



SUDAN UNIVERSITY OF SCIENCE AND TECHNOLOGY

College of Graduate Studies



**Study on Some Meat Characteristics and Nutritive Value of
Fresh, Chilled and Frozen Camel Meat**

دراسة بعض خصائص اللحم والقيمة الغذائية للحوم الإبل الطازجة والمبردة والمجمدة

**A dissertation submitted in partial fulfillment of the
requirements for M. Sc. Degree in tropical Animal
Production**

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DEDICATION

To my dear parents and family

To my dear friends and colleagues

I dedicate this work with sincere pleasure and respect.

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Praise is to Allah who gave me the strength and patience to conduct this study.

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Abstract

Camel is a good source of meat in areas where climate adversely affects the production efficiency of other animals. This study aimed to evaluate camel meat quality characteristics in order to determine the nutritive value of camel meat at different storage states (fresh, chilled and frozen) and to study effect of the storage state on the quality characteristics. 27 samples of camel meat were taken from Souq Libya at Omdurman in Sudan. The sample divided in to three group (A, B, C) each group consist 9 sample.

The results revealed high significant difference at ($p < 0.05$) in concentration of moisture, ash, pH and WHC in meat samples tested, whereas there was no significant difference in the fat content of different meat, while the difference in crude protein was slightly significant at roughly 0.05. From the results, moisture content in the meat on the storage state ranged between (74.99% to 76.98%) and crude protein varied from (18.52 -19.29%). It was also observed that fat content of different storage states ranged from (1.20 to 1.33%). Ash content of the different samples ranged from 1.19 to 1.28%. The pH levels of the different meat samples ranged between (5.6 -5.8) and WHC from (1.91 – 2.26).

The study concluded that the chilled meat was best in the nutritive value.

ملخص الدراسة

يعتبر لحم الإبل مصدرا جيدا للحوم في المناطق التي يؤثر فيها المناخ سلبيًا على كفاءة الإنتاج للحيوانات الأخرى. هدفت هذه الدراسة إلى تقييم خصائص جودة لحم الإبل من أجل تحديد القيمة الغذائية للحوم الإبل في حالات تخزين مختلفة (طازجة ومبردة ومجمدة) وتأثير درجة حرارة التخزين على خصائص الجودة. تم أخذ 27 عينة من لحوم الإبل من سوق ليبيا في أم درمان بالسودان تم تقسيم العينات إلى 3 مجموعات وكل مجموعة تضم 9 عينات. أظهرت النتائج وجود اختلافات معتبرة عالية ($p < 0.05$) في تركيز الرطوبة والرماد والحموضة (pH) وسعة تخزين الرطوبة (WHC) في عينات اللحم. في حين لا توجد فروق معينة في محتوى الدهون في اللحم، بينما كان الاختلاف في البروتين الخام معتبرا نسبيا عند حوالي 0.05. أظهرت النتائج أن تركيز الرطوبة في اللحوم وفقا لحالة التخزين تراوح بين (74.99% إلى 76.98%) والبروتين الخام تراوح بين (18،52- 19.29%). ولوحظ أيضا أن مستويات الدهون في العينات المختلفة تراوحت بين (1.20 إلى 1.33%) وفي حين تراوح محتوى الرماد للعينات المختلفة تراوح من 1.19 إلى 1.28%. كما تراوحت مستويات الحموضة (pH) لعينات اللحوم المختلفة بين (5.6 - 5.8) وسعة تخزين الرطوبة WHC بين (1.91 - 2.26).

خلصت الدراسة إلى أن اللحوم المبردة سجلت أعلى قيمة غذائية.

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CHAPTER ONE

Introduction

Camel is a good source of meat in areas where climate adversely affects the production efficiency of other animals. It continues to be the preferred livestock species for exploiting extreme dry land areas, with the total population of large camelids in the world reaching 30 million heads in 2013 (Faye, 2013). The total population of camel heads in the Arab world is estimated as 16546.36 heads. In Mauritania, the population of camel is 1408.59 heads. (AOAD, 2016). The dromedary camel is one of the most important domestic animals in the arid and semi-arid regions as it is equipped to produce high quality food at comparatively low costs under extremely harsh environments (knoess, 1977; Yagil, 1982).

