TRADITIONAL PROCESSING KNOWLEDGE, SOCIAL-CULTURAL VALUES, NUTRITIONAL QUALITY AND SAFETY OF MEAT PRODUCTS AMONG THE BORANA WOMEN OF NORTHERN KENYA

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Traditional Meat Processing Knowledge, Social-Cultural Values, Nutritional Quality and Safety amongst the Borana Women of Northern Kenya

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DECLARATION

This thesis is my original work and has not been presented for degree award in any university.

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DEDICATION

I dedicate this thesis to my husband Bulle Golicha and my children Diramu, Darmi, Adale and Rufo for their unwavering support and understanding during my long period of absence from home as I undertook this study. Also, to my parents and all family members, I thank you all, for your special prayers and encouragement during the period.

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ABBREVIATIONS AND ACRONYMS

ANOVA	Analysis of Variance
AOAC	Association of Official Analytical Chemists
°C	Degrees Centigrade
FAO	Food and Agriculture Organization
HPLC	High Performance Liquid Chromatography
JKUAT	Jomo Kenyatta University of Agriculture and Technology
KALRO	Kenya Agricultural and Livestock Research Organization
RELOAD	Reducing Losses Adding Value
RT	Room Temperature
TBARS	Thiobabituric Acid Reacting Substances
TVC	Total Viable Counts
SPSS	Statistical Package for Social Scientists

DEFINATION OF LOCAL TERMS AND TERMINOLOGIES

Abrasa	Name of traditional month for ceremonies
Adhayu	A lady who is lazy in handling household chores
Alaqa	A lady Who Handles Issues in a Perfect Manner
Basaa	Fat from fermented milk
Adhano	Fat from Milk
Banya, Bisiq	Sticks Used for Fumigating Storage Items
Buthunu Qori	Traditional utensils
Itille, Licho	Ttraditional Artefacts
Burki, Mandazi	Wheat flour products
Chomm, Morr	Fat from meat
Chonni, Sorio, Jill	Traditional Ceremonies
Dhankah, Masen	Barren Female Cows
Damansa	Moldly Growth
Dirra,	Traditional Meat Preservation Techniques
Chumfa	Cleaning of intestines
Dakar, Agobay	Smoking Sticks for Traditional Storage Containers
De'effe,	Dam Nourishment
Dhool, Dhibe Subb	Meat Storage Items
Fuda, Gubis, Mogati	Traditional Ceremonies
Garbu	Barley
Fonntuma, Guguble	Traditional Meat Products
Jaji, Dadam, Dhigalo	Traditional meat Products
Jagi, Indhore	Traditional artefacts
Jifuu	Share given to neighbours or relatives
Kharab, Sangaa	Castrated Bull, a highly regarded castrated bull
Koche	Name of Preserved Cooked Meat Products.
Kochesa Alalo Guba	Other Traditional meat products
Miyu, Qodha, Okole	Traditional Artefacts
Obattu, Oketu	People Who Take Care of Cattle
Radhu, Kataweel	Traditional meat products
Siqe, Ororo Saqa, Saqe,	Traditional Artefacts

Totu, Tisitu	Herders of cattle
Kalankal Tuma	Traditional Meat Processing Methods
Nagesu, Medich	Traditional Ceremonies
Wadha, Konsa	Artisanal Meat Preservation Technique

ABSTRACT

Food preservation has been practiced for centuries by different communities around the world, with approaches manifested in different ways as they were in different localities. As such, meat is a one highly valued food among the Borana pastoralist community who produced a number of traditionally preserved beef and goat meat products. Meat is not only relished for eating and nutritional contentment, but also for multiple social and cultural roles among the Borana community. Although these traditional meat products are widely utilised and appreciated, there is little information about their quality, especially because some of them are preserved with fats and other ingredients. Therefore, this study documented knowledge of traditional meat preservation as practiced by women of the Borana community and social cultural links of these products to the people in Northern Kenya. This documentation is geared towards preserving the indigenous knowledge that has existed amongst the Borana community since time immemorial, but which would otherwise be lost with the passing of the older generation. Due to the sensitive and perishable nature of meat, chemical and microbiological analysis of the traditional meat products were also done to establish nutritional value and safety. In addition, the sensory acceptability of the products were evaluated. The study used both qualitative and quantitative methods to generate required information about the preservation and processing of traditional meat products. The data collection methods included household survey, consumer evaluation questionnaire, key informant interviews, narrative interviews, focus group discussions and practical demonstrations through participatory observation. The study observed that pastoralist women had tacit skills and knowledge of processing the traditional meat products. Fourteen traditional meat products and seven preservation techniques were documented, and it was found that drying and deep frying were the major forms of meat preservation. Nevertheless, it was found that only four of the products are currently in use, an indication of the steady decline in traditional meat processing practices among the Borana community. The results also showed that cattle played an important economic and social cultural role in Borana community where the processes of *sanga* (bull) slaughtering was used as a coping mechanism during severe droughts in mitigating food insecurity as well as playing important roles of enhancing the social cultural fabric. Results from chemical and microbial analysis of traditional meat products showed moisture contents ranged from 3.3% to 6.1 %, crude protein contents ranged from 55.8% to 72.5%, crude fat ranged from 9.4% to 13.3%, crude ash ranged from 1.7% to 2.8 %, crude fiber ranged from 1.5% to 4.1%. The low moisture content of these products are compatible with good keeping quality. The microbial results showed that there was presence of *Staphylococcus aureus*, yeast and mould for the period of seven weeks observed. There was significant ($p<0.05$) increase in S*taphylococcus aureus* counts from (1.44 log cfu/g) to (2.28 log cfu/g) over the observed period at room temperature. These counts are within the accepted range in meat products. For rancidity indices, free fatty acid and peroxide values increased significantly ($p<0.05$) from 0.97% to 2.05% and 2.26% to 4.45 % respectively at week 1 and week 7. Thiobarbituric acid reactive substances (TBARS) level was below the value associated with meat spoilage during the expected shelf life. Thus, both microbial and chemical quality indices gave a positive outlook of the traditional products. However, the study observed that there is need to improve hygiene and sanitation during the traditional processing of the various meat products. These

products were highly regarded among the community, where the sensory evaluation done on perception of these products revealed that the products were strongly liked as special food with good organoleptic indicators.
In conclusion, the nutritional composition of the traditional products were established to be having all the essential micro and macro-nutrients, making the product suitable for general consumption.

CHAPTER ONE
INTRODUCTION

1.1. Background

Borana speaking groups are the predominant group in Marsabit County and they dominate the area stretching from Southern Ethiopia and vast parts of Northern Kenya. Livestock keeping is the main economic activity in Marsabit County with the main livestock being cattle approximated at 218,755, goats at 1,186,482, sheep at 2,029,490, camels at 217,368. The main livestock products are milk, beef, mutton and camel meat (Marsabit County Integrated Development Plan, 2017).

The Collins Dictionary defines knowledge as awareness, consciousness or familiarity gained by experience or learning. On the other hand skill is the practical application of an acquired knowledge within a specific context to get the expected results (Ribeiro, 2014). As scholars have argued, it is important to remember that knowledge is not fixed or universal, but is rather situated, partial, and embedded in a context/place/position, be that a scientific laboratory or a village kitchen (Bolt, 2007; Nightingale, 2003; Richardson-Ngwenya, 2012). This study therefore explored knowledge of traditional meat preservation as practiced by Borana women, since traditionally it was the women who prepared such products. It engaged local women groups in Marsabit County, food scientists, and consumers in villages and town centres. These different actors have different knowledge of, ideas about and experiences with these meat products.

This approach goes against the entrenched dichotomy between science and local knowledge by critically and reflexively exploring the diverse knowledge around artisanal meat preservation. The overarching purpose was to document this knowledge to effectively bring out the potential for income-generating activities for the benefit of the Borana Women.

While in the past the Borana were purely pastoralists and depended mainly on livestock and livestock products, their source of livelihood has changed overtime, partly because of increasing population, formal education and urbanization. In addition, because of adverse climate change, manifested in increased frequency of droughts, the Borana have progressively lost their livestock and this has greatly

compromised their food security situation. Such catastrophic livestock losses caused by recent droughts in the Horn of Africa have generated tremendous interest among donors and national governments in support of livelihood diversification as a "drought resilience-building" initiative (Abebe et al., 2016).

Borana pastoralists have been forced to diversify their asset and income holdings to cope with shocks and improve food security. Main diversification strategies commonly used by the Borana included crop cultivation, petty trading, livestock trading, collection and trading of non-timber forest products, bee keeping, charcoal making, sale of fuel wood, wage labour, mining, and house construction in towns (Mahoo et al., 2013). As part of their culture, Borana prepared a number of traditional meat products with good keeping quality, and these used to improve food availability during droughts. It is important to understand how such products were used in the cultural context to promote food security, in order to gain an understanding of how such concepts may be modified and applied in the modern context.

Moreover, such traditional products might contribute to uplifting the economic and food security status of the Borana, if they can be brought into mainstream markets, even outside the Borana community, as has happened with other traditional meat products such as *Biltong* from South Africa, which has gained international acceptance, or *Alia* from the Luo community that has gained acceptance in Urban areas in Kenya.

However, the Borana are increasingly depending on crop products such as cereals, pulses and vegetable oil, purchased from shops or donated by Non-Governmental Organizations who provided relief services or food assistance program especially during drought (Golicha et al., 2012). This reduced dependence on livestock and livestock products has had adverse consequences on the knowledge of food preparation methods and processing techniques.

Therefore, this study sought to identify and document local knowledge on approaches to traditional meat processing and preservation in the Borana pastoral production system. It also sought to strengthen these approaches with laboratory analysis to establish nutritional quality and safety of these products, as well as and their sensory acceptability to both Borana and non-Borana people.

1.2 Statement of the problem

Although meat products preserved locally were traditionally consumed by Borana, there has been limited scientific investigation regarding the processing techniques, nutritional quality and safety aspects of these products. High meat supply levels have existed amongst pastoralist, as glut experienced during floods which cause massive deaths of small stocks, or impending drought where livestock were slaughtered and preserved indigenously to be consumed during hard times (Field, 2000). However, such practices amongst pastoralists in Northern Kenya were poorly documented especially the meat preservation knowledge.

There was limited research on this important topic and the few documents available were on the Somali version of the product (Field, 2000; Madete et al., 2015; Wanyoike et al., 2009). The traditional meat knowledge is tacit and verbalized sparingly, making it vulnerable to becoming extinct or unavailable as a coping measure by Borana community especially during drought. Such tacit knowledge is rooted in personal knowledge and is generated through the specific engagement of the scientific (or any other) agent with his or her daily activity. This kind of tacit ('pre- verbal') knowledge is difficult to articulate (Arena et al., 2012). This study sought to address the knowledge gap through collaborative documentation as there is potential and opportunity for its beneficial use.

Despite the fact that these traditional products are widely consumed locally, there was concern about their quality, safety and acceptability as there was no information available. Some studies on quality of cooked meat elsewhere revealed that there is public health concern due to improper handling, recontamination or storage conditions (Abong & Kabira, 2012; Matsheka et al., 2014; Raji, 2006). Therefore, in order to understand these traditional meat products, there was need to establish its nutritional quality, safety and shelf life characteristics.

1.3 Justification

Marsabit County's main livelihood is livestock production. Livestock and livestock products sales contribute mainly to income generation for the Borana pastoralists. Huho et al. (2011) reported that pastoralism is not only a livelihood activity but also an important adaptation strategy to the harsh ecological conditions in the dry lands. In Kenya, pastoralism accounts for over 60% of total livestock production. The study

aimed at providing information on traditional meat processing and preservation techniques and determined nutritional, quality and safety characteristics which contributes towards providing information and form basis for options of income generation for Borana Women groups.

The study was also in line with Goal 1 and 3 of Millennium Development Goals (MDG) of eradicating extreme poverty and hunger, promoting gender equality and empowering women (UNDP, 2012) particularly among the pastoralist communities.

Furthermore, the study was in tandem with Economic pillar of Vision 2030 and Marsabit County's flagship projects to improve profitability of livestock trade sector. The county plans to invest in better coordination of livestock value chains, creative branding of meat products from Marsabit County and enacting structural changes to enable better linkages to meat clients in Nairobi and export markets (Marsabit County Integrated Development Plan, 2013).

This study further contribute to the subject body of knowledge, guiding professionals and practitioners of food science and technology, food artisans and researchers in general on indigenous knowledge of meat processing and preservation amongst the Borana pastoralist community, and offer options to incorporate compatible modern approaches, yielding a working manual for use amongst interest groups.

1.4 Objectives

1.4.1 Overall Objectives

The overall objective was to document traditional meat processing techniques among Borana women and to determine nutritional value, chemical quality, microbial safety and sensory properties of the traditional meat products.

1.4.2 Specific Objectives

1.4.2.1 To document traditional meat preservation and processing techniques among Borana women of Marsabit County.

1.4.2.2 To determine the social-cultural importance of Borana traditional meat processing and meat products

1.4.2.3 To determine the nutritional composition of different types of traditional meat products prepared by Borana Women.

1.4.2.4 To assess chemical quality and microbial characteristics of traditional meat products in relation to the different treatment conditions.

1.4.2.5 To determine consumer acceptability of the traditional meat products among Borana and other communities

1.5 Research Questions

1.5.1 What do the Borana women of Marsabit County know about the processing and preservation techniques of Borana traditional meat products?

1.5.2 What is the social-cultural importance of traditional meat processing and products amongst the Borana of Marsabit County?

