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Authors Email:sihamlmn666@gmail.com

# A Study Of Cooking Loss, Shear Force And Proximate Analysis Of Sheep Meat And Goat Meat In Khartoum State

**Dr. Siham Abdelwhab Alamin**

Sudan University of Science and Technology (SUST), College of Animal Production Science and Technology, Department of Meat Science and Technology. Khartoum - Sudan

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This study was conducted in the College of Animal Production Science and Technology, Sudan University of Science and Technology to investigate the chemical composition and some cooking loss of sheep meat and goat meat (longissimus muscle from different carcass of young animals). The chemical composition and pH determined according to Association of Official Analytical Chemists methods [AOAC 2007]. And cooking loss was determined according to [AMSA, 1995] and shear force determines as reported by [. Shackelford *et al*, 1991]. The samples were analyzed in three different brands of these raw cuts in duplicate. The results showed that the moisture concentration showed significant (P<0.05) difference among the treatment muscles. Goat meat had significantly (P<0.01) higher moisture content (72.55%) compared to sheep meat (66.96%). Protein content was not significantly (P>0.05) different among the types of meat. Goat meat had higher protein content (22.55%) compared to sheep meat (21.44%). Fat content was significantly (P<0.05) different among the treatment muscles. However, the fat content of sheep meat was higher (4.89%) compared to goat meat (2.5%). There was no significant (P>0.05) difference between the two types of meat in ash content. Cooking loss was not significantly (P>0.05) different among the two types of meat. Cooking loss percent of sheep meat was higher (21.44%) compared to goat meat (19.89%). Shear force, which measures muscle tenderness, was significantly (P<0.05) different among the two types of meat studied. However, sheep meat had lower shear force values (30.03) compared to goat meat (33.87). Also there was no significant (P>0.05) difference between sheep meat and goat meat in pH values. Sheep meat had lower pH (5.5%) compared to goat meat (5.8%).

**Keywords:** Chemical Composition, Goat meat, Sheep meat, cooking loss, shear force.

## INTRODUCTION

The Republic of Sudan is a country in northeast Africa, bordered to the east by Ethiopia and Eritrea, to the north by Egypt and Libya, to the west by Chad and the Central African Republic and from the south by the State of Southern Sudan. Sudan is one of the richest Arab and African countries in livestock. Sheep and goats make an indispensable contribution to food, agriculture, and rural development in many parts of the world particularly in Sub-Saharan Africa [. Green ,1986] Therefore, quality is directly associated with usage and is a multifaceted concept as reported by [Voisinet *et al.,* 1997]. Tenderness is the primary determinant of eating quality and acceptability of meat as reported by [Voges,et al. 2007]. Also the study by [Hogg *et al*1992.] Reported that goat meat contained little fat and therefore relatively higher proportions of protein and minerals. [Babiker *et al* 1990] And [. Siham, A. A, 2019] reported goat meat have significantly less intramuscular fat and more moisture than sheep. [Lee, *et al* 2008] Found that there was no significant differences in moisture, protein and fat contents between goats and sheep. [Perry *et al* 2001.] Reported that a shear force below 4 kg (40 N) is what equates to meet with an acceptable level of tenderness in Australian markets. There is a general conception that goat meat is inferior in tenderness compared to sheep meat as mentioned by Lee, et al 2008 []. [McMillin, K. W. and Brock, A. P. 2005] Reported that goat meat tends to be less tender, with high shear force values and collagen content. High pH values (6.00) for goat meat compared to the pH values of meat from other species have been found in many studies [Voisinet, *et al* 1997]. The study by [Lee, *et al* 2008] Noted that detailed information of these parameters in sheep and goat in the tropics especially from traditional production systems is missing. Such information on inherent meat quality of sheep and goat is required to help consumers make an informed decision in

