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PROXIMATE AND MINERALS CONTENT ANAYSIS OF DIFFERENT MEAT SOURCES IN JIGJIGA CITY



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Executive Summary

Meat is a good source of protein and different micronutrient that widely consumed in Somali community. The study was conducted in Jigjiga City Somali Regional state with objective to analyze macronutrient and micronutrient/minerals of different meat sources in different part of the city. Four different types of meat samples from camel, cattle, goat and sheep with total of eight (8) samples were collected from different part of Jigjiga city. The collected meat samples were individually grounded packed in air tight polyethylene plastic bags and were stored at -15°C until further analysis. Proximate composition such as crude Protein, crude Fat, crude fiber, moisture content, different minerals like Calcium, Iron, Zinc, sodium, magnesium and Potassium were determined by AOAC. Based on the result obtained the moisture, ash, protein and fat are in the range of 71.97% (SheMH02) -75.94% (GoaMH), 0.99 %(CamM01) -1.57% (CatM02), 19.12% (CamMH) -23.32% (SheMH02) and 3.01% (GoaMH) -5.25% (CatM01) respectively and most of them are statistically different at $P<0.05$. The minerals content is also in the range of 18.20 (CatM02) – 33.33mg/100g (CamM01), 15.78 (GoaMSH) – 59.16mg/100g (CamM01), 8.97 (CatM01) – 21.84mg/100g (CamM01), 30.59 (CamM01)-31.40mg/100g (GoaMSH), 660.93 (CamM01) – 992.32mg/100g (SheMH02) and 59.59 (CatM02) – 198.43mg/100g (Ca,M01) for calcium, iron, zinc, magnesium, potassium and sodium respectively and more or less they were statistically different at $P<0.05$. Overall, from the finding we conclude that, sheep is better in protein content followed by cattle, goat and camel. Species difference, breed difference, livestock management, pre and post slaughter handling practice and some other reasons might be the factor for their different in their nutritional content.

Key words: Meat, camel, cattle, goat, sheep, Nutrition, minerals.

CHAPTER ONE

1. INTRODUCTION

1.1. Background

The general increasing human population in the world leads to the movement of people from rural areas to urban. This will increase the demand for food of livestock origin [1]. Human beings consume protein-rich foods to fulfill their nutritional requirements, mainly of animal origin, such as meat (cattle, sheep, goat, poultry, pig, fish, and seafood/shellfish), milk, and eggs [2]. Meat and meat products are most valuable livestock products and sources of high-quality protein due to their amino acid composition. They are also the major source of iron and some vitamins in the B group. So, meat consumption can alleviate several nutritional deficiencies [3].

Consumers often consider meat quality based on organoleptic properties and microbiological quality. However, meat quality can be evaluated in a more unbiased way by evaluating its chemical composition and physical proprieties. Livestock meat applies a crucial role in human nutrition. Besides, it represents an important constituent of a balanced and healthy diet due to its essential components such as amino acids, long-chain n-3 polyunsaturated fatty acids, and microelements, namely, iron, selenium, zinc, and copper different quality traits of red meat are influenced by several factors, that is, genetic, environmental and management factors. meat composition varies from breeds, from animals, and from one muscle to another in the same animal [4].

Meet is the best source of animal proteins, micronutrients, and B-complex vitamins in the human diet. The chemical composition of meat is an important factor determining both its nutritional value and its suitability for processing meat products [5]. The amount of fat in beef is the source of juiciness and marbling which are some of basic parameter that determines the eating qualities of meat. However, excessive fat content is undesirable by consumers as it is associated with the risk of cardiovascular problems. Fat deposits in meat can be categorized as saturated fatty acids (SFAs) and unsaturated fatty acids (PUFA). The proportion of these two categories of fat has human health implications. SFAs are related to the increased level of cholesterol in blood stream and, consequently, with coronary heart disease and cardiovascular disease [6]. The higher fatty

acid in meat is accompanied by a higher proportion of SFAs and a lower PUFA percentage[7]. Polyunsaturated (PUFA) or monounsaturated fatty acids (MUFA) are known to have cholesterol-lowering properties, thereby limiting the risk of coronary problems [8]. Fatty acid profile and proximate composition of meat vary can be influenced by breed, feed, age and sex of animal [9]. Age of animal and breed in particular influence the concentration of MUFA in beef by affecting Stearoyl-CoA Desaturase (SCD) gene expression and activity. In ruminants, the fatty acid profile is not only a reflection of FA composition in the feed but also the result of complicated reactions of bio-hydrogenation precipitated via rumen microorganisms [. The dominating SFAs in cattle fat are myristic (C14:0), palmitic (C16:0), and stearic (C18:0) acids (Lawrie, 2005; Antunes de Lemos et al., 2017). The ratio of n-6: n-3 fatty acids is the most essential nutritional indices regularly used to describe fatty acid composition of ingredients [10]. The optimum ratio required in human diet was reported as 2 - 5:1 [11].

The chemical composition and physical properties of meat determined the quality of meat (pH, color, water holding capacity, hardness, thermal treatment losses, nutritional value of meat proteins, digestibility, etc.). These characteristics are influenced by animal species, breed, individual characteristics, sex, age, rearing technologies, and fattening, as well as other factors such as meat production procedure (feeding, transporting, and slaughtering condition) and processing (storage time or temperature condition) [12]. Composition, texture of the muscle, and some biochemical processes that take place during slaughtering, fabricating, and storing carcasses essentially affect tenderness, while the flavor, which is influenced by the fat content, can be manipulated by genetic methods, growth performance control, and dietary supplementation [13].

There are no any studies that were conducted to evaluate nutritional qualities of Meat in Somali region and people uses different mythologies to slaughter animals and local traders are selling in different areas and not protecting sunlight, and mostly its open areas, also the hygiene of the meat looks poor. However, the qualities of these meats were not examined or investigated. The minerals composition and profile on the quality of meat and a healthy diet are not well documented. Therefore, this study will conduct to determine macronutrient and micro-nutrient composition of meat from Jigjiga city under the different species category.

1.2. Statement of the problem

Meat has been part of human diets for most of mankind's existence. Beef, is a high source of protein, which contains all the essential amino acids and iron. The iron found in meat is in the form of heme iron, which is better absorbed than the non-heme iron found in plants [14]. There is a rapid increase in the number of smaller abattoirs in the Jigjiga town mostly on-farm facilities and transportation of livestock to abattoirs became less regulated and therefore easier, responding to the demand. Most importantly, meat inspection became a private activity, allowing abattoir owners to employ their own meat inspection personnel. This situation led to a decline in the management of hygiene practices, as adherence to stringent meat inspection procedures was compromised at abattoirs [15].

From the consumer perspective, quality is related to functional characteristics that range from sensory domain taste and appearance properties to cost domain storage and distribution criteria. Among the sensory traits of meat, color, tenderness, flavor [13], and juiciness are important attributes that determine the quality of meat cuts, and consumer studies have shown that tenderness is the most important factor of the perceived eating quality of meat [16].

The HACCP certified abattoirs supply meat and meat products to both the export and the domestic markets. The use of different hygiene management systems at abattoirs may create a perception that fresh meat from abattoirs that use HACCP may be of superior microbiological quality compared to meat from abattoirs. Contamination of meat carcasses has pointed to many sources including abattoir workers. In instances where, abattoir workers' remuneration is linked to the number of head of cattle slaughtered a day, workers tend to increase the slaughter line speed [17]. A line speed that is too high implies inadequate time for slaughter operatives to carry out their functions, which may lead to increased chances of spillage during evisceration and inadequate sterilization of slaughter equipment leading to increased risk of contamination of carcasses. The generation of abattoir specific microbiological data can be used for training purposes and illustrations so that abattoir workers understand the link between their practices and meat safety.