Asia and Africa are home to the species of camels known as Dromedary camels. This type of camel lives in dry hot zones and is used as a vital source of food and milk. The camel possesses unique traits which makes it superior to other domestic animal e.g. transportation, racing and an important source of meat, milk and hide in several countries (Al-Sheddy.et al.2000), (Zidane. et-al 2005). The camel has great tolerance to high temperature, high solar radiation and water scarcity. It can survive well on sandy terrain with poor vegetation and may chiefly consume feeds unutilized by other domestic species (Shalah,

1983).Camel populations are concentrated in the desert belt in the African and Asian continents.

In Saharan countries like Mauritania, where the local population depends primarily on camel milk and meat for food, camel mortality rate do not exceed 5% during extreme droughts as compared to sheep (15-30%) and cattle (20-50%). This has evidently led local breeders to prefer camels than other animals. It has also led to camel meat making-up over 30% of the livestock biomass in desert making it one of the most important sources of nutrition for the desert populations (Tariq et al., 2011).

Camel can provide a considerable amount of high quality meat and in recent years, 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 animal`s meat. The quality of camel meat is high in vital proteins, many vitamins, especially vitamin B and some important minerals such as iron, phosphorus and calcium. This is an important factor in reducing the risk of cardiovascular diseases, which are related to saturated fat consumption (Kurtu, 2004). The low proportion of fat is remarkable and presents essential characteristics of camel meat (Faye et al., 2013).

In some countries camel meat used as a medicine for some diseases including hyperacidity, hypertension, pneumonia and respiratory diseases since it is high in protein and low in cholesterol

(Yam et al., 2016; Kurtu, 2004). Camel meat is a nutritive valuable food rich in many essential amino acids, minerals and vitamins. In addition to the nutritional value of meat, it provides several eating attributes and fulfilling experiences that are normally not achieved by other protein source (Beef, pork). Camel meat is regarded as a main source of animal protein that equals and in some cases surpasses other meats in commercial importance (Williams, 2007).

Generally, the role of the camel as a meat producer is becoming more important due to the versatile role it plays rather than as a symbol of social prestige, which was the role it used to play but which has since greatly diminished (Dawood & Alkanhal, 1995).

Objectives of this study:

General objectives: To evaluate meat quality characteristics of camel meat.

Specific Objectives:

- 1- To determine the nutritive value of camel meat at different storage states (fresh, chilled and frozen).
- 2- To study the effect of storage states on some meat quality characteristic and nutritive value.

CHAPTER TWO

LIETERATURE REVIEW

2.1. Background information

Camels were domesticated by secondary nomads around 5,000 years ago in the Middle East, primarily for transportation and work rather than as a producer of meat (Wilson, 1998). Since then, the total large camelids population in the world has risen reaching, in 2013, between 25-30 million animals (Faye, 2013). However, since camels are migrant animals making it very difficult to conduct a census for camels, this number is probably underestimated. About 88% of camels are in Africa, while Asia has 12%.

The family camelidae includes two sub-families: 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*), most widely distributed in the hot arid areas of the Middle East and Africa where as the Bactrian two-humped camel (*Camelus bactrianus*) is found in parts of central Asia and China (Dorman, 1986).

The main concentration of dromedary camels in Africa is in the East African countries with 80% of the total camel population raised under various production systems. The most important countries with a

camel population of more than 1 million are Somalia, Sudan, Mauritania, Ethiopia, Niger, Chad, and Kenya.

Camel meat is a significant source of animal protein in many African and Asian countries especially in area where the climate adversely affects the production efficiency of other animals. The culinary and cooking practice, as well as the palate for meat, in several African and Arabian countries have evolved to prefer camel meat over other meat animal species because of beliefs in medicinal benefits, its availability and/or affordability (Bekhit and Farouk, 2013).

2.2 Camel meat production:

Meat is the most important product from the camel. The importance of the camel as a meat producing animal is increasing due to the amount of high nutritive value meat they produce, besides their ability to survive under harsh environments (Khadim et al., 2008).

The total camelids meat production in 2011 was approximately 338,289 tons, around 0.18% of total red meat production. Africa produced 62,2% of the world camelids meat followed by Asia at 35,8% while South America contributed only 5,3% central Asia contributed 0,38% of the total world camelids meat production. In Africa, the largest contribution came from eastern Africa, followed by northern Africa, and western Africa. In Asia, the largest contribution came from western Asia followed by eastern Asia (FAO, 2013).