1.5.3 What is the nutritional composition of different types of traditional meat products prepared by Borana Women?

1.5.4 How safe are the traditional meat products obtained under different treatment conditions?

1.5.5 How acceptable are the traditional products to the Borana people and people from other communities?

1.6 The Theoretical Review

1.6.1 Knowledge Spiral Model

The knowledge spiral model has been proposed by the Japanese Scientists Ikujiro Nonaka &Takeuchi as cited in Nonaka & Toyama (2015). They stated that knowledge is created in the spiral that goes through seemingly antithetical concepts such as order and chaos, micro and macro, part and whole, mind and body, tacit/implicit and explicit. This knowledge spiral model has been very influential in management of schools and it also found its way into a small community of people working on innovation in agriculture in Tanzania (Lwoga et al., 2010) and Nigeria (Ha et al., 2008).

In relation to local meat knowledge among the pastoralists of Northern Kenya, this model was useful in describing and conceptualizing the roles and cooperation of women practitioners and the researcher; aiming jointly at finding the potential and opportunities for local meat knowledge.

The model strongly relies on the concept of tacit/implicit knowledge as it was proposed by Nonaka as cited in Gray & Densten, (2005). The model has four conversion modes: socialization, externalization, combination and internalization. The four modes of

knowledge conversion commence with socialization where individuals share experiences and mental models to refine the knowledge. Tacit knowledge is then converted into explicit knowledge through a process referred to as externalization.

For the Borana, local meat preservation was a tacit knowledge and was embedded in the skills of women practitioners and the cooking and storage tools they use. It was also a process where the women just used unwritten scripts to do the preparations step by step. This tacit knowledge was not verbalized much as it was learnt by practice (Gray & Densten, 2005).

The central thought of the model was that tacit knowledge held by individuals or certain groups was shared (socialization) with other individuals or groups so that it interconnects to a new (shared, explicit) knowledge, the externalization stage. It was then combined with other knowledge held by the people involved, so that it becomes connected to the things they already know (combination stage) as shown in Figure 1.1 below. This can add to this knowledge or let it appear in a new light. As a final step, in the internalization stage, it will appear again as tacit knowledge but at a higher level (Lwoga et al., 2010).

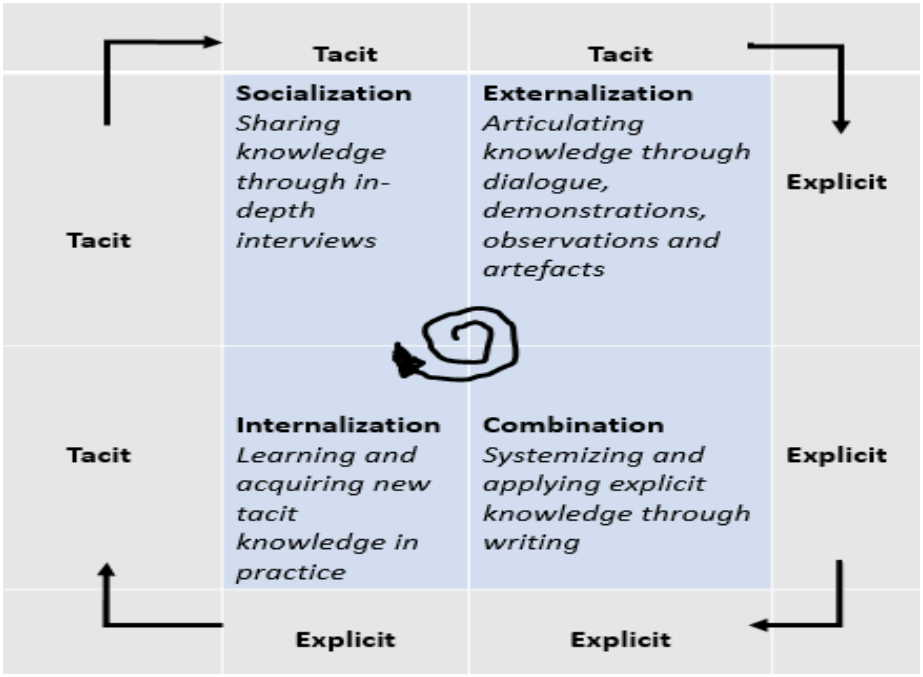

Figure 1. 1: Knowledge spiral model

Source: Adapted from Nonaka and Takeuchi (1995) and standardized to traditional meat knowledge processing.

Socialisation: Brainstorming sessions for sharing tacit knowledge was created by meeting with the women at their homes and shared experiences and dialoguing with them through questions answer sessions.

Externalization: Articulating knowledge through observations and demonstrations to convert the knowledge into form that can be understood and used by others.

Combination: Assessed the local meat products in the laboratory for quality and shelf life

Internalization: Knowledge was verbalized by sharing and learning the acquired knowledge.

CHAPTER TWO
LITERATURE REVIEW

2.1 Food Cultures and Meat Preservation

Food preservation has been practiced for centuries by different communities around the world, in different ways, either to increase shelf life of food, to reduce spoilage or to enhance flavour or taste (Anderson et al., 2017; Bora et al., 2014; Guyot, 2006; Nam & Lee, 2010; Mishra et al., 2014). In Africa, there are various traditionally processed and preserved cereals, vegetables, and milk and meat products. These include *pastrima* (Egypt), *odka* (Somalia), *qwanta* or *olobe* (Ethiopia) and *kilishi* (Nigeria) (Legwaila et al., 2011; Omojola, 2008). In Kenya, communities such as Bukusu, Luo, and Somali also have their local food preservation practices and products, such as *khusika*, *omena* and *nyirinyiri* respectively. (Chikati et al., 2014; Okiyo et al., 2008; Oniango et al., 2005). Food preparation includes activities such as handling, processing, preparation, cooking, and storage (Nam and Lee, 2010). Food preservation practices are part of food cultures, or food ways and, as such, have a strong element of local identity (Fonte, 2008).

The main ways of preserving meat traditionally are drying, smoking, salting and fermentation, or combinations of these processes (Pittia and Antonello, 2013). As with other cultural groups, among the Borana residing in Southern Ethiopia and Northern Kenya, food is not only relished for eating and nutritional contentment, but has multiple social and cultural properties. For example there is a universal requirement for milk provision by surplus producing families to food-deficit households. The traditional institution of food sharing is established not only as a matter of strict moral obligation in several respects but is also often mandatory (Berhanu, 2011).

Mintz (2002) reported that, eating and ritual is a mechanism for maintaining ecological balance in local environments and/or for redistributing food. In relation to meat in the Borana cultural context, it forms part of many social occasions, rituals and ceremonies. Furthermore, skills and artefacts have emerged through the interactions of people and food, as numerous methods of processing and storage materials have been developed and maintained. Sharma and Kondaiah (2005) suggested that, processing helps in producing varieties and convenient meat products in order to meet various lifestyle

requirements, while preservation supported by processing extends the shelf-life of meat and meat products.

Preservation starts when the harvested foods are separated from the medium of immediate growth (plant, soil, or water) or meat from the animal after slaughter, The methods of preservation depend on the origin of foods—particularly whether they are of plant or animal origin (Rahman, 2007). In the case of dried traditional meat, various stages of processing are applied. The dried traditional meat, *Koche* is made from particular parts of muscles of sirloin and silverside steak, from beef or goat carcass. This dried traditional meat products can be classified as dehydrated food as moisture was reduced using different ways. Javeed and Ram (2015) described, meat drying is preservation techniques used to prolong shelf-life of raw meat which makes handling stress-free by reducing size and weight.

2.2 Local meat products among the Borana

Traditional meat products are not consumed as day to day meal but as delicacies given to respected members of the family, guests, in-laws and husbands mainly when they come home from distant travels. It is regarded as a welcoming gesture and hospitable food. Furthermore, these meat products are abundantly availed during special occasions such as ceremonies and weddings. For instance, during the naming ceremony for the first born child, referred to as *Gubbis* by the Boran, *koche (a* type of traditional meat) is prepared to be lavishly enjoyed and its container opened in a special way by the father of the child and his age mates to feast. Anbacha & Kjosavik (2018) indicated that in the past, Borana pastoralists shared food items for love and affection rather than as form of security.

Among the Borana, milk and meat were the staple and preferred food. Amenu et al. (2019) described that, cow milk was processed into different products such as butter, ghee and fermented milk. *Ititu* (traditional fermented milk) is widely liked by the Borana people and often served to the household head or to special guests. It is also served during festivities such as *Jila.* When livestock was slaughtered, the most perishable parts were eaten first (liver, intestines, blood kidney and heart) then all the red meat chunks were cut into strips and dried. The ribs and other meat on bone were eaten but the bones were not thrown away, as there were repeatedly boiled and the soup consumed overtime. The head and the legs parts were roasted then boiled to make

soup. The dried strip meat was prepared to make *koche* and *guba*. The fat and fatty parts were fried to extract fat and stored as *chomm* and stored in a *dhool*. Even the skin and hides were processed and utilized as food, clothing and other ornamental items e.g. *gathi,* (rope made from hide for restraining cows when milking) and *itille* (hide preserved into making sleeping beddings).

The preparation of these products also has the social role, when one homestead slaughters a bull, the neighbouring women give a hand in preparing the products, hence there is socializing and networking. It is also a norm among the Borana to share the meat, *Jiffu* with close relatives and pregnant women. Haukanes (2008) stated that the cooking and serving of food are embedded in a discursive framework that defines female care, a vital element in the maintenance of family relatedness and proper femaleness.

Unfortunately, these vital skills and practices as well as indigenous meat preservation knowledge are often underrated and, in the process, this important knowledge are at risk and on the verge of disappearing if documentation is not done. Consequently, it is important to know why there is decline in the use of knowledge especially among younger people who are either ignorant about the knowledge or abandoning it all together. Loo et al. (2003) suggested that this knowledge in all its forms is so tenuous and the need to retain and promote what still exists is vital. Indigenous women who have retained this knowledge need recognition and support in their efforts to practise it and pass it on to future generations. Local meat preservation knowledge also faces potential loss due to lack of use by younger members of the society and to gradual loss of senior members of the society who know the most about the skills. Walingo (2009) described social networks have changed the traditional mode of knowledge transmission, and there is failure of knowledge transmission from generation to generation, more so because of attitude formation relegating these methods into categories of primitive technologies. Thus, it is important to document and address the identified gaps to improve on the traditional meat products quality, shelf life and safety.

Generational change and modernization is also contributing to the loss of traditional meat preservation knowledge as more pastoralist are changing trends to settlement and young people are oblivious of traditional ways of preserving meat. These was further

observed by Walingo (2009) who opined that indigenous knowledge transfer systems are collapsing, creating gaps in knowledge regarding production and utilization of indigenous foods.

2.3 Meat nutritional composition and quality deterioration

Animal foods are excellent sources of high-quality protein and micronutrients that are often deficient in the diets (Wu et al., 2014). Meat, is rich in iron, which is of utmost importance to prevent anaemia, especially in children and pregnant women. Meat is a concentrated nutrient source essential for optimal growth and development. It is highly nutritious and provides proteins of high biological value (Boe, 2012).

Raw meat is a perishable product which is prone to spoilage and deterioration. It is important to observe hygiene from the point of slaughter through all stages of processing to storage to maintain high quality and safety. There are three main mechanisms for meat and meat products spoilage these are microbial spoilage, lipid oxidation and autolytic enzymatic spoilage (Dave & Ghaly, 2011). Meat used for drying amongst pastoralists is usually derived from fresh carcasses Traditional dried meat are usually cut into slice into strips and sun dried (Hui, 2012,). Reducing the moisture content of the meat is achieved by evaporation of water from the peripheral zone of the meat to the surrounding air and the continuous migration of water from the deeper meat layers to the peripheral zone. Natural drying (sun and shade-dried) methods have a potential for contamination from bacteria due to the low drying temperature (Park and Park, 2007).

Food quality is a multivariate notion ('it tastes good – it looks traditional, safe, healthy, etc.'). Traditional foods are sometimes used to carry an image of foods tasting good but at the same time could be perceived either good for health (as related to natural products, no chemical modification, no additives) or bad for health as related to high fat content and microbial contamination (Cayot, 2006)

According to Huang et al. (2013) total viable count (TVC) of bacteria is one of the most important indices in evaluation of quality and safety of meat.

Coliform bacteria, especially feacal coliforms, are microbial indicators of the potential presence of disease causing bacteria and also show the general sanitary quality of the food. (Odwar, et al., 2014). Owing to the spoilage potential of meat, varieties of preservation techniques are employed in improving its keeping quality. Meat can be

preserved by processing to semi-dry and dry forms. An example is *kundi*, a dry meat product produced by cutting raw meat into pieces which is then sundried (Olusegun, 2011). Microbial spoilage of these products should not occur unless exposure to high relative humidity or other high-moisture conditions results in an uptake of moisture.

Food preservatives contribute to preserve food attributes such as tastes and chemical composition, and thereby improve food shelf life. According to Fonkem (2010) some spices used in *Kilishi* production played a key role in inhibiting the growth and proliferation of some micro-organisms. The antimicrobial compounds in plant materials are commonly found in the essential oil fraction of various plant parts, including leaves (as in rosemary and oregano), flowers or buds(clove), bulbs (garlic and onion), seeds (fennel and parsley), and fruits (pepper) (Gutierrez et al.,2008). These compounds may inactivate bacteria or inhibit the production of undesirable metabolites. Generally, essential oils are more effective against Gram-positive than Gram-negative bacteria (Gutierrez et al 2008; Shan et al., 2009).

Through meat processing, all edible livestock parts which are suitable for processing into meat products can be optimally used. The processing and preservation of meat products gives consumer quality, shelf stable and healthy products. Enhanced meat safety involves the application of measures to delay or prevent microbiological, chemical, and physical changes that makes meat less healthy for human consumption (Rahman, 2007).