Food security is more critical than food safety among both rural and urban poor [18]. The lack of vigorous surveillance of food pathogens in Somali region meat and meat products presents a challenge for food hygiene trainers, as it becomes difficult to demonstrate the magnitude of contamination with these pathogens. Therefore, the aim of this study was analyze the macro and micro-nutrient content of different meat sources in Jigjiga City.

1.3. Objectives

1.3.1. General objectives

- To analyze the macro-nutrient and micro-nutrient content of different meat sources establishments in Jigjiga city.

1.3.2. Specific Objectives

- To analyze the macro nutrient composition of different meat sources
- To analyze the minerals contents of different meat sources

1.4. Significance of the study

This study will be important as it is the 1st in its nature to conduct such a study on different meat source macro and micro nutrient composition. The outcome of the study will be important to get up-to-date data on the nutritional composition, minerals and as well as. The result obtained from this study will further be important for the future researchers as baseline information to conduct their research. Based on the recommendation come out from this study, policymakers, government (Jigjiga City council) and other interested institutions working on the area will be expected to get up-to-date information from the study.

CHAPTER TWO

2. LITERATURE REVIEW

2.1. Meat Composition

Meat is not only an important source of amino acids, minerals, and vitamins but also a good source of energy [19]. In terms of micronutrients, red meat is an excellent source of bioavailable iron and zinc and provides selenium and vitamins D, A, and B. It has also been proven that protein and vitamins (A and B12) in meat cannot be substituted by plant sources [20].

The common features of the meat structure such as connective tissue, muscle fibers, and tendon which attaches the muscle to its bone are visible in joint meat examined through the naked eye [21]. Muscle fibers are arranged in bundles surrounded by fibrous connective tissue [22], which is continuous with the tendon [23]. Endomysium is the connective tissue between individual muscle fibers. Perimysium is the sheath surrounding bundles of muscle fibers, and the connective tissue around an entire muscle is known as epimysium [22]. Individual muscles have unique connective tissue infrastructure; muscles responsible for locomotion have a greater collagen content than postural muscles, and the nature of their function contributes to the distribution of collagen within the muscle (e.g., parallel, fusiform, and pinnate) [24].

2.1.1. Water

Water is quantitatively the most important component of meat comprising around 75% of weight [23] and has an important influence on color, texture, and surface appearance [25]. The water content varies inversely with the fat content, while the protein content is maintained constantly within the muscle [24]. Water-holding capacity means the ability of meat to retain tissue water present in its structure and its effects on the appearance of raw meat and its juiciness on mastication [23].

2.1.2. Protein

From the nutritional and processing meat point of view, protein is the most valuable component in meat. It is the building block of the muscular tissue. Protein is a complex molecule made up of simple organic molecules known as amino acids [26]. There are 20 amino acids that are necessary for human growth and metabolism. Eight of these amino acids cannot be synthesized in our body and are described as essential, meaning that it is necessary to be contained in our

diets [26]. The remaining amino acids are nonessential ones. Proteins of beef consist of essential amino acids such as leucine, isoleucine, lysine, methionine, cystine, phenylalanine, threonine, tryptophan, valine, arginine, and histidine; the last two of these are considered essential for infants [20].

2.1.3. Fat

The fat portion of meat includes some fat-soluble substances, including some vitamins [19]. The fat may be present as intermuscular fat (between the muscles), intramuscular fat (marbling, i.e., within the muscles), and subcutaneous fat (under the skin/adipose tissue) [27]. Whether in the adipose tissue or muscle, fat contributes importantly to various aspects of meat quality and is central to the nutritional value of meat [28]. Fat acts as one of precursors of flavor by combining with amino acids from proteins and other components when heated [21]. its main component as fatty acids [13, 25]. Fatty acids are carbon chains with a methyl group at one end of the molecule and a carboxyl group at the other end. Fatty acids differ from each other in length of their hydrocarbon chains and presence or absence of double bonds. According to the degree of unsaturation, the most common dietary fatty acids have been divided into saturated fatty acids (SFA) that lack double bonds and unsaturated fatty acids (USFA) which have double bonds. USFA are subdivided into monounsaturated (MUFA) (sometimes monoenes) and polyunsaturated (polyenes) fatty acids (PUFA). MUFA have one double bond, and PUFA have two or more double bonds [29].

The fatty acid composition of adipose tissue affects its firmness because different fatty acids have different melting points. The composite fatty acids of meat melt between about 25°C and 50°C, with SFA melting at higher and PUFA at lower temperatures [29]. The total lipid content of the muscle, or intramuscular fat, has a role in the tenderness and juiciness of cooked meat. Intramuscular fat is often termed as marbling fat, although this is strictly the flecks of adipose tissue composed mainly of neutral lipid [21].

2.2. Meat Quality

Quality can be defined in an economic and nutritional value. Economic quality reflects upon the physical lean meat yield. A high nutritional quality refers to a high Bioavailability of amino acids, in addition to sufficient essential fatty acids for energy, Iron, zinc, and vitamins.

As previously mentioned, there is little to no classification of carcass quality, and little classification of economic quality of Ethiopia's meat products. Age, marbling, tenderness, etc. are not considered when setting the price[30]. There is no system for naming meat. A few butcheries and several supermarkets reported that the beef round was the highest quality of meat, but there was no price differentiation except for one supermarket case. Butcheries also reported that kitfo was classified as the highest with still no price differentiation. The supermarkets butcher and package meat to supermarkets in developed countries. Butcheries, however, cut off random pieces of meat, bone, and fat and sell only per kilogram. Thus, the higher quality meat is purchased in the supermarkets. In regards to the sanitation of meat disposal, this process is also unorganized and inefficient. While the supermarkets sell bones and trimmings as pet food, the butcheries sometimes sell bones but more frequently simply discard them into the street for stray dogs. Some also reportedly disposed of bones to waste containers. All meat, however, is sold. The butcheries and supermarkets trust the abattoirs to dispose of inedible meat before it is delivered to their establishment. They simply keep all meat until it is sold, of the timeframe. The safety concerns from pathogens, chemicals, and hazards are not continuously controlled[31].

2.3. Factors Affecting Meat Quality

2.3.1. Intrinsic Factors

The characteristics of quality meat vary among species of animal, even within more similar groups such as small ruminants [32]. On the contrary, differences in meat characteristics are assessed in sensory analyses [33]. Species-related flavors are associated with species-dependent adipose tissues, even though the acceptability of meat from different species is also linked to the population's consumption habits [34]. Breed is a clear source of variation in carcass morphology associated to fat quantity or meat quality. +e impact of breed or genetic type in the lamb varies a lot. It may be stated that, as a rule, the effect of breed on instrumental and sensory meat quality, such as pH, color, texture, and sensory characteristics, is slight. Most differences are probably justified by differences in muscularity levels [35]

Gender effect (male, female, and castrated) is mainly related to the quantity of fat deposited, deposition site, growth rate, and carcass yield. Carcass attributes are more affected by gender; similarly, females are more affected than males due to their higher precociousness, whereas

steers maintain an intermediate position. Differences in carcass, fat, and conformation might also affect other meat quality parameters [36]. Age and weight at slaughter also affect meat quality and are analyzed together because, taking the same genetic base, a greater weight implies a higher age, except when feed composition or level is manipulated or the animal has periods of strong feed restrictions. Fat and carcass yield proportions were affected by weight, with light lambs featuring less internal fat and lower commercial and slaughter yields but more muscle and bone percentage. Furthermore, weight affected fat contents and meat color: meat of heavy lambs was darker.

2.3.2. Extrinsic Factors Previous to Slaughter

The feed of animals usually used has an influence on quality of color, odor, and flavor of meat, but its effects are more evident in fat [33]. +e yellow color of fat due to grass feeding is common within some da iry breeds and is considered to be a negative determinant of quality [18]. Preslaughter stress of the animal also has effects on meat quality; thus, two main types of meat can be considered as aberration: dark, firm, and dry (DFD) meat and pale, soft, and exudative (PSE) meat [33]. Factors such as transportation, confinement, unfamiliar surroundings, additional handling, and deprivation of water for various periods can induce preslaughter stress [37].