2.3. Chemical composition of camel meat

Dawood and Alkanhal, (1995), found when evaluating the chemical composition of camel meat that the moisture range was 68.8 - 76.0 %, protein was 19.4 – 20 %, fat was 4.1 – 10.6 %, and ash was about 1.5 %. However, (Saliha, 2001), reported that the chemical composition of camel meat was 79.0 % moisture , 19-20 % protein , 2.49 % fat and 1.30 % ash. (Fathi El-rahman, 2005) compared the chemical composition of camel and beef meat and found that camel meat had higher moisture content (75.78 %) and protein (22.5 %), lower fat was (1.30 %) and ash content (1.6 %).The results from these three researches show a discrepancy in fat levels in the meat with minor deviations in the values for the other three compositions. Camel meat varies in composition according to breed type, age, sex, condition and site. Water content differs only slightly between species, while differences in fat content are more marked (Sales, 1995). Meat like other red meats contains high levels of potassium followed by phosphorus, sodium, magnesium and calcium, respectively, plus smaller percentages of other elements. Calcium content of camel meat is higher than that of beef which may partly explain the tight structure of some cuts of camel meat (El-faer et al., 1991; Dawood and Alkanhal, 1995). There are differences in the chemical and physical composition. kamoun, (1995). Reported average contents of protein, moisture, fat and ash of 18.7%, 76.3%, 0.92%, and 0.76%, respectively. However Naser, El-

Bahay, and Moursy, (1965). Studied the effect of camel meat composition. They reported average contents 78.7% moisture, 22.0% protein, 1.0% ash and 2.6% fat in camel meat.

2.4. Meat quality characteristics of camel meat

Meat quality is a term used to describe a range of attributes of meat (Maltin et al, 2003). It is a combination of physical structural and chemical characteristic of meat which resulted in maximum desirability. Color and firmness are the most determinate factor of meat presentation and appearance while tenderness, juiciness flavor and aroma are the most characteristics influencing acceptability. The optimum and economical age for slaughtering camel is 2-3 years, with increase in age the meat becomes tough and its quality deteriorates. An average carcass weighing 210kg would yield 10 kg fat, 160kg meat and 40kg bones (Ghada, 2008). Color is a primary attribute affecting acceptability of meat products by consumer (Trout, 1991) and is primarily related to the amount of desirable pigments present in the meat. Camel competed favorably with other livestock regarding yield and quality (Ghada, 2008). The quality of meat produced by younger animals five year or less was comparable to beef in taste and texture, camel meat was palatable but coarser than beef and vary in color from raspberry red to brown red and having white fat (Leupold, 1968).

2.4.1 Color of camel meat

Meat color is an important criterion especially for consumers (Faustman and Cassens, 1990). The color of meat is related to the level of pigmentation (myoglobin) present in the muscle (Bennion, (1980). When meat is exposed to air the myoglobin react with oxygen and becomes oxidized and change to brown color(Judge et al, 1989). Generally, the brighter red color of fresh camel meat may affect the acceptability of camel meat and products by consumers. When beef is cut the myoglobin oxidizes, giving rise to a bright red color and a process known as "blooming" If beef is left exposed to air for prolonged period, its color changes slowly to brown (Bennion, 1980). Redness, also, (myoglobin concentration) increases as an animal matures and with exercise (Muir, et al 1998). A high level of pre-slaughter stress can lead to a rise in pH, which results in dark colored beef (Moloney, 1999). The principle pigment of cooked meat is known as globulin haemichromogen. Camel meat color varies from raspberry red to brown red, according to the variation associated with muscle location. Camel L.dorsi had more lightness (L) and significantly different more redness (a) and yellowness (b) values than Semitendinosus and Triceps brachia muscle (Babiker and Yousif, 1990). Fathi El-rhman, (2005) also noted that Camel muscle had more color lightness (L 32-35), redness (a 19.15), and yellowness (b 15.85), than beef muscle (L 28.65), (b 18.45) and (a 15.55). The color of camel meat sustains its redness up to five days of storage, It contains a

higher level of "myoglobin" that interacts for a longer period with oxygen.(Al-Qadi, 2007)also pointed out that the meats color should always be considered when buying it, for bright red pieces of meat show that it is fresh and obtained from a young animal. (Kadim &Maghoub, 2006), reported that the muscle of camel meat hade more color lightness (L33.58), redness (a 18.19), and yellowness (b 6.40). Camel meat is described as raspberry red to dark brown in color.