2.4 Use of meat among the Borana

Amongst the pastoralist communities, milk and meat production is the cornerstone of production system, and often abundance occurs without possibility of immediate consumption, triggering the need to preserve surplus for future consumption (Field, 2000). While small stock (goats & sheep) are of convenient size for a family consumption without need for preservation, the slaughter of larger ruminants necessitates the need for meat preservation techniques.

The local meat knowledge was as a result of a need to cope with food insecurity experienced during famine where livestock was slaughtered to preserve for future consumption. Indigenous knowledge and traditional approaches to food preservation, especially meat handling and preservation, helped avail meat to the pastoralist families and represents valuable source of local solutions to the food insecurity in terms of

accessibility by the rural population, particularly during seasonal food shortage or major stress periods such as droughts (Asogwa et al., 2017; Field, 2000). Agrawal (2014) indicated that indigenous knowledge is often seen to exist in a local context, anchored to a particular social group in a particular setting at a particular time. The traditional meat knowledge among the Borana is embedded but also dynamic; due to social-economic and cultural changes caused by urbanization and education, the products have under gone some transformations.

However, like in many other rural societies, the traditional knowledge in handling, processing and preserving foods are under threat from modernization, where better traditional practices have been discarded for supposedly better industrial processing approaches of foods that are expensive and actually unavailable to the rural people. According to African Union (2010) policy framework for pastoralism in Africa, urban centres pull people, especially young people, away from pastoral areas, thereby reducing the number of people available in the pastoral force in some cases. Unfortunately, the low levels of education and literacy in pastoral areas means that urban migrants are more likely to find employment in low paying jobs. This is aggravated by generational change without traditional knowledge changing hands. Formal schooling is useful for many purposes but separates children in school from their families, creating wider social environment where new cultural background is acquired at the cost of traditional informal learning acquired from household and livestock camps (Siele et al., 2012).

2.5 Indigenous meat preservation knowledge

Use of indigenous knowledge to solve food shortage in times of drought/famine or food surplus in times of rare bumper harvest remains powerful means of sustaining household food security (Ibnouf, 2011). Even in the absence of modern processing technology, the traditional approaches to food preservation, especially meat handling and preservation, helped avail meat to the pastoral families where meat was preserved and gained shelf-stable capacity, providing good nourishment to the whole family during times of severe long-lasting drought, and while on transit in search for pasture and water, or during floods or conflicts and escapes to safer grounds (Field, 2000). Local food preservation techniques have also been praised for being natural and free from chemical additives unlike many industrial food products.

Traditional meat knowledge is not only place based but interacts with surrounding social economic systems and cultural contexts. It is also embedded in history. According to Fonte (2008) and Sylvander (2004) 'local' refers not only to the dimension of space (zero miles), but also to the dimension of time, then tradition and history, the complex of characteristics that gives birth to the socioeconomic concept of 'territory'. Hence traditional meat processing knowledge and products are indigenous to Northern Kenya and among Borana people.

All knowledge, be it scientific or local is embedded in social, physical and cultural environments and real-life practices. Sometimes knowledge is hidden and learnt by doing and all knowledge is situated, partial and linked to the contexts in which it is created' (Nightingale, 2003)

The term` traditional` knowledge sometimes has a negative connotation of referring to knowledge that is old fashioned and used by people who are not 'modern' or exposed to western ways of doing things. Sillitoe (2006) reported that Indigenous knowledge is often contrasted with, and until recently has been undervalued in comparison to, international scientific knowledge. On the other hand, it has been argued that traditional is not necessarily ancient; knowledge is created every day and evolves due to responses to changing social environment (Fonte, 2008).

2.6 Role of women in indigenous meat preservation

Amongst the pastoral communities of Northern Kenya, women remain charged solely with the responsibility of handling, processing and preserving food. They more specifically handle dairy and meat products, in addition to securing water and fire wood for food preparation at the household level (Keya et al., 2005). As the managers of available local resources and knowledgeable about local resources and environment, rural women are best placed to ensure sustainable food supplies and hence achievement of household food security (Ibnouf, 2011).

Livestock is a family resource owned by both the man and the woman but for it to be exploited economically, the control mostly rest with the man who mainly engages in pastoralism (Rao, 2019). Women on the other hand, though contributing towards the labour of herding and taking care of young animals, have to consult the husband to utilize. Women are in charge of livestock products (milk and meat) and decisions of buying and cooking food are in the woman's domain. Kelkar (2007) noted that the

gender of an individual actor and gendered institutional norms do have a major significance in influencing the entire process of acquisition, processing and transfer of local knowledge

The local knowledge of meat processing was transmitted from one generation to another where young girls and women learnt from the older ones through observation and experience. To acquire the product, the woman involves the man to either offer livestock for slaughter or avail money for purchase from butchery. Nyamongo (2000) explained that among the Borana, cattle are the basic form of subsistence where women have minimal control while men are expected to establish their own herd early in their life. However, men do not traditionally make/cook the meat product, due to cultural conventions, hence are excluded from the process of preparation.

CHAPTER THREE

TRADITIONAL MEAT PROCESSING KNOWLEDGE AMONG THE BORANA PASTORALISTS OF MARSABIT COUNTY

Abstract

The objective of this study was to document traditional meat preparation knowledge, processing techniques and types of products among the Borana women of Northern Kenya. The method of collecting information included narrative interviews and participant observations to document meat preparation skills and knowledge of Borana people as appertains to traditional food ways. It was observed that methods of traditional meat processing and preparation included different forms of drying, use of heat and storage in fat. Fourteen traditional meat products and seven preservation techniques were documented. Drying and deep frying were the major forms of meat preservation. Women skilfully put a lot of effort in all stages of meat preparation to produce an end product that is shelf stable and appreciated. It was observed that only four of the fourteen products are currently in use, an indication of steady decline in meat handling knowledge and preparation.

3.1 Introduction

Borana speaking groups are the predominant group in Marsabit County and they dominate the area stretching from Southern Ethiopia and vast parts of Northern Kenya. While in the past they used to depend mainly on livestock and livestock products, their source of livelihood has changed over time, and they now consume crop products such as cereals, pulses and vegetable oil. Historically, pastoralist populations of Northern Kenya have tended to be marginalised and this has compounded their vulnerability to climatic shocks and scarce resources, which resulted in rapid settlement and urbanisation coupled with a reliance on food aid. (Elliott & Fowler, 2012). This reduced dependence on livestock and livestock products may have adverse consequences on the knowledge of food preparation methods and processing techniques. Like in many other rural societies, the traditional knowledge in handling, processing and preserving foods is under threat from modernization where traditional practices have been neglected for supposedly better modern processing approaches of foods.

Therefore, documentation of valuable meat traditional knowledge is necessary so as to explore opportunity for reviving the knowledge and possibly promote the traditional products for income generation through value addition. Sims (2009) described that by telling the "story" of food production in this way, it is possible to use desire for authenticity to encourage the development of products and services that will boost sustainability and benefit rural regions for visitors and residents alike.

Moreover, since Borana traditional meat knowledge is tacit in nature, and thus only known to talented individuals within this community. In this case, the knowledge is held by women as they prepared and processed the traditional meat. Documentation of this knowledge availed not only historical experiences but practical aspect of processing. Hence various methods were applied to collect data and gather information on the aspects of knowledge, processes, products as well as preservation techniques

According to Nonaka (2006) tacit knowledge is highly personal and hard to formalize as it is deeply rooted in actions and routines unlike explicit knowledge which is formal and systematic. Among the Borana, the daily activities of tending to livestock and domestic chores entails processes of socialization and networking. While men mostly perform outdoor activities mainly herding livestock, women usually take charge of domestic chores of milking cows, cleaning and preparation of food. Fonte (2008) reported that tacit knowledge is created through normal processes of socialization as a form of knowledge transmitted in a community through its social norms and habits. To build relationships through the research process focus was made on particular region and people to get in-depth information on traditional meat knowledge by employing integrated methods of data collection.

Thus, the objective was to document traditional meat preparation knowledge, processing techniques and types of products among the Borana women of Northern Kenya.

3.2 Materials and Methods

3.2.1 Study design

This study used cross sectional design, villages inhabited by Borana community were selected through key contacts (elders and leaders in the villages) who were identified by chiefs in their locations. These were selected based on their geographic location,

from a list of villages inhabited by the Borana in Obbu, Sololo, Sagante and Central wards of Marsabit County. At the beginning of the study, the names and contact details of key contacts were gathered from each village and a snowball technique was used to reach other respondents.

The groups were diverse, with people interviewed differing from each other in a number of ways like gender, age and marital status (Table 3.1) To build relationships through the research process, focus was made on particular region and people to get in-depth information on traditional meat knowledge by employing integrated methods of data collections.

Table 3. 1: Characteristics of groups

Study Sites	**Groups**	**No. of Part.**	**Age**		**Gender**		**Venue**	**Source of meat**	**Product made**
			<50	**>50**	**F**	**M**			
Sagante	Waldag-ena	18	10	8	18	0	Group's place	Goat slaughtered	Goat *Koche*
Central	Adhajab-esa	10	2	8	10	0	Group's place	Beef and goat meat purchased from butchery	Beef *Koche Fonntuma kochegarbu*
Central	Mata-arba	7	3	4	5	2	Member's house	Beef purchased from butchery	Beef *Koche Kochegarbu*
Obbu	Ramole	6	2	4	5	1	Member's house	Goat slaughtered	Goat *Koche*
Sololo	Borolle	4	1	3	4	0	Member's house	Goat slaughtered	Goat *Koche*
Total		45	18	27	42	3			

3.2.2 Study sites

The study sites were Marsabit Central, Sagante Sololo and Obbu wards of Marsabit County (Figure 3. 1). In these wards, Borana speaking people are majority. The area experiences temperatures ranging from a minimum of 10^{o}C to a maximum of 30^{o}C, with an annual average of 20^{o}C. Rainfall ranges between 200mm to 1000mm per annum and its duration, amount and reliability increases with increase in altitude (KNBS, 2013)

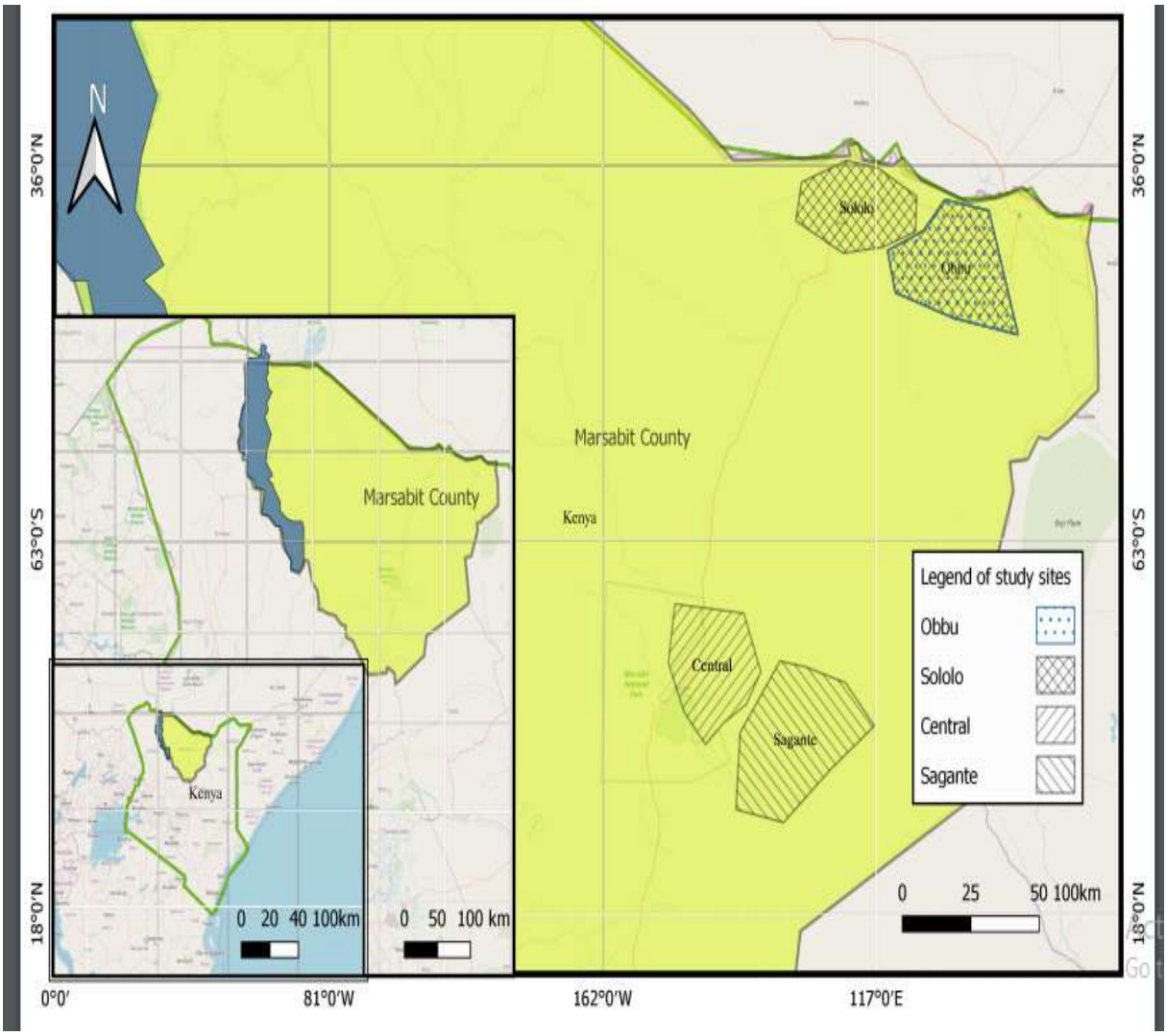

Figure 3. 1: Location of the study areas

3.2.3 Target Population

Marsabit County has a population density of about 300,000 in terms of population, according to KNBS (2009) population census. Traditionally, Borana were nomadic pastoralist but due to climatic and economic changes the livelihoods now include subsistence farming and small scale trade of livestock and livestock products. The Borana in Marsabit Central and Sagante wards practice agro-pastoralism where livestock such as cattle, goats, donkeys and camels are kept combined with crop cultivation in the humid zone of Mount Marsabit (Dabasso, 2012). The Borana in Obbu and Sololo wards are still more rural and practices nomadic pastoralism. In addition to consumption of milk and meat products, Borana now prepare and consumes cereals,

pulses, vegetables and fruits sparingly. Food is predominantly prepared by women and girls.

