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A Review on Compositional Constituents, Quality Characteristics and Trace Elements in Beef, Sheep and Goat Meat in Ethiopia

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Abstract
The Consumption of meat and meat product is increased in the world from time to time, even if its increment in the developing country is not as such as that of developed country. In Ethiopia the sailor and the consumers have no awareness about the composition, quality characteristic and content of trace elements found in beef, sheep and goat meat, but they fill to eat the best one. So, the aim of this review is to create awareness among our community about composition constituents, quality characteristics and content of trace elements found in beef, sheep and goat meat of Ethiopia. Therefore a review paper motivates our community to choose meat which is appropriate for their health.
Keywords: Composition, Element, Meat, physico-chemical, Quality, Trace

INTRODUCTION

Ethiopia has huge livestock population standing 1st in Africa and 10th in the world, indicating that the country has great potential for meat and meat by-products. But, practically the sector is under exploited/ utilized for three basic reasons such as: animal health problems, improper feeding practices and low genetic potential of the livestock kept. In addition, the livestock are not raised for specific production purpose. That is, the meat industry is not well organized (back yard dominated type) and the personnel are not well educated. Meat consumption in developing countries has been continuously increasing from a modest average annual per capita consumption of 10 kg in the 1960s to 26 kg in 2000 and will reach 37 kg around the year 2030 according to FAO projections. This forecast suggests that in a few decades, developing countries' consumption of meat will move towards that of developed countries where meat consumption remains stagnant at a high level (FAO 2007).

In Ethiopia in 1991/93 and 1994, 595 million and 577 million tones of meat, respectively, have been produced. In addition to this, due to the export of the 3,790 bovine live cattle in three years (1990-1992) a total value of 1,493 million US $ foreign currency has been gained (ILRI, 2000).The value of output from livestock in Ethiopia was estimated at around birr 12 billion in 2000 and accounted for about 45% of the value of all agricultural output excluding the contribution of animal draft power (FAO, 2003).

In many developing countries, especially in Ethiopia meat is widely consumed as a source of protein; it is eaten as raw or/ either cooked or processed into other forms to avoid associated spoilage (Olaoye *et al*., 2010; Olaoye and Onilude, 2010). Meat is defined as 'the edible part of the skeletal muscle of an animal that was healthy at the time of slaughter (CFDAR, 1990). Chemically meat is composed of four major components including water, protein, lipid, carbohydrate and many other minor components such as vitamins, enzymes, pigments and flavour compounds (Lamber *et al*., 1991). The relative proportions of all these constituents give meat its particular structure, texture, flavour, colour and nutritive value. However, because of its unique biological and chemical nature, meat undergoes progressive deterioration from the time of slaughter until consumption (Lamber *et al*., 1991).

Meat is a nutritious, protein-rich food which is highly perishable and has a short shelf-life unless preservation methods are used. Shelf life and maintenance of the meat quality are influenced by a number of interrelated factors including holding temperature, which can result in detrimental changes in the quality attributes of meat (Olaoye and Onilude, 2010). There are several groups of people that could be at risk of deficiencies of one or more micronutrients: elderly people for vitamins A, D, E, folate, iron and calcium, mostly because of diseases and an age-adapted lifestyle, less because of physiological problems (with the exception of iron and vitamin B_{12} uptake due to gastric mucosal atrophy) (Biesalski and Nohr, 2007). In pregnant women, risk of deficiency of vitamin D, folic acid, zinc and iron is due to enhanced demands, especially when meat is avoided in the diet (Saletti *et al*., 2000). Supplementation is recommended, especially for folic acid, in order to avoid serious birth defects. Vitamin A deficiency also seems to be a risk, as shown by (Schulz *et al*. 2007) for women with twins or births at short intervals.