Stress is an imprecise term but can be defined as an animal's response to any demand made upon it [51]. When an animal is stressed in the preslaughter environment, there is a rapid release of enzymes, cortisol and catecholamine, which may lead to depletion of glycogen, high meat ultimate pH, and dark cuts [38]. pH rises when the glycogen stores become depleted from a more prolonged stress, and lactic acid can no longer be produced [39].

Darkening of meat in the DFD condition is due to a higher respiration rate that reduces the depth of oxygen penetration and, therefore, reduces the level of visible oxymyoglobin [21]. Spoilage of DFD meat occurs more quickly than spoilage of meat with normal pH due to the absence of glucose in the tissues [40]. PSE occurred when pH of meat is less than 6 at 45 minutes after slaughter, and DFD is when ultimate pH postmortem measured after 12–48 hours is more or

equal to 6. PSE meat looks pale and lean and has soft texture, low water-holding capacity, and poor functional attributes [41].

2.3.3. Biochemical Changes

Muscles do not suddenly terminate all their living functions and become meat. A number of physical and chemical changes take place over a period of several hours. These include the onset of rigor mortis and the proteolytic postmortem processes [24]. In beef cattle, the conversion of muscle to meat can be a lengthy process requiring up to 48 hours or even more [24]. In particular, fresh meat quality is directly associated to muscle fiber characteristics because skeletal muscles mainly consist of muscle fibers [42].

The most significant change occurring on death is that circulation stops, and as a result, oxygen is no longer sent to the animal cells. This means that reactions begin to take place under anaerobic conditions [19]. One of the major consequences of this is that pH decreases (from ∼7.1 to ∼5.6) because in the absence of oxygen, glucose is converted into lactic acid rather than carbon dioxide and water which tenderizes the meat [19, 24].

Shortly after death, the meat appears dark and extremely firm [19]. Early postmortem, while the temperature and pH are still high, the normal level of ATP is maintained preventing actin-myosin cross-bridge formation [43, 44]. When the oxygen supply to the muscles stops, glycolysis continues anaerobically, and only two moles of ATP are produced compared to 12 moles under aerobic conditions [25, 43, 44].

Among others, ATP is produced in the muscle to drive calcium pumps and to provide energy for muscle contraction [25]. As ATP levels are reduced, Ca2+ levels raise and actin-myosin cross-bridges form, resulting in stiffness or rigor mortis. +ese rigor bonds are related with an increase in toughness [45].

The anaerobic glycolysis produces lactic acid via glycogen stores in the muscles [25, 43, 44]. Lactic acid is normally removed by the blood system, but postmortem, this removal stops, and lactic acid accumulates in the muscle causing pH to decrease, and pH will continue to decline until either the glycogen stores are used or pH is so low that the glycolysis is inhibited. +e water-holding capacity is also affected by the postmortem changes mentioned above. Excessive decline

of postmortem pH results in reduced WHC because pH affects the electrostatic repulsion between the filaments and thereby leads to the shrinking of myofibrils. WHC and pH are thereby correlated [44].

After slaughter, the postrigor meat is most often conditioned, also called the ageing process. During this process or period, the meat tenderness increases. The period of ageing before the meat reaches a maximum tenderness depends on species; beef needs to be conditioned for minimum ten days [44]. Tenderization during conditioning is mainly caused by changes in the myofibrillar proteins since only slight changes have been observed in the major connective tissue components such as collagen [43, 44]. pH of meat can also be related to its tenderness. The rate of pH fall along with ultimate pH has been studied though a precise relationship between tenderness and pH is not fully understood [45]. A few studies show that meat with pH below 5.3, also called PSE meat (soft, pale, and exudative), has a higher WB shear force compared to DFD meat [46]. DFD meat stands for dark firm dry and has pH above 6.0. Other studies have found that peak/shear force was lowest at pH 5.4, then increased until pH 5.8–6.0, and then decreased again [19, 47].

When the ageing time increased, the difference between WB peak forces between different ultimate pH became smaller [19]. A day or so later, meat is lighter in color and is moist. Over 30% of fluid can be squeezed from it. Protein synthesis and degradation rates in the live animal may influence tenderization postmortem, levels of stored glycogen may influence the rate and extent of postmortem glycolysis, and levels of fat in all the depots may influence the rate of temperature decline postmortem, thus affecting rigor development and proteolytic enzyme activities [24].

2.4. Vitamins and Minerals in Meat

Protein foods including meat, poultry, seafood, eggs, beans and peas, soy products, nuts, and seeds are good sources of B vitamins (niacin, thiamin, riboflavin, and B6), Vitamin E, iron, zinc, and magnesium [48].

2.4.1. Minerals

Minerals are one of the classes of essential nutrients in the human diet. The broad function of minerals is to help build body structure and to help coordinate body function [49]. Meat is especially rich in iron, zinc, and phosphorus, however, lacks calcium, iodine, and magnesium in sufficient amounts [50]. In meat, more than half of the iron is heme iron, the most readily absorbed form of iron [50]. Heme iron primarily functions in transport of and in the binding of oxygen to hemoglobin in the blood. [49]. Zinc is involved in numerous enzyme systems and is necessary for normal growth [49]. Phosphorus has many functions throughout the body: it has a key role in maintaining the acid/base balance of blood, chemically reacts with macronutrients to release energy, is a component of ATP (functional form of energy), and is part of nucleoproteins that carry genetic information [49]. Animals require molybdenum, nickel, selenium, chromium, copper, fluorine, manganese, cobalt, magnesium, and iodine for cell functions; therefore, these minerals are present in beef muscle, but not in levels necessary for human nutrition [50].

Plant mineral content can be influenced by soil, climate, seasonal conditions, and maturity of the plant, which in turn influences the mineral content of meat [49]. [51] found that 85 % lean ground beef samples from grain-finished cattle contained lower concentrations of Mg, P, and K, but had greater concentrations of Na, Zn, and Vitamin B-12 than strip steaks of grass-finished animals. [51] attributed this difference to the difference in percent fat. [52] found that tissue from grass-finished steers contained greater amounts of Zn, P, Mg, and K compared to tissue from grain-finished steers. Similarly, [53]Duckett et al. (2009) found greater Ca, Mg, and K contents in grass-finished beef than grain-finished, whereas Na, Zn, and Fe were not different between the two.

2.5. Meat production and consumption in Ethiopia

As Ethiopia's 2003 estimated population of 70.5 million continues to grow at a rate of 2.7 percent, it is critical to understand the food situation. Many Ethiopians, like residents of other developing countries, do not consume an adequate amount of meat. The few that do, however, maintain a meat diet of beef, sheep, goat, and poultry. In 1987, 51 percent beef, 19 percent sheep, 14 percent goat, and 15 percent poultry contributed to a meat diet composition (Map Zones). Most Ethiopians do not consume pork, in addition to 17 many types of fish, due to

religious beliefs. The consumption of sufficient meat is a rare extremity in most developing countries. General trends of meat consumption from 1997 to 2001. While developed countries consumed a consistent level of 77kg of meat per capita annually, developing countries struggled to maintain a diet with only 25kg of meat per capita annually. More specifically, while the United States had an average meat intake of over 120kg per capita annually, at hardly over 8kg annually, Ethiopians remained slightly below the meat intake of all low-income countries consuming 9kg per capita annually [54]. The meat consumption in developing countries, however, increases slightly. At a 2.8 percent increase from 1993 to the year 2020, developing countries will consume 30kg of meat per capita in 2020. Meat consumption in sub-Saharan Africa, however, remains at only 11kg per capita annually [55].