2.4.2 Flavor of camel meat

Camel meat is recognized as having a similar flavor to that of beef (Ghada, 2008). Meat flavor is complex stimulus to the human senses involving chiefly aroma, texture, temperature, pH, and taste. The overall flavor sensation may depend essentially on volatile compounds that comprise the more important part of the total meat flavor profile, the flavor of meat can be associated with either the water in meat or the fat components of the tissue. (Lawrie, 1991). As the fat content of meat, the flavor increases, thus beef from older animals is more intense in flavor than meat from younger animals. Flavor is influenced by the deposition of compounds from the feed in the fat of the animal; the odor and taste of cooked meat arise from water or fat soluble precursors and by liberation of volatile substances pre-existent in the meat as several rather compounds containing sulphurs (Melton S.L, 1990). Prolonged storage under unfavorable condition may cause the development of proteolytic or putrid odor from protein decomposition, Sour or taint odors from

microbial growth and rancid odor from oxidation (Judge et al (1990). The nitrous oxide developed during curing and involved in cured pigment formation of flavor compounds, the phenolic compounds in smoked meat appear to be important and affected flavor (Ghada, 2008). Curing agents such as salt enhanced flavor and caused few changes in meat and a cereal like aroma. Flavor is increased with fatness and is affected by age sex, and breed (Cole et al, 1960).

2.4.3 PH of camel meat

In the living camel the pH of the muscular tissue is about 7.0 – 7.4 and decrease immediately after slaughter to 6.3 the pH changes after slaughter are largely due to differences in the amount of glycogen available for transformation into lactic acid (Loughlin, 1970). After slaughter the glycogen in muscle is converted into lactic acid causing a fall in pH. From an initial value of pH. 6.8-7.3 to about 5.4-5.8 at rigor mortis (FAO, 12 1991). The effect of pH value of three Camel muscles for tenderness were reported that pH values of L.dorsi 5.80, Semitendinosus 5.72 and Triceps brachia 5.69 (Babiker and Yousif , 1990). The pH changes take place continually in frozen foods, even during long period of frozen storage (Guinpoint et al, 1992). The pH value of camel meat is important in relation to the changes occurring in water holding capacity during conversion of muscle to meat depending on the rate and extent of pH drop and degree of protein denaturation

(Mendenhall, 1989). The pH of bovine longissimus dorsi muscles range from 5.40 to 5.49 (Page et al, 2001). In normal muscle, pH fall to 5.5 if the animal is stressed for long duration for any reason the glycogen concentration can fall to less than 0.6%. High pH meat has following feature: Dark cutting meat, a coarse texture, high water holding capacity and reduced shelf life. (Ghada, 2008). The pH of living muscle is just above 7 in well fed and rested cattle with glycogen concentration from 0.8% to 1.0% when the animal is harvested. The ultimate pH value of camel meat was higher 5.73 than beef meat sample 5.45 (Fathi-Elrhman, 2005). The changes in pH during freezing might be caused by the increase in concentration of soluble materials, by the subsequent precipitation of salt, and probably by the interaction of protein with ionic substance (Van den berg et al, 1961).

2.4.4 Cooking loss of camel meat

Cooking loss is one of the most important properties of emulsion type of sausage products and it is related to water holding capacity, there are variations in water holding capacity among different types of meat from different animals and muscles, higher water holding capacity of meat decreased cooking loss in final product, cooking loss is also affected by the muscle location (Lawrie, 1991). comparing in camel muscle cut L.dorsi (Lumber part), Semitendinosus muscle had significant lower cooking loss than L.dorsi and Triceps brachia muscle which conceded with it is superior water holding capacity (Babiker and

Yousif ,1990) Bulls well fattened fed high energy diets revealed improved water holding capacity and reduced cooking losses(Mohammed, 1999). Camel meat samples have less cooking losses and higher water holding capacity Babiker and Tibin, (1986), the lowest cooking loss was observed in the 15% fat 7.9% and the highest cooking loss with 25% fat 10%, cooking losses increased as the salt level in the formulation decreased. (Sofos, 1983). In addition, these losses increased with the use of lower binding quality meat, it is possible to reduce cooking loss by using binder indicated that binders such as dried milk used in different levels reduced cooking loss from 22% in zero level to 13% with 10% dried milk ,(Froning, 1966). The percentage of losses in cooking were affected by the level and type of fat in frankfurters, and was observed that increasing losses are correlated with decreasing content of fat in frankfurter prepared with cotton seed oil (Ghada , 2008). Bull fed diets high in energy and high protein showed improved water holding capacity and reduced cooking loses than those fed on diet with low energy and protein levels. Ahmed, (2003) found that the effect of the different slaughter weights on meat produced in Western Baggara bulls , the water holding capacity of longissms dorsi muscle improved significantly as the animal weight increased and the cooking loss percentages for M.biceps femoris , M.longissms dorsi, M. infraspinatus, M.triceps brachia , M . Posses major, M .gluteus medius, M. rectus femoris, M .semimembranosus, M .adductor, M .supraspinatus

and M .semitendinosus were (18.7), (20.7), (20.7), (22.0), (23.6), (23.6), (24.4), (25.6), (26.9), (7.3), and (27.4%) eleven beef muscles. Cooking loss of beef frankfurter 7.36% was higher than that of Camel meat frankfurter with different type of fat, cooking loss was (4.13) for treatment A (Camel meat with corn oil), (13.63) for treatment B (Camel with kidney fat) and (3.13) for treatment C (Camel with intramuscular fat) (Fathi El-rhman, 2005).