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 (Abbey, 2004). Currently, little attention has been given to the awareness of meat and its consumption among many consumers of the product in many developing countries, such as Ethiopia. Broadly, the composition of

meat, after *rigor mortis* but before post-mortem degradative changes or fresh meat, can be approximated to 75% water, 19% protein, 3.5% soluble non-protein substances and 2.5% fat. The proteins in muscle can be broadly divided into those which are soluble in water or dilute salt solutions (the sarcoplasmic proteins), those which are soluble in concentrated salt solutions (themyofibrillar proteins) and those which are insoluble in the latter, at least at low temperature - the proteins of connective tissue and other formed structures (Lawrie and Ledward, 2006).

There is little information on meat cut yields, quality and sensory characteristics on indigenous breed of livestock raised on natural pastures with or without concentrate supplementation. But, most consumers prefer meat based on their interest they have which is not scientifically indentified and investigated on the composition of meat, quality characteristic the meat has and required compositions of trace elements in meat. Even if the butcher men sold the meat of beef, sheep and goat, they didn't know the composition of trace elements found in the meat. But the only thing that our communities have is at roomer level small ruminant meat is better than large ruminant's meat without any justification. This is due to lack of knowledge on composition, quality characteristic and amount of trace elements in meat that our community have. Meat composition, meat quality characteristics in Ethiopia is constrained due to lack of awareness and understanding of the composition, quality and content of trace elements, as well as limited consumption of meat product. Research and evaluation is needed to determine the content of trace elements that found in meat and create awareness among the Ethiopia community. Thus, this study will play its role in solving the problem resulted from the trace elements in the meat of beef, sheep and goat.

Therefore this review paper highlights the composition, content of trace elements and quality characteristic of meat of beef, sheep and goat.

Meat Consumption Habits

Since world population is close to 7 billion (FAO, 2003), food consumption has become a concern. World population is growing by more than 200,000 people per day and it has an impact on increasing demands for food production. The economic development is normally accompanied by an increase of the average household income and subsequent improvements in food supply. Meat is one of the most important foods in the world and in some countries it is considered an essential product with very high consumption rates. In fact, meat provides valuable amounts of protein, fatty acids, vitamins, minerals and other bioactive compounds. In other countries, meat is just a complement for an already balanced diet. Recently, especially from the 1980, meat consumption has been questioned by vegetarians, animal welfare supporters, environmental contamination supporters, to the point that a feeling that it is somewhat a dangerous product has been introduced into the consumers´ mind. Meat and meat products may be viewed as having a double mirror image with respect to its composition and nutrition (Troy; Kerry, 2010).

Actually there are consumers that consider meat to be a healthy and important component in the diet (Verbeke *et al.,* 2010) and others are convinced that it is an agent associated with cardiovascular disease, diabetes and some types of cancer. Family income, prices, individual preferences and beliefs, culture and traditions, as well as geographical, environmental, social and economic factors interact in a complex manner to determine dietary consumption (Grunert, 2006). In any case, meat, as any other food product, needs to improve its quality at three different scenarios:

Nutrition: - increased transparency on the nutritional contents of food products may also induce changes in consumers´ demand; in fact, it has already led producers to reformulate some meat products with lower fat or higher polyunsaturated fatty acid contents.

Sensorial: - providing an acceptable product that invites more consumption and increases its demand, with a deep knowledge of consumers´ cultural and cooking cultural background of each potential market.

Beliefs:-improving the image of the product with regard to all possible and imaginable aspects: welfare, ecological, nutritive, etc., i.e. indicating factors that meat and meat products are excellent foods for the intake of bioactive compounds without changing dietary habits; for example, Omega-3 (n-3) fatty acids play a major role in human health and are involved in the development of the brain and retinal tissues and in the prevention of human illnesses, including heart diseases and some cancers (Connor, 2000). From the three aspects mentioned above, the problem arises since meat varies with respect to numerous intrinsic and extrinsic factors. These include animal diet, the factor most easily manipulated and with the most profound effects on its composition, pre- and post-slaughter, technology and factors related to consumer sciences, such as Sociology, Acceptability, Economy and Marketing.

