CONSUMER PREFERENCES AND MEAT CHARACTERISTICS OF FOUR INDIGENOUS GOAT STRAINS RAISED IN TRADITIONAL LIVESTOCK PRODUCTION SYSTEM IN SELECTED AREAS OF TANZANIA

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EXTENDED ABSTRACT

A study was carried out in Bahi, Kwimba, Ngorongoro and Same districts in Tanzania to assess consumer preferences and meat characteristics of four Small East African (SEA) goat strains raised under traditional livestock production system. The study aimed at determining age, sex and meat cuts preferred by consumers in the four districts and comparing the carcass characteristics of Sonjo, Pare, Gogo and Sukuma goats raised in those districts.

To determine the age, sex and meat cuts preferred by consumers a household survey was conducted in the four districts. Information on consumers' preferences on goat meat attributes was gathered using a structured questionnaire. In each district, two goat meat shops and 15 goat meat consumers per meat shop were randomly selected for interview. Descriptive statistics were used to generate means, frequency and percentages of variables studied. The majority (48%) of the respondents interviewed had primary school education and this was observed in all districts. Only few respondents reported to have secondary school education level (19%), University education level (3%) and informal education (2%). The results revealed that the preference for meat from different livestock species was significantly different ($P \leq 0.05$) among the four districts. The majority of the respondents interviewed across the districts consumed goat meat and most of them were found in Ngorongoro district while pork meat was consumed more in Same district than in the other districts. Mutton was least preferred in Bahi district than in the other districts. The majority of the respondents consumed beef (28%) and goat meat (27%) three to four times in a week and 21% of the respondents consumed five to six times per month. Very few respondents (3%) ate meals that included pork every day. The highest percentage of people who ate beef daily (17%) were observed in Ngorongoro, Bahi and Kwimba. Beef

was the most frequently consumed meat, followed by goat meat (10%) and mutton (10%). Most of the respondents (58%) scored excellent for taste of goat meat, while 48.3% scored very good on juiciness and 55.8% of the respondents scored poor on fatness. Castrate was the most predominantly (49.2%) consumed sex of goats compared to entire male and female. Goats of two to three years were the most preferred by consumers (59.2%) compared to other age groups (< 1 year and > 3 years). The most preferred part of the goat carcass was the hind leg (60.8%), followed by fore leg (51%) and loin (49%) due to leanness. Hind legs were the carcass parts which fetched the highest price (TZS 10 317 ± 3844.83 in Kwimba district, TZS 9966 ± 511.89 in Same district, TZS 9676 ± 461.01 in Ngorongoro district and TZS 9233 ± 379.88 in Bahi district). For non- edible meat parts the majority (94%) of the respondents preferred lungs, followed by testicle (91%) and nose (89%) in all districts. Among the non- carcass components livers was sold at the highest price (TZS 5817 ± 199.64), followed by intestines (TZS 5591 ± 189.71) in Same district. Heart was sold at the lowest price (TZS 1622 ± 90.44) in Ngorongoro district.

For specific objective 2, a study was conducted to determine carcass characteristics and meat composition of four strains of SEA i.e. Gogo, Sonjo, Pare and Sukuma. Animals from each strain were sampled from two villages in the respective districts where the goat strain is dominant. A total of six adult goats (three males and three females) at the age of 1 – 3 years from each village were purchased from livestock farmers and slaughtered, making a sample size of 48 goats for study two. After slaughtering and evisceration, the left half carcass was jointed into standards joints and composition was determined by dissecting the carcass into lean, bone and fat. Lean, bone and fat were scrubbed from each joint using a scalpel blade and then weighed separately. *Longissimus dorsii* muscle was sampled for proximate analysis. Gogo (10.3 ± 0.45 kg) and Pare (9.8 ± 0.44 kg) goats had

heavier mean (± se) carcasses than Sonjo (7.8 ± 0.45 kg) and Sukuma (8.4 ± 0.44 kg). There were significant differences ($P \leq 0.05$) among the strains in terms of weight of non-carcass components and linear carcass measurements. Fore leg, hind leg, and ribs contributed more than 60% of the carcass weight and Gogo goats had the highest values for these meat cuts. The carcasses of goats slaughtered contained 65.2 – 67% muscle, 23.5 – 25.7% bone and 8.4 – 10.7% fat. Sonjo goats had the highest muscle mass in the hind leg and significantly ($P \leq 0.05$) differed from Pare, but not ($P > 0.05$) from Gogo and Sukuma goats. The lowest proportion of muscle was found in the ribs of the Sonjo goats. The highest proportion of bones was found in the ribs of Gogo goats and was significantly ($P \leq 0.05$) different from that of Sukuma but not ($P > 0.05$) from that of Pare and Sonjo goats. For the hind leg, Pare goat carcass had more bones than Sonjo goats, but had values similar to those of Gogo and Sukuma goats. Primal cut with the highest proportion of fat was the breast (23.83%), which was observed in the Sonjo goats and the lowest (4.47%) was found in the foreleg of the Pare goats. With regard to chemical composition, only crude protein and ash contents were significantly ($P \leq 0.05$) influenced by strain. Pare goats had carcass with less crude protein content (20.7%) than the carcasses from other goat strains. The carcass from Sukuma goats had the least mineral content (4.01%) and differed significantly ($P \leq 0.05$) from that of Sonjo (4.43%), but not ($P > 0.05$) to that of Gogo (4.11%) and Pare goats (4.25%).

It can be concluded from the first study that, goat meat is highly preferred than other meat types like beef, mutton, pork and chicken. Goat meat is highly preferred in Ngorongoro district compared to Bahi, Same and Kwimba districts. Hind leg and fore legs are the most preferred meat cuts and highly priced in all districts. From the second study, it is concluded that, there is significant variation among the SEA goat strains in carcass and killing out characteristics, tissue distribution (meat, bones and fat) in the meat cuts and

carcass chemical composition. Gogo and Pare goats yield higher slaughter and carcasses weights than Sukuma and Sonjo goats. It is recommended that efforts are needed to improve the breed (Gogo and Pare) which revealed bigger carcass weight and meat cuts and also with good qualities.

DECLARATION

I, Yusuf Daud Semuguruka, do hereby declare to the SENATE of Sokoine University of Agriculture that this dissertation is my own original work done within the period of registration and that it has neither been submitted nor being concurrently submitted in any other institution.

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The above declaration is confirmed by:

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DEDICATION

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LIST OF ABBREVIATIONS AND ACRONYMS

AOAC	Association of Official Analytical Chemists
BW	Body weight
CD	Chest depth
CL	Carcass Length
cm	Centimeter
COSTECH	Tanzania Commission for Science and Technology
CP	Crude Protein
CW	Carcass weight
DP	Dressing percentage
EBL	External Body Length
EE	Ether extract
GIT	Gastro Intestinal Tract
HCL	Hind leg circumference
HLL1	Hind leg length 1
HLL2	Hind leg length 2
IBL	Internal Body Length
kg	Kilogram
km	Kilometer
LSM	Least squares means
MLFD	Ministry of Livestock and Fisheries Development
mm	Millimeter
^{o}C	degree celsius
P	Probability
SAS	Statistical Analysis System
SE	Standard error

SEA	Small East African Goat
SPSS	Statistical Package for Social Science
TALIRI	Tanzania Livestock Research Institute
TZS	Tanzanian Shillings

CHAPTER ONE

1.0 INTRODUCTION

1.1 Importance of Goat Keeping in Tanzania and other Countries

Tanzania has 16.7 million goats and 98% of them are of the indigenous type belonging to the Small East African breed. This breed is widely distributed in all agro-ecological zones of the country (MLFD, 2015). Goat keeping forms an important and essential part of small-holder farming in Tanzania and is undertaken mainly by agro-pastoralists, pastoralists and farmers engaged in mixed farming. The advantages of goats over other livestock species in traditional farming systems is associated with their small size, low initial costs, rapid turnover and efficient conversion of feed resources not directly eaten by man (Chenyambuga *et al.,* 2012; Shija *et al.,* 2013). Goats serve as a living bank for the resource deprived rural communities, because they can easily be changed into cash once a need happens (Umeta *et al.,* 2011). Goats are considered as an insurance that is used under urgent situations such as payment of medical bill, school fees and purchase of food during the period of food scarcity (Chenyambuga *et al.,* 2014).

Goats provide readily available animal protein in human diets. Utilization of small land holdings, small body size, early maturity, higher digestion efficient (Tshabalala *et al.,* 2003), short generation interval of goats make them appropriate for use in improvement of household nutrition, income generation and increased farm output (Peacock *et al.,* 2011). The most common traditional goat production system in Tanzania is extensive system and animals are grazed on natural pastures throughout the year (Mushi *et al.,* 2009). In the traditional sector goats are slaughtered at the age of three to five years with live body weight (BW) of approximately 20 – 30 kg (Mushi, 2004). The annual goat off

take under the traditional sector is low (28%) and carcass weight is small (15 kg) for commercial purposes. However, in African traditions, goat meat yield is greater than the conventional carcass weight, as internal organs, portions of the offal and skins are consumed. This significantly increases the percentage of body weight that can be consumed (Aduku *et al.,* 1991; Ermias *et al.,* 2000).

Carcass yield and quality are of interest in meat production. Body weight is one of the most important predictors of carcass yield and is the determinant of the commercial value of an animal. Meat quality is influenced by many factors including breed, age, sex, and nutrition, pre-slaughter and post-slaughter managerial aspects (San *et al.,* 1998; Nardone *et al*., 2004). Goat production in tropical countries involves grazing on natural pastures whose availability and quality are highly variable. Consequently, these animals produce poor carcasses of low quality meat (low carcass weight, poor conformation and that meat is tough. The demand for quality meat in Tanzania is growing due to expanding markets composed of tourism, mining industries, expatriates as well as increased income and purchasing power of the general society (Hozza *et al.,* 2014). The importance of goat farming has increased in recent years due to their fast economic return. Goats provide more meat and milk per unit live weight per year than other large ruminants. Nutrition and management are considered crucial in determining the quantity, quality and economics of meat production (Goetsch *et al*., 2011).

1.2 Carcass Characteristics

1.2.1 Carcass weight

Carcass weight is defined as the whole body of a slaughtered animal after bleeding, skinning, evisceration and removal of head, feet, genitals and udder (Sen *et al*., 2003).

However, there is variation between authors, some include tail, and diaphragm, kidney and pelvic fat as components of the carcass while other consider them as non-carcass components (Malole, 2002). Carcass of meat animals are generally evaluated commercially in terms of yield and quality of lean. Yield refers to the amount of saleable meat. Carcass quality is evaluated subjectively by assessing the conformation of the carcass and the amount and distribution of visible carcass fat. Quality of the lean refers to the palatability of the lean and is strongly influenced by the degree of marbling (Mushi, 2004). Average carcass weight of goats from different parts of the world range from 10 kg (Africa) to 24 kg in (Far East) with an overall mean of 12 kg (Malole, 2002). Goat meat sellers pay more attention to carcass weight, dressing out percentage and muscling or meatiness which reflects an assessment of meat to bone ratio. The characteristics of interest are carcass weight, dressing percentage and carcass composition. On average carcass weight of indigenous goats account for about 42.3% of the slaughter weight while gastrointestinal tract, urino-genital tract, pluck and external offal accounts for 10.1, 1.7, 4.8 and 18.2% of the slaughter weight, respectively (Chenyambuga *et al.,* 2004). Heterogeneity in carcass yield and quality emanates from differences in age, breed, nutrition and sex.

1.2.2 Dressing percentage

Dressing percentage is the proportion of carcass weight to slaughter weight. The dressing percentage of goats in the tropics ranges between 45 and 55% and in Tanzania it ranges from 39 to 43% (Tshabalala *et al*., 2003). Dressing percentage is affected by nutrition, breed, sex, slaughter weight, age, gut fill, methods of dressing the animal, type of water provision and transport prior to weighing and dressing (Malole, 2002). Live weight affects the dressing percentage, the heavier the weight the higher the dressing percentage of the animal (Hoza *et al*., 2014).

1.2.3 Carcass composition and quality

Carcass composition is the proportion of muscle, bone and fat in the carcass and it varies according to species, breed, and age of the animal and live weight at slaughter. Species has an influence on carcass composition (Adam *et al*., 2010; Sen *et al*., 2003). A higher plane of nutrition increases the percentage of fat while undernutrition level reduces fat percentages and to some extent retard muscle development. Several research have indicated that among the three tissues, fat is the most variable carcass component in the body and it plays an important role in carcass quality as it contributes to the appealing appearance and yield value of the carcass. In Tanzania several studies have shown that fat composition in goat varies from 6.7 to 14.5%, depending on the state of nutrition, while lean content account for 65% of the total composition of the carcass (Mushi *et al*., 2009).

With regard to meat consumption, quality includes palatability, freshness and being free of pathogens and toxins. Palatability attributes of meat includes tenderness, flavour, marbling, taste and juiciness and these properties are again reliant on an elongated chain of other influences such as age, sex, condition of animal and biochemical composition of the muscle (Webb *et al*., 2005).

1.3 Non-carcass Components

The edible non-carcass components include; head, liver, kidney, skin, feet, tongue, brain, cheek, intestines, lungs, spleen, blood, and fat (Malole, 2002). Non–carcass components are of significant importance in Tanzania and other tropical countries because they are consumed, profitable and contribute to the overall source of animal protein. During dressing of animals, some of these components are left with the carcass depending on the market and country (Mushi, 2004).

1.4 Consumer Preferences on Goat Meat

Goat meat is virtually commonly consumed in many societies and social and economic conditions and purchasers in different societies have different preferences (Casey *et al*., 2003). The meat consumption behavior is the major determining factor for the development of livestock industry in many countries (Raju and Suryanarayana, 2005).

The consumer theory indicates that consumer performance is influenced by taste and favorites of consumers and these are reflected in the market through choice and acquisition of meat basing on visible and invisible appearances of meat (Raju and Suryanarayana, 2005; Mushi *et al.,* 2006). Many studies have shown that consumers are very anxious with qualities and attributes of meat (Webb *et al*., 2005). Different ethnic groups have different preferences for goat meat. Some ethnic groups prefer either young kids, weighing 6.82 - 11.36 kg live weight or young goat that yield 11.36 kg carcass (approximately 22.72 kg live weight) (Gipson, 2003). Muslims in West Africa prefer slightly heavier carcasses (approximately 32 kg live weight).

However, people from other social groups in West Africa prefer mature bucks from which they prepare goat's head soup and other dishes that are reported to have aphrodisiac qualities (Pinkerton, 1994). In Gairo district Tanzania, meat consumers choose meat cuts based on the visual appraisal of fat content. The higher the fat content, the more preferred is the meat (Knight, 2006). Also meat consumers prefer castrated male and infertile female goats because they have higher fat content than the other categories. In addition, it is interesting to note that, although the consumers prefer fatty carcasses, the legs (hind and fore) are the carcass part sold readily by meat seller because of their meatiness (Mushi, 2004).

1.5 Justification and Objectives of the Study

Despite the existence of many SEA goat strains with diverse and distinct features, there is very little information on consumer preference and meat characteristics of the different Small East African goat strains in Tanzania. This drives a need for more research so as to generate more information on consumer preference and carcass quality with respect to different goat strains and management systems in Tanzania. The information on meat characteristics is useful to goat breeders, extension staff, policy makers and producers as it can be used for designing breeding strategies for production of meat of high quality so as to satisfy the demand of a wide range of consumers. This study was carried out to determine consumer preferences for goat meat and compare meat characteristics of indigenous goats raised under traditional livestock production systems in selected areas of Tanzania.

The specific objectives were:

i. To determine the age, sex and meat cuts preferred by consumers in four districts in Tanzania
ii. To compare carcass characteristics of four strains of Small East African goats

REFERENCES

Adam, A. A. G., Atta, M. and Ismail, S. H. A. (2010). Quality and sensory evaluation of meat from nilotic male kids fed on two different diets. *Animal Science Journal* 1(1): 07 – 12.

Aduku, A. O., Aganga, A. A., Okoh, P. N., Ingawa, S.A. and Phillip, D.O.A. (1991). Contribution of offal to the gross value of goat carcasses in Nigeria. *Small Ruminant Research* 6: 179 – 184.

Casey, N.H., Van Niekerk, W.A. and Webb, E.C. (2003). Goat meat. In: Caballero, B., Trugo, L., Finglass, P. (Eds.), Encyclopaedia of Food Sciences and Nutrition. Academic Press, London. pp. 2937 – 2944.

Chenyambuga, S.W., Mtenga, L. A. and Kifaro, G.C. (2004). Carcass characteristics of indigenous goats in Tanzania. In*: Tanzania Society of Animal Production Conference series* 31: 202 – 211.