3.2.4 Sampling

The sampling frame for this study were women aged twenty years and above at the study sites based on the knowledge and skills on traditional meat processing and who were recommended by chiefs and elders as key contacts in the villages.

3.2.5 Data Collection

3.2.5.1. Narrative interview

Narrative interview guide (Appendix I) was used to document traditional meat preservation techniques. The narrative interview guide was pretested prior to the interview with five respondents in areas near the study sites due to its similarity in terms of population and practices.

The narrative interview involved respondents giving an account of their experiences to the researcher who was interviewing them in traditional meat processing technique. At the beginning of the study, knowledgeable women who were identified by local elders as the experts in processing traditional meat products were identified as respondents. After the interview, the respondents were asked to identify more knowledgeable women in their neighbourhood. In total fifteen women were identified and interviewed.

To achieve a relaxed setting during the interview, ample time was created by initiating small talk on general conditions of weather, livestock and happenings in the area, reducing any anxiety or feelings of uneasiness before starting the formal interview.

Respondents were then asked by the researcher a series of open-ended questions about traditional meat processing and all activities involved recalling from their experiences. The respondents recalled their personal experiences and observations in traditional meat processing. The narration also included probing and clarification from respondents where necessary. Interviews generally lasted between forty minutes to one and half hours.

The narrative interviews covered topics of what, how, when and why the traditional meat were processed and preserved. The respondents had time and space to give detailed information as they recalled and gave their experiences with confidence and

passion without interruptions. The respondents spoke the same language and the interview was conducted in Borana language as the researcher was also a native speaker of the language.

3.2.5.2 Participatory observation of traditional meat processing and preservation

The aim of participatory observation (Appendix II) was to observe and record women groups as they demonstrated the activities of making the recipes and processing of traditional meat products.

Participatory observation, was done with the same respondents of narrative. From the four research sites, five women groups were identified to participate in practical demonstrations of processing the traditional meat products and to document recipes and ingredient of meat products. The groups were selected based on the recommendation by key contacts. The groups consisted of rural based women groups and urban women groups (Table 3.1). The sites for participants' observations were mostly at shared premises and in some cases at member's homes. All the participant observations took between two to three days. Day one was preparation and striping, day two was drying and day three cutting and cooking. Meat was either sourced from a local butchery or a goat was purchased and slaughtered for the activities.

Audio recordings, video recordings and notes were used to gather information on activities of traditional meat processing. For example, what quality they want to see, why the criteria used in selecting of meat parts were recorded. Traditional meat product recipes and ingredients were documented to come up with list of traditional meat products women working together to display their knowledge in traditional meat processing.

Active interaction was encouraged to categorize the traditional meat products according to types, methods, use of the products and occasion of use. Informal talks and interactions took place as more documentation was done. The researcher sought further clarification of the activities where necessary. Observation was made as the women engaged in the meat preparation and product handling activities.

3.2.6 Data management and analysis

The interviews were recorded on voice recorder, note book and transcribed verbatim. Once the interviews had been transcribed, the material was entered into the qualitative data analysis software RQDA and coded (Appendix VII**).** The interviews were read to develop coding frame corresponding to themes. The code frame was categorized according to activities; knowledge, products processing, and preservation. When quoting text into the paper, the key word or theme was searched in the saved interviews to confirm the commonality and cited.

The code frame were categorized according to activities; knowledge, processing, products and preservation.

From narrative interview and participant observation, the following were documented: - (1) Meat knowledge and products, (2) criteria used in all stages and processes (3) What they did - traditional preservations methods applied by women, Recipes and ingredients, (4) Tacit knowledge observed was also recorded- Why they prepared the products the way they did (5) Women working together displaying their traditional knowledge

3.2.7 Ethical considerations

This research was carried out in Marsabit County Kenya, with group of women who lived in the villages within the study sites and permission was sought from the area chief and village elders to conduct the interviews. The research ethics were addressed by briefing the respondents about the purpose of the study and the processes involved and were assured of confidentiality. Verbal consent was then obtained from respondents to conduct the interviews.

3.3 Results and Discussions

3.3.1. Borana Women's Traditional Meat Knowledge and Products

Fourteen meat products were documented and tabulated (Table 3.2). Out of the fourteen meat products that were documented in the narrative interviews the women in almost all the groups had knowledge of preparing only four meat products.

Table 3. 2: Borana traditional meat products

Product name (Boran)	Description	Source and parts used	Method of preparation	Storage	Storage time
Koche	Deep fried red meat	Beef/goat Sirloin steak	Cutting dried strip meat into smaller pieces and deep fried	Stored in fat	2 months
Guba	Deep fried red and fatty meat	Beef/goat Steak and fatty part	Cutting dried striped meat into smaller pieces and deep fried	Stored in fat	2 months
Fonntum ma	Deep fried ground meat	Beef/goat Sirloin steak	Roasting dried striped meat then pounded and deep fried	Stored in fat	3 months
Kataweel	Shallow fried meat	Beef /goat steak	Dried striped meat cut into pieces and shallow fried	Stored in fat	1 month
Fonn qadabe	Dried strip	Beef/goat steak	Roasting dried striped meat then eaten with fat	Stored in traditional container subb	2 months
choom	Fat	fatty tissues from meat	Extracting of fat from fatty meat and bones by boiling	Stored in traditional container dhool	3 months
Guguble	Fat granules	fatty parts of stomach tissues	By-product from extracted fat	In pots	2 weeks
Lafeqoan	Bone	Beef/goat bones	Boiling bones repeatedly for soup and fat	Arranged on bedlike structure saqe	1 month
Digallo	Meat on bone	Beef /goat	Boiled or roasted stored meat	Stored in subb/saqe	1 month
Maruma ndira	Dried intestines	Beef/goat intestines	Boiling and placing intestines in sticks to dry	Dried over fire place	2 months
Koche garbu	Mix of fried meat with fried barley	Beef/goat steak and barley	Frying meat and barley	Stored in fat	2 months
Koche mandasi	Fried meat mix with wheat flour	Beef /goat steak and Mandasi	Frying meat and wheat flour	Stored in fat	1 month
Radhu	Soft inner parts of hides/skin	Beef /goat hide and skin	Boiling the soft tissue of skins for soup	Placed in the sun for drying	2 months
Daddam	Soft tissues and organs	Beef /goat	Boiling or frying soft organs for sharing	None	2 days

These were *koche, beef or from goat meat, fonntuma* and *fonntuma garbu.* (Section 3. 4.4) These products used to be consumed in large quantities at one serving, but this has changed since the introductions of cereals and pulses.

When a goat was slaughtered, the carcass was separated from other products such as liver, heart, kidney, pancreas, bones, fat, horns, hides and tails. The carcasses were cut into parts. The first part to be consumed was the soft organs referred to as *daddam* partly to avoid spoilage. It also acted as an appetizer. The rest of the carcass was separated into meat used for short term and long term purposes. Meat from hind legs was striped and dried to make products like *guba, koche* and *kataweel,* and was thus earmarked for long term use.

One narrative interview respondent from Obbu expounded as: -

Initially, the women cook dadam which was an appetizer. It consisted of ribs, liver and steak that were cut into small pieces, cooked and shared out to neighbours and all household members. Thereafter, the red meat parts were deboned and cut into long strips. This activity was carried out by the respective household women with help from others in the homestead. The strips of meat were then suspended by hanging over ropes which were usually tied around the hut

The respondents displayed both general and product specific knowledge on processing of traditional meat products. The elderly women, age fifty and above displayed good understanding of the various meat preparation techniques, depicting how this was ingrained in their culture during their youthful life. The respondents had deep knowledge and skills of traditional meat products preparations. These skills were learnt overtime and with accumulated experiences. Giovanna (2011) reported that local knowledge is about "how things work": a technical form of knowledge about how to produce and prepare local food. From the responses there were reasons behind all the technique they applied. For instance, they understood that the foundation of spoilage and contamination was water. Therefore, from the initial steps of slaughtering they regarded drying as one of the important steps in making meat products that is shelf stable.

3.3.2 Criteria used in selection of meat parts and all stages of preparations

Women displayed their skills and knowledge on meat products and added value in terms of preserving it for future use. They employed methods such as striping and drying to reduce water content (Table 3.3).

A respondent in narrative interview from Sagante had this to say,

It was a norm among the Borana that when a household slaughters a bull, the women from the same neighbourhood came together to assist in meat cutting. They sliced the meat into long strips. Subsequently, they hang the strips strategically on ropes made of skin; two folds on two sides and four folds on the remaining sides. This was possible in the past because Boranas made big huts. When the meat strips have dried, the women (dressed in their work cloth 'wadhare') took them down and cut into small pieces: an activity that took a whole night. Afterwards some of the meat was preserved while another portion was cooked in melted 'bassa' (ghee).

Cooked meat was later kept in smoked storage containers (*Dhola* or *Dhibe or Subb)* and used over long time as it had long shelf life. One narrative interview respondent from Obbu affirmed this as follows;

Some meat and bones were boiled and eaten upfront. The father of the house was given some bones with pieces of meat and the children ate pieces of meat whilst drinking soup all day long without going hungry. However, the rest of the meat was made into guba or dhigalo. Dhigalo was meat that was only dried (no moisture involved) and kept away in subb. (Traditional storage container) After fresh meat was over, the (strips) jaji in subb was used to feed the family.

The traditional knowledge of meat processing is declining, restricting this knowledge only to the elderly women. Even among the women, there are few who are known locally for their expertise in making the local meat product. In terms of geographical distribution of study site, the respondents from Obbu, who were all elderly gave detailed knowledge on the past experiences of traditional meat processing. Eighty year-old respondent highlighted her knowledge through sayings, songs and proverbs, narrating practices she witnessed only during her youth.

The respondent was not able to exactly tell what people practice now because she was old and does not make any koche herself .However, she had observed that people nowadays make small, circular balls of wheat flour and call it koche. For her, on the

contrary, she knew koche made of fonn tumma and garbu. She explains that when she was young her family was famous for cattle ("borr abbiyu lake"). (Borr abbiyu lakeh jaldessi saku dake, dheth bekhu daqe, onn bekhu daqe bor Abbiyu Lake') … it was a line in cattle song. The cattle belonged to them and koche was in plenty those times. She further explains that she was the daughter of Abbiyu Lake, the renowned cattle owner.

3.3.3 What they did – preservation techniques, recipes and ingredients

The Borana had several preservation techniques for storing meat for long periods, drying of meat was observed as a very important step in shelf stability of meat. Meat meant for long storage period was usually cut thin like a rope (strips) and suspended on the rope for aeration (Table 3.3). Such slicing was the common technique used when making traditional meat products. The respondents were unanimous that strip meat had advantages like having easier air circulation which enhanced drying, ease of arranging on rope and also ease of cutting after drying. The drying was moderated as much as possible to avoid quality compromise. Respondents explained that too much drying leads to hardening of product while inadequate drying leads to spoilage. Sometimes sun drying was also practiced especially by those at satellite camps for quick drying.

Use of heat in preserving was also applied (Table 3.3). Meat was prepared by smoking, roasting or deep frying. Meat which was dried and preserved was usually smoked in a fire place. The meat parts which were normally smoked are *mogolle*, *Iree* and *rajeji* (the lower hind legs, forelegs and pancreas), an action done to impart the flavour and taste. Roasting of meat meant for pounding was done by putting the meat strip in between sticks and roasted over red charcoal. This was also done to impart flavour.

Another heat technique was deep frying of meat where the meat was fried for a short period of ten to twenty minutes. The use of additives in the meat also enhanced its quality. The addition of salt, sugar and cardamom not only improved flavour but also helped in extending the shelf life of the products by playing a role in reducing the water activity. Furthermore, these additives are known to have antimicrobial properties which may have helped reduce the levels of spoilage. A narrative interview respondent from Marsabit Central, reported that,

"To enhance the aroma we used (elki) Cardamom instead of urgo (traditional basil leaves). So the cover part of the elki was removed and then the elki seeds were grounded. It was then added at the point when cooking was almost done. It was crucial to add at the end so that the meat can retain the aroma".

The storage containers were smoked well with special kind of sticks which gives good aroma and also enhance the shelf life of the products. Smoking was done on traditional storage containers to impart flavour and to keep the product for long in storage. Subsequently, the meat products were stored in oil. The products were preserved in oil to create state of protection to reduce spoilage and keep quality.