Meat consumption is based largely on availability, price and tradition. Meat production is a very complex operation depending not only on demand (which is usually based on price and income) but on many social and economic influences such as official policy, price support mechanisms, and interrelations such as the interaction between beef and milk production, the availability of animal feedstuffs and competition for food between man and animals. Up to a certain level of income the amount of meat eaten varies with income, in the relatively affluent western world where the proportion of available income spent on food has been steadily falling over the past generation, there is now little if any difference between the amounts of meat eaten by the different income groups. This contrasts with the Third World countries [56]. Meat consumption is often an indicator of the civilization or economic status of a country or that of an individual. People with a higher social or economic status consume a sufficient amount of meat products. The amount of meat consumed in different countries varies significantly with the social, economic, political influences, official policy, price support mechanisms, availability of livestock feeds and competition for food between man and animals, religious beliefs and geographical differences to name a few. In Ethiopia, the average annual meat consumption per capita is very low, which is estimated to be around 8 kg per year[57].

Table 1: Slaughter house present in Ethiopia it's used in meat production

Slaughter locations				
Region	**laughter house**	**Slaughter slab**	**Meat processing plant**	**Export abattoir**
SNNPR	31	27	1	0
Oromia	42	20	0	5
Amhara	15	6	2	0
Tigray	15	0	0	0
Addis Ababa	3	0	1	0
Afar	1	0	0	0
Somali	1	0	0	0
Harar	1	0	0	0
Dire-dawa	1	0	1	0
Others	3	0	0	0
Total	**113**	**53**	**5**	**5**

SOURCE: Mahmud 2000

2.6. Constraints on Meat Production

Other constraints on meat production include inadequate feeding and poor management of animals, to which must be added animal health problems, lack of skilled manpower, problems arising from land tenure, lack of financial resources, and poor rural infrastructure - roads, power, health care, marketing organization. There is a great deal of illegal or poorly supervised slaughterwhich means that regulations are not being enforced, and conditions are unhygienic. Disease, parasites and poor management of all aspects of meat production impede progress. It is estimatedthat world-wide per year up to 50 million head of cattle and buffaloes and 100 million sheep and goats die from disease and parasites - mostly in the Third World. Even greater losses of production are estimated to arise from ailing and unthrifty animals and from poor handling before slaughter. In many regions of developing countries animals trek to market, often with inadequate feed and water and under considerable stress which lead to losses of both of weight and quality of meat. In parts of Africa, for example, it is estimated that there is often a 30% loss of weight and 10% mortality on the way to market. In most areas animals are slaughtered on a simple slab, usually at night or in the early morning when the temperature is lower, and the meat is sold without refrigeration or further processing within a few hours. The general disregard for grades and quality of meat both in buying and selling

does not encourage investment to improve meat output. A more discerning market tends to develop with economic growth, and both producers and consumers would benefit by sale and purchase on grade and quality bases[31].

2.7. Meat production challenges in Ethiopia

2.7.1. Low Production Levels

Cattle sector is highly dualistic: -communal, subsistence & small-scale farmers co-existing with– large commercial farmers. Off-take from the commercial sector is high, while it is still low in other sectors as a result of low fertility, high mortality. The major challenges to Livestock production in Ethiopia were severe feed shortage, high disease prevalence, high predatory, poor market, genetically less productive breed, severe water shortage and high shortage of laborer [58]. Improved environment improves the genetic potential with the result of improved productivity. There are also many Non-Governmental Organizations (NGO) that are working on improving living and livelihood through improving the production and productivity of their animals. Government is also working to solve the challenges [59].

2.7.2. Main Challenges for Meat

Although Ethiopia has ample potential to export its livestock and livestock products to the Middle East and make further improvement to enter other markets, there are challenges that should be dealt with in order to realize these benefits. These challenges can be roughly grouped into internal and external challenges [60].

2.7.3. Internal Challenges

The internal challenges are many and inter connected. Their major cause is under development and lack of market-oriented production approach and entrepreneurial capacity by the stakeholders. These internal problems can be grouped into four depending upon the specific area to which they fall [55].

I. Supply Problems

The country's livestock number, annual off-take, productivity, and consumption levels are not adequately known. This creates problems in planning and designing of policies to enhance the

sector's development [60].

II. Inadequate port facilities

The Djibouti port is the only port for exporting livestock to the Middle East countries. However, the port is ill-equipped for handling large number of livestock. The livestock-resting place is too small. It has no sufficient fencing and there is no compartment for handling different categoriesof livestock and isolation of sick animals [55].

2.7.4. External Challenges

I. Competition

Many countries compete for livestock and products markets in the Middle East. The main competition for Ethiopia Its major source of supply is believed to be the Ethiopian Somali Region, Eastern Hararghe and parts of Bale zones of Oromia [60].

2.8. Meat production opportunities in Ethiopia

There are higher livestock production potentials in Ethiopia for different reasons. These are that existence of large animal population, diverse genetic resources, diverse ago-ecologies, different livestock production systems, increased demand for livestock products, growing interest in market-oriented livestock production, less commercialization, inadequate livestock product processing and by-product (offal) investment opportunities in livestock sectors that include[57]:

- Establishment of ranches
- Establishment of meat export abattoir
- Rearing and breeding of cattle
- Livestock fattening and export
- Trading of cattle domestically after the completion of fattening v
- Production and processing of feed for domestic market and use
- Processing of offal for export

2.8.1. Domestic consumption

The domestic meat is believed to increase with increasing literacy and family income. Meat consumption is often an indicator of economic status of a country or an individual. People with a higher social or economic status demand a greater amount of high-quality meat products. The per capita consumption of meat in developed/industrialized countries is much higher than in developing countries. Countries whose population consumes the least amount of meat are located in Africa and Asia. Developed countries consumed a consistent level of 77 kg of meat per capita annually, while developing countries struggled to maintain a diet with only 25 kg of meat per capita annually. Ethiopians remained slightly below the meat intake of all low-income countries and consuming 9 kg per capita annually [61].

2.8.2. Inadequacy of infrastructure

The sources of livestock for export are pastoral areas that are far from the center. The Afar and Somali Regions, parts of Borana in Oromia are lowland areas forming internal boundary to neighboring countries. Further, the pastoral livestock producers are scattered through large expanse of lowland and semi-arid areas. However, these infrastructures are poorly developed in the pastoral areas. Further, export standard slaughterhouses are located in central areas far from surplus producing areas. In addition, transport facilities that allow adequate flow of livestock and meat are not adequately employed [62].