2.4.5 Water holding capacity of camel meat

It is the ability of meat to retain its own or added water during application of some external force. (WHC) is affected by several factors such as pH, species, age muscle type and function. WH) in meat is at a minimum at what is called iso-electric point of proteins. The iso-electric point is the pH at which all protein side chain groups are charged (Ghada, 2008). The isoelectric point of meat is the pH range between (5.0 - 5.4) which is also the pH of meat after it has gone through rigor mortis. When water holding capacity is reduced PSE (pale soft exudation) meat has higher drip and cooking losses, although water holding capacity is increased at normal the DFD (dark firm dry) meat is suitable for Scalded/boiled sausages and other cooked products but it has poor beef flavor (FAO, 1991).

2.4.6 Juiciness of camel meat

Juiciness is the initial impression of wetness due to rapid release of meat fluids and longer action of fat on the salivary gland. Juiciness tend

to be associated with marbling, hence heavier fatter animals produce beef, which seems juicy, Juiciness tends to decline as animal ages (Moloney , A.1999). The principle source of juiciness in meat as detected by consumer, are the intramuscular lipids and water content. Tenderness and juiciness are closely related the more tender meat, more juicer the meat, juiciness varies inversely with cooking loss (Judge et al, 1990). The differences in juiciness were related primarily to the ability of muscle to retain water during cooking). (Judge et al, 1989). Juiciness in sausage was affected by the level of common salt and phosphate groups (Ghada, 2008). Juiciness reaches minimum when the pH level of the meat is about 6.0, the ranking order shows that juiciness was greatest in the fresh (frozen) meat at high ultimate pH 17 (Lawrie , 1979). Juiciness is more highly associated with intramuscular fat (Romans et al, 1965)

2.4.7 Tenderness and texture of camel meat

Texture of meat involves all sensory manifestations of the structure of meat and the manner in which this structure reacts to the force applied during biting and specific senses involved in eating; it is how meat felt in the mouth during manipulation. The tenderness attribute has been shown to be the most important trait affecting camel acceptability (NCBA, 2001).

2.5 Nutritive value of camel meat

Method 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 condition, and time (Dawood and Alkanhal, 1995; Schweigert, 1987).

CHAPTER THREE

MATERIALS AND METHODS

This study was conducted in the period October 2018 to December 2018 at the meat laboratory of Khartoum University in Shambat to study the quality and the nutritive value of camel meat at different storage states. 27 samples of camel meat were taken from Souq Libya at Omdurman in Sudan. The sample divided into three group (A, B, C) each group consist 9 sample. The samples used were of fresh, chilled and frozen camel meat.

The fresh meat was analyzed directly. The chilled sample was left in a fridge for a week at 4° C before being analyzed. The frozen sample was frozen for two weeks at -20° C before being analyzed. The analysis was carried on 9 samples of each storage state.

3.1 Physical Analysis

3.1.1. PH measurement

The pH was determined for fresh, chilled and frozen meat samples. 10g of the sample were placed in a blender jar, and 100 ml of distilled water were added, the mixture was blended at high speed for one minute. The pH was measured using a pH-meter (Model L. puslMunchen 15), which has calibrated with two standard buffers (7 and 14).

3.1.2 Color measurement

The color for the meat samples of the various storage states were measured using Hunter Lab Model Color Flex EZ, (L), (a) and (b), where (L) measure lightness, (a) measures redness and (b) measures yellowness.