According to Abbey (2004), many Ethiopians, like other developing countries, do not consume adequate amount of meat. The few that do, however, maintain a meat diet of beef, sheep, goat, and poultry. In 1987, 51% beef, 19% sheep, 14% goat and 15% poultry contributed to meat diet consumption. Most Ethiopians do not consume pork, in addition to many types of fish, due to religious factor. Consumption of sufficient meat is a rare extremity in most developing countries.

Table 1: Trends in annual consumption of Meat in Ethiopia

Product	Annual consumption ('000 tons)			Per capita consumption (kg)		
	1980	1993	2000	1980	1983	2000
Beef	200.8	230	298.1	6.5	4.8	4.7
Mutton and Chevon	131.4	138.9	145.3	4.2	2.9	2.3
Total Meat	539	597.9	683.1	16.2	12.4	10.9

Source: FAO (2004).

As can be seen from the above, per caput consumption of all kinds of meats (including beef, small ruminant meat, poultry and pork) averaged 11 kg in 2000 in Ethiopia compared with about 12.4 kg in 1993 and 16.2 kg in 1980 (FAO, 2004). Beef is the dominant meat consumed in the country, its share in meat consumption in 2000 amounting to as high as 57%.The low level of meat consumption in Ethiopia is primarily due to the low level of meat production per caput which in turn is a consequence of the low productivity of the livestock sub-sector in the region.

Composition of meat

Muscle composition varies with increasing animal age irrespective of sex, breed or species. Research on various species has indicated that an increase in age is accompanied by an increase in intramuscular fat, increased saturation of intramuscular lipids, increased myoglobin concentration and an increase in toughness due to changes in the nature of the connective tissue present in the muscle (Lawrie, R. A. 1991). Meat is an important edible post-mortem constituent originating from the live animals that are used as food by the humans. All muscle tissues of meat contain high amount of protein, and are considered as adequate source of vitamin B_6, vitamin B_{12}, phosphorus, niacin, zinc, choline, riboflavin, selenium and iron. However they do not contain dietary fiber and are very low in carbohydrates. The meat fat content varies depending on the breed, species and the way of growth (Leaf, A., *et al*., 2003).

Pakistan's total production of meat up to the year of 2011 was estimated 3095,000 tons, from which mutton and beef were 616,000 tons and 1,711,000 tons respectively (Clifton, P.M., *et al*., 2004). Increased consumer awareness and demand about quality products in the recent past have urged the food manufacturers to produce homogeneous and high quality products. Similarly the meat quality has become an area of great importance and concern in the recent years. Chemical composition, sensory and technological attributes of meat affected by weight, sex, breed, environment and post-mortem factors, storage time and temperature (Corl, B., *et al*., 2003). Lean goat meat is low in fat and saturated fatty acids, but high in unsaturated fatty acids such as linoleic and oleic those have been shown to possess hypo-cholesteremic properties (N. Dawkins, *et al.,* 1999,). The chemical composition of goat meat is as follows:

Moisture: - 74.2-76%; protein: - 20.6-22.3%; fat: - 0.6-2.6%; ash:-1.1% (C. Devendra, 1988). Goat meat cuts have protein levels comparable to similarly prepared beef, lamb, and veal but have lower fat content (N. James *et al.* 1990). In addition, the percentage of saturated fat in goat meat is lower than in chicken, beef, pork, or lamb (Bakalivanova, T. *et al.*, 2007), United States Department of Agriculture (USDA, 1988,), considering its high nutritional value and its greater unsaturated to saturated fatty acid ratio.

Goat meat has the potential to improve the health of susceptible populations without taking meat products out of their daily diet. Consumption of goat meat is becoming popular and is often available at the fine dining level (Packaged Facts, 2007).

Meat quality characteristic

Meat quality and characteristics differ among animal species, even within more similar or homogenous groups such as small ruminants (Sañudo *et al*., 2012). The lamb and goat products (even very young and milk-fed animals) differed in carcass characteristics and several instrumental measurements of quality. Differences were mainly species dependent. On the other hand, differences in meat characteristics are assessed in sensory analyses. Sensorial differences between species are detected by consumers, even when meat is seasoned, as (Rhee *et al*., 2003) showed when they compared goat and beef meat. Species-related flavours are associated with species-dependent adipose tissues. However, the acceptability of meat from different species is also linked to the population´s Consumption habits. Consequently, global appreciation rates of meat from different species depend on consumers´ food background (Guerrero *et al*., 2013).