CHAPTER THREE

3. MATERIALS AND METHOD

3.1. Structure of the experiment work

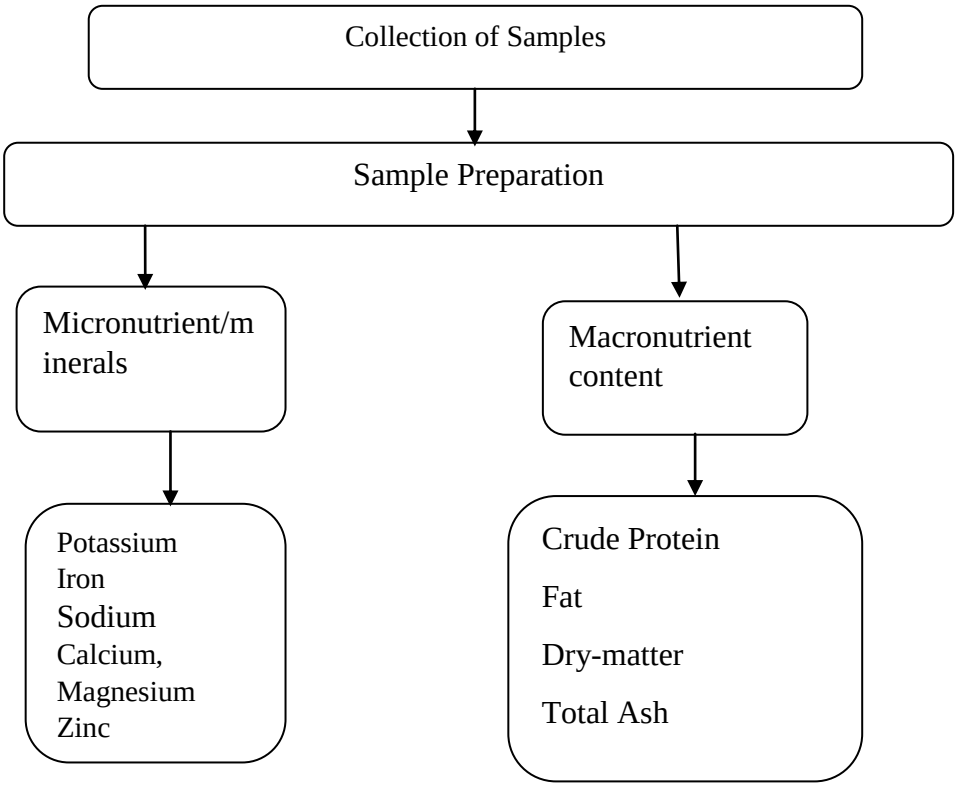


Fig 1 Experimental structure

3.2. Materials and Equipment

Meat samples from different livestock sources were collected from the different establishments in Jigjiga city. The meat sources were camel, cattle, goat and sheep. Two samples were collected from each source of meat which make the total samples 8. All necessary precaution was taken to ensure hygienic and sanitation during sample collection and on the occasion of storage. All equipment used in sample preparation was used from SoRPARI laboratories and missed equipment can be used from local institutes. Further, after bringing to the laboratory, meat samples were size reduced until it suitable for utility, packed in airtight polyethylene plastic bags and were stored at -15°C until further analysis.

3.3. Determination of Proximate Composition

Samples from L. dorsi muscle were thawed for 24 - 48 hours at 4˚C - 8˚C. All exterior muscles, connective tissue and external fat was removed leaving only the Longissimus thoracis muscle. Samples were cubed, submerged in liquid nitrogen for rapid freezing, placed in a blender (VITA-MIX Corp, Cleveland, OH; model # VM0100A) and ground to form beef homogenates. Grinded/powdered samples were double packed in VWR sample bags (BPR-4590 VW1, Radnor, Pennsylvania) and stored at −40˚C for subsequent analysis [63]. For each parameter approximately 5 g of lean meat was taken from Longissimus dorsi muscle (eye rib area).

Fat content

Soxhlet method of solvent extraction of fat was determined according to AOAC standard procedure [64]. About 2 g milled samples were measured into an extraction thimble lined with fat free cotton. Then the thimbles with the samples were attached to the extraction apparatus. The aluminum cup with a boiling cheap was placed in the oven at 100˚C for 30 minutes and cooled to room temperature in the desiccators for 30 minutes then the cup weight was measured using a digital balance and recorded as W1 (weight of cup), then 50 ml of diethyl ether was added into each cup, after which set up of the extraction apparatus was done.

The samples contained in the thimbles were soaked for about 1 hour by lifting the thimble down into the cup, started from the apparatus hot plate temperature reached 55˚C, after soaking the thimbles will be lifted up and the extraction process takes place for 5 hours. Then the recycling process made by the diethyl-ether was stopped to let the solvent evaporate from the aluminum cup with the extract, in the process the evaporated solvent was recovered in the apparatus. Then aluminum cup and the content were dried in the oven for 30 minutes at 100˚C to evaporate the remaining solvent in the cup. After drying, it was removed from the oven and cooled in the desiccators for 30 minutes then weighed and recorded as W2 (cup + fat).

The percentage of fat will be calculated using the following formula

$$\text{Fat\%} = \frac{(W2-W1)*100}{\text{Sample weight}}$$

Moisture Content

The chemical composition was performed by employing the classical procedures of the Association of Analytical Chemists [65]. For moisture content, the samples were dehydrated in a hot air oven at 125°C until obtaining two successive.

Ash

Ash was determined according to the AOAC standard procedure [64]. Two-gram ground meat sample will be placed into a dried crucible with known weight. The crucible was placed inside a muffle furnace at 150˚C. Temperature will be increased gradually till it reached 600˚C and heated at that temperature for 3 hrs. Then the crucible will be taken out, cooled into a desiccator and weighed. The ash percentage was calculated as

$$\text{Ash \%} = \frac{(\text{Crucible weight containing incinerated meat- Empty crucible weight}) * 100}{\text{Meat sample weight before incineration}}$$

Crude protein

For determination of crude protein Kjeldhal method of AOAC standard procedure [64], Crude protein was obtained by multiplying the amount of nitrogen by 6.25. The sample was weighed in a Kjeldhal flask. Half a tablet of catalyst mixture (10 parts) of K2SO4 to 1 part of CuSO4 was added (10 ml). 25 ml Concentrated H_2SO4 was added. The content of the flask was digested under boiling at maximum heat for 2 hours. The flask was cooled and transferred to the distillation unit. The sample was distilled using 40% NaOH solution and received in 4% Boric acid. The content was titrated against 0.1 M HCl.

$$\text{\%Crude protein} = \frac{(\text{mlHCL for sample-mlHCLfor blank}) * 0.1 * 14 * 100}{\text{Weight of sample}}$$

3.4. Mineral analysis

A total of 5 gm of the well-mixed sample was introduced inside porcelain crucibles, then ashing of the sample by using muffle furnace. The obtained ash was dissolved in 1.5% nitric acid and then completed with distilled water up to 100 ml. The sample was filtrated and the trace elements were determined using a spectrophotometer (Unico-UV-2100 spectrophotometer, USA), and the wavelength was 623, 630, 578, 560, 578, and 630 nm for iron, magnesium, calcium, zinc, potassium, and sodium, respectively [66]

3.5. Statistical analysis

All the analysis will be performed in duplicate (unless stated otherwise) and presented as mean ± standard deviation. Statistical significance of the data obtained will be analyzed by One-way analysis of variance (ANOVA) followed by Duncan test by using Genstat version 18.0. The level of significance will be considered at $P < 0.05$.

CHAPTER FOUR

4. RESULT AND DISCUSSION

4.1. RESULT

4.1.1. Macro-nutrient content different meat sources

Table 4.1: Proximate composition of different Meat sources

Sample Code	Moisture	Ash	C.Protein	C.Fat
CamM01	75.14 ± 0.74^{e}	0.99 ± 0.01^{a}	20.55 ± 0.24^{d}	3.32 ± 0.08^{b}
CamMH	75.37 ± 0.78^{f}	1.5 ± 0.02^{ab}	19.12 ± 0.17^{a}	4.01 ± 0.12^{d}
GoaMH	75.94 ± 0.81^{g}	1.31 ± 0.02^{bc}	19.74 ± 0.21^{b}	3.01 ± 0.05^{a}
GoaMSH	74.97 ± 0.67^{d}	1.42 ± 0.02^{c}	20.06 ± 0.22^{c}	3.55 ± 0.09^{c}
CatM01	73.25 ± 0.54^{c}	1.06 ± 0.03^{c}	20.44 ± 0.24^{d}	5.25 ± 0.15^{f}
CatM02	73.26 ± 0.55^{c}	1.57 ± 0.04^{c}	20.48 ± 0.24^{d}	4.69 ± 0.14^{e}
SheM01	72.91 ± 0.46^{b}	1.4 ± 0.03^{c}	21.74 ± 0.29^{e}	3.95 ± 0.11^{d}
SheMH02	71.97 ± 0.41^{a}	1.57 ± 0.05^{c}	23.32 ± 0.34^{f}	3.14 ± 0.06^{a}

Key: Same letter in the same column is not significantly different from each other at $p<0.05$
Cam: Camel, Goa: Goat, Cat: Cattle and She: Sheep