3.1.3 Water Holding Capacity (WHC)

Approximately 0.5g of samples was placed on a humidified filter paper and pressed between two Plexiglass for two minutes at 25 Kg/cm. the meat and moisture areas were measured using a compensating Plano-meter. The result was expressed as a ratio. The water holding capacity was calculated from the equation:

$$\text{Water Holding Capacity (WHC)} = \frac{\text{Loose water area} - \text{Meat film area}}{\text{Meat film area}}$$

3.2. Chemical analysis

3.2.1. Determination of moisture content

A sample of 5g was weighed and put into a drying crucible. The sample was dried overnight in a drying oven at 100°C for 18 hrs. The dried sample was put into desiccators then allowed to cool and reweighed. The moisture content percentage was calculated from the equation:

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

Where:

W_1 = initial weight of empty crucible

W_2 = weight of crucible + sample before drying

W_3 = final weight of crucible + sample after drying

3.2.2 Determination of fat content

Crude fat was determined based on the sohxlet extraction method of the Association of Official Analytical Chemists (AOAC, 1990). 2g of the sample was weighed into a thimble. This was inserted into the extraction column with the condenser. 200 ml of the extracting solvent (petroleum ether, boiling point 40 to 60° C) was poured into the cleaned, dried and weighed round bottom flask and fitted into the extraction unit. Then, the sample was subjected to continuous extrication with ether for 6hrs. After extraction, the thimble was removed and the solvent salvaged by distillation. The flask containing the fat and residual was allowed to dry in an oven at 100° C for 30 min to complete the evaporation the solvent. The flask containing the fat was cooled in desiccators and weighed. The fat obtained was expressed as a percentage

of the initial weight of the sample. The fat content percentage was calculated from the equation:

$$Fat (\%) = \frac{W_2 - W_1}{Weight\ of\ sample} \times 100$$

Where:

W1= weight of empty extraction flask

W2=weight of flask and oil extract

3.2.3 Crude protein content

Crude protein was determined by the method of the Association of Official Analytical Chemists (AOAC, 1990). 1g of the sample was weighed into a Kjeldahl digestion flask and 1g of catalyst was added to it. 25 ml of concentrated H₂SO₄ was added and the flask was shaken to mix the contents. The flask was then placed on a digestion burner for 3 hrs and heated until the solution turned green and clear. The sample solution was then transferred into a 100 ml volumetric flask and made up to the mark with distilled water.

25 ml of 2% boric acid was pipetted into a 250 ml conical flask and two drops of methyl red indicator solution was added into the decomposition chamber of the distillation apparatus and 12 ml of 40% NaOH solution, 5 ml of the digested sample solution was then introduced into a Kjeldhal tip of the distillation apparatus, then dipped into the boric acid contained in the conical flask. The ammonia in the sample solution was then distilled into the boric acid until it changed

completely to blue. The distillate then titrated with a 0.1 NHCl solution until it became colorless. The total nitrogen crude protein percentage was calculated using a conversion factor of 6.25 based on the following equation:

$$\text{Crude Protein (\%)} = \frac{T(N \times 14 \times VF) \times 6.25}{\text{Sample weight}} \times 100$$

Where:

N=Normality of the titrate (0.1N)

VF= Total volume of the digest

T= Titre Value

3.2.4 Determination of ash

Five grams of the sample was put into a previously dried and weighed porcelain crucible, transferred into a muffle furnace at 150° C. The temperature was increased gradually until it reach 600° C for 3hrs. The contents of the crucible were removed and reweighed. The percentage of ash content was calculated as:

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

3.3. Statistical Analysis

All the results obtained from the laboratory were tabulated and subjected to statistical analysis using ANOVA. Gomez and Gomez (1984)

CHAPTER FOUR

RESULT

This study was carried out to evaluate the meat characteristics and nutritive value of fresh, chilled and frozen of camel meat. All the samples were subjected to physical and chemical analysis.

The mean values \pm standard deviation of moisture, crude protein, fat, ash, acidity (pH) and the water holding capacity (WHC) of the camel meat samples are presented in tables 1,2,3,4 and 5.

Table 1: Average values \pm SD of physical and chemical characteristic of fresh camel meat

Element	Mois%	CP%	E.E%	Ash%	pH	WHC
Mean	76.88	19.2	1.28	1.26	5.8	2.3
\pm	\pm	\pm	\pm	\pm	\pm	\pm
sd	0.56	0.69	0.14	0.69	0.3	0.7

Table1 shows average values of the chemical and physical characteristic of the fresh meat sample. The analysis showed that the fresh meat had high moisture content as 77% \pm 0.6 with a protein level was 19%, fat content was 1.3%, ash as 1.3%. The pH of fresh meat was 5.8 with a water holding capacity of 2.3.