Chenyambuga, S.W., Jackson, M., Ndemanisho, E.E. and Komwihangilo. D.M. (2014). Profitability and contribution of small scale dairy goat production to income of smallholder farmer in Babati and Kongwa districts Tanzania. *Livestock. Livestock Research for Rural Development,* 26(27). [www.lrrd.org/lrrd26/chen 26027.htm]. Site visited on 9/11/2015.

Chenyambuga, S.W., Komwihangilo, D. M. and Jackson, M. (2012). Production performance and desirable traits of Small East African goats in semi-arid areas of Central Tanzania. *Livestock Research for Rural Development,* 24(7) [www.lrrd.org/lrrd24/chen2407.htm]. Site visited on 16/10/2015.

Ermias, E., Rege, J. E. O. and Banerjee, A. K. (2000). Alternative approach for evaluating small ruminant genotypes for meat production in Ethiopia. In: The Opportunities and Challenges of Enhancing Goat Production in East Africa, Workshop Proceedings, Langston University, OK, E (Kika) de la Garza Institute for Goat Research, Langston, OK pp. 196 - 200.

Gipson, A.T. (2003). Marketing channels and strategies. Virginia State University [http://www.geocities.com/junipercreekfarm/farming/Livestock/meatgoatmkt.htm]. Site visited 25/10/2015.

Goetsch, A. L., Merkel, R. C. and Gipson, T. A. (2011). Factors affecting goat meat production and quality. *Small Ruminant Research* 101(1): 173 – 181.

Hozza, W. A., Mtenga, L. A., Kifaro, G. C., Shija, D. S. N., Mushi, D. E., Safari, J. G. and Shirima, E. J. M. (2014). Meat Quality Characteristics of Small East African Goats and Norwegian Crosses Finished under Small Scale Farming Conditions. *Asian-Australasian Journal of Animal Sciences* 27(12): 1773 – 1773.

Knight, E., House, L., Nelson, M. C. and Degner, R. (2006). An evaluation of consumer preferences regarding goat meat in the South. *Journal of Food Distribution Research* 37(1): 88.

Malole. J. L. (2002). Studies on goat growth rate, carcass quality and healthy resistance of three strains of Tanzania local goat. MSc. Dissertation, Sokoine University of Agriculture, Morogoro, Tanzania. 109pp.

MLFD (2015). Budget speech 2015/16. Ministry of Livestock and Fisheries Development Tanzania. [www.mifugouvuvi.go.tz]. Site visited on 10/2/2016.

Mushi, D. E. (2004). Studies on marketing of meat goats and carcass composition:- a case study of Gairo auction markets. MSc. Dissertation, Sokoine University of Agriculture, Morogoro, Tanzania. 153pp.

Mushi, D. E., Mtenga, L. A., Eik, L. O., Safari, J. and Mwilawa, A. J. (2006). Some factors affecting the quality of meat from ruminants and their relevance to the Tanzania meat industry. In: *Tanzania Society of Animal Production Conference series* 32: 109 – 124.

Mushi, D. E., Safari, J., Mtenga, L. A., Kifaro, G. C. and Eik, L. O. (2009). Growth and distribution of non-carcass components of Small East African and Norwegian crossbred goats under concentrate diets. *Livestock Science* 126(1): 80 – 86.

Nardone, A., Zervas, G. and Ronchi, B. (2004). Sustainability of small ruminant organic systems of production. *Livestock Production Science* 90(1): 27 – 39.

Peacock, C., Ahuya, C. O., Ojango, J. M. K. and Okeyo, A. M. (2011). Practical crossbreeding for improved livelihoods in developing countries: the FARM Africa goat project. *Livestock Science* 136(1): 38 – 44.

Pinkerton, F., Harwell, L. and Drinkerwater, W. (1994). Marketing meat goats: Chanel supply and demand. (www.geocities.com/junipercreekfarm /farming /livestock/meatgoatmkt.htm-22k). Site visited on 15 September 2014.

Raju, D. T. and Suryanarayana, M. V. A. N. (2005). Meat consumption in Prakasam district of Andhra Pradesh: an analysis. *Livestock Research for Rural Development 17(11*) [www.lrrd.org/lrrd17/raju/1711/.htm]. Site visited on 02/10/2015.

Tshabalala, P. A., Strydom, P. E., Webb, E. C. and de Kock, H. L. (2003). Meat quality of designated South African indigenous goat and sheep breeds. *Meat Science* 65: 563 – 570.

San, C., Sanchez, A. and Alfonso, M. (1998). Small ruminant production systems and factors affecting lamb meat quality. *Meat scienc*e 46: S29 - S64.

Sen, A.R., Santra, A. and Karim, S.A. (2003). Carcass yield, composition and meat quality attributes of sheep and goat under semi-arid conditions. *Meat Science* 66: 757 – 763.

Shija, D. S., Mtenga, L. A., Kimambo, A. E., Laswai, G. H., Mushi, D. E., Mgheni, D. M. and Safari, J. G. (2013). Chemical composition and meat quality attributes of indigenous sheep and goats from traditional production system in Tanzania. *Asian-Australasian Journal of Animal Sciences* 26(2): 295 - 305.

Umeta, G., Duguma, M., Hundesa, F. and Muleta, M. (2011). Participatory analysis of problems limiting goat production at selected districts of East Showa zone, Ethiopia. *African Journal of Agricultural Research* 6(26): 5701 - 5714.

Webb, E. C., Casey, N.H. and Simela, L. (2005). Goat meat quality. *Small Ruminant Research* 60 (1–2): 153 – 166.

CHAPTER TWO

PAPER I

2.0 Assessment of consumer preferences for goat meat in four districts in Tanzania

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Abstract

A study was conducted to assess consumer preferences for goat meat in four districts in Tanzania. The districts were Bahi, Ngorongoro, Same and Kwimba located in Dodoma, Arusha, Kilimanjaro and Mwanza regions, respectively. Information on consumption frequencies and preferences for meat from different livestock species, goat meat attributes preferred, goat meat cuts preferred and their prices was gathered using a structured questionnaire. In each district, two goat meat shops and 15 meat consumers per meat shop were randomly selected for the interview. In all districts the majority (48%) of the respondents interviewed had primary school education level. Only few respondents had secondary school (19%) and University education (3%). The majority (43.3%) of the respondents preferred to consume goat meat and beef (36.7%). Most consumers ate meals with either beef (28.5%) or goat meat (26.8%) three to four times per week. Most consumers reported that they consume chicken meat once per month (31%) and they do not consume mutton (40%) and pork (43%). Most (58%) of the respondents said that good taste is the most important criterion for preferring goat meat. Out of the 120

respondents, 48.3% gave very good scores for goat meat on juiciness and 55.8% scored poor for fatness. Castrate was the most predominant (49.2%) sex of goat consumed. Goats with the age of 2- 3 years were most preferred by consumers (59.2%). The most preferred parts of goat meat were the hind leg (60.8%), fore leg (51.7%), and loin (49%) because of higher lean content. Hind legs were most saleable carcass parts and fetched the highest price in Kwimba, (TZS 10 317 ± 3844.83), same (TZS 9966 ± 511.89), Ngorongoro (TZS 9676 ± 461.01) and Bahi (TZS 9233 ± 379.88) districts. With regard to non-edible meat parts, the majority (94%) of the respondents preferred lungs (94%), testicles (91%) and nose (89%). Among the offals, liver was sold at the highest price (TZS 5817 ± 199.64), followed by intestine (TZS 5591 ± 189.71) in Same district. Heart was sold at the lowest price (TZS 1622 ± 90.44) in Ngorongoro. It is concluded that, goat meat is highly preferred by consumers than other meat types and there is variations in preferences of different goat meat parts among the consumers in different districts.

Keywords: *Meat cuts, Meat attributes, Price, Small East African goats*

2.1 Introduction

Goats are broadly spread around the world and have been a source of human diet since the very commencement of human development and nowadays is one of the main red meat in human foods (Webb *et al.,* 2005). Goats are mainly kept for production of milk, meat and fibre (Mohair and Cashmere). The goat meat is extremely preferred in different countries because of its meatiness, tenderness, juiciness compared to other red meats (Babiker *et al.,* 1985). About 30% of meat consumed in Africa is from goat and it is the top most meat preferred by people (Reed *et al.,* 1988). The growth of tourism, expanding mining industries and establishment of international hotels in Tanzania has led to increase in the demand for goat meat in urban areas (Chenyambuga *et al.,* 2012). Goat

consumption in rural areas also has increased as there are no religious or traditional taboos against consumption of goat meat (Sen *et al.,* 2004).

In the traditional sector, goats are slaughtered at the age of three to five years with live body weight (BW) of approximately 20 - 30 kg (Mushi *et al.,* 2009). They are slaughtered mainly for guests and during festivals such as Christmas and Eid Fitr. However, in Tanzania, there is scanty information on consumers' preference for goat meat (Shija *et al.,* 2013). It is not known which animal age and meat cuts are most preferred by the consumers. This information is vital for promotion of goat production and marketing of goat meat. Therefore, the objective of this study was to compare the preferences for meat from different livestock species and determine the goat meat cuts and attributes preferred by consumers in different localities in Tanzania.

2.2 Materials and Methods

2.2.1 Study Location

The study was carried out in four districts of Tanzania (i.e. Bahi (Dodoma region), Ngorongoro (Arusha region), Same (Kilimanjaro region) and Kwimba (Mwanza region) where goat keeping is predominant. Bahi district lies between Latitude 05°58'0" S and Longitude 35°21'0" E. It is situated in semi-arid areas and have a dry savannah type of climate which is characterized by long dry season, unimodal and erratic rainfall that falls between November/December and April. The district has an annual average rainfall of about 500 to 700 mm and annual average temperature of about 22.6^0 C. Ngorongoro district lies between Latitude $2^0$45‘0’’S and Longitude $35^0$30‘0’’ E. The climate of Ngorongoro is warm and temperate. The short rains are normally received from November to December and long rains start in February and end in June. About 877 mm

of precipitation falls annually and the average annual temperature is 16.5 °C. Same district is located in a semi-arid area with bimodal rainfall regime. Its coordinates are 4°15'0" S and 37°55'0" E. Rainfall in the area is highly variable with annual precipitation averaging 562 mm. The temperatures go up as far as 40^0C in the lowlands and in the mountainous areas temperature ranges from about 15^0C to 30^0C. Kwimba district is situated at an elevation of 1163 meter above sea level and its coordinates are 2°55'0" S and 33°15'0" E. The average temperature range from about 15°C to 25°C. Rainfall is unreliable, bimodal and ranges from750 mm in dry areas to 1200 mm in wet areas.

2.2.2 Sampling and data collection

In each district two goat meat shops and fifteen (15) goat meat consumers per meat shop were randomly selected for interview, making a total sample size of 120 respondents from four districts. A well structured questionnaire was used to collect data. Goat meat shops were visited and thereafter questionnaires were administered to meat consumers visiting the meat shops.

Information was collected from consumers on household characteristics (age, sex, education level, marital status and religion of the respondent) and consumer preferences and frequency of consumption of meat from different livestock species. Moreover, information was collected on age, sex and meat cuts of goats preferred by consumers. Also, information was collected on reasons for preference of goat meat and quality attributes preferred by consumers (i.e. fatness, leanness, juiciness, tenderness, marbling). The reasons for preference were ranked using an index that was calculated based on meat parts of five animals species arranged in rows and consumers from four district arranged in columns.

The formula used to calculate index is shown as follow:

$$\text{Index} = \frac{\text{Sum of } (5 \times \text{rank 1}) + (4 \times \text{rank 2}) + (3 \times \text{rank 3}) + (2 \times \text{rank 4}) + (1 \times \text{rank 5})}{(\text{Totalr5} \times \text{rank1}) + (\text{Totalr4} \times \text{rank2}) + (\text{Totalr3} \times \text{rank3}) + (\text{Totalr2} \times 4) + (\text{Totalr5} \times \text{rank5})}$$

Note: The values are indices computed using the formula below. The value in bracket are the ranks assigned to each species based on the index values.

2.2.3 Statistical analysis

Data from the questionnaires were cleaned, coded, entered and analysed using the Statistical Package for Social Science (SPSS, 2003). Descriptive statistics analysis was used to generate means, frequencies and percentages. Chi-square test was used to test the significance differences of the difference of the frequencies/percentage among the districts.

2.3 Results

2.3.1 Household socio-economic characteristics

Information on household characteristics is presented in Table 1. Results show that across the districts education levels were significantly different ($P \leq 0.05$). In all districts the majority of the respondents had primary school level of education, except in Kwimba where most of the respondents had secondary school education level. Overall, the majority (48%) of the respondents had primary education, followed by those who had secondary school education level (28%). Only few respondents reported to have gone to mid college (19%) and University (3%).

The analysis showed that, there was no significant difference ($P > 0.05$) in marital status among the districts. On average 83% of the respondents interviewed in all districts were

married and these were followed by singles (16%) and widows (1%). With regard to religion, there were no significant difference ($P > 0.05$) among the districts. On average, 79% of the respondents interviewed in all districts were Christians while Muslims comprised 20% of the respondents and very few respondents reported that they had no religion (1%). Sex of the respondents did not differ among the districts ($P > 0.05$). The majority (77%) of the respondents interviewed were males while a few (23%) were females. Age of the respondents did not differ among the districts ($P > 0.05$). Distance from home to the goat market was significant different ($P \leq 0.05$) among the districts. Most (42%) of the goat meat consumers were staying close to the goat meat markets within a distance of less than 1 km or between 1 and 2 km (41%).

2.3.2 Consumer preference for meat from different livestock species

Consumer's preference for different meat types are presented in Table 2. The results revealed that preference for meat of different livestock species differed significantly ($P \leq 0.05$) in the four districts. Goat meat was highly preferred in Bahi and Ngorongoro districts and was followed by beef. In Same district pork was highly preferred, followed by beef and goat meat. In Kwimba district beef ranked first while chicken and goat meat ranked second and third, respectively. Mutton preference across the districts was least, except in Bahi district where pork was ranked last. Overall the respondents interviewed in all districts ranked goat meat first, and it was followed by beef, pork, chicken and mutton in that order of preference.

2.3.3 Frequency of consumption of different types of meat

Frequencies of consumption of meals that included meat from different livestock species in the last six months are presented in Table 3. In all districts few people reported that they eat livestock meat every day. Beef and goat meat were frequently consumed and

most respondents said that they eat these types of meat three to four times in a week. Chicken meat was another type of meat which was consumed frequently. Most of the respondents reported that they eat chicken meat once per month. Mutton and pork were less frequently consumed. The majority of the respondents reported that they had not eaten mutton and pork for the last six months. The frequency of consumption of different types of meat differed among the districts.

In Bahi district, 17% of the respondents said that they eat beef and chicken meat every day and none of the respondents ate mutton and pork every day while in Ngorongoro, 17% of the respondents consumed beef and goat meat every day and none of them consumed mutton and pork. In Same district very few people consumed beef every day, but more people consumed mutton every day than in Ngorongoro and Bahi districts. In Kwimba districts, 17% and 20% of the respondents consumed beef and mutton every day, respectively.

2.3.4 Goat meat quality attributes preferred by consumers

Meat quality attributes preferred by consumers in different districts are presented in Table 4. The results show that the proportions of respondents who considered the different quality attributes of goat meat differed significantly among the districts ($P \leq 0.05$). The results indicate that goat meat was ranked poor in terms of fatness by the majority of the consumers in all districts. The highest percentage of consumers who said that fatness in goat meat is poor was observed in Same (80%) district while the lowest was found in Kwimba district (30%).

Most consumers ranked goat meat as either excellent or very good in terms of leanness. The percentage of consumers who reported that the lean content of goat meat is very good

ranged from 33.3% in Ngorongoro and Same districts to 43.3% in Bahi district. With regard to juiciness, goat meat was judged either good or fair by most consumers in all districts. In terms of marbling goat meat was considered to be either very good or good by the majority of the consumers. Similarly goat meat was considered to be either very good or good in terms of tenderness. The taste of goat meat was ranked as excellent by most of the consumers in all districts. The proportion of respondents who said that the taste of goat meat is excellent ranged from 43.3% in Ngorongoro to 76.6% in Same districts.