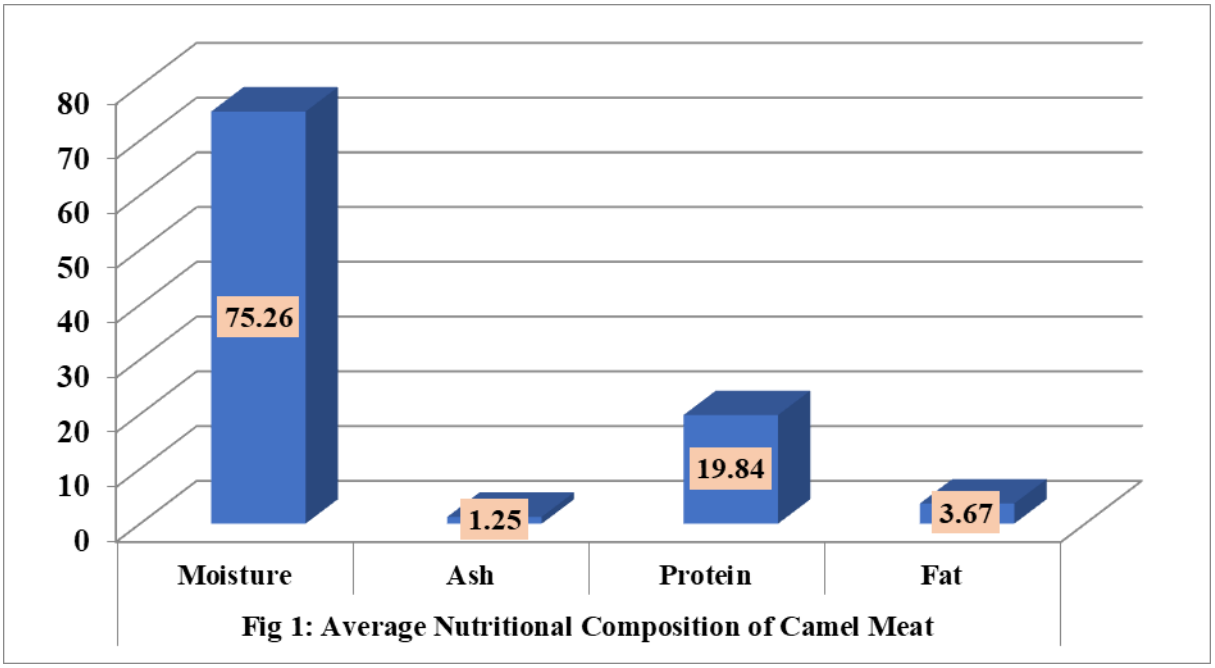


Fig 1: Average Nutritional Composition of Camel Meat

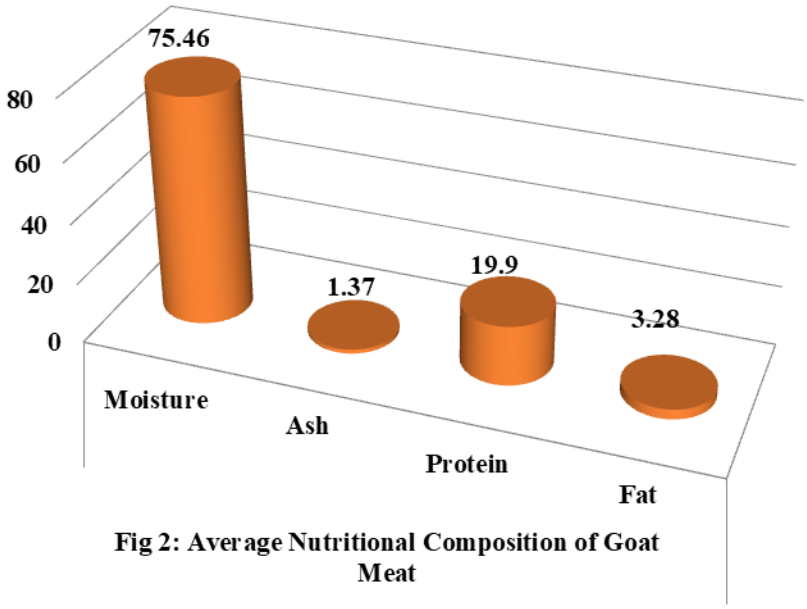


Fig 2: Average Nutritional Composition of Goat Meat

The proximate composition of different meat of camel, cattle, goat and sheep are indicated in table 4.1. The moisture content in the range of 71.97% (for SheH02) to 75.94% (for GoaMH). Statistically significant different were observed at $p<0.05$ in moisture content of different meat sources. Significant differences were also observed within same species of meat sources. This not only true for the cattle where there no difference in moisture content as shown in table 4.1 above which is 73.25% and 73.26% for Cat01 and Cat02 respectively.

When it comes to ash content, CamM01 has the lowest while CatM02 (0.99) & and SheMH have the highest which 1.57%. CamM01 ash content is significantly different from all others samples such as GoaMH, GoaMSH, CatM01, CatM02, SHeM01 and SheMH02 which were 1.31%, 1.42%, 1.06%, 1.57%, 1.40% and 1.57% respectively. On the other hand, the ash content is not statistically different among GoaMH, GoaMSH, CatM01, CatM02, SHeM01 and SheMH02 which were 1.31%, 1.42%, 1.06%, 1.57%, 1.40% and 1.57% respectively.

CamMH has the lowest in protein content (19.12%) while SheMH02 has the highest in protein content which is 23.32%. Statistically there is no significant different in protein content among CamM01 (20.55%), CatM01 (20.44%) and CatM02 (20.48%). The protein content is significantly different among CamMH, GoaMH, GoaMSH, SheM01 and SheMH02 which are 19.12%, 19.74%, 20.06%, 21.74% and 23.32% respectively. These samples protein content are

significantly different with that of the above mentioned samples protein content which are CamM01 (20.55%), CatM01 (20.44%) and CatM02 (20.48%).