purchasing meat. [Hopkins *et al* 2006.] Reported that sheep meat with shear force values less than 49 N is considered and acknowledged as tender. [Simela,*et al.* 2003.] Stated that meat tenderness and flavor are the most important components that determine meat quality. Several studies have been conducted to compare chemical composition of sheep and goats at the same slaughter weight, age or under similar feeding management. [Sen, *et al* 2004] Found that goat meat is characterized by low intramuscular fat and higher moisture content. Meat tenderness has been evaluated instrumentally using the Warner-Bratzler shear method, which gives the best correlation with sensory panel scores for tenderness within muscles as reported by [Destefanis *et al* 2008.] and [Schönfeldt, H. C. and Strydom , P. E. 2011]. The study of [Babiker et al.,1990] reported that the chemical composition and quality attributes of goat meat and lamb, found that the shear force measured across muscle fibers and the connective tissue strength were greater, but no significantly so, in goat meat than in lamb meat. The quality of sheep meat is defined by tissue composition, physical and chemical properties, chemical composition, nutritive value and sensory characteristics as reported by [Lambe *et al* 2009]; [Kaic*, et al* 2012]; and [Krvavica, M. 2012]. Beef had higher protein content compared to goat meat as reported by [Siham, A. A., 2015]. The pH of the muscle is the main indicator used to measure meat quality at a commercial level. The pH at 24 h ranged from 5.47 to 5.69, indicating that the animals were not stressed at the time of slaughter. The results of this research support the assumption that the sheep are not very susceptible to stress and rapid falls in pH in the muscles after slaughter are not characteristic for this animal species as reported by [Kaic,*et al*. 2012]. Male's carcasses had more muscles and bone while female's carcasses had more fat and trimming. [Bellew, *et al* 2003.] Found that the average weekly rate of gain was 0.8 Kg in the desert X temperate crossbred kids and 0.6 Kg in the local male desert goat kids. Compared to sheep, goat meat tends to be less tender, with high shear force values and collagen content [McMillin, K. W. and Brock, A. P. 2005] and [Voisinet, *et al* 1997]. Goat meat is characterized by low intramuscular fat and higher moisture content as reported by [Mahgoub, O. and Lodge G. A. 1998]. The ultimate pH of muscles is a consequence of lactic acid accumulation through postmortem glycolysis process that affects meat quality characteristics [Simek, 2003.]. Effect of goat sex on meat shear force was reported by [El Moula, *et al* 1999] who found that shear force was not significantly different between the two sexes. Studies on beef tenderness are common because tenderness is a determining factor in the acceptability of the product by consumers. Indicators, such as sensory evaluation and instrumental analysis by shear force, have been reported in several studies [Destefanis, *et al* 2008.] and [Bellew, *et al* 2003.]. Also according to [Dani, *et al* 1985.] who reported 75 -76 % moisture in the carcass of lamb at 9-12 months of age. The study by [Mohanty, S. C. and Mishra, M. 1992.] reported that moisture content in lamb meat as77.34 - 76.56 %. 27 reported that moisture percentage in lamb 77.38 - 75.95%. [Dani.*et al* 1985.] Reported that the protein content of meat from Bannur lamb's at an age of 10 months is 17.60 %. [Mohanty, S. C. and Mishra, M. 1992.] Reported that the protein content in sheep meat is 18.50 - 19.16 %. The study by [Mule A. D. 2007] Reported protein percentage among different primal cuts of Deccani lamb of 4, 6, 9 and 12 month as 19.33, 19.40, 19.51 and 19.54 % respectively. [Mhaske P. S. 2010] Reported protein percentage among different primal cuts of sheep at an age of 3, 4, 5 and 6 months as 17.08, 17.50, 17.91 and 18.33 % respectively. The results obtained by [Latif, M. G. A. and Owen, E. 1980] who observed 25.7 % fat in Suffolk ram lamb's at an age of 4 months. [Sents,*et al*. 1983] Concluded that fat thickness measurements increased in a linear manner as live weight increased from 48.4 to 84.8 kg. Mohanty, S. C. and Mishra, M. 1992. [Mohanty, S. C. and Mishra, M. 1992.] Reported the ash content of carcass from sheep at an age of 10 months as 1.18 and 0.93 %. The study by [Mule A. D. 2007] Reported that ash percentage of carcass from sheep at 4, 6, 9 and 12 month old as 0.92, 0.95, 0.99 and1.00 % respectively. Also Mhaske P. S. 2010 [Mhaske P. S. 2010] reported fat percentage among different primal cuts of sheep at an age of 3, 4, 5 and 6 months 0.91, 0.92, 0.93 and 0.94 % respectively.