Table 3. 3: Traditional meat preservation technique among Borana

Preservation technique	Objectives	Activities	Prevalence of use
1. Drying	To reduce the water content	Striping of meat and drying by suspending on ropes for aeration.	Common about 90% of respondents still practice
2. Preservation by use of heat	To reduce the water further and cooking the meat	Roasting, deep frying and cooking of meat	Common about 90% of respondents still practice
3. Storing in fat	To preserve meat by reducing air entry	keeping of meat products by immersing in fat	Not very common 50% of respondents say they completely immersed the meat in fat
4. Additions of salt, spices and sugar	For flavour and preservation	adding small parts of salt, cardamom and sugar	Common 90% of respondents use additives
5. 5.Smoking of storage containers	To improve the flavour and preserve the meat	keeping products in smoked containers	Occasional, 20% of elderly women use smoked traditional containers. The rest used aluminum jug for storage

3.3.4 Characterization of traditional meat product and product processing (recipes and ingredient)

3.3.4.1. *Koche* (Beef or Goat meat)

Koche in (Figure 3.2) was a dried, bean sized cooked product made either from goat meat or beef. The meat was sliced into strips and suspended on a rope at room temperature to dry for one to two days. When the expected level of dryness was attained the strips were removed and cut into bean sized pieces. The pieces were then put in a pot and heated. Salt, spices and sugar were added while cooking on low heat as it evaporates all the steams till it dries. Then oil was added for deep frying with continued stirring until it is dark brown. Then, it was removed from fire for cooling overnight or more than ten hours. The cooled product was then stored in oil either in aluminium/stainless steel jug or traditional containers.

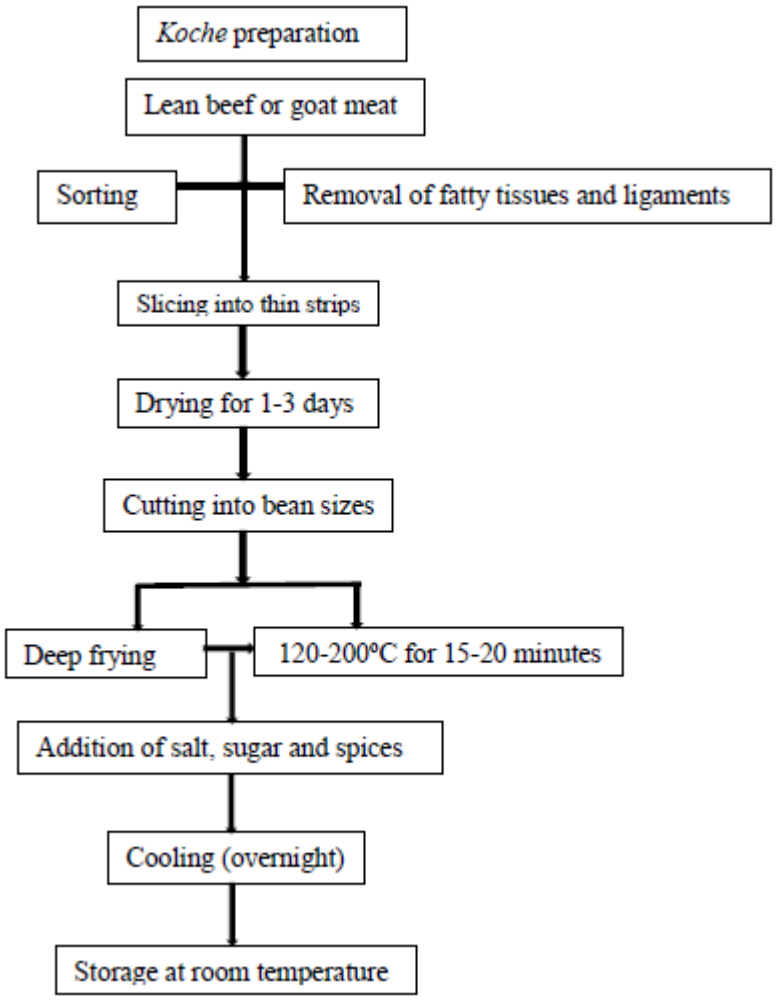

Figure 3. 2: *Koche* process flow chart

3. 2.4.2 *Fonntuma* (pounded meat)

Fonntuma a dried, roasted and pounded product was made from beef (Figure 3.3). The meat was sliced into tiny strips and suspended on a rope at room temperature to dry for three days. When expected dryness was attained, the strips were removed and roasted over a jiko (hot charcoal) then pounded using wooden mortar and pestle until the meat is grounded. Then it was deep fried, with continuous stirring. Sugar, salt and grounded cardamom were added. The heat used for cooking was medium and when the products turned golden brown it was removed from fire and cooled overnight or approximately ten hours and stored in closed a jug (aluminium/stainless steel or traditional containers).

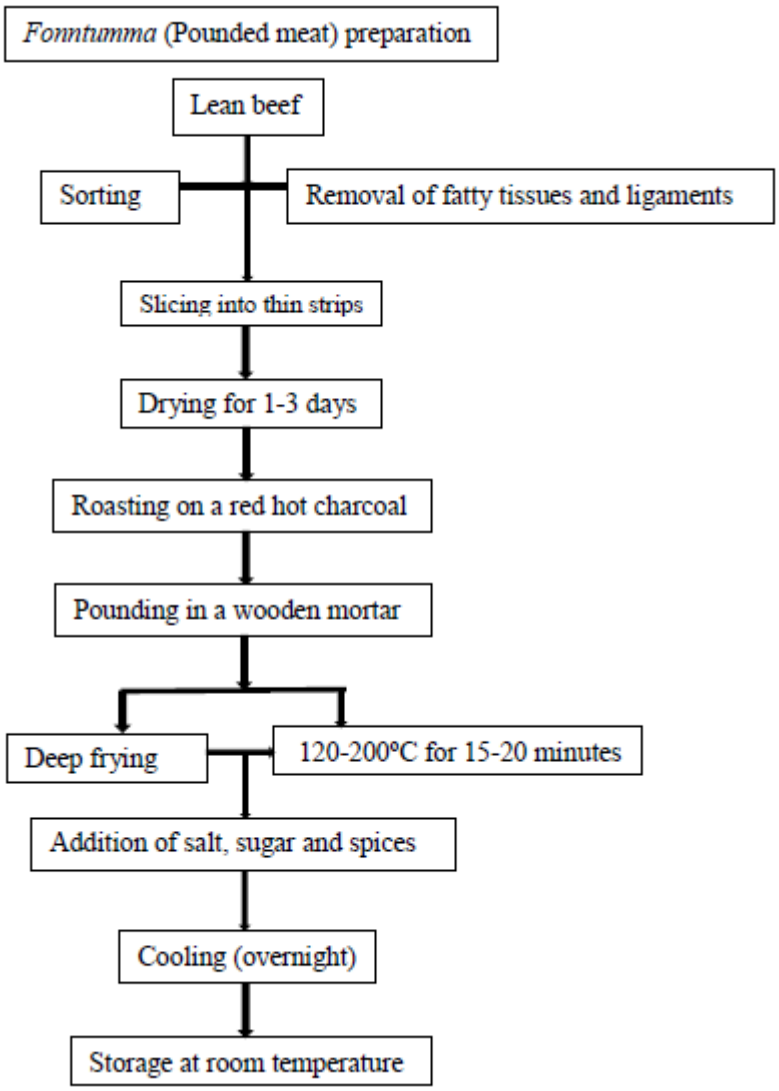

Figure 3. 3: Pounded meat flow chart

3.3.4.3 *Fonntumma garbu* (Pounded meat with barley)

Fonntuma garbu was a mixture of *fonntuma* (pounded meat) and barley (*Hordeum vulgaris) (*Figure 3.4) Barley grains were winnowed, soaked in hot water and pounded to remove the hull. The de-hulled grains were roasted until golden brown and mixed with *fonntuma* while deep frying. The product was cooled overnight or approximately ten hours and stored in closed a jug (aluminium/stainless steel or traditional containers).

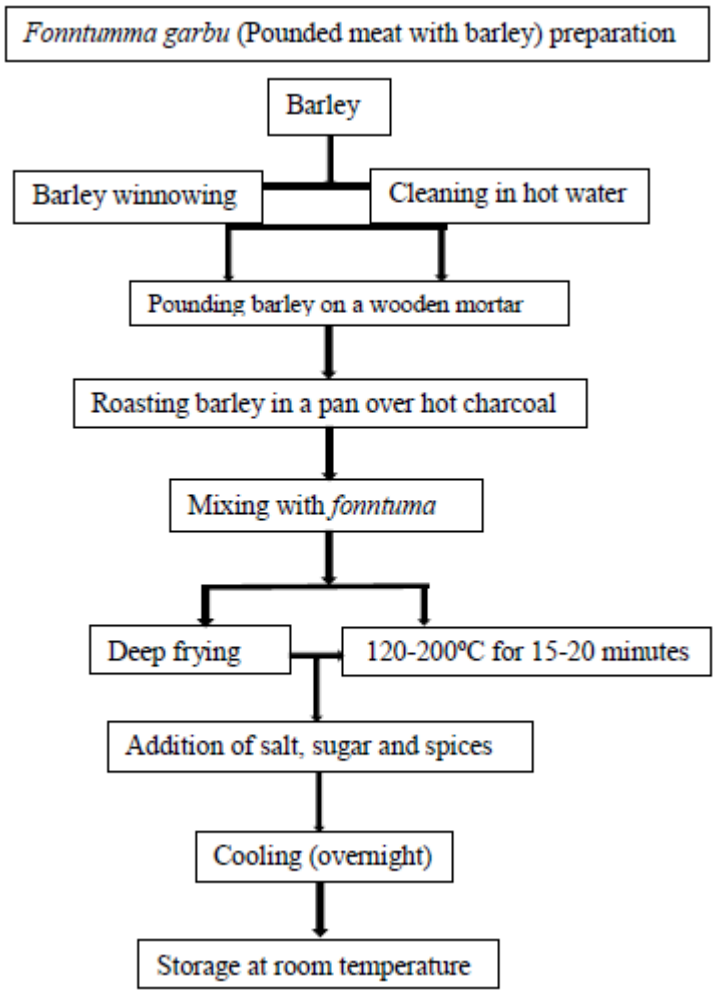

Figure 3. 4: Pounded meat barley processing flow chart

Traditional meat products were carefully prepared following the traditions, procedures and practices. Women paid careful attention to both taste, aroma and skilfully handled the products for appreciation by the family and communities. Women communicate through their cooking, asserting their place in the family and community, and shaping the actions and behaviours of others (Adapon, 2008). Such experts/skilled Borana women who possess the traditional meat processing knowledge were acknowledged and identified in the villages. In their rural abode their skills and products are sought after beyond village borders elevating traditional meat product to a prestigious position in the community.

Feagan (2007) suggested that traits and characters of place and the skills of the producers and traditions of cuisine in places are perceived in such designation as containing more meaningful and comprehensive information about food status. It is

this tacit knowledge and skills that Borana women have, which led to various processing and preservation of traditional meat products among the Borana communities.

3.3.5 Product Preparations and the Observed Tacit Knowledge of Borana Women in Making Traditional Meat Products.

Why they prepared the products the way they did

Before the actual processing and preservation phases, women systematically gathered tools which helped them carry out the activities. These included cutting knives, cooking pots, ropes for suspension, bowls, spoons, firewood, fireplace, charcoal, wooden mortar and pestle.

The part of meat selected to make traditional meat was important, where women automatically removed and sorted the meat out, as a first step (Figure 3.2). When buying meat for *koche* from the butchery, the butcher was instructed to cut steaks (rump, thick flank and silverside or all) depending on desired size. When it was home slaughtered, the hind leg, steaks were usually prized and reserved for making *koche*. The women explained that the part which makes the best products were the steaks of hind leg which has the red meat (as they called it *Allalo*). They further clarified that, it should have less fat and less ligaments. The ribs and back meat were described as parts which cannot produce good *koche* due to hard texture. Sorting was done to remove fatty tissues and ligaments which the women considered to make the products hard and also lead to spoilage. One respondent summarized these by a commonly used proverb that '*tandach thiiqaat fonn ajesa'* meaning small fatty node if not removed can lead to spoilage of whole meat part.

When making the strips (Figure 3.5 (a)) the sitting position was kind of natural as women enjoyed sitting on traditional stools and bent to cut meat into bean size pieces by holding the knife in between their toes, as shown in the second photo of (Figure 3.5 (b)). They explained that it helped them to do the work quickly and also good for ease of cutting. The only shortcoming of this technique was, as they explained, that "it's a bit tiring, causes backache when done for long". Another technique was where two people were involved with one holding the meat and while the other did the strip. The

only problem with this, as they explained, was that the holder sometimes holds the strip loosely making the cutting slow and cumbersome.

After the striping process, a hand-made rope was sought, cleaned and tied. For arranging striped meat, the women had a particular way of arranging the strip. They would hold the strip making some kind of inverted W. This was said to make it easier for removal of strips without making a knot on the rope and also helped in spacing. The exercise was done with such an ease and it was very natural. After drying, the meat was cut into bean size or tiny cubes. The women knew that different sizes may result in under cooking, for bigger and burning for tiny sizes. They therefore inherently maintained uniform cut sizes.

Drying of traditional meat product was considered a critical stage of processing, as shown in process flow chart in (Figure 3.2). Drying was of two types, where one is moderate drying or *kafaf,* done within 24hrs. This is where the meat is dried in the house at room temperature to maintain good texture of the product. The individual preparing would look and touch the meat and conclude that it's at right level. Meat products made from such method are *koche, guba* and *kataweel.*

This is a quote from a respondent from Marsabit central

> *"The steak was cut into strips and then suspended for drying. After it had moderately dried (kafaf) the active, neat women (alaqa), process it before it spoils."*

The other drying method was complete drying or *gogosa*. Here, the strip was cut thinly and dried for several days, at least more than two days. This was done to store the raw meat in *Suub or Dhool* for future use. This complete drying technique is also a procedure for *fonntuma.*

Drying was a very important step in traditional meat processing making. The women explained in participatory observation that if *koche* was not dried it does not cook to golden brown colour. If the meat does not attain the golden-brown colour it remains greyish, then it does not last for long and the unique aroma of *koche* will not be felt.