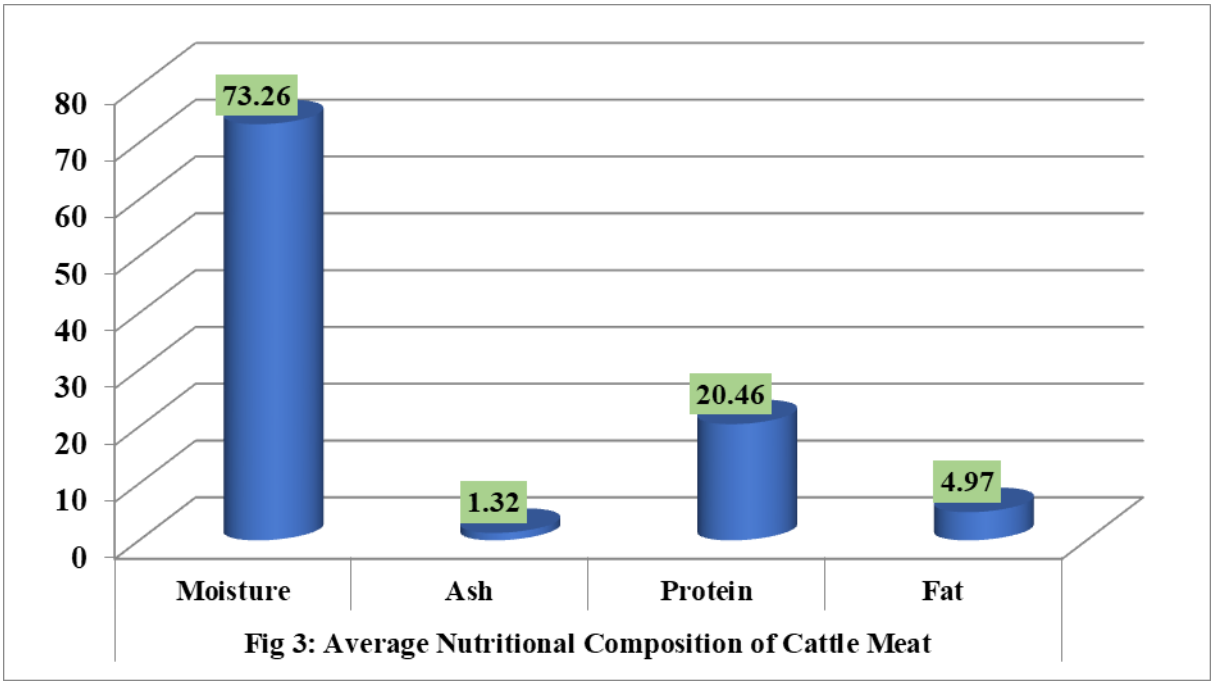


Fig 3: Average Nutritional Composition of Cattle Meat

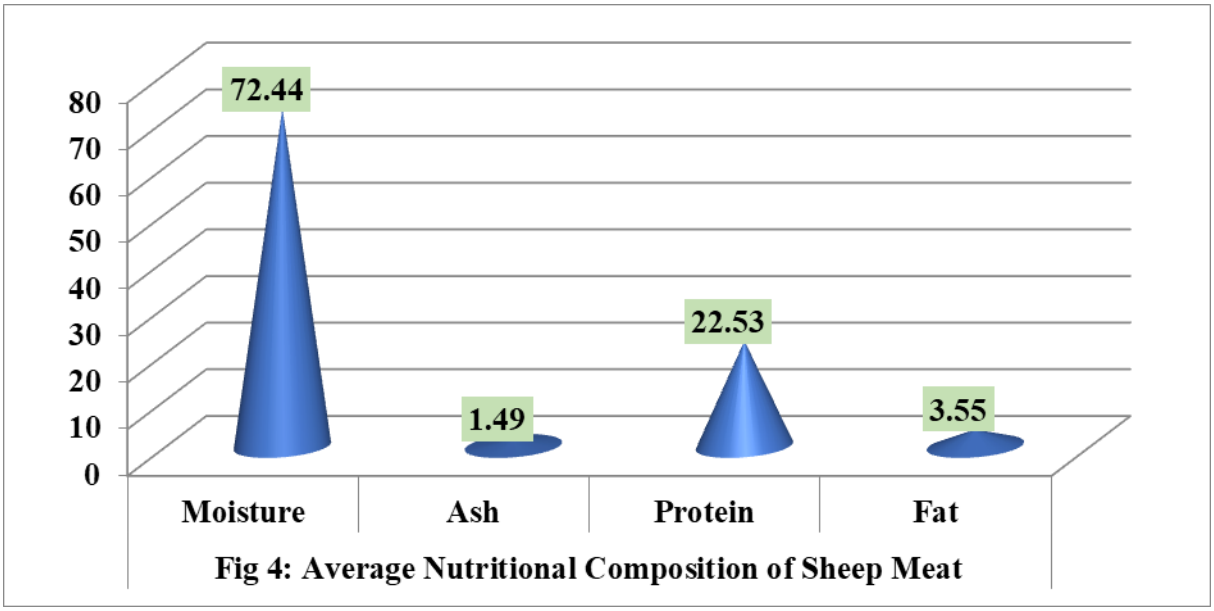


Fig 4: Average Nutritional Composition of Sheep Meat

When it comes of fat content, it is in the range of 3.14% (SheMH02) and 5.25% (CatM01). No significant difference were observed among SheMH02 (3.14%) & GoaMH (3.01%) and also among SheM01 (3.95%) and CamMH (4.01%). The fat content is statistical difference among CamM01, GoaMSH, CatM01, CatM02 which are 3.32%, 3.55%, 5.25% and 4.69% respectively. The average macronutrient composition also indicated in fig 1, 2,3 and 4 for each commodities.

4.1.2. Micro-nutrient content different meat sources

Table 4.2. Mineral's content of different Meat Sources

Sample Code	Result in (mg/100g)					
	Calcium (Ca)	**Iron (Fe)**	**Zinc (Zn)**	**Magnesium (Mg)**	**Potassium (K)**	**Sodium (Na)**
CamM01	33.33 ± 0.32^{f}	59.16 ± 0.55^{e}	21.84 ± 0.21^{e}	30.59 ± 0.32^{a}	660.93 ± 0.69^{a}	198.43 ± 0.98^{c}
CamMH	21.20 ± 0.21^{c}	42.73 ± 0.42^{d}	15.56 ± 0.15^{d}	30.83 ± 0.26^{d}	818.75 ± 0.81^{cd}	72.78 ± 0.74^{a}
GoaMH	22.20 ± 0.22^{c}	16.98 ± 0.14^{a}	13.84 ± 0.13^{c}	31.16 ± 0.29^{b}	703.07 ± 0.71^{ab}	77.86 ± 0.77^{a}
GoaMSH	23.80 ± 0.28^{d}	15.78 ± 0.12^{a}	14.98 ± 0.34^{d}	31.40 ± 0.30^{cd}	777.44 ± 0.79^{bc}	80.99 ± 0.81^{ab}
CatM01	25.23 ± 0.25^{e}	18.96 ± 0.18^{ab}	8.97 ± 0.09^{a}	31.13 ± 0.28^{b}	756.54 ± 0.76^{bc}	76.12 ± 0.76^{a}
CatM02	18.20 ± 0.18^{a}	22.46 ± 0.22^{b}	11.33 ± 0.11^{b}	31.35 ± 0.30^{bc}	900.61 ± 0.91^{d}	59.59 ± 0.61^{a}
SheM01	19.40 ± 0.15^{bc}	16.45 ± 0.13^{a}	11.86 ± 0.12^{b}	31.23 ± 0.31^{bc}	850.69 ± 0.86^{cd}	95.88 ± 0.93^{ab}
SheMH02	17.37 ± 0.17^{ab}	34.40 ± 0.32^{c}	12.84 ± 0.32^{b}	31.20 ± 0.27^{bc}	992.32 ± 1.99^{e}	112.49 ± 0.99^{b}

Key: Same letter in the same column is not significantly different from each other at $p<0.05$
Cam: Camel, Goa: Goat, Cat: Cattle and She: Sheep

Tables 4.2 indicate the minerals content different meat sources. Six different minerals were considered in this study. CatM02 has the lowest in calcium content while CamM01 has the highest in calcium content. There is no significant difference in the calcium content among CamMH, GoaMH and SheM01 which are 21.20mg/100g, 22.20mg/100g and 19.40mg/100g respectively at $P>0.05$. The same true when it comes to the calcium content for CatM02 and

SheMH02 which are 18.20mg/100g and 17.37mg/100g respectively. Statistically significant difference were observed among CamM01, GoaMSH, CatM01 at $P<0.05$ which are also true with the above mentioned samples calcium content.

Iron is also the 2nd minerals considered in this study. No significant differences were observed among SheM01 (16.45mg/100g), GoaMSH (15.78mg/100g), GoaMH (16.98mg/1006) and CatM01 (18.96mg/100g) at $P>0.05$. Statistically significant difference were observed among meat samples of SheMH02, CamMH and CamM01 which are 34.40mg/100g, 42.73mg/100g and 59.16mg/100g respectively which are also significantly different from the above mentioned samples at $P<0.05$.

The zinc content of different meat samples are indicated in the table 4.2 above. It is in the range of 21.84mg/100g for CamM01 and 8.97mg/100g for CatM01. No significant difference were observed for the samples SheMH02 (12.84mg/100g), SheM01 (11.86mg/100g) and CatM02 (11.33mg/100g) at $P>0.05$. The same is true for samples GoaMSH and CamMH which are 14.98mg/100g and 15.56mg/100g respectively at $P>0.05$. But statistically significant difference were observed in meat samples CatM01, GoaMH and CamM01 which are 8.97mg/100g, 13.84mg/100g and 21.84mg/100g respectively at $P<0.05$ which are also significantly different with the above mention meat samples.