Table 1: Households characteristics of respondents

Variable	Districts					
	Bahi n =30	**Ngorongoro** n =30	**Same** n =30	**Kwimba** n =30	**Overall** % n= 120	**P value**
Education of respondent (%)						0.003
Informal	0	10	0	3	3	
Primary school level	80	33	47	30	48	
Secondary school level	17	27	20	47	28	
Mid College level	3	27	30	17	19	
University level	0	3	3	3	3	
Marital status (%)						0.369
Married	90	80	87	77	83	
Single	7	20	13	23	16	
Widow	3	0	0	0	1	
Religion (%)						0.349
Christian	73	90	73	80	79	
Muslims	27	10	27	17	20	
None	0	0	0	3	1	
Sex of respondents (%)						0.684
Males	83	77	70	77	77	
Females	17	23	30	23	23	
Age of respondents (%)						0.078
Below 31 years	13	33	27	47	47	
31 – 50 years	77	63	53	47	60	
Above 50 years	10	3	20	6	10	
Distance to meat market place (%)						0.0001
Below 1 Km	47	57	30	33	42	
1 – 2 Km	37	20	63	43	41	
2 – 5 Km	17	23	7	23	18	

Table 2: Ranking of consumer preference for meat from different livestock species

Meat parts	Bahi	Ngorongoro	Same	Kwimba	Overall index
Beef	0.272 (2)	0.287(2)	0.261(2))	0.225(1)	0.261(2)
Goat	0.273 (1)	0.364(1)	0.250(3)	0.214 (3)	0.275(1)
Mutton	0.131(4)	0.091(5)	0.139(5)	0.170(5)	0.133(5)
Pork	0.126(5)	0.234(3)	0.354(1)	0.176(4)	0.223(3)
Chicken	0.198 (3)	0.202 (4)	0.224(4)	0.215(2)	0.210(4)

Note: The values are indices computed using the formula below. The value in bracket are the ranks assigned to each species based on the index values

$$\text{Index in bracket calculated as} = \frac{\text{Sum of } (5 \times \text{rank 1}) + (4 \times \text{rank 2}) + (3 \times \text{rank 3}) + (2 \times \text{rank 4}) + (1 \times \text{rank 5})}{(\text{Totalr5} \times \text{rank1}) + (\text{Totalr4} \times \text{rank2}) + (\text{Totalr3} \times \text{rank3}) + (\text{Totalr2} \times 4) + (\text{Totalr5} \times \text{rank5})}$$

Table 3: Frequency of consumption of different types of meat

District	Type of meat	Frequency of consumption (%)							
		Never	Once/ month	Twice/ month	Once/week	Twice/week	3-4/ week	5-6/ week	Everyday
Bahi	Beef	3	23	7	13	0	27	10	17
	Goat	0	30	7	17	0	27	7	13
	Mutton	47	40	3	3	0	7	0	0
	Pork	60	23	0	7	0	7	3	0
	Chicken	0	30	10	13	0	23	7	17
Ngorongoro									
	Beef	0	3	0	17	10	27	27	17
	Goat	0	0	0	21	0	17	47	17
	Mutton	53	13	0	10	0	13	7	3
	Pork	40	7	7	27	0	13	7	0
	Chicken	17	47	7	13	0	17	0	0
Same									
	Beef	0	17	3	10	0	40	27	3
	Goat	3	23	0	7	3	43	17	3
	Mutton	43	17	0	10	3	7	3	17
	Pork	53	23	3	7	0	7	3	3
	Chicken	7	27	3	10	0	37	10	7
Kwimba									
	Beef	3	27	0	13	0	20	20	17
	Goat	3	27	3	13	0	20	27	7
	Mutton	17	27	0	10	0	20	7	20
	Pork	10	20	3	30	3	20	7	7
	Chicken	10	20	3	30	3	20	7	7
Overall Mean									
	Beef	**3**	**19**	**3**	**13**	**3**	**28**	**21**	**13**
	Goat	**6**	**20**	**3**	**14**	**1**	**27**	**24**	**10**
	Mutton	**40**	**18**	**1**	**8**	**1**	**12**	**4**	**10**
	Pork	**43**	**12**	**3**	**16**	**1**	**11**	**5**	**3**
	Chicken	**8**	**31**	**6**	**17**	**1**	**24**	**6**	**8**

NB: The results are from multiple response questions

Table 4: Score for quality attributes of goat meat as ranked by consumers

		Districts					
Meat attributes (%)	**Score**	**Bahi**	**Ngorongoro**	**Same**	**Kwimba**	**Overall**	**P value**
Fatness	Excellent	6.7	20	0	6.7	8.4	0.0001
	Very Good	10	16.6	10	20	14.2	
	Good	3.3	6.7	3.3	30	10.8	
	Fair	6.7	6.7	6.7	23.3	10.8	
	Poor	73.3	50	80	20	55.8	
Leanness	Excellent	30	13.3	33.3	40	29.2	0.0470
	Very Good	43.3	33.3	30.1	30	3.4	
	Good	13.3	30.1	20	10	18.4	
	Fair	6.7	20	3.3	20	12.5	
	Poor	6.7	3.3	13.3	0	5.8	
Juiciness	Excellent	10	13.3	0	3.3	6.7	0.1310
	Very Good	20	33.4	10	10	18.7	
	Good	36.7	30	20	26.7	28.3	
	Fair	23.3	20	50	30	30.8	
	Poor	10	3.3	20	30	15.8	
Marbling	Excellent	10	26.6	3.3	6.7	11.7	0.1880
	Very Good	16.7	16.7	16.7	20	27.7	
	Good	33.3	30	50	30	25.6	
	Fair	30	20	26.7	23.3	25	
	Poor	10	6.7	3.3	20	10	
Tenderness	Excellent	23.3	17.7	3.3	3.3	16.6	0.0001
	Very good	50.1	50.1	73.3	20	48.3	
	Good	23.3	23.3	13.4	30	22.5	
	Fair	0	6.7	10	36.7	13.4	
	Poor	3.3	3.3	0	10	4.2	
Taste	Excellent	63.3	43.3	76.6	46.7	57.5	0.1900
	Very Good	16.7	30	16.7	36.7	25	
	Good	10	13.3	6.7	10	10	
	Fair	0	0	0	3.3	0.8	
	Poor	10	13.4	0	3.3	6.7	

2.3.5 Sex and age of goats preferred by consumers in different districts

Table 5 shows sex and age of goats preferred for meat consumption. Results show that the sex of goat preferred by consumers was not significantly different (P > 0.05) among the districts. On average most of the goat meat consumers preferred meat from castrated goats (49%) and female goats (24.2%). The majority of the consumers who preferred castrate goats were from Ngorongoro (57%) and Same (53%). Very few of the goat meat consumers preferred entire male (16.7%) and any sex (9.9%) in all districts. Across the districts, the age of goats preferred by consumers was not significantly different (P > 0.05). The majority (59.2%) of the consumers in all districts were eating goats with the age between 2 and 3 years. Very few (15.8%) consumers were eating meat from goats with less than one year.

Table 5: Sex and age of goats preferred by consumers in different districts

	Districts (%)					
Variable	**Bahi**	**Ngorongoro**	**Same**	**Kwimba**	**Overall**	**P value**
Goat sex						0.142
Entire male	20	6.7	23.3	16.7	16.7	
Female	20	23.3	10	43.3	24.2	
Castrate	50	56.7	53.3	36.7	49.2	
Any sex	10	13.3	13.3	3.3	9.9	
Age of goat						0.126
Less than 1 year	16.7	13.3	3.3	30	15.8	
Between 2 and 3 years	56.7	56.7	76.7	46.7	59.2	
over 3 years	26.7	30	20	23.3	25	

2.3.6 Edible and non-edible goat meat parts

Percentages of consumers who considered the different offal as edible or non-edible are presented in Table 6. The results show that the proportions of respondents who considered the different meat parts as edible or non-edible differed significantly among the districts (P ≤ 0.05). The results revealed that there were more respondents in Kwimba

district who considered penis, vulva, udder and rectum as edible meat parts than in the other districts. With regard to ears, nose, lungs and testicles there were more respondents in Bahi and Same districts who considered them as edible meat parts than in the other districts. In general, the majority of the respondents in all districts preferred lungs (94%), followed by testicles (91%) and nose (89%). On average, many consumers in all districts did not prefer vulva (61%), penis (57%) and udder (55%).

2.3.7 Reasons for preference of different meat parts

Rank of meat cuts in order of preferences and reasons for their preference are presented in Table 7. Most of the respondents in Same (81%), Bahi (67%), Ngorongoro (53%) and Kwimba (43%) districts preferred hind leg because it has more lean meat. The results revealed that, the majority of the respondents in Same (80%), Bahi (70%) and Kwimba (37%) districts preferred fore leg because of having more lean meat, while in Ngorongoro district, 23% of the respondents preferred fore leg because of marbling.

The majority of the respondents in Bahi (67%), Same (50%) and Kwimba (46%) districts preferred loin because of having more lean content. Overall, the majority (61%) of the respondents in all districts most preferred hind leg, followed by fore leg (51%) and loin (49%) because of leanness. Neck meat was preferred by few respondents (3%) because of low marbling. With regards to non-carcass components, the majority (41%) of the respondents preferred heart, followed by intestine (31%) and breast (30.5%) due to good aroma.

Table 6: Edible and non-edible organs from goat meat

		Districts					
Offal organ	**Category**	**Bahi (%) n =30**	**Ngorongoro (%) n =30**	**Same (%) n =30**	**Kwimba (%) n =30**	**Overall (%) n = 120**	**P value**
Penis	Edible	60	17	23	70	43	
	Non edible	40	83.3	77	30	57	0.0001
Vulva	Edible	53	7	27	67	39	
	Non edible	47	93	73	33	61	0.0001
Testicle	Edible	97	77	97	93	91	
	Non edible	3	23	3	7	9	0.019
Udder	Edible	70	47	43	76	45	
	Non edible	30	53	57	23	55	0.016
Uterus	Edible	97	7	17	93	54	
	Non edible	3	93	83	7	46	0.0001
Rectum	Edible	36	50	33	90	52	
	Non edible	64	50	67	10	48	0.0001
Skin	Edible	50	63	83	50	62	
	Non edible	50	37	17	50	38	0.024
Ear	Edible	100	53	100	97	88	
	Non edible	0	47	0	3	12	0.0001
Nose	Edible	100	57	100	97	89	
	Non edible	0	43	0	3	11	0.0001
Lungs	Edible	100	83	100	93	94	
	Non edible	0	17	0	7	6	
							0.017

Table 7: Reasons for preference of different meat cuts and organs

District	Reasons	Meat cuts (%)										
		Neck	Hind leg	Foreleg	Loin	Chump	Rib	Breast	Heart	Intestine	Liver	Head
Bahi	Low fat	54	10	7	3	20	20	10	16.7	26	27	33
	More lean	30	67	70	67	34	12	7	10	8	7	0
	Tender	10	17	20	23	30	39	37	26.7	17	33	3
	Good aroma	3	3	3	0	10	29	39	33.3	42	33	63
	Marbling	3	3	0	7	6	0	7	13.3	8	0	0
Ngorongoro	Low fat	20	3	20	13	27	20	10	10	22	11	7
	More lean	63	53	20	33	33	23	20	23.3	16	33	17
	Tender	11	18	17	24	10	14	7	43.3	31	33	17
	Good aroma	3	3	20	7	7	30	26	6.7	17	13	46
	Marbling	3	23	23	23	23	13	37	16.7	14	10	13
Same	Low fat	20	3	3	0	7	10	3	6.7	13	17	17
	More lean	64	81	80	50	29	30	33	4	22	40	40
	Tender	10	13	7	34	27	27	27	17.7	23	17	17
	Good aroma	3	0	3	13	17	30	20	23.3	36	23	23
	Marbling	3	3	7	3	20	3	17	13.3	5	3	3
Kwimba	Low fat	30	13	13	3	10	23	30	23.3	28	23	23
	More lean	30	43	37	46	26	23	16	16.7	12	30	33
	Tender	20	10	23	24	27	13	17	23.3	19	11	10
	Good aroma	17	27	27	7	17	31	37	30	28	33	33
	Marbling	3	7	0	20	20	10	0	6.7	13	3	3
Overall means	Low fat	31	7	11	4.8	16	18.3	13.2	20	21	19	31
	More lean	46.8	61	51	49	30	30	19	22.1	12	27	46.6
	Tender	12.7	15	17	26.1	24	24	22	11.8	22	24	12.7
	Good aroma	6.5	8	13	6.8	12.7	12.7	30.5	41.3	31	26	6.5
	Marbling	3	9	8	13.3	17.3	15	15.3	4.8	14	4	3

2.3.8 Prices of different meat parts

Price of different meat parts of the carcass in the markets are presented in Table 8. The results show that the price of different meat parts differed significantly among the districts ($P \leq 0.05$). The results indicate that hind legs were the carcass parts which fetched the highest price in Kwimba (TZS 10 317 ± 384.48), Same (TZS 9966 ± 511.89), Ngorongoro (TZS 9676 ± 461.01) and Bahi (TZS 9233 ± 379.88) districts, while the carcass parts which fetched the lowest price were loin (TZS 2542 ± 748.54) and breast (TZS 2650 ± 143.14) both from Kwimba district. Among the offals, the liver fetched the highest price (TZS 5817 ± 199.64), followed by intestines (TZS 5591 ± 189.71) in Same district. The heart fetched the lowest price (TZS 1622 ± 90.44) in Ngorongoro.

Table 8: Average price for various goat meat cuts (TZS)

	Districts				
Meat cuts	**Bahi n = 30**	**Ngorongoro n = 30**	**Same n = 30**	**Kwimba n = 30**	**P value**
Neck	3250 ± 94.38	3363 ± 177.71	3291 ± 133.52	2926 ± 150.14	0.0370
Hind leg	9233 ± 379.88	9676 ± 461.01	9966 ± 511.89	10317± 384.48	0.3630
Fore leg	6533 ± 343.73	6782 ± 303.19	6742 ± 399.79	7683 ± 367.29	0.0001
Loin	3233 ± 203.04	3925 ± 992.15	3883 ± 748.54	2542 ± 748.54	0.0420
Chump	3416 ± 202.48	2725 ± 1320.07	3407 ± 999.37	2650 ± 150.48	0.0001
Rib	8316 ± 298.93	6700 ± 249.54	9050 ± 306.39	7350 ± 306.39	0.0001
Breast	3483 ± 150.16	3717 ± 171.93	322 5 ± 985.48	2650 ± 143.14	0.0060
Heart	2408 ± 136.39	1622 ± 148.84	1683 ± 90.44	1758 ± 90.45	0.0001
Liver	3700 ± 170.95	4241 ± 994.79	5817 ± 199.64	5458 ± 199.65	0.0001
Intestine	4992 ± 20.10	3935 ± 390.07	5591 ± 189.71	4725 ± 189.71	0.0001
Head	2583 ± 84.19	2238 ± 115.11	2958 ± 992.79	2350 ± 992.79	0.0012

2.4 Discussion

2.4.1 Household socio-economic characteristics

The current study found that, the majority of the respondents had primary school education, and therefore, could read and write. This is a desirable situation given the fact that education is a tool for successful running of any economic activities and it increases the ability of a person to solve problems in a more knowledgeable manner. Since, the

majority of the goat meat consumers in all districts had formal education, provision of additional training for new innovations and technologies to the communities of the study areas could be easy (Jackson, 2013; Mwambene *et al.,* 2012). Education can help retail meat sellers in all districts surveyed to cut up carcasses into standard joints and goat meat consumers to be aware of the value of the different cuts (Mushi, 2004). Similar observations have been reported by Mahmood and Rodriguez (1993) on traditional knowledge in meat sector in Nigeria. The current study indicated that most of the goat meat consumers were Christians. This could be that, these results may have been influenced by the selection of the study areas where the majority of the respondents were Christians (Chenyambuga *et al.,* 2012).

Most of the goat meat consumers were males. This observation concurs with the findings by Jessica (2013) and Nelson *et al.* (2004) who reported that men consume more goat meat than women because they have access to the meat which is sold as roasted meat in restaurants and bars while women spent more time at home to take care of children. Most of the respondents interviewed were between 31 and 50 years old, which is the productive age group and consumes meat more frequently compared to the other age groups. Similar findings have been observed by Kaur (2010) that the people with the age of 30 – 50 years have significant influence on meat goat consumption due to economic power. In this study it was noted that most of the goat meat consumers were staying close to the goat meat markets. This makes it easier for the goat meat consumers to access the product.

2.4.2 Consumer preferences for meat from different livestock species

In the current study it was found that mutton and pork were the type of meat not preferred by most consumers. This could mostly be due to religious and custom reasons or unavailability (Semuguruka *et al.,* 2009). Similar findings have been reported by

Devendra and Mcleroy (1982) that the top most preferred meat in Africa is goat meat due to taste and tenderness. Most of the respondents across the districts reported that they consume meal that include meat and the top most score was in Ngorongoro district. This could be due to the reason that many respondents interviewed were coming from pastoralist communities in which meat consumption is very common. Similar findings have been reported by Mtenga *et al*. (1984) that most of the people coming from pastoralist communities consume meal that include meat every day than other people who are not pastoralists. Low consumption of meals that include meat in some places could be due to low income and ignorance of the communities of the study areas on the importance of animal protein in human diets (Semuguruka *et al.,* 2009). Comparable findings have been reported by Kaur (2010) who said that in Malaysia less than 1% of the households have meals which include meat every day and only 4% of the households eat meat at least three to four times a week.