Further drying took place when deep frying was applied (Figure 3.5 (e)). The women explained that the steam which comes out of fried meat removes more moisture. Frying was done until the meat released brownish bubbles which indicated that the product was ready. In case of roasting, (Figure 3.5 (c)), the meat was roasted till it was golden

brown while burning was avoided. The pleasant aroma from meat also signified the readiness of meat. The women applied their skill in preparation in addition to constant observations made through unspoken actions. Organoleptic properties of taste, aroma, appeal and texture were used to measure the progress at different stages of preparation. For *fonntuma*, pounding (Figure 3.5 (d)) was done to make meat have filaments like fish. This reduced the size completely and increased surface area for absorbing more oil. Prior to pounding the thin dried strip meat were roasted over red charcoal. The roasting helped in pounding as it also imparted flavour. Depending on the size of the pounded meat, the process can take between one to two hours. The process of lifting pestles and crushing meat in a mortar continually was labour intensive and it needed energy. During participant observation, older women were seen requesting younger ones to do the pounding on their behalf.

While roasting the meat, women used dry stick made into 'scissor or pliers like' tools for holding meat strip as shown in the third photo of (Figure 3.5 (c)). Three to four meat strips were arranged in between the sticks and suspend over the red charcoal with continuous turning. The meat was then turned from side to side, from time to time making sure that it does not touch the live charcoal to avoid burning the meat. This was done skilfully and systematically by the women.

During the deep frying, frequent stirring was made. This was done to ensure uniform spreading of heat and release of more vapour from the product. A long stirring spoon was normally preferred for this exercise to avoid hot escaping vapours while turning the pieces properly.

The storage process was regarded as important aspect in obtaining long shelf life and good quality of meat product. A traditional storage container called *Ejito* made from wood was used. The smoking sticks, (*qalqach* and *bisiqaaa)* were inserted inside the *Ejiito* till some steam was produced. Smoking continued until the steam dried and was closed to cool for a while. Closing helped in imparting the aroma inside. Wetness and water inside the *Ejiito* was avoided completely. This is represented in the last photo in (Figure 3.5 (f)).

Proper cooling was also an important aspect in traditional meat preparation. Hence, after cooking process, the products were left to cool without any covering of the heated

product to avoid steam on the cover from dripping back to the content. This was also done to prevent spoilage. One respondent narrated the importance of cooling thus.

> *"After cooking was done, the pot was left uncovered until the meat has fully cooled. This was to avoid the steam on the cover from cooling back into the pot as water which will spoil the meat. So it was better to leave the meat uncovered as it cools"*

Figure 3. 5: Photos of traditional meat processing

3.3.6 Women working together displaying their traditional knowledge

For participatory observation in Obbu and Sololo wards, a goat was slaughtered for demonstration because the butcheries in the area only had goat meat. In Marsabit central, the women who showed interest in making products were the ones who were recommended as knowledgeable and they were all elderly women age fifty and above. This group was a peri-urban group and sourced meat from a butchery. It was this group who made *fonntuma,* a rare product. Waldagenna group, in the rural setting of Sagante ward, were mixed group of both young and elderly. They also slaughtered a goat to make *koche* from goat meat due to distance from the urban centre. This group being predominately rural, gave detailed knowledge on traditional meat practices. The

younger women 20-35 years from this area seemed knowledgeable and gave valuable knowledge on meat producing processing.

There were five women groups in different wards (Central, Sagante, Sololo and Obbu wards) who demonstrated the processing of traditional meat. 93% of the groups were women and 60% were members who were fifty years and above. During the preparation it was observed that there were some concepts which were similar to each group. Selecting appropriate carcass parts, stripping and drying were done in similar ways for four groups out of five. The other group differed in the process at point which oil was added. While rest of the groups cooked the meat first and added the oil later; this other group boiled the oil and added the meat, explaining that when meat was put into boiling oil the rate of moisture removal was higher.

From the interviews, the women showed that they are knowledgeable on traditional meat processing only that the elderly women recalled more detailed knowledge than the younger counterparts. In Sololo, which is more rural and borders Southern Ethiopia, the Borana still practiced their culture and traditional meat preparation techniques were easily remembered.

There has been emergence of butcheries and slaughter houses in the region where people buy meat unlike in the past where households slaughtered even for home consumption as the source of food supply. Nevertheless, the few who sourced from butcheries still expressed selection and preference for meat parts, where women purchased the steak of hind leg for these purposes of making "*Koche*".

In Central ward of Marsabit County, most people sourced their beef supply from butcheries, such that when one needed to make the traditional products, they purchased the parts or cuts that they required for the products. Most respondent reported that beef was more preferred for *koche* than goat meat because of the longer shelf life and also the size. In Obbu, Sololo and Jaldessa, wards most villages did not have butchery, hence people still slaughtered small stock (goats) for home use or cattle when it was a big occasion. The few butcheries in Sololo township sale only goat meat. In all the four wards, it had emerged that due to lifestyle changes, the slaughter of bulls had been on the decline except for ceremonies and thanksgiving, which were also fewer in occurrence. Bikila (2019) stated that drought often leads to shortage of pasture and death of livestock, men often move away with the livestock which reduces women

access to livestock products further making women to diversify leading to sedentarization of households, and which is a growing trend that can have both positive and negative impacts on pastoralists women. This further contributed to the dwindling traditional meat handling knowledge amongst the Borana community of Northern Kenya.

For the participatory observations, women groups were selected to demonstrate how the traditional meat was processed. This was done because most groups selected were already engaged in similar activities and the selection enhanced their abilities to do something they already knew. They passionately shared their experiences, expertise and also learnt from each other during their get-to-gather sessions. Coppock and Desta (2013) stated that groups have elected leaders and are governed under constitutional frameworks with extensive bylaws. Groups form to improve living standards for members, and numerous success stories were noted. Groups undertake activities including microfinance, livelihood diversification, and mitigation of drought effects.

Traditionally, Borana are organized along kinship lines which was used in socialization, networking and helped in sharing of responsibilities. Women would invite their friends and neighbours during occasion of slaughtering to help in the chores. Anbacha and Kjosavik (2018) described that it is common among Borana women to prepare food for households when woman in the household is sick, gave birth or has some special programmes, during bonding *marro.* (Women helping each other through resource sharing and labour).

However, with advent of modernization, there has been emergence of women and self-help groups who come together for specific purposes, such as pulling efforts together to achieve tasks satisfactorily in shorter time. Hence working with these existing and active groups offered the importance of getting detailed information through participatory methods which also gave the group opportunities to showcase their knowledge. As Kuhnlein et al. (2006) postulated, food relates to social needs and local economy. Indigenous peoples have their own unique perspectives on the relationships between environment, culture, food, well-being and health, in many dimensions. The women knew that meat is a perishable product and needed to be preserved in order to extend shelf life hence the need to reduce water/ moisture content as shown in (Figure 3.3). The women made use of drying meat moderately at room temperature by striping

the meat to increase surface area for better evaporation and knew at what stage the extent of dryness was to be done. This demonstrated inherent tacit knowledge that the women had. Abarca and Colby (2016) noted that the physical manipulation of a knife on a cutting board or dough rolled out on marble was a learnt skill, and the memory of learning that skill was recalled in the process of performing these actions

They also deep fried at high temperature of 120-200^{o}C after cutting into small cubes to remove more water till the meat turned to dark red. Dark brown bubbles of oil are an indicator that most moisture has been removed. The meat was cooled overnight without cover to avoid collection of steam which eventually drips back to meat. Covering of meat was avoided for enhanced keeping quality. The cooled meat was then stored in smoked traditional containers. Seifu, (2007) reported that smoking of storage containers for both meat and milk are generally fumigated with burned woods of specific trees (*Olea africana* and *Balanites galabra)*. Compounds released from these tree species during smoking of the containers may in part be responsible for the longer shelf life of camel milk.

3.4 Conclusion

The preparation of traditional meat products among the Borana community is an artful activity, one that requires skill and knowledge. Appreciation of these products is partly rooted in tacit knowledge of the elderly Borana women, who by their advanced age are getting fewer and will lead to gap of the knowledge in the years to come. This was evidenced by the fact that out of the fourteen documented meat products, only four products are currently being practiced. Also, with fewer ceremonial events that can occasion slaughter of cattle for meat especially in peri urban areas, few opportunities arise for passing knowledge through experience. Therefore, conscious efforts need to be initiated to address the generational gap and create awareness about this knowledge amongst the younger generation so that traditional food preservation methods among the community are preserved and/or integrated with modern food handling techniques. The knowledge on processing exhibited by the women and as documented herein showed that processing of traditional meat products had potential not only for home consumption but could be used as income generating activities for the group.

CHAPTER FOUR

BEYOND NUTRITION: SOCIAL CULTURAL VALUES OF MEAT AND MEAT PRODUCTS AMONG THE BORANA PEOPLE OF NORTHERN KENYA

Abstract

To most indigenous communities, livestock and crops play important socio-cultural roles that go beyond nutrition. Thus, for the Borana people, livestock, especially cattle have played a major role in the past not only as the main source of food but also in shaping social cultural values. Livestock used to be slaughtered to obtain meat and other by-products. However, the livestock and livestock products had other socio-cultural value that was important for communal prosperity and resilience. Cattle and especially bulls were slaughtered for meat consumption, rituals and high value ceremonial purposes.

This objective of this chapter was to determine the social-cultural importance of Borana traditional meat processing and meat products.

Qualitative methods including key informant interviews and focus group discussions were used. The interviews were audio recorded, transcribed, and analysed. The results showed that cattle played an important economic and social cultural role in Borana community where the processes of *sanga* slaughtering was used as coping mechanism during severe droughts in mitigating food insecurity and also played important role in enhancing the social cultural fabric of the community. The traditional meat sharing practices, taboos are discussed in relation to their implications on food security, and the changing socio-cultural environment.

4.1 Introduction

The Borana pastoralist community of Northern Kenya, have since time immemorial attached lots of value to cattle and by extension to cattle products specifically meat and milk. The life of the Borana fully depended on livestock and entirely revolved around it, and specifically on cattle where cattle wealth was revered beyond ranges, hills and valleys.

The ownership of large number of herds of cattle was valued only second to health as posited by the saying "*Fayaan abba kaar",* meaning health is wealth (referring to wealth only in cattle context). The significance of cattle to the Borana community was

historical. Other cultural and economic contributions of cattle included the prestige inherent in their ownership and their place in custom, religion and festive occasions (Desta et al., 2008).

Its relevance as a symbol of status and wealth, cattle is highly regarded where songs and poems have been formed in praise of renowned cattle owners, herders and even raiders. Leadership status has also been offered to individuals who owned large herds, signifying how much the Borana revered the herd numbers. As Kurlansky (2007) suggested, food is not just what we eat. It is an expression of who we are, how we live and the world we inhabit. In Boran case, milk and meat indeed describes the community in all its spheres.

Livestock, used to be slaughtered to obtain meat and other by products such as hide, skin, hooves, horns, bones and blood. The use of the processed meat and dairy products became more important as the supply of milk dwindled and when the dry season sets in, traditional meat products were used as drought coping food. Meat products among the Borana not only served as food but had other symbolic purposes. Asafa (2010) reported that, the Borana have used cattle for food, ritual (*ariro*), status, wealth accumulation and sacrifice (or s*orrio*) in birth, initiation, marriage and burial/memorial ceremonies.

The actual slaughtering process was in itself a cultural procedure that demands revered approaches such as the blessing ritual called "*ariracha",* with family members lined up dressed in traditional regalia of a turban or "ruff" on the head of the family head – the father, with whisk or "*licho"* in hand and for the woman donned in "s*aqaa*" and "*siiqee"* traditional regalia and the sons and daughters with respective *"thanis",* a blessed stick in hand. Hence, it was essential to remember that food was a social commodity that had cultural value. (Mintz, 2002) reported that, eating and ritual as a mechanism for maintaining ecological balance in local environments and/or for redistributing food.

Currently, the above elaborated Sanga slaughtering practices is not being undertaken, or rarely happens. This was mainly due to changing lifestyle and modern practices. The changing grazing environment where land ownership drastically changed from communal to private tenure systems, series of severe drought leading to dwindling herd numbers, changing trends from pastoralist economy to school going, urbanization

and existence of modern markets for meat supplies, leaves little room for traditional *sanga* practise. According to Mengistu (2016) cattle are the most affected livestock type during severe drought due to higher input requirement than other livestock types. Yet, it is the potential top priority of the society due to its principal role in socio-economics and cultural heritage.

However, there has been a changing food culture among the Borana, where reliance on meat and milk has shifted to other food sources, such as food crops – cereals, pulses and vegetables, concomitantly with changing occupations from herding to other forms of employment. Frintan et al.(2011) described that alternative livelihoods in northern Kenya are based on a variety of strategies, including the marketing of livestock, dairy products, hide and skins, and cultivated crops; a variety of wage-earning occupations ranging from professional to manual labor; and entrepreneurial activities including shop keeping, craft production and sales, and transportation.

Nguni and Mwila (2007) pointed out, food has both biological and social value. The biological value hinges on the nutritional importance of food while the social value embodies a patterning of social status based on age and genders. In this connection, it is important to understand the socio-cultural functions that animals and meat products played in the Borana community, how this is affected by the changing socio-cultural changes, and how this relates to the resilience of the people.