Table 2: Average values \pm SD of physical and chemical characteristic of chilled camel meat

Element	Mois%	CP%	E.E%	Ash%	pH	WHC
Mean	74.99	19.2	1.32	1.29	5.7	1.9
±	±	±	±	±	±	±
sd	0.6	0.7	1.38	0.6	0.2	0.1

Table2 shows the results obtained for chilled meat samples. The analysis showed that the chilled meat has moisture content at as 75% ± 0.6. The protein content was 19%, the fat content was 1.32%. the ash content was 1.29%. The PH of chilled meat was 5.7. The water holding capacity a recorded 1.9.

Table 3: Average values ± SD of physical and chemical characteristic of frozen camel meat.

Element	Mois%	CP%	E.E%	Ash%	pH	WHC
Mean	75.98	18.5	1.2	1.2	5.7	2.6
±	±	±	±	±	±	±
sd	1.9	0.7	1.5	0.6	0.7	0.8

In Table3 the results of the study showed that the frozen meat moisture content was $75.98\% \pm 1.9$. The protein level was $18.5\% \pm 0.7$; however the fat content was 1.2% with a standard deviation of ± 1.5 . Similarly the ash content was reaching 1.2%. The PH of frozen meat was 5.7 and it had water holding capacity of 2.6.

Table 4: Comparison of average values \pm SD of physical and chemical characteristic of fresh, chilled and frozen camel meat.

Element	Mois%	CP%	E.E%	Ash%	pH	WHC
Fresh Meat	76.98 \pm 0.56	19.20 \pm 0.70	1.28 \pm 0.14	1.26 \pm 0.06	5.8 \pm 0.03	2.26 \pm 0.07
Chilled Meat	74.99 \pm 0.62	19.29 \pm 0.70	1.33 \pm 0.14	1.28 \pm 0.06	5.64 \pm 0.02	1.91 \pm 0.10
Frozen Meat	75.98 \pm 0.20	18.52 \pm 0.70	1.20 \pm 0.15	1.19 \pm 0.06	5.76 \pm 0.03	2.06 \pm 0.08
sig	**	*	NS	**	**	**

*= Significant

**= Highly significant

NS= Not significant

The mean values \pm standard deviation of moisture, crude protein, fat, ash, acidity (pH) and the water holding capacity in fresh, chilled and frozen camel meat were given in (Table4). The results revealed high significant difference at ($p < 0.05$) in concentration of moisture, ash, pH and WHC in meat of different storage state, whereas there was no significant difference in the fat content of the meat. The difference in crude protein was slightly significant at roughly ($p < 0.05$). The moisture concentration in the meat ranged between (74.99% to 76.98%) with highest moisture level recorded in fresh meat as 76.98 followed by frozen meat as 75.98% and lastly the chilled meat as 74.99%. Meat crude protein content varied from 18.52 to 19.29%. The highest value was recorded in chilled meat (19.29%) followed by fresh meat (19.20%) and frozen meat (18.52%) respectively. The statistical analysis of fat content indicated no significant difference ($p > 0.05$). It was observed that fat levels of different storage states ranged from (1.20 to 1.33%) and the highest recorded value in chilled meat (1.33%) followed by fresh meat (1.28%), while frozen meat recorded the lowest value (1.20%). Ash content of different samples ranged from 1.19 to 1.28%. The highest values recorded in chilled meat (1.28%) followed by fresh camel meat (1.26%), while the lowest value recorded by frozen meat (1.19%). Acidity values of the different meat samples ranged between (5.6 -5.8). Fresh meat recorded pH value (5.8) followed by frozen meat (5.76) and chilled meat (5.64) respectively. The WHC of the different meat samples

varied in the range of (1.91 – 2.26). Fresh meat recorded the highest value (2.26) followed by frozen meat (2.06) and chilled meat (1.91) respectively.

Table 5: Average colour values \pm SD of camel meat at different storage states.

Element	lightness	Redness	Yellowness
fresh	93.05 \pm 1.73	24.87 \pm 0.08	8.69 \pm 0.21
chilled	49.06 \pm 1.30	25.52 \pm 0.32	9.57 \pm 0.28
frozen	46.14 \pm 1.09	22.87 \pm 0.97	7.91 \pm 0.28
sig	NS	S	S

S= Significant

NS= Not significant

Table5 shows the results of Average values \pm SD of color of camel meat. The results showed in lightness there was no significant difference. Fresh meat had the highest lightness measure as 93.05. Both chilled and frozen meat had a low value in lightness at around 49.06 and 46.14 respectively. The variance in redness and yellowness were both significant. In redness, the highest value was 25.52 in chilled meat followed by fresh meat at 24.87 and the lowest value was that of frozen as 22.87. Similarly, chilled meat had the highest value in yellowness as 9.57 followed by fresh meat as 8.69, with frozen meat recording a value of 7.91.