2.4.3 Meat quality attributes preferred by consumers

Taste and tenderness were the most important meat quality attributes considered by goat meat consumers in the study areas. Meat attributes are the factors considered by the goat meat consumers when buying meat. Among the meat quality attributes, fatness, tenderness, leanness, juiciness, marbling and taste are considered to be the most important eating quality attributes which influence consumers overall judgement and perception on any kind of meat (Gerelt *et al.,* 2000; Glitsch, 2000; Burke and Monahan, 2003).

Lepetit and Culioli (1992) defined tenderness of meat as "the ease, perceived by the consumer, with which meat structure is disorganised during mastication" and as such is considered as a sensory property. Another finding have been reported by Bonvillani *et al.* (2010) that preference for fatty carcasses by final consumers in Africa is the main reason

for purchasing goat meat. In this study taste and tenderness were the most important quality attributes considered by meat consumers.

2.4.4 Sex and age of goats preferred by consumers

In the present study most goat meat consumers preferred meat from castrated goats, followed by female goats. Similar results have been reported by Ruvuna *et al.* (1992); Kaur (2010) and Tshabalala *et al.* (2003) that castrated male goats are more preferred by many groups of goat meat consumers because of having fatty and tender carcasses. Mushi (2004) reported similar findings that castrated male goats are more preferred in Gairo district, Tanzania due to fat content of their carcasses. The high preference for fatty carcass observed in this study is contrary to the findings by San *et al.* (1998) who said that fat carcasses cause heart problem and lead to some consumers to prefer to eat lean carcass meat because of low fat contents.

Similar observation has been reported by Ruvuna *et al.* (1992) that castration of the animals influences accumulation of fat, thus making castrated male goats to be more tender comparable to females and have about 5% more fat content than intact male goats. In contrary, Jessica (2013) reported opposite results that, intact males are valued more than castrated males in United States of America. This differences could be attributed to differences in culture. In this study it was found that goat meat consumers in all districts were eating mature animals with the age between two and three years. Very few respondents were eating goat meat from animals with less than one year. This is due to the fact that most goats brought to the markets have the age of above one year because goats above one year of age are bigger in size and, hence, fetch high price. These results are in agreement with the findings of other workers (Mtenga *et al.,* 1984) who reported that goats in Tanzania normally are slaughtered at the age of two to three years. Another

finding has been reported by Kaur (2010) that meat from goat of two to three years are most preferred by many consumers due to the fact that they are mature and their carcasses are tender and have good level of fatness.

Results from this study have shown that most of the respondents in all districts preferred good aroma which was found in meat from goats with the age of over three years. Age and sex have been reported as other important criteria by which consumers judge goat meat (Jessica, 2013). Other findings have been reported by Webb *et al.* (2005) and Bonvillani *et al.* (2010) that age is an important determinant factor in judging meat quality. However, the findings in this study differ from those reported by Jessica (2013) that goat below one year of age are preferred by Muslims in United States of America due low fat content. The findings in the present study agree with those reported by Mushi (2004) in Gairo Tanzania that goat meat consumers prefer meat from mature goats with more than two years of age due fatness.

2.5 Edible and non-Edible Goat Meat Parts

Eating of offal was found to be a common practice in the study areas. Similar findings have been reported by Silva *et al.* (2011) that offal are traditionally used to cover parts of the costs generated during slaughter in Brazil. In addition, Silva *et al.* (2011) reported that lungs and other internal organs like heart, kidneys, and pancreas are highly consumed in Morocco as goat soup. Moreover, dishes made from non-carcass components such as liver, heart, kidney, intestines and tongue are commonly available in most parts of Ethiopia (Sebsibe *et al.,* 2007). Furthermore, goat testicles are highly consumed by men in Kyrgyzstan (Russia) whereby the organ is roasted independently over the fire and consumed for the hope of increasing sexual activities (Sebsibe *et al.,* 2007). Similarly

Rotenberg (2008) reported that eating the reproductive organs of animals retains the potency in males during sexual activities.

2.6 Reason for Preference of Different Meat Parts

Hind leg, fore leg and loin were the most preferred meat parts by goat meat consumers in the study areas because of meatiness. Similar findings have been reported by Mushi (2004) that in Gairo district the majority of goat meat consumers prefer hind and fore legs due to leanness and tenderness. In the current study neck, liver and head meat parts were the least preferred meat parts because of low marbling. This observation agrees with the observations made by Jessica (2013) that neck meat is less preferred by many goat meat consumers because of toughness and less fat content of their meat. Tenderness and fatness has been found to be the main features influencing the choice of meat parts in many African countries (Sen *et al.,* 2004).

2.7 Prices of Different Meat Parts

Hind and fore legs were the carcass parts sold at higher price than the other meat cuts in all district because of leanness. This observation is consistent with Simela *et al.* (2011) who reported that, in South Africa hind limb are more preferred by many goat consumers because of lean and low fat content. Moreover, Mahmood and Rodriguez (1993) reported that hind and fore legs are the meat parts which are most preferred by many consumers in Nigeria because of having more leanness and tenderness. The selling price of meat parts reflect also the preferences of meat parts by consumers (Chrystall, 1998).

2.8 Conclusions and Recommendations

This study has revealed that goat meat is highly preferred by consumers in all districts, followed by beef. The present study further indicates that there is variations in preferences of goat meat parts in different districts. Hind leg and fore legs are the most preferred meat parts in all districts due to leanness and low fat content, and hence, hind leg and fore leg fetch high prices in the market than other meat parts. It is recommended that, more studies on consumer preferences for goat meat should be conducted in other parts of the country in order to come out with the attributes preferred by consumers in different districts.

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2.10 References

Babiker, S. A., Maglad, M. and Koudoda, M. E. (1985). Effects of castration on performance and carcass characteristics of male Sudan desert goats. *World Review of Animal Production* 21 (1): 11 – 13.

Bonvillani, A., Peña, F., de Gea, G., Gómez, G., Petryna, A. and Perea, J. (2010). Carcass characteristics of Criollo Cordobés kid goats under an extensive management system: Effects of gender and live weight at slaughter. *Journal of meat Science and technology* 86 (3): 651 – 659.

Burke, R.M. and Monahan, F. J. (2003). The tenderization of shin beef using a citrus juice marinade. *Journal of meat Science* 63: 161 – 168.

Chenyambuga, S. W., Komwihangilo, D. M. and Jackson, M. (2012). Production performance and desirable traits of Small East African goats in semi-arid areas of Central Tanzania. *Livestock Research for Rural Development*. [www.lrrd. org/lrrd24/7/chen24118.htm]. Site visited on 14/12/2015.

Chrystall, B.B. (1998). Meat quality - How well do we monitor and assure quality. *Animal Production Austrian* 22: 47 – 52.

Devendra, C. and McLeroy, G. B. (1982). Goat Production in the Tropics. Intermediate Tropical Agriculture Service. Longman, New York, 270 pp.

Gerelt, B., Ikeuchi, Y. and Suzuki, A. (2000). Meat tenderization by proteolytic enzymes after osmotic dehydration. *Meat Science* 56: 311 – 318.

Glitsch, K. (2000). Consumer perception of fresh meat quality: cross-national comparison. *British Food Journal* 102: 177 – 194.

Jackson, M. (2013). Production performance and the contribution of dairy goats to income of small scale farmers in Babati and Kongwa districts, Tanzania. MSc. dissertation, Sokoine University of Agriculture, Morogoro, Tanzania 100pp.

Jessica, I. H. (2013). Consumers' preferences for goat meat in the United States: an application of choice-based conjoint analysis. PhD Thesis. Department of Agricultural Economics and Agribusiness, Auburn University, United States of Amrica. 114pp.

Kaur, B. (2010). Consumer Preference for Goat Meat in Malaysia: Market Opportunities and Potential. *Journal of Agribusiness Marketing* 3: 40 – 55.

Lepetit, J. and Culioli, J. (1992). Mechanical Properties of Meat. *Meat Science* 36: 203 – 237.

Mahmood, K. and Rodriguez, A. (1993). Marketing and processing of small ruminants in highland Balochistan Pakistan. *Small Ruminant Research* 10(2): 93 – 102.

Mtenga, L. A., Mandari, G. C. H., Kitaly, A.J. and Sarwart, S. V. (1984). Impact of past and current research on small ruminant meat production in Tanzania. *In: Tanzania Society of Animal Production Conference series* 11: 111 – 144.

Mushi, D. E. (2004). Studies on marketing of meat goats and carcass composition: A case study of Gairo auction markets. MSc. Dissertation, Sokoine University of Agriculture, Morogoro, Tanzania. 153pp.

Mushi, D. E., Safari, J., Mtenga, L. A., Kifaro, G. C. and Eik, L.O. (2009). Effects of concentrate levels on fattening performance, carcass and meat quality attributes of Small East African× Norwegian crossbred goats fed low quality grass hay. *Livestock Science* 124: 148 – 155.

Mwambene, P. L., Katule, A. M., Chenyambuga, S. W. and Mwakilembe, P. A. A. (2012). Fipa cattle in the southwestern highlands of Tanzania: socio-economic roles, traditional management practices and production constraints. *Animal Genetic Resources* 51: 1 – 14.

Nelson, M. C., Whitehead, J. S., Mobini, N. B., Brown, J. R. and Thomas, M. (2004). Segmenting Niche Goat-Meat Markets." *Journal of Food Distribution Research* 35(1): 72 – 79.

Reed, J., Ebong, C., Tanner, I., Gebru, G. and Akale, W. N. (1988). The nutritive value and use of feeds for fattening small ruminants in African highlands. A perspective of ILCA research. *Small Ruminant Research* 12: 10 – 27.

Rotenberg, R. (2008). Udders, penises and testicles. *Ethnology* 123 – 128.

Ruvuna, F., Taylor, J. F., Okeyo, M., Wanyoike, M. and Ahuya, C. (1992). Effects of breed and castration on slaughter weight and carcass composition of goats. *Small Ruminant Research* 7: 175 – 183.

San, C., Sanchez, A. and Alfonso, M. (1998). Small ruminant production systems and factors affecting lamb meat quality. *Meat science* 49: 29 – 64.

Sebsibe, A., Casey, N. H., Van Niekerk, W. A., Tegegne. A. and Coertze, R. J. (2007). Growth performance and carcass characteristics of three Ethiopian goat breeds fed grain less diets varying in concentrate to roughage ratios. *South African Journal of Animal Science* 37(4): 221 – 232.

Semuguruka, Y. D. and Komwihangilo, D. M. (2009). Factors affecting production and productivity of goat and sheep meat in semi-arid in Dodoma. In*: Tanzania Society of Animal Production Conference series* 33: 321 – 333.

Sen, A. R., Santra, A. and Karim, S. A. (2004). Carcass yield, composition and meat quality attributes of sheep and goat under semiarid conditions. *Meat Science* 66(4): 757 – 763.

Shija, D. S., Mtenga, L. A., Kimambo, A. E., Laswai, G. H., Mushi, D. E., Mgheni, D. M. and Safari, J. G. (2013). Chemical composition and meat quality attributes of indigenous sheep and goats from traditional production system in Tanzania. *Asian-Australasian Journal of Animal Sciences* 26(2): 295 – 305.

Silva, A.S., Furtado, D. A., de Medeiros, A. N., Costa, R. G., Cezar, M. F. and Filho, J. M. P. (2011). Characteristics of carcass and non-carcass components in feedlot native goats in the Brazilian semi-arid region1. *Revista da Sociedade Brasileira de Zootecnia* 40(8): 1815 – 1821.

Simela, L., Webb, E. C. and Bosman, M. J. C. (2011). Live animal and carcass characteristics of South African indigenous goats. *South African Journal of Animal Science* 41(1).

SPSS (2003). Statistical Package for Social Science (SPSS 16.0 for windows).

Tshabalala, P.A., Strydom, P. E., Webb, E. C. and De Kock, H. L. (2003). Meat quality of designated South African indigenous goat and sheep breeds. *Meat Science* 65: 563 – 570.

Webb, E. C., Casey, N. H. and Simela, L. (2005). Goat meat quality. *Small Ruminant Research* 60(1): 153 – 166.

CHAPTER THREE

PAPER II

3.0 Carcass Characteristics of four strains of Small East African Goats kept under Extensive Production System

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Abstract

A study was carried out to determine carcass characteristics and meat composition of four strains of Small East African (SEA) goats, namely Gogo (n = 12), Pare (n = 12), Sonjo (n = 12) and Sukuma (n = 12) goats raised on natural pasture under extensive production system. After slaughtering and evisceration, the left side of each carcass was processed into standard joint cuts and each cut separated into subcutaneous fat, lean meat and bone. *Longissimus dorsii* muscle was sampled for proximate analysis. Gogo (10.3 ± 0.45 kg) and Pare (9.8 ± 0.44 kg) goats had heavier carcasses ($P \leq 0.05$) than Sonjo (7.8 ± 0.45 kg) and Sukuma (8.4 ± 0.44 kg) goats. Dressing percentage did not differ among the strains and ranged from 42.1 to 43.5%. There were significant differences ($P \leq 0.05$) among the SEA goat strains in terms of weight of various non-carcass components and linear carcass

measurements. Fore leg, hind leg, and ribs contributed more than 60% of the carcass weight and Gogo goats had the highest values for these meat cuts. The carcasses of goats slaughtered contained 65.2 – 67% lean meat, 23.5 – 25.7% bone and 8.4 – 10.7% fat. Generally, more lean meat was found in the hind legs (21.2 – 26.3%), fore legs (20.8 – 21.1%) and ribs (16.9 – 18.4%). Sonjo goats had the highest muscle mass in the hind leg and significantly differed ($P \leq 0.05$) from Pare, but not from Gogo and Sukuma goats. The lowest proportion of muscle was found in the breast of the Sonjo goats. The highest proportion of bones was found in the ribs of Gogo goats and was significantly different ($P \leq 0.05$) from that of Sukuma, but not different from that of Pare and Sonjo goats. Standard cut with the highest proportion of fat was the breast (23.83%), which was observed in the Sonjo goats and the lowest (4.47%) was found in the fore leg of the Pare goats. Only crude protein and ash contents were significantly ($P \leq 0.05$) influenced by strain. Pare goats had carcass with less crude protein content (20.7%) than the carcasses from other strains. The carcasses of Sukuma goats had the least mineral content (4.01%) and differed significantly ($P \leq 0.05$) from that of Sonjo (4.43%), but not from that of Gogo (4.11%) and Pare goats (4.25%). This study has demonstrated that there are significant differences in carcass and killing out characteristics and carcass chemical composition among the strains of SEA goats studied.

Keywords: Carcass weight, carcass composition, meat cuts, indigenous goat strains

3.1 Introduction

Goat keeping forms an important and essential part of smallholder agriculture in Tanzania and is undertaken mainly by agro-pastoralists, pastoralists and farmers engaged in mixed farming. It is estimated that 30% of the agricultural households in Tanzania keep goats (MLFD, 2012). The advantages of goats over other livestock species in traditional farming systems is associated with their small size, low initial costs, rapid turnover and efficient conversion of feed resources not directly eaten by man (Chenyambuga *et al.,* 2012). Most goats in Tanzania are of the indigenous type belonging to the Small East African (SEA) goat breed. This breed is widely distributed in all agro-ecological zones of the country (MLFD, 2012). The SEA goats are mainly raised for meat production and they provide more meat per unit live weight per year than other large ruminants. Therefore, the SEA goats have a potential for increasing income of the livestock keepers in rural areas because of readily available and expanding markets. The increased demand for meat is a result of growth of tourism, mining industries, international hotels as well as increased income and purchasing power of the society (Mushi *et al.,* 2006). This has created market opportunity for goats kept by pastoralists and agro-pastoralists. Moreover, the demand for goat meat in the international markets has increased in recent years due to emerging export markets in the Persian Gulf countries, Madagascar and the Comoro Islands. Therefore, production of goat meat of high quality and quantity which can meet the requirements of the domestic and international markets is of paramount importance.