The Objectives of this study are to evaluate the chemical composition and some quality attributes of sheep meat and goat meat as well as to determine the sheer force and connective tissue strength of sheep and goat meat.

## MATERIALS AND METHODS

The study was conducted at the Laboratory of Meat Science and Technology, College of Animal Production Science and Technology, Sudan University of Science and Technology (SUST). Khartoum/ Sudan.

**Meat samples:** A total of 5 kg fresh deboned sheep meat was obtained from sheep slaughtered at local market (Khartoum North). Also, a total of 5 kg fresh deboned goat meat was obtained from Kuku Research Centre, Khartoum North. Meat from young male goat at 11-12 month old and young male sheep at 12- 13 month old).

**Samples for Chemical analysis:** Each muscle samples (*longissimus dorsi*) were freed from external visible fat and connective tissue. Samples for chemical analysis were stored at 4$^{o}$C till analysis (24 hrs.).

**Chemical composition (Proximate Analysis):** Determination of total moisture, ash, total protein and fat (ether extract) were performed according to the methods mentioned by [AOAC 2007].

**Crude protein:** Kjeldahl method was used to determine nitrogen; crude protein was determined by multiplying the amount of nitrogen times 6.25. The fresh meat sample was minced and 1 gm was digested in Kjeldahl flask by adding mercury tablets as catalysts and 25 ml of concentrated $H_2SO_4$. The mixture was heated for 3 hrs. The digested samples were cooled and transferred to volumetric flasks. Nitrogen was distilled from the flask in the percentage of 40% NaOH solution and received in 4% boric acid. The mixture was titrated against 0.1 N HCl solutions. The formula used for calculation of crude protein was as follows:

| | |
|---|---|
| Crude protein %= | Tv x 0.1 x 14 x 100 x 6.25 / Weight of sample x 1000 |

Where:

Tv = Actual volume of HCL used for titration.
N = Normality of HCL. 14= each ml is equivalent to 14 mg nitrogen.
1000 = to convert from mg to gm.
6.25= constant factor.
Protein content%=Nitrogen T=Titration volume

**Moisture Determination:** Moisture content was based on weight loss of 5 gm of sample. The fresh muscle samples were put in an oven at 100$^{o}$C for 24 hrs. Consequently the samples were cooled in desiccators and their weights were determined. The moisture content was calculated according to the following equation:

| | | |
|---|---|---|
| Moisture %= | Fresh sample weight – dried sample weight / Fresh sample weight | X 100 |

**Fat Determination:** Fat was determined by the ether extract. Five gram from each Sample was taken to soxhlet apparatus. The samples were subjected to continuous extraction with ether for 5 hrs. The samples were then removed from the extractor and allowed to dry for 2 hrs. at 100C$^{o}$ in drying oven till no traces of ether remained. The calculation was as described as follows:

| | | |
|---|---|---|
| Fat %= | Fat weight / Sample weight | X100 |

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

| | | |
|---|---|---|
| Ash %= | Weight of crucible before aching – weight of crucible after drying / Sample weight | X 100 |