Thus, the objective of this study was to determine the social-cultural importance of Borana traditional meat processing and meat products, and the current relevance of these practices.

The study considers various aspects including the value of cattle, the culture of bull slaughtering, meat sharing, managing the meat products to last through the drought, and the different gender roles related to animals, slaughter and preparation of the products.

4.2 Materials and Methods

4.2.1 Study Design

The study used qualitative methods to generate required information about the preservation and social cultural issues of traditional meat. Purposive and snowball sampling was used to identify informants who in turn led to more knowledgeable

women on social cultural link of traditional meat products. Traditional meat cultural practices were gathered through key informants interviews and focus group discussion (Appendix III and Appendix VI). The questions formed the basis of identifying and describing social cultural linkages of traditional meat.

4.2.2 Study site

Location of the study was Marsabit Central, Sagante Sololo and Obbu wards in Marsabit County

4.2.3 Study population

The study was conducted in Marsabit County in northern Kenya, a pastoralist and agro-pastoralist system with population of about 300,000 people (KEBS) 2013. The area is inhabited predominantly by Borana speaking people who are pastoralists but livestock mobility is still practiced.

4.2.4 Data Collection

In order to document Borana meat culture, the study adopted qualitative methods such as key informant interviews and focus group discussions (appendices III and IV). Village elders and chiefs recommended key contacts of knowledgeable women and women groups in the area. Interviews focused mainly on women because traditional meat products are usually prepared by women. The groups were contacted where meeting was scheduled and discussions on the study topic were conducted. After initial group discussion, knowledgeable women were identified.

Interviews were scheduled depending on availability and consent of respondents. During interview sessions, participants were selected based on their knowledge and interest in traditional meat system. In addition, more inquiries were made for recommendations of women knowledgeable in traditional meat and social cultural linkages. More contacts were established leading to process of snow ball. The criteria for selection for all the interviews were that they were women from Marsabit County recommended by key contacts and had knowledge of Borana traditional meat and its important social cultural linkages.

Study participants age ranged from 25 to 75 years, although the younger ones seemed not confident in giving the information citing that they didn't have the experience of what and how Borana used to slaughter cattle for social cultural purposes.

4.2.4.1 Key Informant Interview

For key informant interview (Appendix III), purposive and snowball sampling was used to identify informants who in turn led to more knowledgeable women on traditional meat preservation technique.

The key informant interviews lasted between one to two hours. Ten key informant interviews were conducted, in the four wards and their responses recorded.

4.2.4.2 Focus group Discussion

Focus group discussions (Appendix IV) were held at the women groups place or one of the member's residences who agreed to host the group. The aim was to understand the group view on traditional meat; the knowledge and practice, and opinions on the subject when people are together, their interactions and attitudes of different ages and in some cases gender. The number of people who participated was eight to ten per focus group discussions. In total four focus group discussion of eight to ten people were conducted in Marsabit Central, Sagante, Sololo and Obbu Wards.

4.2.5 Data handling and analysis

Key informant interviews and focus group discussions were tape recorded while a field note book was used to write down verbatim for those who didn't want to be recorded. Once the interviews had been transcribed, the material was entered into the qualitative data analysis software RQDA and coded. (Appendix VIII)

The interviews were read to develop coding frame corresponding to themes such as, value of Cattle, Social cultural value of meat and food security. All of the interview transcripts were then reread and coded using the established categories. RQDA is designed for coding simplicity, it offers a two level code aggregation a first order code and a second order code themes. (Chandra & Shang 2019)

4.3. Results and Discussions

4.3.1 Value of the Cattle and the Bull - "*Sangaa"* Slaughtering

Cattle and especially bulls were slaughtered for meat consumption, rituals and high value ceremonial purposes. The slaughtering process was an elaborate activity which involved communal consultation to formulate coping strategies particularly during severe dry season and impending drought. Communal participation was essential in the slaughtering process. Cooking and sharing of portions called "*Jiffu*" of the slaughtered cattle were important activities after slaughtering process. Chege et al. (2015) that among the Maasai, if a household has food they have responsibility to share with other households that do not have. The belief in socialism ensures food sharing and availability

The place to slaughter *sangaa* was in the cattle "*Kraal*". The slaughtering process had gendered tasks where men did the actual slaughtering, and women initially stood by to harvest the blood from the slaughtered bull. The carcass was then skinned artistically by men, separating meat parts at the various joints. While the slaughtering process was ongoing, the elders would gather and observe the intestines with a view to predicting future events, a process called *"uss lalan".* This was done to foretell unforeseen fortunes and or misfortunes and how it would impact on the family and the community at large. These unforeseen event ranged from setting in of severe drought, floods, livestock migration in search of pasture, and death of family member/s, increase or decrease of herd among others. Animals are sacrificed, and in that context they are the prime vehicle or conduit for abreacting the problems emerging in human social life. Their intestines are used for divination and, most importantly, cattle provide people, especially men, with symbolic elements of prestige and personal identity (Abbink 2003)

Women would thereafter receive the meat parts to begin cooking. The parts of the meat were identified and cooked in sequence in the order of softer parts to be eaten first, and other parts preserved to be cooked accordingly for later use. The women with artistic culinary skills cooked and served the softer parts (liver, heart, kidney, intestines) immediately after the slaughter. This is in agreement with study by Magoro, (2007) that due to its affordability and unique taste, offal makes classic, frugal and

essential parts of the cultural "food basket. The serving was made to all those who had participated in supporting lifelong herding of the slaughtered bull and its flock, with priority of tasting the initial cooked piece "*dandaam"* given to the herder (or "*tiss'a"), obaat'u* (water men), and "*hamt'u"* (usually women, who are hay gatherers for young calves or the vulnerable livestock fed from homestead). Lokuruka (2006) reported that among the Turkana people livestock-meat cuts serve to identify the different gender age as well as their status in the homestead, sociologically, the format of meat distribution demonstrates the hierarchical performance of a major social function based on the coded rules of age, age grades, order of marriage, etc.

The process of bull slaughtering had many contexts according to the respondents. It was a communal decision making where elders, men and women were involved. It was a collective responsibility touching on food security and how to tackle food scarcity. *Busa-gonofa* in Borana helps people in need and also maintains solidarity and shares wealth. This strategy ensures their survival despite the losses caused by drought. (Tadesse et at., 2015). If the slaughtering was due to hunger and the community was experiencing severe drought, people met for consultation. Households who could afford and had *sanga* were directed to slaughter it. The poor were given some shares and this was institutionalized in the clan systems – a decree or *muraa gosa.* By doing this everyone was catered for.

This was elaborated by a key informant from Central Marsabit respondent below.

"Among the Boran it was culturally viewed that when abrassa (new month) was born then a cow ceremony (chonni) should be slaughtered and any household that do this should announce to the village. If it happens that one was not able to slaughter a chonni during the month of abrassa then those who have slaughtered should give them some ribs, meat and some stomach meat. This is cultural set rules (murti) which must be obeyed for everyone to give to those who don't have""

Cattle held a lot of importance in daily routine and life discourses of the Borana society. For the love of cattle, the Borana identified an individual status according to cattle ownership – as they have and the have-nots of cattle – or "*dhuress loon kaar ethuu*" or "*qoole guutu inqamne*" The first aspect of importance was the economic value of cattle, its products and the prestige it commanded. The numerous resources of milk, meat, hide and skins were obtained by every household from their herd.

Dubosson (2014) explained that herders and cattle become profoundly used to each other and mutually dependent, the herders benefiting from the products of their animals (milk, blood, hide, etc.), only as long as they provide them with food, water, shelter, and care. Cattle did more than provide readily available sources of food products whereas oxen contributed to farming activities like ploughing – land preparation or *gargalcha*, planting or *fachaasa* and weeding or *shalanshalah*. Cows were also used to pay fines or ransom *(qakhe*) or loaned to the less fortunate in the family hood as *"dabareh"* to consume the milk over its milking period as a coping strategy of "*Buusa gonofa".*

Most respondents described the importance of cattle and one respondent of focus group discussion from Waldagena group vividly recalled.

"Back in the day, the cattle were kept in great numbers such that there was no need for selling them. During the rainy season, people would drink milk. Additionally, they would churn the milk into butter and ghee for future use during the dry season. When the drought season sets in, bull was slaughtered it was this ghee (Basaa) which was consumed with meat.

4.3.2 Social Cultural Values of Meat

Cattle are regarded highly in social cultural links which defined social processes and social relationships. Bulls and cows had special purposes necessary during the occasions of ceremonies and thanks giving and most importantly cattle played major social relations roles linking neighbours and relatives that shaped the standing rules of sharing cattle resources Cattle are often the most valuable asset, they serve as a measure of wealth and social prestige. Beyond their practical benefits, cattle also play an essential role in the culture and connections among their herders. They are central to many ceremonies and marking major life events (Dessie and Mwai 2019)

A fifty year old key informant from Waldagena group narrated "The slaughtered animal for ceremonies and special events depended on the magnitude of the jill (ceremony).For instance, during the naming ceremonies of the firstborn (gubis) a bull must be slaughtered. On the other hand when children came from a journey or when a special visitor arrives, meat bought from the butcher was used to make koche".

Meat sharing was always regarded an important aspect in Borana when they slaughter the bull. The act of meat sharing was called *Jiffu* and was customarily for families to share meat. This practise not only enhances social cultural relations among the people but was also important in promoting economic welfare activities especially for families who did not have *sanga* to slaughter during the time of hunger. The people were entitled to *jiffu* as well have customary rights. These were the siblings, relatives and the affine. Other members of the communities who received shared parts were pregnant women, neighbours and less fortunate families. The parts to be shared were predetermined and households who shared out and those who received knew this habitual practice. *Jiffu* parts included ribs, vertebrae and intestines. Food was also an occasion for sharing, for distributing and giving, for the expression of altruism, whether from parents to children, children to in-laws, or anyone to visitors and strangers. (Fox, 2003)

The ceremonial slaughters of *sanga* and old cows had many rituals that were observed. The ritual of *ariracha wa*s an important act where women and men observed carrying traditional items such as *saqaa* and *siqee* as explained by a key informant respondent from Obbu.

The Borana culturally have orro, licho and saqaa. (Ceremony regalia). The Borana also believed that before slaughtering their livestock they should first bless it (ariracha). It was perceived that by killing it, the animal's soul was also removed hence the need for 'nu orsis sa namaan' (ariracha) which is simply a request for blessing to prosper both people and livestock.

The rituals surrounding traditional meat consumption also had perception of time in Borana culture. Meat rituals were organized in accordance to a time schedule. For example, *chonni* a thanks giving ceremony was usually observed in the Borana month of *(abrassa*) in January. S*orio* also a ceremony was observed at during thanks giving and memorial ceremonies. Among pastoralist, cattle are kept as a status symbol and cultural medium, while in other cultures it, also, plays a major role in marriages, weddings, sacrifices, and funerals (Kubkomawa, 2017). During the interview it become clear that there were knowledgeable women who are enthusiastic and nostalgic in the subject of traditional meat and cultural importance associated with it. The occasion of bull slaughtering was also a happy festive and prayer time when the

Borana observed thanks giving ceremonies called *chonni* and *sorio*. *Koche* was a special food which was mostly consumed during ceremonies and prepared for important guests and persons.

Further to ritual undertaken during the slaughter of the bull, the more important need of satisfying hunger was fulfilled. Therefore, *Sangaa* played an important role in mitigating food insecurity, as it fed not only the family or "*warr*", but also *"jiffu"* parts shared with relatives and neighbouring villagers. The rest of the meat was preserved and prepared into products such as *"Koche*" and "*guuba*" to be consumed over time. It was therefore, a key coping mechanism enshrined within the Borana food culture. This was elaborated by Stajcic (2013) that beyond merely nourishing the body, what we eat and with whom we eat can inspire and strengthen the bonds between individuals, communities, and even countries. There is no closer relationship than the one with the family, and food plays a large part in defining family roles, rules, and traditions.

Traditional meat "*koche*" was an important food made to express passion and love. Its elaborate preparations were both social and communal affairs involving elders, women, herders and villagers. The careful artistic handling gave it a special status and those who handled it did these activities with expert skills. Adapon (2008) argues that cooks had culinary agency, not only because their work required considerable technological skill but also because cooking and ultimately serving food was an act of exchange. In these ways cooking shapes social relations.

Because of its artistry work the preparation of *koche* took days and with proper planning. The women had to fetch water and firewood and make a mat like structure called *saqe* for meat holding. In all these processes the involvement was not individual but communal there was a team work involved. Janowski (2012) postulated Food is fuel: not only for our biological selves, but for our social selves, as humans living in groups which eat together in ways which explicitly and implicitly make statements about identity and belonging.

Koche played important role in enhancing social relationship, where the woman who had control on its processing and consumption gave it to her lover as an expression of her love and passion for him. This lover did not necessarily need to be the husband, but even a secret lover, whom if found was fined a cow to appease the husband. Such

women hence, used *Koche* as a tool to gain economic mileage in the community as they gained status because of their artistic knowledge of cooking "*Koche"* that would find its way into a man's heart.

This was elaborated by focus group discussion respondent from Sololo, Obbu division. *Who stated that it was embarrassing among the Borana women for their dhibe (traditional storage container for meat) to be empty. Particularly, women of substance who are at their prime age should have koche in their dhibe always to offer their visitors.*

To exercise profound control over the stationary resources like meat products, a woman can also present *Koche* as gift at her lover's naming ceremony called "*Guubis"* in exchange of a reciprocated reward of a cow from the lover. This traditional practice is still in action amongst the present day Boran, and seen to contribute in harmoniously unifying the community through 'Cows" as a symbol of love and communal continuity. D'yslva & Beagan (2011) argued that food work as part of caring for their families, but also an opportunity to showcase their culinary talents. Having a recipe for a particular dish was seen as a source of pride and influence.

