations are needed particularly in the health and processing potentiality aspects of camel meat.
REFERENCES:


Foods and Agriculture Organization, July 6, (2001). Fresh from your local drome (dairy).


Unique properties of the camel erythrocyte membrane N C B J, 5 April (1975).


Sensory Evaluation Form

There are three samples of burger, please evaluate, Appearance, Color, Flavor, Taste, Juiciness, Tenderness and overall acceptability. Using scores follows:

7 = Extremely like
6 = Moderately like
5 = Like
4 = Slightly like
3 = Slightly dislike
2 = Dislike
1 = Extremely dislike

If you have any question please ask.

Thanks for your cooperation.

<table>
<thead>
<tr>
<th>Samples</th>
<th>A</th>
<th>B</th>
<th>C</th>
</tr>
</thead>
<tbody>
<tr>
<td>Appearance</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Color</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Flavor</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Taste</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Juiciness</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Tenderness</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Overall acceptability</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>