**Cooking Loss Determination:** The cooking loss was determined according to [AMSA, 1995]. Meat samples were thawed at 5$^{o}$C for 24 hrs. Then cut into samples of equal dimensions and weighed. Samples were cooked in plastic bags in a water bath at 80$^{o}$C for 90 min., cooled in running tap water for 20 min., then dried from fluids and reweighed. The cooking loss % was also determined by oven. Frozen samples randomly selected were used for determining cooking losses and thawed for 24 hours in 4$^{o}$C refrigerator. Two fingers from each treatment were weighed separately and rapped by aluminum foil, then cooked by oven at 160$^{o}$C for 25-30min. Samples allowed to cooling at room temperature, then reweighed. Cooking losses were determined by weight difference between raw and cooked sausage. The cooking losses were determined according to [ Zeljka,*et al.* 2015.]. Cooking loss was determined as the loss in weight during cooking and expressed as a percent of pre-cooking weight as follows:

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

**Objective Measurement of Tenderness and Toughness:**

Objective Measurement of Tenderness and Toughness For sheer force and connective tissue strength determinations, Warner Bratzler shear force (WBSF) (mechanical measurement of tenderness) was performed on the steaks that had been used to determine cooking loss. Five cylindrical samples (12.7-mm core diameter) were cored parallel to the grain of the meat, making sure that the whole steak area was covered. Each of the five cores were sheared perpendicular to the fiber direction using a Warner-Bratzler shear attachment (with a circular cross-section of 1.27 cm 0 blade) fitted to an electrical scale programmed to measure maximum weight/resistance. The reported value in kilograms represented the average of the peak force measurements of each of the five cores (Hoffman *et al.,* 2009). For further analysis, samples were categorized into three tenderness groups based on their WBSF values according to threshold levels reported by [Shackelford *et al* 1991], and [Shackelford,*et al* 1999.]: tender (< 3.9 kg), intermediate (3.9-4.6 kg) and 'tough' (> 4.6 kg).

**pH determination**

The pH determination was performed according to [AOAC 2007]. One gm of sample was blended with 9 ml of distilled water in a laboratory blender for 2 min, filtered and then pH of the filtrate was determined by digital pH-meter. The meat samples were packed, labeled and kept frozen in (-18 $^{o}$C.) one gram. The procedure at each measurement involved excising of fresh cut surface and sampling it with sterile plate . The area was covered by polyethylene cover to avoid desiccation. Sample weighing approximately 1 gm was homogenized in 10 ml 5mm iodo acetic acid, 150 mm KCI neutralized to pH 7.0 by dilute NaOH and HCl. The pH was then read on a laboratory pH meter, (adjusted with buffer, ph 7.0) at room temperature.

**Statistical analysis**

The data collected were subjected to statistical analysis by using complete randomized design used to analyze the results obtained from this study and subjected to ANOVA followed by Least significant difference test (LSD) using the SPSS Methods [SPSS, 2008. ] version ,17.

**RESULTS**

As shown in Table (1) and Figure (1 and 2) the moisture content showed significant ($P<0.05$) difference among the treatment muscles. Goat meat had significantly ($P<0.05$) higher moisture content (72.55 %) compared to sheep meat (66.96 %). Protein content was not significantly ($P>0.05$) different among the types of meat. Goat meat had higher protein content (22.55%) compared to sheep meat (21.44%). Fat content was significantly ($P<0.05$) different among the treatment muscles. However, the fat content of sheep meat was higher (4.89%) compared to goat meat (2.5%). There was no significant ($P>0.05$) difference between the two types of meat in ash content.

As shown in Table (2) and Figure (3 and 4) Cooking loss was not significantly ($P>0.05$) different among the two types of meat. Cooking loss percent of sheep meat was higher (21.44%) compared to goat meat (19.89%). Shear force, which measures muscle tenderness, was significantly ($P<0.05$) different among the two types of meat studied. However, sheep meat had lower shear force values (30.03) compared to goat meat (33.87). Also, there was no significant ($P>0.05$) difference between sheep meat and goat meat in pH values. Sheep meat had lower pH (5.5) compared to goat meat (5.8).