CamM01 has the lowest in magnesium content (30.59mg/100g) while CamMH has the highest in magnesium content (30.83mg/100g) as shown in table above. Except these samples of the same species, no significant difference were observed among all samples when it comes to magnesium contents of the different meat samples at $P>0.05$.

When it comes to potassium content, it is in the range of 992.32mg/100g for SheMH02 and 660.93mg/100g as shown in table 4.2. No significant difference were observed among CatM01, GoaMSH, GoaMH and SheM01 which are 756.54mg/100g, 777.44mg/100g, 703.07mg/100g and 850.69mg/100g respectively at $P>0.05$. The same is true for meat samples SheM01 and CamMH which are 850.69mg/100g and 818.75mg/100g respectively at $P>0.05$. But statistically significant difference were observed among CamM01, CatM02 and SheMH02 which are 660.93mg/100g, 900.61mg/100g and 992.32mg/100g respectively at $P<0.05$.

Lastly, the sodium content of different meat samples was indicated in table 4.2. The sodium content of different samples are in the range of 59.59mg/100g (CatM02) to 198.43mg/100g

(CamM01).Statistically, significant difference were observed among CamM01 samples which are 198.43mg/100g with the rests of the other meat samples in one way other at P<0.05. But, significant difference were observed among CamMH, GoaMH, CatM01, CatM02, GoaMSH, SheM01 and SheMH02 which are 72.78mg/100g, 77.78mg/100g, 76.12mg/100g, 59.59mg/100g, 80.99mg/100g, 95.88mg/100g and 112.49mg/100gm respectively at P>0.05.

4.2. DISCUSSION

4.2.1. Macronutrients

The amount of ash, crude fat (CF) and crude protein (CP) were significantly different between breeds. Similarly, a study had reported the presence of significant difference in protein, fat, ash and moisture content of beef across the breeds [67]. The moisture content of the different meat sources are in the range of 71.97-75.94% as shown in table 4.1. The difference in moisture content might be due to species difference, breed difference, handling practice before and after slaughter and some other reasons. The moisture content obtained in agreement with Ante Kasap, et.al. [68]. This result is also in agreement with a Spanish study on three lamb genotypes [69] where breed did not show a significant effect on dry matter ($p > 0.05$). Our results were higher than those reported by Liu et al. [70] and Berrighi et al. [71], respectively, for Chinese (23–25%) and Algeria lambs (18%).

The protein content of different meat sources are in the range of 19.12%-23.32% as indicated in table 4.2. The result obtained for protein analysis is comparable with study done on cattle breed based on their age in Ethiopia [72](T. Dagne *et al)* .The result of the present study in respect to CP implied that sheep are better for red meat production as the percentage protein decreased with advance in age. The obtained results were comparable to those reported by Addis et al. [73] for Agnello di Sardegna lambs, while they were lower than those reported by Liu et al. [70][25] for Oula lambs. The difference in crude protein content among these meat samples is due to species difference, breed difference, management of those species before slaughter, handling practice after slaughter and some other reasons.

The fat content of different meat sources are from 3.14 to 5.25% as shown in table 4.1. The result obtained for fat analysis is lower than with study done on cattle breed based on their age in

Ethiopia [72](T. Dagne *et al)* but higher than the study done by [68]. The CF content of beef of all the breeds under the study can be considered as a good contributor to palatability of the beef as minimum of 3% fat is suggested to ensure acceptable palatability of beef [74]

4.2.2. Micronutrient

After protein and fat, meat is an essential source of several other nutrients, such as minerals [75]. It is defined as poor food in calcium and rich in potassium (K), phosphorus (P), iron (Fe), sodium (Na), and zinc (Zn) [76]. Its consumption can respond qualitatively or quantitatively to the human needs for mineral elements. Fe and Zn were most abundant microelements which much higher than the result obtained by some other research [68, 77]. The Zn content is the range of 8.97-21.84mg/100g as indicated in table 4.2. Meat is a major source of total iron (Fe) and heme iron [78] and thus might help reduce major public health problem worldwide [76]. The iron content depends on the breed, muscle, and animal's age [79][24]. Under this study, the iron content of the meat is in the range of 16.45 to 59.16mg/100g.

When it comes to other minerals, Potassium is the most abundant one followed by sodium, magnesium and calcium. The potassium content is in the range of 660.93-992.32mg/100g. The obtained results were higher than those reported by Osorio et al. [80] in suckling lambs of Churra breed and by Polidori et al. [81] for Fabrianese breed meat. In comparison with the literature, the tested meats presented a high content of major mineral elements [68, 80, 81]. The natural feeding condition-based pasture in phosphocalcic soils rich in phosphorus, sodium, magnesium, and calcium could explain the high levels recorded in the studied meats [82]. The magnesium and calcium contents of the meat sources are in the range of 30.59 to 31.40mg/100g and 18.20 to 33.33mg/100g respectively. The result might be influenced by bread type, breed type, nature of pasture livestock used, handling management of the livestock and some other reasons. In general, all meat types have good sources of both micro-minerals and macro minerals.

CHAPTER FIVE

5. CONCLUSION AND RECOMMENDATION

5.1. CONCLUSION

Eight different samples of meat were used for this study. The meats were used from camel, cattle, goat and sheep from different place in Jigjiga city. Based on the laboratory analysis, the moisture content is in the range 71.97-75.94% which makes sheet meat to be lowest in moisture content while camel to be the highest averagely. Meat from camel has lowest in protein content (19.12%) while meat from sheep has highest in protein content (23.32%). When it comes to fat content, meat from cattle has highest in fat content (5.25%) while meat from goat has lowest in fat content which is 3.01%. six types of minerals were considered in this study. All meat sources are highest in minerals content. Based on their order, potassium, sodium, magnesium, calcium, iron and zinc considered to be from highest to lowest level.

5.2. RECOMMENDATIONS

Based on the data available and identified gaps, the following recommendations are forwarded;

1. Further research should be done for some missed parameters such as type of fatty acid or fatty acid characterization.
2. Research on such commodity (Meat which perishable food product) need especial facilities even for sample collection and preparation. So, facilities should be fulfilled to conduct research on these types of commodities.
3. Special research should be done under control condition to further analyze the effect of different factors on meat nutritional quality.
4. Research should also be done on the effect of post slaughter process/factors on meat nutritional quality.

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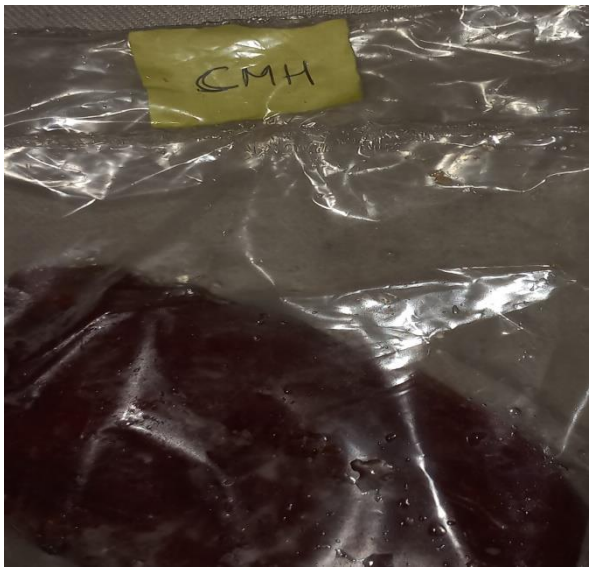
Appendix:

Photo Album of demonstration










SHM01
CM01
GNH
SHM01