The SEA goat breed in Tanzania is composed of many strains located in various localities in the country. The main types include Newala, Ujiji, Sonjo, Pare, Gogo and Sukuma. These strains, though they have not been extensively characterized, have different phenotypic characteristics. The different strains of the SEA goats are the main producers of meat, together with sheep they contribute 22% of the national meat supplies in

Tanzania MLDF (2012). Meat quality attributes are said to be influenced by among other factors, breed and management practices. Despite the existence of many SEA goat strains with diverse and distinct features, there is very little information on meat characteristics of the different Small East African goat strains in Tanzania. This study was carried out to determine and compare the carcass characteristics of four strains of SEA goats kept under different production environments as a step towards their characterization.

3.2 Materials and Methods

3.2.1 Study area

The study was carried out in four districts of Tanzania (i.e. Bahi (Dodoma region), Ngorongoro (Arusha region), Same (Kilimanjaro region) and Kwimba (Mwanza region) where goat keeping is predominant. Bahi district lies between Latitude 05°58'0" S and Longitude 35°21'0" E. It is situated in semi-arid areas and has a dry savannah type of climate which is characterized by long dry season, unimodal and erratic rainfall that falls between November/December and April. The district has an annual average rainfall of about 500 to 700 mm and annual average temperature of about 22.6^0 C. Ngorongoro district lies between latitude $2^0$45 '0'' S and Longitude 35^0 30 '0'' E. The climate of Ngorongoro is warm and temperate. The short rains normally falls from October to December and long rains start in February and end in June. About 877 mm of precipitation falls annually and the average annual temperature is 16.5 °C. Same district is located in a semi-arid area with bimodal rainfall regime. Its coordinates are 4°15'0" S and 37°55'0" E. Rainfall in the area is highly variable with annual precipitation averaging 562 mm. The temperatures go up as far as 40^0C in the lowlands and in the mountainous areas temperature ranges from about 15^0C to 30^0C. Kwimba district is situated at an elevation of 1,163 meter above sea level and its coordinates are 2°55'0" S and 33°15'0" E.

The average temperature is 15°C to 25°C. Rainfall is unreliable, bimodal and ranges between 750 mm in dry areas and 1200 mm in wet areas.

3.2.2 Sampling of the study animals

Animals used in this study were Sonjo, Pare, Gogo and Sukuma goats all of them belong to the Small East African breed. Animals from the strains were sample from four districts in four regions of Tanzania, namely Ngorongoro (Arusha region), Same (Kilimanjaro region), Bahi (Dodoma region) and Kwimba (Mwanza region). Animals for each strain were sampled from two villages in the respective district where the strain is located. A total of six adult goats (three males and three females) from each village were purchased from livestock farmers who were randomly selected. Due to lack of birth records, age of the study animals was determined by dentition. Each animal was marked before being transported to the nearby slaughter slab/abattoir for slaughter and carcass evaluation.

3.2.3 Determination of carcass characteristics

Before slaughtering, all animals were starved for 24 hours to minimize the effect due to gut fill and body weight was measured prior to slaughtering. The animals were slaughtered according to standard commercial procedure, bled and the resulting carcass and non-carcass components weighed immediately using a spring balance. After skinning, the gut was immediately stripped and emptied and hot dressed carcass was weighed. The non-carcass components (blood, head, plaque, liver, kidney, spleen, skin, feet and testicles/udder) were removed, separated and weighed. Dressing percentage was computed based on the hot carcass weight expressed as a percentage of slaughter weight. After slaughtering of goats, the following measurements were taken in cm using a tape measure:

External body length (EBL) - This was determined by measuring the length of the carcass from the thoracic spine to the base of the tail.

Internal body length (IBL) - This was determined by measuring the length of the carcass from the anterior edge of *symphis pubis* bone to the anterior edge of the first rib.

Chest depth (CD) - This was determined by measuring the diameter of the carcass at the 9^{th} rib internally.

Hind leg length 1 (HL_1) - This was determined by measuring the distance between the distal end of tarsal bone and the middle of patella.

Hind leg length 2 (HL_2) - This was determined by measuring from the top end of the tibia to the bottom cut edge of the pubis.

Hind leg circumference (HLC) - This was determined by measuring the circumference around the widest part of the hind leg at the top cut edge of the pubis.

The carcass was divided longitudinally into two equal halves, right and left using a handsaw and knife. The left side half carcass was jointed using the handsaw and knife into standard joints i.e. neck, ribs, breast, loin, chump, hind leg and fore leg (Figure 1) and then each joint was weighed. The carcass composition was determined by dissecting the carcass into lean, bone and fat. Lean, bone and fat were scrubbed from each joint using a scalpel blade and then weighed separately. Proximate analysis for determination of total Moisture, total Crude Protein (CP), Ether Extract (EE) and Ash contents was done according to the methods described by the Association of Official Analytical Chemists (AOAC, 1990).

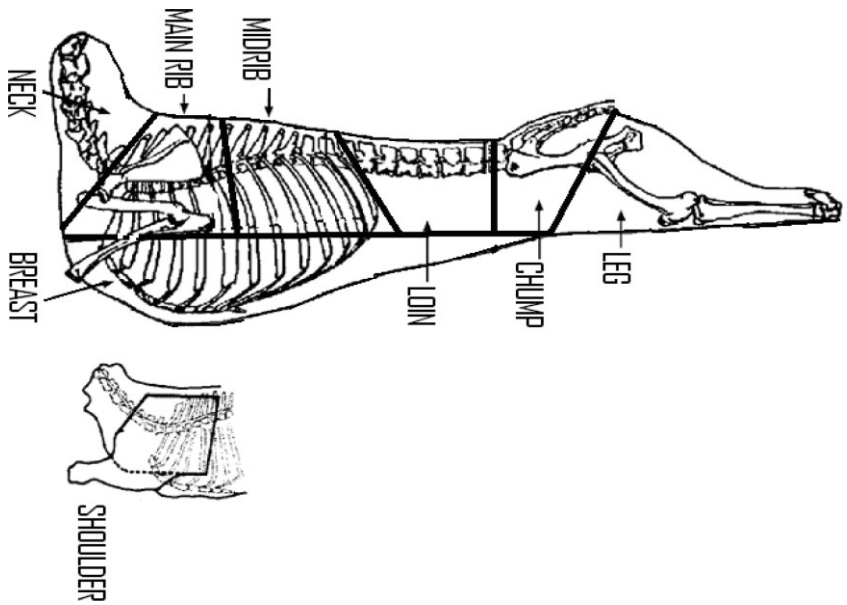

Figure 1: Standard carcass joint used in this study

3.3 Data Analysis

Data on slaughter weight, carcass weight, dressing percentage, edible and non-edible carcass components weights, and weights of the carcass joints and tissues and their percentage to the carcass weight were analyzed using the General Linear Models of SAS (2003) with fixed effects being strain, sex and age.

3.3.1 Statistical model

Data were analyzed for the effects of sex, strain and age using the following model

$Y_{ijkm} = \mu + S_i + B_j + D_{k+(}S*B)_{ij} + (S*D)_{ik} + (B*D)_{jk} + (S*B*D)_{ijk} + e_{ijkm}$

Y_{ijkm} = Observed carcass characteristics (i.e. slaughter weight, carcass weight, dressing percentage, edible and non-edible carcass component weight, weight of carcass joints, weight of tissues and their percentage composition to the carcass weight)

μ = Population mean

S_i = Effect of strain (I =1, 2, 3, 4, i.e. 1 = Gogo, 2 = Sonjo, 3 = Pare 4= Sukuma

B_j = Effect of sex (j = 1, 2 i.e. 1= Male 2= Female)

D_k = Effect of age (k = 1, 2, 3 i.e. 1 = below 1.5 years, 2 = 1.5 – 2.5 years and 3 = above 2.5 years)

$(S*B)_{ij}$ = Effect associated with the interaction between i^{th} strain and j^{th} sex

$(S*D)_{ik}$ = Effect associated with the interaction between i^{th} strain and k^{th} age

$(B*D)_{jk}$ = Effect associated with the interaction between j^{th} sex and k^{th} age

$(S*B*D)_{ijk}$ = Effect associated with the interaction between i^{th} strain, j^{th} sex and k^{th} age

e_{ijkm} = Random error term.

3.4 Results

3.4.1 Carcass measurements

Results for carcass measurements are presented in Table 1. The results indicate that there were significant differences ($P \leq 0.05$) among the strains on slaughter and carcass weights. Pare and Gogo goats had heavier slaughter and carcass weights than Sonjo and Sukuma goats. Dressing percentage did not differ ($P > 0.05$) among the four goat strains and ranged between 42.1 and 43.5%. The highest carcass length was observed in Sukuma goats whereas Sonjo goats had shorter ($P \leq 0.05$) carcass length than the other strains. With respect to carcass chest depth, Gogo goats were significantly ($P < 0.05$) superior to the other three SEA goat strains. Pare goats had higher hind leg length 1 (HLL1) and hind leg length 2 (HLL2), while Gogo goats had the lowest hind leg length 1 (HLL1) and hind leg 2 (HLL2) compared to the other strains.

3.4.2 Weight of carcass joints

Table 2 shows the weight of various carcass joints summarized by strain, sex and age. The weight of the carcass joints differed significantly ($P \leq 0.05$) among the strains. The heaviest carcass joint was the hind leg which was observed in the carcass of Gogo goats while breast weight was found to be the smallest carcass joint and was observed in the

Sonjo goats. Only two carcass joints, neck and breast, were significantly ($P \leq 0.05$) affected by sex of the strains with males goats being heavier.

3.4.3 Carcass composition

Table 3 shows the weight of tissues and their percentage contribution to the carcasses. There were no significant differences among the strains in distribution of tissues in the carcass. The carcasses of goats slaughtered contained 65.2 – 67% muscle, 23.5 – 25.7% bone and 8.4 – 10.7% fat. Carcass fat content in the present study did not vary significantly ($P > 0.05$) among the strains. Sex had a significant effect ($P \leq 0.05$) on the percentage of muscle and fat in the carcass but not on bones. Carcasses from male goats had more lean meat and less fat than the carcasses from female goats. Age had no effect on carcass composition ($P \geq 0.05$).

3.4.4 Distribution of carcass tissues in joints

The proportions of different tissues in the carcass joints were assessed by expressing the weight of the particular tissue as a percentage of the total weight of the joint as shown in Tables 4, 5 and 6. Sonjo goats had the highest muscle mass in the hind leg and significantly differed ($P \leq 0.05$) from Pare, but not from Gogo and Sukuma goats. The lowest proportion of muscle was found in the breast of the Sonjo goats. Sex and a ge influenced muscle distribution in the carcass ($P \leq 0.05$) with males being superior in contribution of loin, fore legs and ribs to the total muscle than females. The percentage of muscles in the hind legs of goats aged between 1.5 and 2 years was higher than that of goats aged below 1.5 years for the same carcass joint. Similarly, hind leg, fore leg and ribs had higher values for bones than the other meat cuts.

The proportion of bones in the hind leg, ribs and breast ranged from 16.79 to 30.69 %, 24.04 to 31.89% and 17.94 to 22.90%, respectively.

Table 1: Comparison of carcass measurements of goats from different strains, sex and age

Variable	Carcass characteristics (LSM ± Se)							
	SW (kg)	CW (kg)	DP (%)	CL (cm)	CD (cm)	HLL1 (cm)	HLL (cm)	HCL (cm)
Strain								
Gogo	22.37±1.11[a]	10.3 ± 0.45[a]	42.1 ± 1.05[a]	40.1± 0.87[a]	28.6± 0.87[a]	21.1 ± 0.72[a]	18.2 ± 0.66[a]	36.2 ± 0.84[a]
Pare	22.03±1.00[a]	9.8 ± 0.44[a]	42.8 ± 1.02[a]	41.1± 0.81[a]	25.8± 0.81[b]	24.3 ± 0.67[b]	22.4 ± 0.62[b]	39.7 ± 0.78[b]
Sonjo	17.60±1.06[b]	7.8 ± 0.45[b]	42.9 ± 1.05[a]	36.3 ± 0.83[b]	24.4 ± 0.83[b]	22.5 ± 0.69[ab]	21.2 ± 0.63[ab]	31.8 ± 0.80[c]
Sukuma	18.76±1.11[b]	8.4 ± 0.44[b]	43.5 ± 1.01[a]	41.6 ± 0.80[a]	24.8 ± 0.80[b]	22.4 ± 0.66[ab]	20.1 ± 0.61[ab]	35.6 ± 0.77[a]
P-value	**0.0001**	**0.0006**	**0.3501**	**0.0070**	**0.0028**	**0.0038**	**0.001**	**0.0001**
Sex								
Males	20.47±0.81[a]	9.4 ± 0.31[a]	43.3 ± 0.72[a]	39.9 ± 0.90[a]	26.46 ± 0.57[a]	22.7 ± 0.47[a]	20.3 ± 0.44[a]	36.1 ± 0.55[a]
Females	20.47±0.81[a]	8.8 ± 0.32[a]	42.3 ± 0.75[a]	39.7 ± 0.59[a]	25.4 ± 0.59[a]	22.5 ± 0.49[a]	20.6 ± 0.45[a]	35.5 ± 0.57[a]
P-value	**0.2722**	**0.1061**	**0.3710**	**0.2507**	**0.2299**	**0.9182**	**0.8679**	**0.4330**
Age								
Below 1.5 years	18.60±2.14[a]	8.8 ± 0.45[a]	43.6 ± 1.05[a]	38.9 ± 0.89[a]	25.3 ± 0.89[a]	22.6 ± 0.74[a]	20.8 ± 0.68[a]	34.5 ± 0.85[a]
1.5 – 2.5 years	20.68±0.51[a]	9.1 ± 0.32[a]	42.8 ± 0.73[a]	40.4 ± 0.58[a]	25.5 ± 0.58[a]	21.9 ± 0.48[a]	19.8 ± 0.44[a]	36.6 ± 0.55[a]
Above 2.5 years	21.30±0.86[a]	9.4 ± 0.43[a]	42.1 ± 1.00[a]	40.2 ± 0.77[a]	26.9 ± 0.78[a]	23.3 ± 0.64[a]	20.8 ± 0.59[a]	36.4 ± 0.74[a]
P-value	**0.1516**	**0.3342**	**0.4133**	**0.7019**	**0.3198**	**0.3055**	**0.5657**	**0.2053**

SW- Slaughter weight, CW-Carcass weight, DP- Dressing percentage, CL- Carcass Length, CD- chest Depth, HLL1- Hind leg length 1, HLL2- Hind leg length 2, HCL-hind leg circumference.
LSmeans with different superscripts down the columns within a factor (i.e. Strains, Sex, Age) differ significantly

Table 2: Least squares means (±s.e) for weight of joints (kg) from goats of different strains, sex and age

Variable	Carcass joints						
	Chump	Neck	Loin	Fore leg	Hind leg	Ribs	Breast
Strain							
Gogo	0.42 ± 0.03[a]	0.36 ± 0.02[a]	0.49 ± 0.03[a]	0.97 ± 0.05[a]	1.10 ± 0.05[a]	1.03 ± 0.05[a]	0.36 ± 0.04[a]
Pare	0.57 ± 0.03[b]	0.33 ± 0.02[a]	0.38 ± 0.03[b]	0.89 ± 0.05[a]	0.95 ± 0.05[b]	0.76 ± 0.05[b]	0.31 ± 0.03[a]
Sonjo	0.37 ± 0.03[a]	0.28 ± 0.02[b]	0.37 ± 0.03[b]	0.72 ± 0.05[b]	0.64 ± 0.05[c]	0.58 ± 0.05[b]	0.20 ± 0.04[b]
Sukuma	0.46 ± 0.03[a]	0.37 ± 0.02[a]	0.42 ± 0.03[a]	0.84 ± 0.05[b]	1.01 ± 0.05[ab]	0.76 ± 0.05[b]	0.34 ± 0.03[a]
P-value	**0.0009**	**0.0238**	**0.0237**	**0.0186**	**0.0001**	**0.0022**	**0.0136**
Sex							
Males	0.45 ± 0.02a	0.36 ± 0.01[a]	0.42 ± 0.02 [a]	0.90 ± 0.04 [a]	0.96 ± 0.03 [a]	0.78 ± 0.04 [a]	0.34 ± 0.02[a]
Females	0.46 ± 0.02a	0.31 ± 0.01[b]	0.40 ± 0.02 [a]	0.82 ± 0.04 [a]	0.89 ± 0.03 [a]	0.79 ± 0.04 [a]	0.26 ± 0.03[b]
P-value	**0.7187**	**0.0275**	**0.3765**	**0.1197**	**0.1187**	**0.9064**	**0.0158**
Age							
Below 1.5 years	0.43 ± 0.04 [a]	0.34 ± 0.02 [a]	0.39 ± 0.03 [a]	0.83 ± 0.06 [a]	0.88 ± 0.05 [a]	0.75 ± 0.05 [a]	0.27 ±0.04 [a]
1.5 - 2.5 years	0.43 ± 0.04 [a]	0.34 ± 0.02 [a]	0.39 ± 0.03 [a]	0.83 ± 0.06 [a]	0.88 ± 0.05 [a]	0.75 ± 0.05 [a]	0.27 ± 0.04 [a]
Above 2.5 years	0.50 ± 0.03 [a]	0.35 ± 0.02 [a]	0.44 ± 0.03 [a]	0.91 ± 0.05 [a]	0.97 ± 0.05 [a]	0.81 ± 0.08 [a]	0.35 ± 0.03 [a]
P-value	**0.2941**	**0.5400**	**0.3156**	**0.3106**	**0.4889**	**0.9185**	**0.1624**