**Table 1.** Mean values of chemical composition of sheep meat and goat meat:

| Parameters | Sheep meat | Goat meat | Significant level |
|---|---|---|---|
| **Moisture %** | 68.76 ± 0.95[b] | 72.55 ± 0.70[a] | * |
| **CP %** | 21.44 ± 0.64 | 22.55 ± 0.71 | NS |
| **Fat %** | 4.89 ± 0.80[a] | 2.50 ± 0.17[b] | * |
| **Ash %** | 2.90 ±0.03 | 2.40 ± 0.02 | NS |

* = Significance different P<0.05
NS = No significant
a, b = means the mean with different superscript in the same row are significantly different at P<0.05

**Table 2**. Mean values of Cooking loss (%), Shear force and pH in sheep meat and goat meat:

| Parameters | Sheep meat | Goat meat | Significant level |
|---|---|---|---|
| Cooking loss (%) | 22.47 ± 0.53 | 19.89 ± 0.55 | NS |
| Shear force kg/cm$^2$ | 32.06 ± 0.89[b] | 36.87 ± 0.95[a] | * |
| pH | 5.5 | 5.8 | NS |

* = Significance different P<0.05
NS = No significant
a, b = means the mean with different superscript in the same row are significantly different at P<0.05

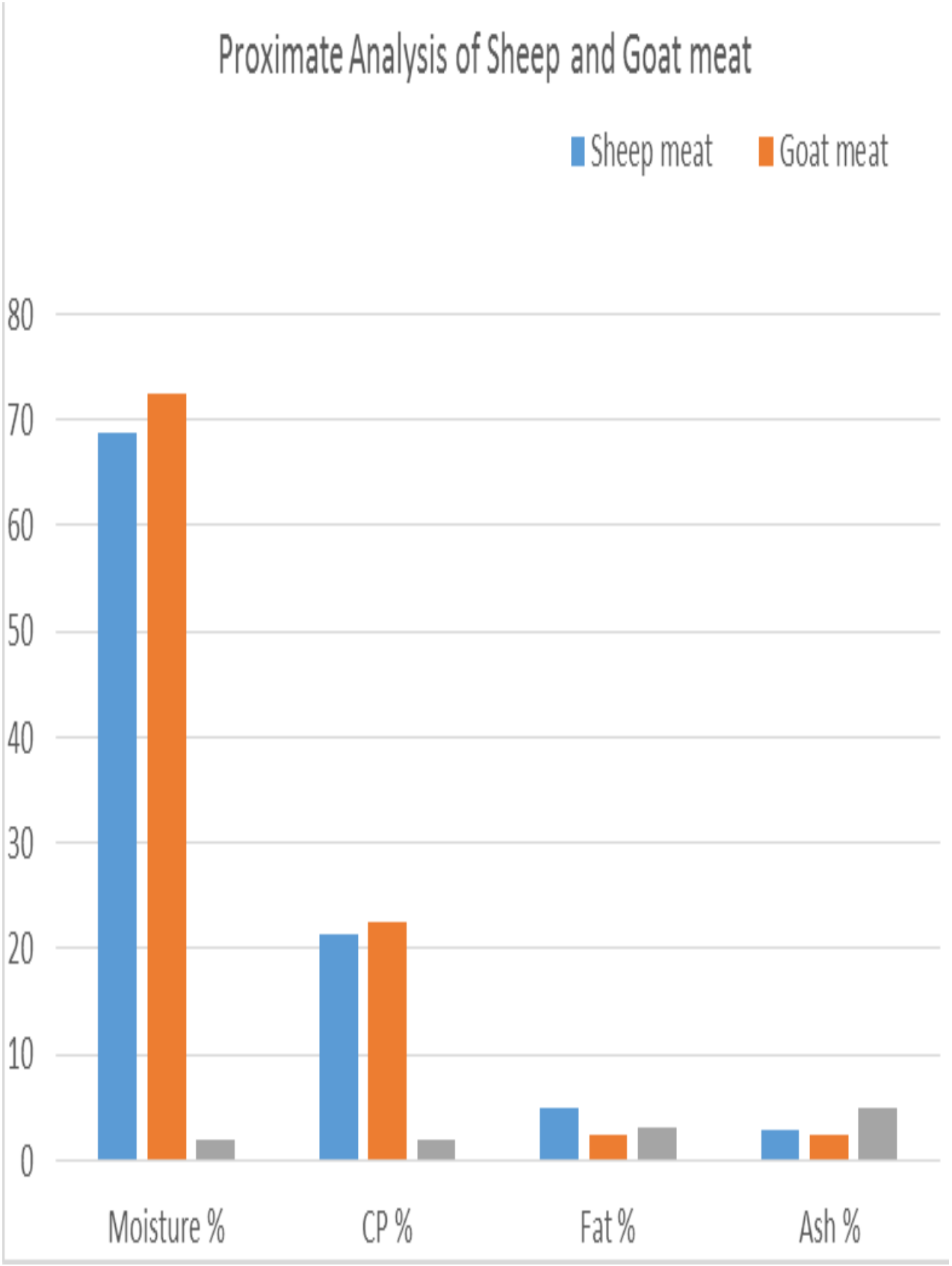


**Figure (1):** Mean values of chemical composition of sheep meat and goat meat

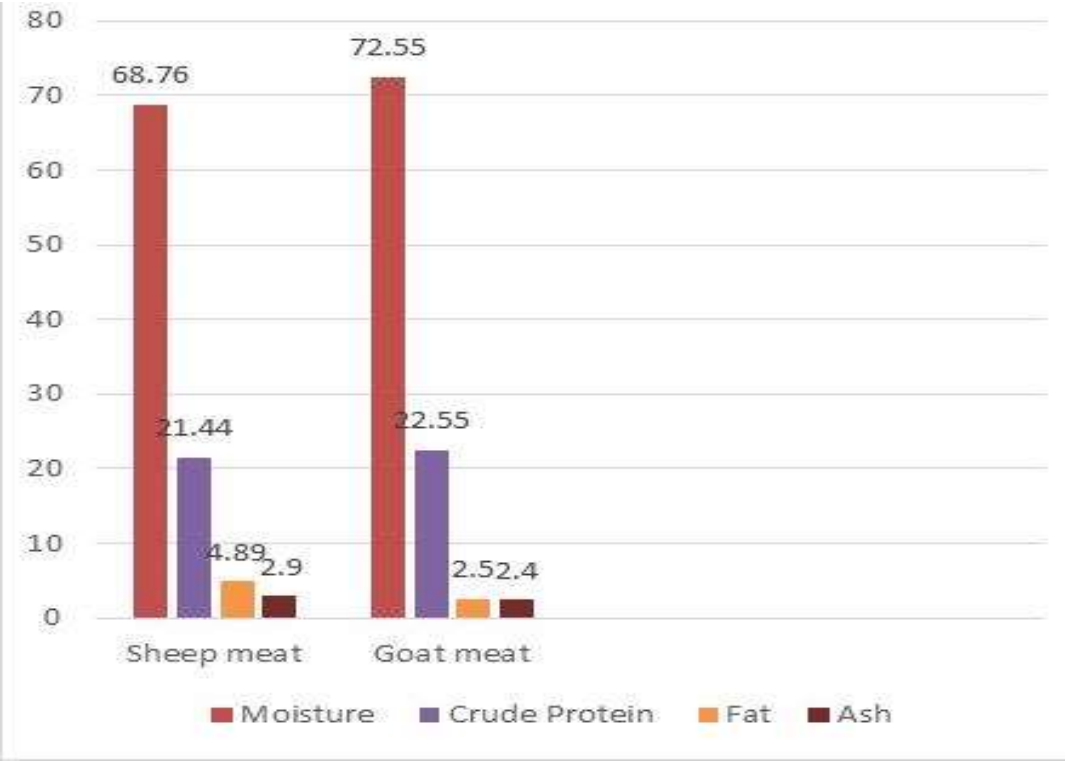