Breed is a clear source of variation in carcass morphology related to fat quantity or meat quality. In fact, it is a complex factor because results depend upon which criteria of comparison are taken into account: same weight, similar age or similar degree of maturity (live adult weight %). The influence of breed or genetic type in the lamb varies a lot and depends on which factor is being studied or compared (Osorio *et al*., 1995). Consequently, the main concern of user is inconsistency in quality characteristics of meat (Warriss, P., 2004, and Modi, V. *et al*., 2009). Quality of meat is most important for meat retailer and producer in order to meet the consumer's demand and applicable standard requirements for a consistent satisfactory product. As a result of

multifaceted combination of visual appeal and eating satisfaction, consumer agrees to take the product. Particularly, flavour, juiciness and tenderness satisfy the eating properties due to influence on replicate purchases, these showing overall meat quality (Aberle, E.*et al*., 2001). Meat should appear good to consumers when they decide to buy it before satisfying their taste. Once the meat is bought, it must meet the expectations of juiciness, aroma, tenderness and flavour (Conforth, D. *et al*., 1994).

Meat colour is the first condition that consumer use to judge meat quality and acceptability. It is one of the most important for consumer's indication of an originality and uprightness. Consumers will often refuse products in which the colour varies from the predictable appearance. Therefore, colour is frequently used to determine economic value of food (Qiao, M.; *et al*., 2001). A comprehensive understanding of the variation in quality properties associated to colour is important for further processing to decrease the potential negative impact of meat colour variation on further processed products (Penny, N.*et al*., 1993). It is declared that the colour is the main quality characteristic that responsible for shelf life of meat products. Retail sale enhanced as colour of the product will be adequate.

The oxidation condition of the muscle pigment myoglobin tells the colour of fresh meat. Three forms of myoglobin stays. In the reduced formed myoglobin is of purple colour in the absence of oxygen. In the presence of oxygen, oxymyoglobin is formed, that has bright red colour. The iron has in ferrous state in both these forms. The reduced myoglbin and oxymyoglobin is convertible that depends on the concentration of oxygen (Ryu, Y.; Kim, B. 2005). The colour of meat is affected by chemical changes like oxidation, changes in pH, enzyme action, hydrolysis and protein denaturation. Muscle fibers are polynucleotide, elongated cells classified on their contractile and metabolic properties. Fibers are classified on the basis of stain reactions, as type I (slow-twitch oxidative) or β- red fibers, IIA (fast-twitch oxidative) or α-red fibers, and IIB (fast-twitch glycol tic) or α-white fibers. Muscles have more than 40% *β*- red fibers are red, more than 40% *α*-white fibers are white, and others are intermediate. Muscle fiber type composition is extremely variable and can be subjective by many extrinsic and intrinsic factors such as animal breed, class, selection intensity and post-slaughter processing (Schiaffino, S.*et al*., 1996).

The diversity of skeletal muscle can be attributed to the heterogeneous characteristics of the individual muscle fibers and the mosaic composition of the numerous fibre types. Fiber type composition can vary significantly in different species and muscle types, depending on function. Moreover, there are many factors that contribute to fiber type varation, such as sex, age, breed, hormones, and physical activity (Bottinelli, R. *et al*., 2000). These fiber type variations differ according to their molecular, metabolic, structural, and contractile properties (AOAC, 2003). Therefore, having an understanding of such muscle fiber characteristics is important for the study of overall muscle characteristics and subsequent meat quality. The present study was planned to assess the meat quality on the basis of muscle fiber types and colour of meat with following objective; to assess chemical composition and quality of meat cuts in relation to meat colour and muscle fiber types.