LSmeans with different superscripts down the columns within a factor (i.e. Strains, Sex, Age) differ significantly

Table 3: Total tissue weights and percentages from carcasses of goats of different strains, sex and age

Variable	Carcass tissues					
	Total muscle (kg)	Total bone (kg)	Total fat (kg)	Percent muscle (%)	Percent bone (%)	Percent fat (%)
Strain						
Gogo	3.2 ± 0.17[a]	1.1 ± 0.12[a]	0.5 ± 0.05[a]	65.8 ± 2.11[a]	23.5 ± 1.82[a]	10.7 ± 0.90[a]
Pare	2.9 ± 0.16[a]	1.2 ± 0.11[a]	0.4 ± 0.05[a]	65.2 ± 1.96[a]	25.7 ± 1.70[a]	9.16 ± 0.84[a]
Sonjo	2.1 ± 0.16[b]	0.8 ± 0.12[b]	0.3 ± 0.05[a]	66.9 ± 2.02[a]	23.7 ± 1.75[a]	9.4 ± 0.86[a]
Sukuma	3.0 ± 0.16[a]	1.1 ± 0.11[a]	0.3 ± 0.05[a]	67.0 ± 1.95[a]	24.7 ± 1.69[a]	8.4 ± 0.83[a]
P-value	**0.0021**	**0.0120**	**0.4022**	**0.7322**	**0.7201**	**0.4210**
Sex						
Males	2.9 ± 0.01[a]	1.0 ± 0.08[a]	0.4 ± 0.03[a]	68.1 ± 1.16[a]	23.6 ± 1.20[a]	8.3 ± 0.59[a]
Females	2.6 ± 0.12[a]	1.1 ± 0.08[a]	0.4 ± 0.03[a]	64.3 ± 1.21[b]	25.2 ± 1.25[a]	10.5 ± 0.62[b]
P-value	**0.3076**	**0.3010**	**0.4353**	**0.0038**	**0.3107**	**0.0012**
Age						
Below 1.5 years	2.7 ± 0.18[a]	1.1 ± 0.12[a]	0.4 ± 0.05[a]	64.1 ± 1.80[a]	25.9 ± 1.86[a]	10.1 ± 0.92[a]
1.5 - 2.5 years	2.8 ± 0.11[a]	1.0 ± 0.08[a]	0.4 ± 0.03[a]	66.7 ± 1.15[a]	22.8 ± 1.19[a]	10.5 ± 0.59[a]
Above 2.5 years	2.9 ± 0.16[a]	1.0 ± 0.11[a]	0.3 ± 0.05[a]	67.8 ± 1.60[a]	24.4 ± 1.66[a]	7.8 ± 0.82[a]
P-value	**0.6111**	**0.5511**	**0.4203**	**0.7221**	**0.4001**	**0.3124**

LS means with different superscripts down the columns within a factor (i.e. Strains, Sex, Age) differ significantly

The highest proportion of bones was found in the ribs of Gogo goats and significantly differed from that of Sukuma, but not from that of Pare and Sonjo goats. For the hind leg, Pare goat carcasses had higher percentage of bone than Sonjo goats but similar to Gogo and Sukuma goats. Age significantly affected the distribution of bones in the joints whereby hind legs of goats aged below 1.5 years had more bones than that of goats aged between 1.5 and 2 years. Primal cut with the highest proportion of fat was the breast (23.83%), which was observed in the Sonjo goats and the lowest (4.47%) was found in the fore leg of the Pare goats. Fat distribution in the carcasses was significantly ($P \leq 0.05$) influenced by sex, but not age. The effect of sex on fat distribution was observed in hind leg and ribs. Female goats had more fat in the hind legs and ribs than males.

3.4.5 Chemical composition

Proximate chemical compositions of meat from the four goat strains are presented in Table 7. Dry matter and fat contents were not significantly affected by strain ($P > 0.05$) whereas crude protein and ash contents were significantly ($P \leq 0.05$) influenced by strain. Pare goats had carcass with less crude protein contents (20.7%) than carcasses from the other goat strains while carcass from Sukuma goats had the least mineral content (4.01%) and significantly differed from that of Sonjo (4.43%) but similar to that of Gogo (4.11%) and Pare goats (4.25%).

Table 4: Percentage of muscle in various joints of carcasses from different strains, sex and age

Variable	Carcass characteristics (%)						
	Chump	Neck	Loin	Fore leg	Hind leg	Ribs	Breast
Strain							
Gogo	65.98 ± 2.8 [a]	6 7.34 ± 3.67 [a]	63.81 ± 4.6 [a]	70.19± 2.7[a]	73.06± 2.83[a]	63.35 ± 0.73 [a]	58.59 ± 2.79 [ab]
Pare	62.45 ± 2.6 [a]	72.89 ± 3.38 [a]	66.37 ± 4.24 [a]	71.41 ± 2.49[a]	62.95 ± 2.61[b]	64.62 ± 2.06 [a]	64.80 ± 2.56 [a]
Sonjo	58.39 ± 2.71 [a]	66.26 ± 3.53 [a]	67.69 ± 4.43 [a]	71.06 ± 2.61[a]	77.11 ± 2.73[a]	64.88 ± 2.15 [a]	53.27 ± 2.69[b]
Sukuma	67.78 ± 2.59 [a]	68.79 ± 3.38 [a]	62.52 ± 4.24 [a]	62.39 ± 2.49[b]	73.66 ± 2.61[a]	63.81 ± 0.68 [a]	62.45 ± 2.58[a]
P-value	**0.0967**	**0.5305**	**0.0846**	**0.0436**	**0.0061**	**0.9610**	**0.0175**
Sex							
Males	64.51 ± 1.84 [a]	68.69 ± 3.01 [a]	72.50 ± 2.40[a]	71.37 ± 1.77[a]	71.86 ± 1.85 [a]	66.36 ± 1.46[a]	61.56 ± 1.83 [a]
Females	62.79 ± 1.9 [a]	61.55 ± 3.13 [a]	65.15 ± 2.49[b]	66.13 ± 1.84[b]	72.53 ± 1.92 [a]	61.96 ± 1.52[b]	57.99 ± 1.89 [a]
P-value	**0.5220**	**0.1046**	**0.0408**	**0.0485**	**0.8049**	**0.0441**	**0.1868**
Age							
Below 1.5 years	64.32 ± 2.72 [a]	69.53 ± 3.56 [a]	59.65 ± 4.46 [a]	66.88 ± 2.62 [a]	67.08 ± 2.74[b]	63.7 ± 2.17 [a]	58.29 ± 2.41 [a]
1.5 - 2.5 years	62.73 ± 1.96 [a]	68.48 ± 02.56 [a]	64.17 ± 3.21 [a]	68.47 ± 0.44 [a]	77.11 ± 1.98[a]	63.48 ± 1.56 [a]	58.76 ± 1.95 [a]
Above 2.5 years	63.89 ± 2.51 [a]	68.46 ± 3.31 [a]	71.39 ± 4.11 [a]	70.95 ± 2.42 [a]	72.08 ± 2.53[ab]	65.24 ± 2.0 [a]	62.28 ± 2.5 [a]
P-value	**0.8712**	**0.9703**	**0.1822**	**0.5437**	**0.0175**	**0.7779**	**0.4794**

LSmeans with different superscripts down the columns within a factor (i.e. Strains, Sex, Age) differ significantly

Table 5: Percentage of bone in various joints of carcasses from different strains, sex and age

Variable	Carcass characteristics (%)						
	Chump	Neck	Loin	Fore leg	Hind leg	Ribs	Breast
Strain							
Gogo	22.79 ± 2.26 [a]	25.41 ± 3.43 [a]	21.99 ± 5.06 [a]	21.19 ± 2.18 [a]	20.84 ± 2.61 [a]	31.89 ± 1.67 [a]	18.94 ± 1.85 [ab]
Pare	21.22 ± 2.09 [a]	21.50 ± 3.16 [a]	25.82 ± 4.67 [a]	24.12 ± 2.01 [a]	30.69 ± 2.41 [b]	30.45 ± 1.54 [a]	18.89 ± 1.25 [a]
Sonjo	28.47 ± 2.18 [a]	25.99 ± 3.31 [a]	19.46 ± 4.88 [a]	21.79 ± 2.11 [a]	18.39 ± 2.52 [a]	27.91 ± 1.61 [ab]	22. 90 ± 1.25 [b]
Sukuma	21.08 ± 2.09 [a]	23.99 ± 3.17 [a]	27.93 ± 4.67 [a]	25.21 ± 2.02 [a]	16.79 ± 1.2.41 [a]	24.04 ± 1.54 [b]	17.94 ± 1.25 [a]
P-value	**0.0664**	**0.5813**	**0.7519**	**0.4515**	**0.0008**	**0.0053**	**0.0490**
Sex							
Males	24.04 ± 1.48 [a]	22.28 ± 2.25 [a]	22.36 ± 3.32 [a]	21.97 ± 1.43 [a]	20.42 ± 1.78 [a]	28.94 ± 1.13 [a]	19.20 ± 0.89 [a]
Females	22.74 ± 1.54 [a]	26.16 ± 2.33 [a]	25.25 ± 3.32 [a]	24.19 ± 1.48 [a]	22.94 ± 1.72 [a]	28.94 ± 1.09 [a]	20.14 ± 0.92 [a]
P-value	**0.5504**	**0.2410**	**0.5518**	**0.2905**	**0.3145**	**0.6482**	**0.4721**
Age							
Below 1.5 years	21.34 ± 2.19 [a]	22.73 ± 3.32 [a]	28.08 ± 4.91 [a]	22.42 ± 2.12 [a]	26.14 ± 2.53 [a]	30.48 ± 1.62 [a]	19.77 ± 1.32 [a]
1.5 - 2.5 years	24.79 ± 1.58 [a]	22.86 ± 2.39 [a]	23.21 ± 3.54 [a]	24.14 ± 1.53 [a]	17.49 ± 1.82 [b]	26.06 ± 1.17 [a]	20. 03 ± 0.95 [a]
Above 2.5 years	24.04 ± 2.03 [a]	27.08 ± 3.06 [a]	20.11 ± 4.53 [a]	22.68 ± 1.95 [a]	21.41 ± 2.34 [ab]	29.18 ± 1.49 [a]	19.77 ± 1.32 [a]
P-value	**0.4537**	**0.5180**	**0.5354**	**0.7410**	**0.0290**	**0.0635**	**0.8642**

LSmeans with different superscripts down the columns within a factor (i.e. Strains, Sex, Age) differ significantly

Table 6: Percentage of fat in various joints carcasses from different strains, sex and age

Variable	Carcass characteristics (%)						
	Chump	Neck	Loin	Fore leg	Hind leg	Ribs	Breast
Strain							
Gogo	11.23 ± 1.91 [a]	7.26 ± 2.81 [a]	14.20 ± 3.16 [a]	8.62 ± 2.38 [a]	6.10 ± 0.91 [a]	4.76 ± 2.59 [a]	22.47 ± 2.72 [a]
Pare	16.32 ± 1.77 [a]	5.56 ± 2.59 [a]	7.91 ± 2.91 [a]	4.47 ± 2.19 [a]	6.25 ± 0.84 [a]	4.932 ± 2.39 [a]	16.30 ± 2.51 [a]
Sonjo	13.14 ± 1.84 [a]	7.75 ± 2.71 [a]	12.85 ± 3.05 [a]	7.15 ± 2.29 [a]	4.91 ± 0.87 [a]	7.21 ± 2.50 [a]	23.83 ± 2.51 [a]
Sukuma	11.15 ± 1.77 [a]	7.22 ± 2.59 [a]	9.54 ± 2.92 [a]	12.39 ± 2.19 [a]	7.56 ± 0.84 [a]	12.16 ± 2.39 [a]	19.61 ± 2.51 [a]
P-value	**0.1604**	**0.4112**	**0.9407**	**0.0982**	**0.1065**	**0.1171**	**0.3159**
Sex							
Males	11.45 ± 1.3 [a]	5.22 ± 1.84 [a]	8.94 ± 2.07 [a]	6.66 ± 1.62 [a]	5.19 ± 0.59 [a]	4.70 ± 1.76 [a]	19.24 ± 1.78 [a]
Females	14.47 ± 1.3 [a]	8.69 ± 1.91 [a]	13.30 ± 2.15 [a]	8.66 ± 1.62 [a]	7.06 ± 0.62 [b]	9.83 ± 1.69 [b]	21.36 ± 1.85 [a]
P-value	**0.1045**	**0.1998**	**0.1537**	**0.1913**	**0.0367**	**0.0435**	**0.3159**
Age							
Below 1.5 years	14.34 ± 1.86 [a]	7.74 ± 2.73 [a]	12.26 ± 3.07 [a]	10.72 ± 2.31 [a]	6.78 ± 0.88 [a]	5.75 ± 2.52 [a]	21.93 ± 2.64 [a]
1.5 - 2.5 years	12.48 ± 1.14 [a]	8.67 ± 1.96 [a]	12.62 ± 2.21 [a]	7.40 ± 1.66 [a]	5.40 ± 0.64 [a]	10.46 ± 1.81 [a]	21.22 ± 1.90 [a]
Above 2.5 years	12.06 ± 1.71 [a]	4.46 ± 2.51 [a]	8.49 ± 3.07 [a]	6.37 ± 2.13 [a]	6.2 ± 0.81 [a]	5.58 ± 2.32 [a]	18.51 ± 2.43 [a]
P-value	**0.6633**	**0.4153**	**0.4969**	**0.4023**	**0.4214**	**0.1531**	**0.6023**

LSmeans with different superscripts down the columns within a factor (i.e. Strains, Sex, Age) differ significantly

Table 7: Chemical composition of carcass for Small East African goats (On fresh basis)

Variable	Strain			
	Gogo	Sonjo	Pare	Sukuma
Dry Matter (%)	25.63 ± 0.37[a]	25.27 ± 0.37[a]	25.01 ± 0.37[a]	25.86 ± 0.37[a]
Crude Protein (%)	21.78 ± 0.37[ab]	21.33 ± 0.37[ab]	20.77 ± 0.37[b]	22.40 ± 0.37[a]
Fat (%)	0.15 ± 0.03[a]	0.13 ± 0.03[a]	0.19 ± 0.03[a]	0.21 ± 0.03[a]
Ash (%)	4.11 ± 0.013[ab]	4.43 ± 0.013[a]	4.25 ± 0.013[ab]	4.01 ± 0.013[b]

LS means with different superscripts in the same row differ significantly at P<0.05

3.4.6 Non-carcass components

Non-carcass components of the four strains of SEA goats slaughtered at different ages are presented in Table 8. The weights of non-carcass components were significantly different ($P \leq 0.05$) among the strains. Gogo goats had higher values for different organs including blood, head, liver, kidney and spleen compared to the other strains. However, Pare goats had heavier skin while Sonjo and Sukuma were superior in feet and testicle weights. The liver and spleen of Gogo goats weighed higher ($P \leq 0.05$) than the same organs in the other goat strains. Kidney weight was different for each goat strain and ranged between 0.08 and 0.2 kg. Pare goats had higher feet weight than the other strains while Sonjo goats were superior in testicles. Pare goats had the heaviest GIT when weighed with its contents while the weight of empty GIT was largest in Sonjo goats. Gogo goats had significantly more internal fat than the other strains.

Sex did not have significant effects ($P > 0.05$) on non-carcass components except for head weight which was higher in males than in females. Age affected ($P \leq 0.05$) only weight of blood and liver which increased with age of the goats.