**Figure (2):** Mean values of chemical composition of sheep meat and goat meat

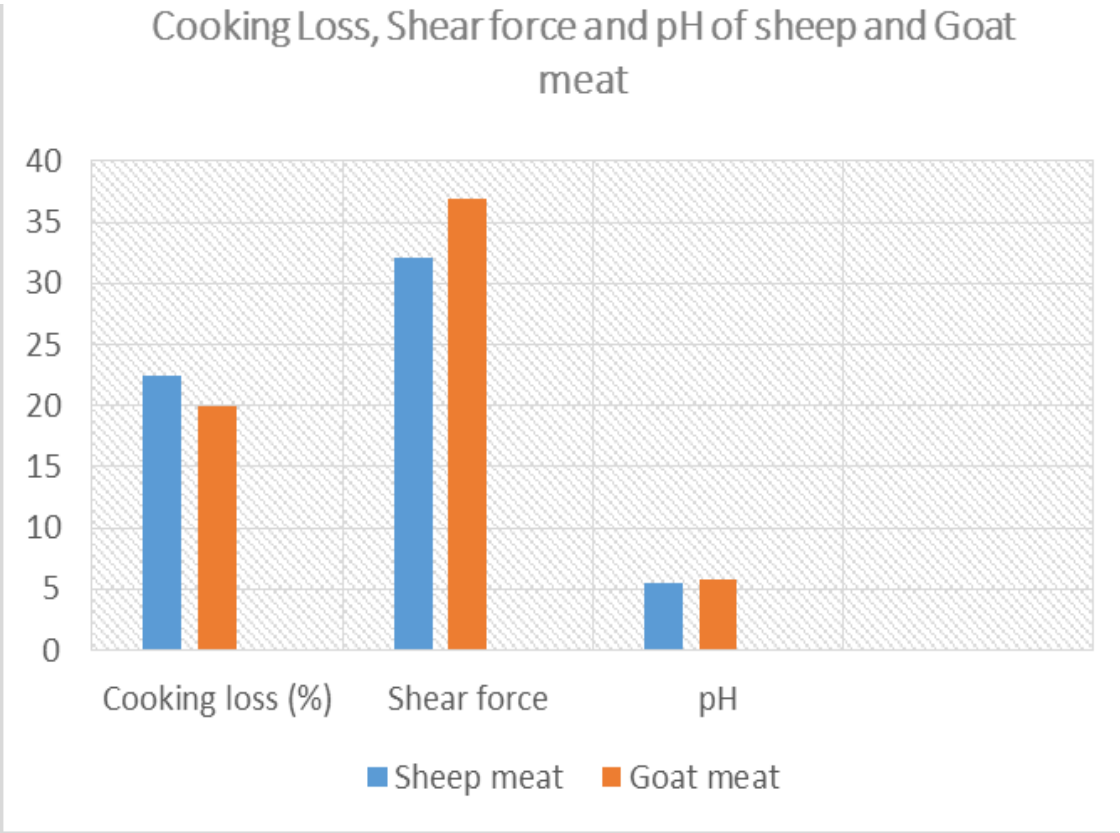


**Figure (3)**. Mean values of Cooking loss (%), Shear force and pH in sheep and goat meat:

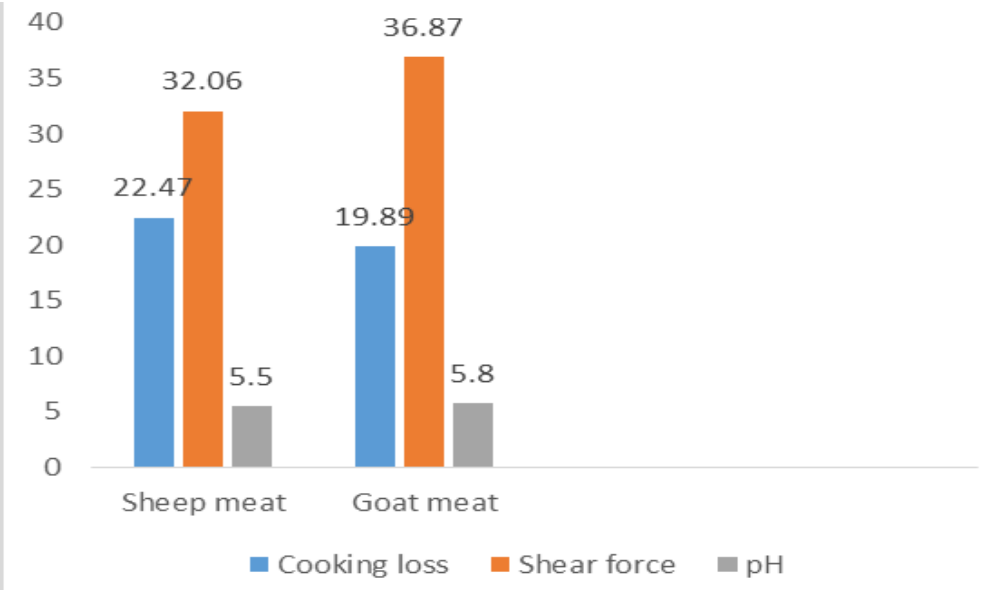


**Figure (4)**. Mean values of Cooking loss (%), Shear force and pH in sheep and goat meat

## DISCUSSION

In the present study goat meat had significantly high moisture content and lower fat compared to sheep whereas protein and ash content were not significant difference between them. These findings are in line with the findings of [Mahgoub, O. and Lodge G. A. 1998] which reported that goat meat is lower fat and higher moisture content compared to sheep meat. The present result in line with the findings of [Hogg *et al*1992.].who reported that goat meat contained little fat and higher proportions of protein. Also the present result in line with the results reported by [Babiker *et al* 1990] and [Siham, A. A., 2015] who found that the goat meat have significantly less intramuscular fat and more moisture than sheep. The present