Trace elements in meat

Trace elements are necessary for development, growth and physiology of the organism. They take part in various mechanisms in the body, but cannot be synthesized in the organism. These elements are iron, zinc, copper, selenium, chloride, florid, iodine, chrome, manganese, bore, cobalt, molybdenum, vanadium, spelter and silisium. They take part in functions like immune regulation, nerve conduction, and regulation of membrane potential and maintenance of mitochondrial activity.

Zinc is an essential element for thyroid hormone functions. Copper is the vital component of numerous oxidative enzymes (M. Usdal, *et al*., 1991). Free copper takes role on cellular membranes as a pro-oxidant agent. Selenium is essential for deiodinase activities and thyroid hormone synthesis and metabolism. Selenium acts as a co-factor in the structure of glutation peroxidase which has anti-oxidant features. Glutation peroxidase takes role in degradation of hydrogen peroxide to water. After interacting with vitamin E, selenium protects the cellular membrane against oxidative damages caused by lipid metabolism. Iron takes place in structures of many enzymes in the body. Vitamins are the essential elements which are necessary for occurrence of metabolic events and maintenance of health status, while they cannot be synthesized in the body or synthesized inadequately, and need to be intake. Non-enzymatic anti-oxidants, like vitamin E and A, contribute to decrease the oxidative damage caused by oxygen radicals by taking their high-energy electrons (F. Karatas, *et al*., 2006).

Another function of vitamin E is to increase the absorption of vitamin A from the intestines and its level in the tissues. Concomitance of hypothyroidism and pernicious anaemia is very frequent, and vitamin B_{12} deficiency is observed in pernicious anaemia. Due to its anti-inflammatory and immune modulatory features and potential effects on cytokine levels, decreased levels of vitamin D is associated with the increased risks of many disorders, particularly autoimmune diseases (P. Bordelon, *et al*., 2009). Folic acid, which is actually a pro-vitamin, is changed to dihydro folat by dehydro folat reductase enzyme after being absorbed, and then it is converted to tetrahydro folate. Using single carbon units, the nascent tetrahydro folate transfers single carbon to some endogenous substances via various oxidating mechanisms.

Meat is a very good source of various micronutrients: low-fat pork contains 1.8 mg iron, 2.6 mg zinc; and pigs' liver contains 360mg magnesium, 20 mg iron and 60µg selenium per 100 grams. A daily intake of 100 g of meat and liver can supply up to 50% of the recommended daily allowance for iron, zinc, selenium, vitamins B_1, B_2, B_6, B_{12} and 100% of vitamin A (Biesalski and Nohr, 2007). The importance of meat as an essential source of some micronutrients is due to the fact that it is either the only source, or they have a higher bioavailability. Vitamins A and B_{12} occur exclusively in meat and can hardly be compensated for by plant-derived pro-vitamins (Biesalski, 2005). Iron has a higher bioavailability from meat than from plants (heme iron), as has folic acid which is nearly 10-fold more, especially from liver or eggs, compared to vegetables). Vitamin A, one of the micronutrients in meat, is essential for the growth and development of various cells and tissues. Its active form, retinoic acid, controls the regular differentiation as a ligand for retinoic acid receptors and is involved in the integration of cell formation, i.e. the formation of gap junctions. The incidence of lung diseases is enhanced by moderate vitamin A (Biesalski, 2005.

Conclusions

Many nutritional advantages are inherent in the consumption of meat. However, in meat, there are some associated undesirable changes and microbial agents which could constitute major disadvantages when necessary precautions are not observed during use of animals as source of meat and during processing. Meat should appear good to consumers when they decide to buy it before satisfying their taste. Once the meat is bought, it must meet the expectations of juiciness, aroma, tenderness and flavour. Trace elements which are found in meat are inorganic substances found in the order of micro-grams. These elements are incorporated into the structures of proteins, enzymes, and complex carbohydrates of human body after consumption of meat. They take part in biochemical reactions together with enzymes for normal metabolic activities. In general the compositional constituents, quality characteristics and content of trace elements in meat of beef, sheep and goat is to aware the societies on meat consumption habits and also to increase the power of our society in the identification of meat which is good or bad for their healthiness .

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