Table 8: Least squares means (± se) of non-carcass components (kg)

Variable	Non-carcass components										
Strain	Blood	Head	Plaque	Liver:	Kidney	Spleen	GIT full	GIT empty	Skin	Feet	Testicles
Gogo	0.71 ± 0.07[a]	1.84 ± 0.11[a]	0.39 ± 0.03[a]	0.86 ± 0.07[a]	0.20 ± 0.01[a]	0.17 ± 0.01[a]	3.7 ± 0.16[ab]	1.3 ± 0.07[a]	1.3 ± 0.12[a]	0.42 ± 0.05[a]	0.19 ± 0.02[a]
Pare	0.53 ± 0.07[b]	1.76 ± 0.10[a]	0.38 ± 0.03[a]	0.56 ± 0.07[b]	0.14 ± 0.01[b]	0.08 ± 0.01[b]	3.8 ± 0.16[a]	1.7 ± 0.07[b]	1.7 ± 0.12[b]	0.70 ± 0.05[b]	0.19 ± 0.02[a]
Sonjo	0.50 ± 0.07[b]	0.97 ± 0.10[b]	0.29 ± 0.03[b]	0.42 ± 0.07[b]	0.12 ± 0.01[c]	0.06 ± 0.01[b]	3.5 ± 0.16[ab]	1.2 ± 0.07[a]	1.7 ± 0.12[b]	0.70 ± 0.05[b]	0.26± 0.02[b]
Sukuma	0.71 ± 0.06[a]	1.31 ± 0.10[c]	0.41 ± 0.03[a]	0.41 ± 0.07[b]	0.08 ± 0.01[d]	0.06 ± 0.01[b]	3.3 ± 0.16[b]	1.4 ± 0.07[a]	1.3 ± 0.12[a]	0.56 ± 0.05[a]	0.18 ± 0.02[a]
P-value	**0.0001**	**0.0001**	**0.0287**	**0.0001**	**0.0001**	**0.0001**	**0.0312**	**0.0001**	**0.0230**	0.0001	0.0027
Sex											
Males	0.88 ± 0.05 [a]	1.62 ± 0.07[a]	0.38 ± 0.02 [a]	0.55 ± 0.05 [a]	0.14 ± 0.01 [a]	0.09 ± 0.01 [a]	3.7 ± 0.11 [a]	1.4 ± 0.05 [a]	1.3 ± 0.08 [a]	0.58 ± 0.04 [a]	0.21 ± 0.01 [a]
Females	0.85 ± 0.05 [a]	1.32 ± 0.07[b]	0.36 ± 0.02 [a]	0.58 ± 0.05 [a]	0.14 ± 0.01 [a]	0.09 ± 0.01 [a]	3.5 ± 0.12 [a]	1.4 ± 0.05 [a]	1.2 ± 0.09 [a]	0.50 ± 0.04 [a]	0.20 ± 0.02 [a]
P-value	**0.3245**	**0.0040**	**0.4485**	**0.7270**	**0.7456**	**0.9119**	**0.3421**	**0.6465**	**0.0780**	0.4084	0.1529
Age											
Below 1.5 years	0.78 ± 0.08[a]	1.34 ± 0.11 [a]	0.33 ± 0.03 [a]	0.47 ± 0.07[a]	0.13 ± 0.01 [a]	0.08 ± 0.01 [a]	3.3 ± 0.16 [a]	1.3 ± 0.07 [a]	1.2 ± 0.12 [a]	0.51 ± 0.05 [a]	0.18 ± 0.02 [a]
1.5 - 2.5 years	0.84 ± 0.05[ab]	1.54 ± 0.08 [a]	0.40 ± 0.02 [a]	0.51 ± 0.05[a]	0.14 ± 0.01 [a]	0.09 ± 0.01 [a]	3.6 ± 0.11 [a]	1.4 ± 0.05 [a]	1.4 ± 0.08 [a]	0.59±0.04 [a]	0.21 ± 0.01 [a]
Above 2.5 years	0.98 ± 0.06[b]	1.53 ± 0.10 [a]	0.37 ± 0.03 [a]	0.72 ± 0.06[b]	0.14 ± 0.01 [a]	0.10 ± 0.01 [a]	3.9 ± 0.16 [a]	1.4 ± 0.07 [a]	1.2 ± 0.12 [a]	0.52 ± 0.05 [a]	0.22 ± 0.02 [a]
P-value	**0.0047**	**0.2140**	**0.9122**	**0.0182**	**0.2986**	**0.4625**	**0.0753**	**0.8272**	**0.0730**	0.5481	0.4203

LSmeans with different superscripts down the columns within a factor (i.e. Strains, Sex, Age) differ significantly

3.5 Discussion

3.5.1 Slaughter characteristics

The study assessed the slaughter characteristics of four strains of SEA goats (Slaughter weight, Carcass weight, Chest depth, dressing percentage, External body length, Internal body length, Hind leg circumference, Hind leg length1 and Hind leg2). There were significant differences in slaughter characteristics among the SEA goat strains whereby Pare and Gogo goats had heavier slaughter weight than Sonjo and Sukuma. The values for slaughter weight in the present study differ from the range of 20 – 25 kg reported by Shija *et al.* (2013) in other SEA goats.

However, Hango *et al.* (2007) reported similar values for slaughter weight of 19 - 22 kg for SEA goats slaughtered in Tanzania. In this study Pare and Gogo goats had heavier carcasses than Sonjo and Sukuma goats. The reasons for this differences could be due to genetic potential and nutrition back ground. The values for carcass weight in the present study are not different from a range of 7.1 - 10.8 kg reported by Hango *et al.* (2007) and Hoza *et al.* (2013) in other SEA goats and 9.7 - 10.25 kg for West African Dwarf goats and Red Sokoto goats (Attah *et al.,* 2004).

However, Mushi (2004) reported higher carcass weight of 12.67 kg for SEA goats slaughtered at Gairo auction market. In the present study DP values were within the range of DP of 42.1 - 43.5% reported in goats (Tshabalala *et al.,* 2003). Dressing percentage in goats has been reported by various authors to vary between 42 and 56% and it is dependent on breed, sex, age, body weight and level of management (Tshabalala *et al.,* 2003; Mushi, 2004; Webb *et al.,* 2005; Hango *et al.,* 2007; Sebsibe *et al.,* 2007; Assan, *et al.,* 2015).

3.5.2 Linear Carcass Measurements

The values for carcass length observed in the present study are lower than those reported by Hozza *et al.* (2014) and Mushi (2004) in other strains of SEA goats and by Sebsibe *et al.* (2007) in South African indigenous goats. With respect to carcass chest depth, Mushi (2004) found it to be 26.3 cm for the SEA goats in Gairo which is within the range of values observed in the present study. On the contrary, lower values for internal chest depth have been reported by Hozza *et al.* (2014) for other SEA goats (22.9 cm) and Attah *et al.* (2004) in Red Sokoto (18.3 cm) and West African Dwarf goats (17.7 cm). The former authors also reported hind leg length of 37.9 cm and hind leg circumference of 26.9 cm which are outside the range of 18 - 24 cm obtained in the present study. The hind leg circumference of 33.7 cm reported by Mushi (2004) for SEA goats in Gairo is comparable to that of Sonjo goats in the present study. This discrepancy of weights between the authors might be due to differences in the genetic potential of the goat strains studied.

3.5.3 Weight of carcass joints

The differences among the strains in weight of joints and their percentage contribution to the carcass did not have a definite order. High contribution of fore leg, hind leg and rib to the carcass in the present study agrees with the findings by Mushi (2004) who reported that fore leg, hind leg and ribs contribute 63.2% of the carcass weight. Fore leg, Hind leg and rib joints are preferred in Tanzania by consumers because of high lean meat content and this corresponds well to the criterion used by consumers to buy meat from retail butchers (Mushi *et al.,* 2009). These primal cuts fetch high prices compared to other cuts and can further be split into smaller retail units for easiness of marketing depending on the market where the meat is going to be sold.

3.5.4 Carcass composition

The proportions of muscle in the carcasses of goats reported in the present study are similar to those reported for other SEA goats (Safari *et al.,* 2009; Hozza *et al.,* 2014), but are higher than the proportion of muscle (58.7%) found by Mushi (2004) in goats slaughtered at Gairo auction market. These authors reported the carcasses of goats in their studies to be composed of more bones than in the present study. The reasons for this variations is probably due to different nutritional back ground. Carcass fat in the present study ranged from 8.4 to 10.7 %. This agrees with the observation made by Hozza *et al.* (2014) who reported carcass fat content of 8.4% and Owen *et al.* (1977) who reported fat content of 9.29% for Boer goats, but it is lower than the values of 12.34% and 15.5% reported by Mushi (2004) and Hango *et al.* (2007), respectively.

These authors, worked on goats under supplementation unlike the goats in the present study which were raised under traditional grazing conditions and this could be the reason for the lower fat content observed in their carcasses. The lack of significant differences between the strains for the content of subcutaneous and intramuscular fats as percentage of the carcass implies that there is no differences in carcass quality. Fat content is an important quality determinant of carcasses and has a direct effect on the commercial value of carcasses. Also fat content influences the organoleptic properties, keeping quality and nutrient value of meat (Casey, 1992). The differences in fat content contribute to the sensory difference in characteristics of meat as it affects juiciness, tenderness and flavor.

3.5.5 Distribution of carcass tissues in the joints

Generally, more muscles were found in the hind legs and this is in agreement with the observation made by Mushi (2004). Primal cut with the highest proportion of fat was the breast which was observed in the Sonjo goats and the lowest was found in the fore leg of

the Pare goats. High fat content in the primal cut can be the reason for customers to avoid it. Consumers are more conscious about their diet and tend to avoid meat with high fat content, but rather prefer to consume leaner meat (Tshabalala *et al.,* 2003).

The jointing of goat carcasses into cuts should be based on the perceived value and preference of consumers which varies with cultural background. While in most of the western world, cuts from the hind limb and the dorsal region are of prime value and the breast region is of low value, a high preference for the breasts has been shown by some studies conducted in Africa and Asia (Wilson, 1992; Prasad and Kirton, 1992). In choven industry in Tanzania, most consumers purchase choven from retail outlets in form of cuts and joints. The hind limb of goats seems to be suitable for the production of high value cuts because it has a low fat and high lean content. According to Tshabalala *et al.* (2003) the hind limb is perceived to be an indicator of meat quality as far as retailers are concerned.

3.6 Chemical Composition

The nutrient value of meat lies in the extent to which the protein requirements of humans are satisfied (Webb *et al.,* 2005). However, complete dietary analysis of the goat meat was not done in the present study and therefore the quality of meat is discussed on the basis of proximate analysis results. The percentages of dry matter content reported in the present study are in agreement with values found in other studies (Sen *et al.,* 2004; Safari *et al.,* 2009; Babiker *et al.,* 1990). However, several other studies have reported higher dry matter content in the goat carcass ranging from 27.6 to 32.9% (El- Waziry *et al.,* 2011; Madruga *et al.,* 2009; Lee *et al.,* 2008; Tshabalala *et al.,* 2003 and Hozza *et al.,* 2014). It should be noted that these authors worked on goats in feedlot and high energy diet unlike goats in the present study which were raised under pasture alone.

Irrespective of strains, the values for protein content of the carcasses in the present study are comparable to the values ranging from 20.8 to 22.8% obtained in other studies (Safari *et al.,* 2009; Lee *et al*., 2008; Sen *et al.,* 2004; Babiker *et al.,* 1990, Tshabalala *et al.,* 2003; Hozza *et al.,* 2014), but higher than the value of 18.4% reported by El-Waziry *et al.* (2011). Other studies have reported higher protein content than the present study (Madruga *et al.,* 2009; Tshabalala *et al.,* 2003). The proportions of minerals and fat in the carcasses in the present study are in agreement with the findings by Safari *et al.* (2009) who worked on SEA goats and found the carcasses to be composed of 4.7% minerals and 0.3% fat under zero supplementation. Hozza *et al.* (2014), also working on SEA goats, obtained 3.5% as the proportion of minerals in the meat.

Numerous other studies have reported higher fat contents in animals that received high energy diets under feedlot conditions (Babiker *et al.,* 1990; Tshabalala *et al.,* 2003; Madruga *et al.,* 2009; Hozza *et al.,* 2014; Sen *et al.,* 2004). The chemical composition of carcass varies considerably with factors such as breed, age, sex, weight, and nutritional history. The variation reported in this study with respect to ash and protein contents among the studied strains and with other goats documented in the literature may partly be attributed to nutritional history. Sonjo goats which had the highest ash content in the present study are raised in Sale and Loliondo divisions of Ngorongoro district which partly include the hot arid lowland area around Lake Natron which is rich in volcanic soils and minerals.

3.7 Edible and non-edible Carcass Components

Higher weight values for organs of Gogo goats including blood, head, liver, kidney and spleen were proportional to the bigger size of their carcass compared to the other strains. Pare goats had heavier skin while Sonjo and Sukuma had higher feet and testicle weights.

The larger weight of the skin observed in Pare goats may be attributed to their larger body size in comparison to the Sonjo and Sukuma. The larger size also resulted into higher stomach weight as observed by Berihun *et al.* (2013). Also variation in skin weight between the strains could have been contributed by large size of the hairs in the skin as Pare goats had long hair and heavier skin than Gogo goats despite the fact that the two strains had similar carcass weight. This is supported by the findings of Greenwood *et al.* (1993) who said that short-haired goats have low skin weight. Gogo and Pare had significantly heavier heads than Sukuma goats whose head weighed higher than that of Sonjo goats. The trend of head weights was consistent with the slaughter weights of the goats and their carcass weight. This is in agreement with the observations made by other studies that head weight corresponds to the weight of the carcass (Berihun *et al.,* 2013; El-Waziry *et al.,* 2011; Gürsoy *et al.,* 2011). Gogo and Sukuma goats had higher blood weight than Pare and Sonjo goats.

The range of blood weights observed in the four strains is lower than the weight reported in other studies (Sen *et al.,* 2004; Gürsoy *et al.,* 2011). The liver and spleen of Gogo goats weighed higher than the same organs in the other goat strains. The range of weights of the liver in the present study is in agreement with the weights reported by El-Waziry *et al.* (2011) and Moyo *et al.* (2014) but lower than the liver weight of goats reported by Berihun *et al.* (2013) and Sen *et al.* (2004). Kidney weight observed in the four SEA goat strains is similar to the kidney weight of goats reported by Moyo *et al.* (2014), but higher than that reported by Gürsoy *et al.* (2011).

The weight of testicles observed in this study is in agreement with the weight of testicles of goats reported by Moyo *et al*. (2014), but lower than that observed by Berihun *et al.* (2013). The weights of GIT when full and when empty in the present study is lower than

the weight reported by Sen *et al*. (2004). Gogo goats had significantly more internal fat than the other strains and it is comparable to 0.4 kg of fat reported by Gürsoy *et al.* (2011), but lower than that found by Moyo *et al.* (2014). These differences could be due to the fact that the goats were raised under different feeding conditions or genetic differences as the weight of the non-carcass components may correspond with pre slaughter weights of the goats. The higher internal fat content in Gogo goats partly explains their higher dressing percent compared to the other strains.

3.8 Conclusions and Recommendations

The present study has shown that there is significant variation among the SEA goat strains on carcass and killing out characteristics, tissue distribution in the meat cuts and carcass chemical composition. Gogo and Pare goats strains yield bigger carcasses than Sukuma and Sonjo goats. Sukuma and Pare goats strains have more muscle and fat content. For carcass joints, more muscle content is found in hind leg and fore leg while chump joint has more fat content. Ribs have more bones than other carcass joints. More research is needed on improving breed which revealed bigger slaughter and carcass weights and meat parts with good quality as preferred by consumers.

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3.1 REFERENCES

AOAC (1990). Official methods of analysis (15th Ed.). Washington, DC: Association of Analytical Chemists. DC, USA.

Assan, N. (2015). Some factors influencing dressing percentage in goat meat production. *Scientific Journal of Review* 4(10): 156 – 164.

Attah, N., Rouissi, H. and Mahouachi, M. (2004). The effect of dietary protein level on growth, carcass and meat composition of male goat kids in Tunisia. *Small Ruminant. Research* 54 (1–2): 89 – 97.

Babiker, S. A., Elkhider, I. A. and Shafie, S. A. (1990). Chemical-composition and quality attributes of goat meat and lamb. *Meat Science* 28 (4): 273 – 277.

Berihun, K., Banerjee, S. and Yigrem, S. (2013). Carcass Traits of Arsi-bale Sheep and Goat Reared under Farmers Management System in Sidama Region of Southern Ethiopia. *Middle-East. Journal of Scientific Research* 13 (11): 1465 – 1470.

Casey, N. H. (1992). Goat meat in human nutrition. In: *Proceedings V International Conference on Goats. Indian Council of Agricultural Research, New Delhi.* 2 (2): 581 – 598.

Chenyambuga, S. W., Komwihangilo, D. M. and Jackson, M. (2012). Production performance and desirable traits of Small East African goats in semi-arid areas of Central Tanzania. *Livestock Research for Rural Development*. [www.lrrd.org/ lrrd24/7/chen2 118.htm]. Site visited on 14/12/2015.