result in line with that reported by [Lee, *et al* 2008] who found no significant differences in protein percent between sheep and goat meat. On the other hand the result in this study showed significant differences ($p < 0.05$) in moisture and fat contents between sheep and goat meat which was disagree with the findings of [Lee, *et al* 2008] who reported no significant difference ($P>0.05$) in moisture and fat contents between sheep and goat meat. The result in this study was higher than the result of [Webb et al 2005.] who found that the protein in sheep meat as 19.45%. In this study cooking loss was not significantly ($P > 0.05$) different among the two types of meat, which is comparable with the result of [Lee *et al* 2008]. In this study shear force, was significantly ($P<0.05$) different among the two types of meat studied as sheep meat had lower shear force values (30.03) compared to goat meat (33.87). In this study, sheep meat had higher cooking loss and lower shear force values than goat meat. This result disagrees with that reported by [Marichal, *et al* 2003.] who found that shear force values of lamb meat were higher when compared with shear force values reported in other animal's species. The results in this study were in line with those [Sen, *et al* 2004] and [. Lee,*et al* 2007] who found shear force values were significantly greater in goat meat. The average pH of 5.5 and 5.8 for sheep and goat meat, respectively, observed in the present study were less than the figures reported by [Voisinet, *et al* 1997] and [29] who found the pH to be 6. Also the results recorded in this study were in line with those reported by [. Kadim *et al.,* 2009.] who reported the pH in sheep meat at a range of 5-5.8. the result in this study disagree with the result of [Babiker *et al* 1990] who reported that the shear force measured across muscle fibers and the connective tissue strength were greater, but no significantly so, in goat meat than in lamb meat.

## CONCLUSION

The present study confirmed the differences in chemical composition and some quality attributes of sheep meat and goat meat. The results showed that goat meat has less fat and more moisture compared to sheep meat.

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