CHAPTER FIVE

DISCUSSION

The results of this study will be discussed in this chapter based by demonstrating the significance of the findings and comparing them to results reviewed in the scientific literature.

5.1 chemical composition of camel meat:

5.1.1 Moisture%

The chemical composition showed that the moisture content of the meat varied significantly, depending on the storage state. The fresh meat showed the moisture content as 77%, which is comparable to the result reported by Siham, et al (2015) as 77.9 and slightly higher than result determined by Dawood and Alkanhal(1995)and Fathi El-rahman (2005) as 76%. The frozen and chilled meat had result that varied significantly than the fresh meat as 75.98% and 74.99% respectively. The chilled meat showed the moisture content as 74.99% which is slightly lower the result determined by Naser El- Bahay, and Moursy (1965) as 78.2% .the frozen meat showed the moisture content as 76% which is comparable to the result reported by Kamoun (1995) as 76.2%.

5.1.2 Crude protein%

In fresh camel meat, crude protein was 19.2% while chilled meat was 19.29% and frozen meat was 18.52%. The deviations between the three storage states were slightly significant. For the fresh meat, the c.p% was within the range found by Saliha (2001) and Dawood and Alkanhal (1995) who found the c.p values in the range of 19.2% - 20%, the result of this study was similar to values reported by Fathi El-rahman (2005) as 19-20%. For the chilled meat, the c.p% was slightly lower the result determined by Naser, El-Bahay, and Moursy (1965) as 22, 0%. The c.p of frozen meat, was agreed with the result reported by Kamoun (1995) as 18, 7%.

5.1.3 Fat%

However, variations in fat content were not significant at ($p>0.05$) with fresh meat recording 1.28%, chilled meat, 1.33% and frozen meat 1.2%. These results were lower than the results reported by Dawood and Alkanhal (1995) as 4.1% - 10% and lower than the result reported by Saliha (2001) as 2.5%, which maybe probably due to the diet, however they were comparable to those of Fathi El-rahmar (2005) who reported, fat content as 1.3%.

5.1.4 Ash%

The influence of the storage method on Ash content, was highly significant ($P<0.05$). Ash content from 1.2% in frozen meat to 1.33% in chilled meat and 1.26% in fresh meat. These results were slightly lower

than the result reported by Dawood and Alkanhal, (1995) who reported ash content 1.5% and Fathi El-rahman as 1.6%, the ash content of the present study were nearly similar to that reported by Saliha (2001) as 1.3%.

5.2 physical characteristic of camel meat

5.2.1 PH and WHC

WHC and pH witnessed highly significant variations ($P < 0.05$) depending on the storage state. The results for pH and WHC showed a direct correlation between the acidity of the meat and WHC. more acidic sample was lower in capacity to hold water. Fresh meat had the highest pH was 5.8 with WHC of 2.26. The result obtained for the pH of the fresh sample agreed with the results obtained by Babiker and Yousif (1990). The values witnessed dropped in the frozen to 5.76 for pH and 2.06 for WHC. The lowest WHC was recorded in chilled meat as 1.91 with pH of 5.64.

The results showed that the pH of the sample dropped as it cooled, which could be a result of the concentration of soluble minerals and their subsequent dissolving. The results also indicated that the chilled meat had the best nutritive value with the lowest WHC and the highest percentage of ash.

5.2.2 Color

The camel meat lightness varied from raspberry red to light brown (reddish brown) depending on the storage state. However the changes in

redness and yellowness witnessed significant variations ($P < 0.05$) between the three storage states. The highest value in lightness was in fresh meat as 93.05 which is far different than results reported by Fathi El-rhman (2005) as 32-35. Chilled meat registered the highest values in redness and yellowness as 25.52 and 9.57 respectively. Lightness is far different than result reported by Kadim and Maghoub (2006) as 33-58 respectively. The changes in color are probably due to the oxidization of the myoglobin protein in the meat due to interaction with the air.

CONCLUSION AND RECOMMENDATION

The results of this study showed a close link between the chemical and physical characteristic with storage state of the camel meat. The most significant variations were registered in moisture, ash, pH and WHC. The highest nutritive value of camel meat was the chilled meat due to its significant values of WHC and ash content.

However, data on chilled and frozen camel meat is lacking in the literature, further research is needed to enrich the scientific communities understanding of camel meat quality and nutritive value.

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