El-Waziry, A. M., Al-Owaimer, A. N., Suliman, G.M., Hussein, E. S. and Abouheif, M. A. (2011). Performance, carcass characteristics and meat quality of intact and castrated Ardhi goat kids fed high energy diet. *Journal of Animal and Veterinary Advances* 10(16): 2157 – 2162.

Greenwood, P. C., May, T. J. and Finn, J. A. (1993). Development of object methods for marketing and promotion of goat meat. *MRC/NSW Agriculture final report. (Dan 041, Sydney)*. 98pp.

Gursoy, O., Sentut, T. and Çankaya, S. (2011). Feedlot performance and carcass characteristics of Kilis goat breed. *Macedonian Journal of Animals Science*, 1(1): 39 – 51.

Hango, A., Mtenga, L., Kifaro, G. C., Safari, J., Mushi, D. E. and Muhikambele, V. R. M. (2007). A study on growth performance and carcass characteristics of Small East African goats under different feeding regimes. *Livestock Research for Rural Development*. [www.lrrd.org/lrrd19/9/hang19130.htm]. Site visited on 25 /11/ 2015.

Hozza, W. A., Kifaro, G. C., Safari, J. G. and Mushi, D. E. (2013). Effect of concentrate supplementation levels on growth and slaughter characteristics of SEA and SEA× Norwegian goats under on-farm conditions. *Tropical Animal Health and Production* 45(8): 1789 – 1794.

Hozza, W. A., Mtenga, L. A., Kifaro, G. C., Shija, D. S. N., Mushi, D. E., Safari, J. G. and Shirima, E. J. M. (2014). Meat Quality Characteristics of Small East African Goats and Norwegian Crosses Finished under Small Scale Farming Conditions. *Asian – Australasian Journal of Animal Science* 27(12): 1773 – 1782.

Lee, J. H., Kouakou, B. and Kannan, G. (2008). Chemical composition and quality characteristics of choven from goats fed three different post-weaning diets. *Small Ruminant Research* 75: 177 – 184.

Madruga, M. S., Medeiros, E. J. L. D., Sousa, W. H. D., Cunha, M. D. G. G., Pereira Filho, J. M. and Queiroga, R. D. C. R. D. (2009). Chemical composition and fat profile of meat from crossbred goats reared under feedlot systems. *Revista Brasileira de Zootecnia* 38(3): 547 – 552.

MLDF (2012). Ministry of Livestock and Fisheries Development. Annual Budget Speech 2011/2012 United Republic of Tanzania, Dodoma. [http://www.mifugo.go.tz/documents storage/Livestock%20 Programe.pdf]. Site visited on 9/8/2015.

Moyo, B., Masika, P. J. and Muchenje, V. (2014). Effect of feeding Moringa (*Moringa oleifera*) leaf meal on the physico-chemical characteristics and sensory properties of goat meat. *South African Journal of Animal Science* 44(1): 64 – 70.

Mushi, D. E. (2004). Studies on marketing of meat goats and carcass composition: A case study of Gairo auction markets. MSc. Dissertation, Sokoine University of Agriculture, Morogoro, Tanzania. 153pp.

Mushi, D. E., Mtenga, L. A., Eik, L. O., Safari, J. and Mwilawa, A. J. (2006). Some factors affecting the quality of meat from ruminants and their relevance to the Tanzania meat industry. *In Proceedings of Scientific Conference of Tanzania Society of Animal Production* 32: 109 –124.

Mushi, D. E., Safari, J. Mtenga, L. A., Kifaro, G. C. and Eik, L. O. (200**9).** Effects of concentrate levels on fattening performance, carcass and meat quality attributes of Small East African× Norwegian crossbred goats fed low quality grass hay. *Livestock Science* 124: 148 – 155.

Owen, J. E., Norman, G. A., Philbrooks, C. A. and Jones, N. S. D. (1977). Studies on the meat production characteristics of Botswana goats and sheep - Part III: Carcasses tissue composition and distribution. *Meat science 2*(1): 59 – 74.

Prasad, V. S. S. and Kirton, A. H. (1992). Evaluation and classification of live goats and their carcasses and cuts. In: *The 5th March International Conference on Goats* pp. 440 – 449.

Safari, J., Mushi, D., Mtenga, L. A., Kifaro, G. C. and Eik, L. O. (2009). Effects of concentrate supplementation on carcass and meat quality attributes of feedlot finished Small East African goats. *Livestock Science* 125: 266 – 274.

SAS (2003). Statistical Analysis System. SAS/STAT User's guides version 9.1.3 for window. Statistical Analysis System Institute Inc., Car, NC. USA.

Sebsibe, A., Casey, N. H., van Niekerk, W. A., Tegegne, A. and Coertze, R. J. (2007). Growth performance and carcass characteristics of three Ethiopian goat breeds fed grain less dietary levels varying in concentrate to roughage ratios. *South Africa Journal for Animal Science* 37 (4): 221 – 232.

Sen, A. R., Santra, A. and Karim, S. A. (2004). Carcass yield, composition and meat quality attributes of sheep and goat under semiarid conditions. *Meat Science* 66 (4): 757 – 763.

Shija, D. S., Mtenga, L. A., Kimambo, A. E., Laswai, G. H., Mushi, D. E., Mgheni, D. M. and Safari, J. G. (2013). Chemical composition and meat quality attributes of indigenous sheep and goats from traditional production system in Tanzania. *Asian-Australasian Journal of Animal Sciences* 26(2): 295 – 305.

Tshabalala, P. A., Strydom, P. E., Webb, E. C. and de Kock, H. L. (2003). Meat quality of designated South African indigenous goat and sheep breeds. *Meat Science,* 65: 563 – 570.

Webb, E. C., Casey, N. H. and Simela, L. (2005). Goat meat quality. *Small Ruminant Research* 60 (1–2): 153 – 166.

Wilson, R. T. (1992). Goat meat production and research in Africa and Latin America. In: *Proceedings 5th March International Goat Conference, New Dehli, India* pp. 458 – 472.

4.0 GENERAL CONCLUSIONS AND RECOMMENDATIONS

4.1 Conclusions

i. On the basis of the findings of this study there are differences in consumers preferences for meat from livestock species in different districts. Goat meat is the most preferred meat in Ngorongoro and Bahi while pork is highly preferred in Same district.

ii. Across the districts meat attributes i.e. fatness, leanness, juiciness, marbling, taste and tenderness are the factors considered by the goat meat consumers when buying meat. Among these factors taste and tenderness are the most important meat quality attributes in all districts.

iii. Consumers in different districts prefer meat from castrates and goats with the age of two to three years.

iv. Hind leg, fore leg and loin are the most preferred meat cuts due to leanness and tenderness and consequently these meat parts have higher prices compared to the other meat parts.

v. With regard to goat carcass characteristics, this study has shown that there are significant differences among the SEA goats strains in respect to slaughter weight, carcass weight, carcass length, chest depth, hind legs, and hind leg circumference. Pare and Gogo goats have heavier slaughter weight and carcasses than Sukuma and Sonjo and therefore produces more meat.

vi. There are no significant differences among the SEA strains on dressing percentage.

vii. There are no significant differences among the SEA strains with regard to carcass composition, but the distribution of carcass tissues in joints differ among the strains.

viii. Crude protein and mineral contents of goat meat differ significantly among the SEA goat strains.

4.2 Recommendations

In light of the results of this study, it is recommended that more studies should be conducted on goat meat consumer preferences and meat characteristics of other SEA goat strains in Tanzania in order to come up with the attributes preferred by consumers and improve the performance the strains which show superior carcass weight.

APPENDICES

Appendix 1: Goat meat consumers in the selected area of Tanzania

1. Enumerator's name .....Date.....
2. Name of the region.....District.....Ward.....
3. Name of butcher.....
4. Name of the respondent (meat consumer).....
5. Distance from home to the meat market place (km).....
6. Sex: 1 Male 2 Female
7. Age (in years): .....
8. Marital status: (a) Married (b) single (c) Widow (d) divorced
9. Religious a) Christian b) Muslim c) others (specify).....
10. Education level. a) primary b) secondary c) college d) university e) none

11.0 Preference for meat from different livestock species.
Rank in terms of preference *(1 = topmost preferred, 2= second preferred 3 = preferred, 4 = less preferred, 5 = not preferred)*

i. Beef [ ]

ii. Goat meat [ ]

iii. Mutton [ ]

iv. Pork [ ]

v. Chicken meat [ ]

vi. Fish meat [ ]

vii. Other (specify) [ ]

12.0 During the last 6 months, how often did you eat meals that included the following meat type?

Meat type	Never	Once per month	Twice per month	Once per week	Twice per week	3-4 times per week	5-6 times per week	Everyday
Beef								
Goat meat								
Mutton								
Pork								
Chicken meat								
Fish								
Other _____								

13.0 Give a score for each of the meat type with regard to the meat attributes indicated (e.g. 1= excellent, 2 = very good, 3 = good , 4 = fair, 5 = poor

Meat	Meat attribute					
	Fatness	Leanness	Juiciness	Marbling	Tenderness	Taste
Goat						
Mutton						
Beef						
Pork						
Chicken						
Fish						

14.0 FOR GOAT MEAT:

14.1 Do you prefer meat from which sex of goat: (Tick)

1) = Entire male 2) = Female 3) = Castrates 4) = No preferences

14.2 Do you prefer meat from goats of which age?

Age: (i). ≤ 1 year (ii). 2 – 3 years (iii) > 3 years

14.3 Give reason for your preference (choose the reason among the alternative answers provided:

1)= low fat content 2) = more lean meat 3)= tender meat, 4)= good aroma 5) = marbling 6)= others (specify)

Age	Reason for preference
≤ 1 year	
2 – 3 years	
> 3 years	

15.0 Rank the following meat cuts in order of preferences (*(Give rank in the first column by writing 1 for first preference, 2 – second preference, 3- third preference, 4 – fourth preference, 5 – fifth preference , 6 least preference, 7 – not preferred*) and give reason for your preference in the second column(*choose the reason among the alternative answers provided: 1 = low fat content, 2 = more lean meat, 3 = tender meat,4 = good aroma, 5 = marbling, 6= others (specify)*)

Part	Rank	Reasons
Neck		
Hind legs		
Fore hand		
Loin		
Chump		
Ribs		
Chest		
Heart		
Liver		
Intestine		
Spleen		
Breast		
Leg		
Ribs		
Head		
Other (specify)		

16.0 Which parts of the goat meat are **NOT** edible in your community?

Mention them a) .....B).....c).....d).....

17.0 Is there a difference in pricing among the meat parts? a) Yes b) No

18.0 If yes, what is the price range for:

Part	Range of price
Neck	
Hind legs	
Fore hand	
Loin	
Chump	
Ribs	
Chest	
Heart	
Liver	
Intestine	
Spleen	
Breast	
Leg	
Ribs	
Head	
Other (specify)	

Appendix 2: ANOVA for leaner carcass measurements

Source of variation	Degree of freedom	Slaughter weight	Carcass weight	Dressing Percentage	Carcass length	Chest depth	Hind leg Length 1	Hind leg Length 2	Hind leg circumference
Strain	3	*	*	ns	*	*	*	*	*
Sex	1	ns	ns	ns	ns	ns	ns	ns	ns
Age	2	ns	ns	ns	ns	*	ns	ns	ns
Strain *Sex	3	ns	ns	ns	ns	ns	ns	ns	ns
Strain *Age	4	ns	ns	ns	ns	ns	ns	ns	ns
Sex *Age	1	ns	ns	ns	ns	ns	ns	ns	ns
Strain* Sex* Age	1	ns	ns	ns	ns	ns	ns	ns	ns

Note: ^{ns} non- significant at ($P > 0.05$); *significant at ($P < 0.05$).

Appendix 3: ANOVA for joint weights (kg) carcass summarized by strain, sex and age

Source of variation	Degree of freedom	Chump	Neck	Loin	Fore leg	Hind leg	Rib	Breast
Strain	3	*	*	*	*	*	*	*
Sex	1	ns	*	ns	ns	ns	ns	*
Age	2	ns	ns	ns	ns	ns	ns	ns
Strain *Sex	3	ns	ns	ns	ns	ns	ns	ns
Strain *Age	4	ns	ns	ns	ns	ns	ns	ns
Sex *Age	1	ns	ns	ns	ns	ns	ns	ns
Strain* Sex* Age	1	ns	ns	ns	ns	ns	ns	ns

Note: ^{ns} non- significant at ($P > 0.05$); *significant at ($P < 0.05$).

Appendix 4: ANOVA for total tissue weights and percentages summarized by strain, sex and age

Source of variation	Degree of freedom	Total muscle	Total bone	Total fat	% muscle	% bone	% fat
Strain	3	*	*	ns	ns	ns	ns
Sex	1	ns	ns	ns	*	ns	*
Age	2	ns	ns	ns	ns	ns	ns
Strain *Sex	3	ns	ns	ns	ns	ns	ns
Strain *Age	4	ns	ns	ns	ns	ns	ns
Sex *Age	1	ns	ns	ns	ns	ns	ns
Strain* Sex* Age	1	ns	ns	ns	ns	ns	ns

Note: ^{ns} non- significant at ($P > 0.05$); *significant at ($P < 0.05$)

Appendix 5: ANOVA for percent muscle in various joints summarized by strain, sex and age

Source of variation	Degree of freedom	Chump	Neck	Loin	Fore leg	Hind leg	Rib	Breast
Strain	3	ns	ns	ns	*	*	ns	*
Sex	1	ns	*	ns	*	ns	ns	ns
Age	2	ns	ns	ns	ns	*	ns	ns
Strain *Sex	3	ns	ns	ns	ns	ns	ns	ns
Strain *Age	4	ns	ns	ns	ns	ns	ns	ns
Sex *Age	1	ns	ns	ns	ns	ns	ns	ns
Strain* Sex* Age	1	ns	ns	ns	ns	ns	ns	ns

Note: ^{ns} non- significant at ($P > 0.05$); *significant at ($P < 0.05$).

Appendix 6: ANOVA for percent bone in various joints summarized by strain, sex and age

Source of variation	Degree of freedom	Chump	Neck	Loin	Fore leg	Hind leg	Rib	Breast
Strain	3	ns	ns	ns	ns	*	*	*
Sex	1	ns	ns	ns	ns	ns	ns	ns
Age	2	ns	ns	ns	ns	*	ns	ns
Strain *Sex	3	ns	ns	ns	ns	ns	ns	ns
Strain *Age	4	ns	ns	ns	ns	ns	ns	ns
Sex *Age	1	ns	ns	ns	ns	ns	ns	ns
Strain* Sex* Age	1	ns	ns	ns	ns	ns	ns	ns

Note: ^{ns} non- significant at ($P > 0.05$); *significant at ($P < 0.05$).

Appendix 7: ANOVA for percent fat in various joints summarized by strain, sex and age

Source of variation	Degree of freedom	Chump	Neck	Loin	Fore leg	Hind leg	Rib	Breast
Strain	3	ns	ns	ns	ns	ns	ns	ns
Sex	1	ns	ns	ns	ns	*	*	ns
Age	2	ns	ns	ns	ns	ns	ns	ns
Strain *Sex	3	ns	ns	ns	ns	ns	ns	ns
Strain *Age	4	ns	ns	ns	ns	ns	ns	ns
Sex *Age	1	ns	ns	ns	ns	ns	ns	ns
Strain* Sex* Age	1	ns	ns	ns	ns	ns	ns	ns

Note: ns non- significant at (P > 0.05); * significant at (P < 0.05).

Appendix 8: ANOVA for non-carcass components

Source of variation	Degree of freedom	Blood	Head	Plaque	Liver	Kidney	Spleen	Fat	GIT full	GIT fill	Skin	Feet	Testicle
Strain	3	*	*	*	*	*	*	*	*	*	*	*	*
Sex	1	ns	*	ns	ns	ns	ns	*	ns	ns	ns	ns	ns
Age	2	*	ns	ns	*	ns	ns	ns	ns	ns	ns	ns	ns
Strain *Sex	3	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns
Strain *Age	4	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns
Sex *Age	1	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns
Strain* Sex* Age	1	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns

Note: ns non- significant at (P > 0.05); *significant at (P < 0.05)

Appendix 9: Summary of ANOVA As for proximate analysis for goat meat

Source of variation	DF	DM	CP	EE	ASH
Strain	3	ns	*	ns	ns
Sex	1	*	*	*	*
Strain*Sex	3	ns	ns	ns	ns

Note: ns non- significant at (P > 0.05); * significant at (P < 0.05).