4.3.3 Changing Cultural Practices and Implication on Food Security.

Reasons for food insecurity ranged from recurring drought that led to reduced number of herds, poverty which was manifested through food unavailability, flash floods and diseases that led to deaths of livestock in large numbers. In severe cases droughts have compelled destitute families to abandon their nomadic lifestyle and settle in urban centres but many have fallen deeper into poverty as a result. In the Borana zone, the frequency of livestock population fluctuations may increase. With droughts becoming more and more frequent, pastoralist drop-out is increasing, leading to the migration of men to nearby towns in search of wage labour (Riche et al., 2009).

Traditional meat was regarded highly as it offered both economic and nutritional advantages as well as social cultural values which are essential element of food security. Respondent's used remarks such as '*we were strong and healthy'*, '*people don't get tired'* and it's a '*happier moment bringing people together to share'* to signify the strong cultural linkages to consumption of traditional meat.

The questions on the livestock and role it played in food security among the Borana and the changing scenario, generated rich narratives from the respondents who with nostalgia recounted that livestock especially cattle was not only used as source of livelihood but had uses in social cultural functions and services such as dowry (*loon arara* and *qarat*), ransom payment (*qakhe*) and prestige. Mbororo tendency to sacrifice a bull and distribute its meat in celebrations of all kinds is related to the idea of collective belonging to the pastoral group/lineage, which is of equal importance to both men and women, each of who receive their share of the sacrificed beast (Virtanen, 2010)

However, in recent times things have changed due to occurrence of consecutive droughts that the Borana refer to as o*ollaah*. Almost all responses tended to emphasize the devastating effect of these droughts that lead to high herd mortality rate making Borana communities more vulnerable and food insecure. The Borana herders experience food insecurity as a result of recurring droughts causing huge losses of cattle, and are thus increasingly shifting from cattle pastoralism to multi-species herding. (Megersa et al., 2014)

Several respondents said that the effects of successive droughts were felt for a long time. The increasing frequencies of these droughts also made recovery more difficult. During Focus Group Discussions and Key Informant Interviews, what came out strongly was devastating outcomes that had been caused by recurrent droughts. In all sites, respondents stressed that the majority of population had suffered serious livestock losses and that most of the population had become poor, with recovery in some cases never to happen again. During drought and famine men move away with their livestock and women have reduced access to livestock products and may have to depend on firewood collection and other income generation activities (Watson, 2010) This was elaborated by a respondent in a focus group discussion from Obbu as follows.

"Unlike in the past when we used to slaughter sanga (bull) and process meat products that lasted a long time, we mainly feed on dry grains. There are barely any more sanga. We no longer churn or ferment milk. Personally, I have two female cows because the rest were killed by a recurrent drought."

The pastoral Borana were vulnerable to droughts, they lost large number of livestock and many of them became destitute and hungry. In some instances, the drought was compounded by diseases leaving people more vulnerable.

This made many people to abandon pastoralism and settle in peri-urban centres in search of other means of livelihood. From the responses the recurrent drought even made the community to discard the traditional coping mechanism of "*buusa and gonofa*" but gave way to the introductions of relief food and aid, food for work, cash for food that has become modern strategies to cope with effect of drought to reduce immediate hunger. This was elaborated by respondents who mentioned the many Non-Governmental Organization s that worked in their area. Many people in the Borana region are food-insecure due to the recent pattern of droughts. As a result, food aid is common in the region. Women depend on food aid and supplementary food to survive. This food is distributed by the government and is donated through the World Food Program, Save the Children and others. (Hurst et al. 2012)

The modern development and urbanization not only increased varieties of foods but has also caused a shift in eating pattern and food consumption activities in households. While in the past the Borana depended on livestock and livestock products, currently they consume grains and pulses, In addition to using livestock as sources of subsistence and income, Borana households also depended on non-pastoral livelihood activities. These includes crop cultivation for subsistence, sale of crop produce, food-for-work, collecting and selling gum Arabic, incense, wage employment, petty trade, remittance, charcoal and firewood sale (Abebe et al., 2015). Similarly, in the response below from a focus group discussion in Marsabit Central a respondent emphasized the satiety property of meat compared to cereals.

"These days, the drought has become too much. Instead of slaughtering sanga, people are forced to sell them for money. Nonetheless, the money is not sufficient as the sack of maize that is bought does not satisfy the children unlike the meat which gives more dietary satiety. "

Respondents explained that apart from the numerous droughts that have decreased the herd numbers, introduction of formal education and urbanization have also had a great effect on livestock keeping as many people abandoned the practise after repeated losses and changed other forms of livelihood like small scale trade and causal work.

Flintan & Beth (2011) explained that children are not taught about livestock and natural resources at school and how to manage them. Many youth are becoming increasingly disinterested in working in pastoralism. Meanwhile lack of labour to cater for livestock was also cited as another setback as more children are now enrolled in school, making livestock rearing challenging for lack of herders. As resources in pastoral areas dwindled as a result of climate change, more pastoralists dropped out of the system, migrated to urban areas, and took economically inferior jobs. Increasingly, more households are willing to invest in their children's education for future generations to be able to diversify their livelihood strategies (Mahoo et al., 2013). This has further been aggravated by more herding space being lost to commercial land owners, shrinking grazing zones. The trend of change in pastoral land use system is shifting towards resource 'privatisation', relating to spontaneous expansion of private enclosures (Flintan et al., 2011).

4.4 Conclusion

Livestock and livestock products play a very important role in Borana community. Apart from providing food, livestock played role in defining the social cultural ways of living, and has been documented in this chapter. The findings from the respondents indicate that livestock products especially the aspect of sharing meat during the drought strengthen social ties amongst people in this community and also mitigated risks such as food insecurity during the dry season. However, this practise is being threatened by the changing lifestyle and reduction of livestock numbers caused by varieties of factors such as urbanization and rural urban migration.

CHAPTER FIVE

NUTRIENT PROFILE OF TRADITIONAL MEAT PRODUCTS OF THE BORANA COMMUNITY OF NORTHERN KENYA

Abstract

Meat is a highly valued food among the Borana pastoralist community in Northern Kenya. Borana produce a number of traditionally preserved beef and goat meat products. Although these traditional products are widely appreciated, there is little information about their nutritional composition and quality, thus, the objective of this the study was to establish their nutrient profile and quality of the meat products. Samples were collected from study sites and analysed in the laboratory for proximate, mineral, vitamins and fatty acid. Results showed that for the four products analysed beef and goat meat (*koche, fonntuma, fonntumagarbu)* moisture contents ranged from 3.3 to 6.1%, crude protein contents ranged from 5.1 to 71.5% while crude fat ranged from 9.4 to 13.3%. Calcium, magnesium, iron, potassium, ranged from 35.8–110mg/100g, 52.8–60.7mg/100g, 4.5–7.4mg/100g and 701–826mg/100g respectively, while riboflavin and niacin ranged from 0.03–0.14mg/100g and 2.38–3.82mg/100g respectively. The fatty acid composition showed that beef and goat *koche* contained good amount of monounsaturated oleic acid at mean levels of 37.2% and 39.2% respectively.

5.1 Introduction

Livestock products, specifically, milk and meat products occupy a special place in the Borana diet for a variety of reasons including availability, preference, tradition and prestige. Borana people produce different type of traditional meat products from Boran cattle (*Bos indicus*) and goat (*Capra hircus*) meat for nutritional supplement including snacks for special occasions and to meet seasonal fluctuation in the available protein in their diet. They have developed unique recipes and storage methods that increase products shelf-life under the traditional pastoral production environment. Meat is a concentrated nutrient source essential for optimal growth and development. It is highly nutritious and provides proteins of high biological value (Wyness, 2016).

Javeed and Ram (2015) described that meat drying is preservation techniques used to prolong shelf-life of raw meat which reduces storage and makes handling stress-free by reducing size and weight. Traditional meat products are still prestigious and highly valued products among the Borana at household level. These meat products are still processed and preserved by traditional methods that lack technological advancement. Mekonnen (2015) observed that traditional methods of meat preservation such as drying, smoking, brining and canning have been replaced elsewhere by new preservation techniques such as chemical, bio preservative and non-thermal techniques.

Some of these products are intended for long storage to meet nutritional needs during droughts, and also as delicacies for special occasions. These meat products are still processed and preserved by traditional methods that lack technological advancement. However, there is no documented information about their nutritional composition and quality status. Gichure et al. (2014) observed that the preserved meat products from the pastoral area are not standardized and that most of the process and product parameters are currently unknown.

Hence the objectives of this study was to determine nutrient composition of the traditional meat products.

5.2 Material and Methods

5.2.1 Study Site

The samples were collected from Sagante, Obbu, Sololo and central wards of Marsabit County.

5.2.2 Sample Collection

Fifty samples of different traditional meat products were processed by local women from Marsabit County. Samples of products included: Beef *koche*, Goat meat *koche*, pounded meat *fonntuma* and pounded meat mix with barley *fonntuma garbu*. The preparation of the products took one to three days and samples were transported to Jomo Kenyatta University of Agriculture and Technology Food Science laboratory for nutritional and quality analysis. They were packed in universal bottles and stored in a cool box while on transit. At the laboratory, the meat samples were minced in a mincer

and about 0.5% acetic acid was added to the meat samples and heated for 30 min then filtered and pressed The pressed cake was heated at 70-80^{o}c in a water bath with ethanol (1:2) for 1 hour to remove fat and moisture from the meat The solvent was drained and the extraction was repeated twice The meat powder was dried properly and packed in polyethylene plastic bags and stored at room temperature for use in subsequent analysis and analysis were performed in triplicates

5.2.3 Proximate Analysis

5.2.3.1 Moisture content

Moisture content was determined by AOAC (1995) Method. About 2 g of meat sample was accurately weighed into a moisture dish and transferred to an oven previously heated to temperatures of 110^{o}C and drying done for 2 hours. The drying was done until a constant weight of was attained. The final weight of the sample was taken after cooling in a desiccator. The residue was then reported as total solids and the moisture loss was calculated as percentage moisture content.

$$\text{Moisture}(\%) = \frac{(\text{W1} - \text{W2}}{\text{W1}} X100$$

Where:

W1= Weight of sample before drying

W2 = Weight of sample after drying

5.2.3.2 Crude protein

Crude protein was determined using the Kjedahl Method (AOAC, 1995). About 1g of sample was weighed into a digestion flask together with a catalyst composed of 5 g of potassium sulphate (K_2SO_4) and 0.5g of copper sulphate ($CuSO_4$) and 15 ml of concentrated sulphuric acid (H_2SO_4). The mixture was heated in a fume hood till the digest colour turned blue signifying the end of the digestion process. The digest was cooled, transferred to a 100 ml volumetric flask and topped up to the mark with distilled water. A blank digestion with the catalysts and acid, but no sample, was also made. Ten (10) ml of diluted digest was transferred into a distilling flask and washed with 2 ml distilled water. 15 ml of 40% NaOH was added and this was also washed

with 2 ml distilled water. Distillation was done to a volume of about 60 ml distillate. The distillate was titrated using 0.02N-HCl to an orange colour of the mixed indicator which signified the end point. All determination was performed in triplicate the titres was recorded and protein content determined following the formula below: -

$$\text{Nitrogen } \% = (V1 - V2)\ X\ N\ X\ f\ X\ 0.014\ X \frac{100}{S}\ X \frac{100}{V}$$

Where: -

V_1=Titer for the sample (ml);

V_2= Titer for blank (ml)

N= Normality of standard HCl solution

f= Factor of standard HCl solution

V= Volume of diluted digest taken for distillation (10ml)

S= Weight of sample taken (g)

Protein %= Nitrogen × protein factor

52.3.3 Crude fat

Crude fat was determined using soxhlet extraction method (AOAC, 1995). About 5g of sample was weighed into extraction thimble and covered with defatted cotton wool. The thimble was placed in the thimble rapport holder and fixed into the extraction unit. A cup holder was used to insert the extraction cup containing 70ml of solvent Extraction was done using petroleum ether boiling point of 40-60^{o}C for 16 hours. Solvent was removed by Vacuum rotary evaporator at 40°C and the fat dried in the oven at 70^{o}C for 30 Minutes, cooled in a desiccator and weighed. The weight of the fat was obtained by subtracting the weight of the empty flask and expressed as a percentage of the sample weight.

$$\text{Fat } \% = \frac{\text{Weight of extracted fat}}{\text{Weight of sample}} X\ 100$$

5.2.3.4 Crude ash

Crude ash was determined by dry ashing AOAC (1995) Crucibles were preconditioned in the oven, cooled in a desiccator and weighed. About 5g of dried sample was weighed in the conditioned crucibles then charred using flame until all smoke is removed the samples was transferred into a muffled furnace and incinerated at 550ºC for 5 hours or until the ash is white or greyish-white. The residues were cooled in desiccators and the weighed. Ash content was expressed as percentage of the original sample weight on dry weight basis as follows

Calculations were done as shown below:

$$\text{Crude ash } \% = \frac{W1 - W2}{W} X\ 100$$

Where W1 – weight of ash and crucible

W2 = weight of crucible

W = weight of sample

5.2.3.5 Crude fibre

Crude fibre was determined as per AOAC (1995) approximately 2g of meat sample was weighed (W) into a 500 ml conical flask. About 200ml of boiling 1.25% sulphuric acid (H_2SO_4) was added and boiling done for 30 minutes under reflux condenser. The mixture was filtered under slight vacuum condition using Pyrex glass filter after which the residue was washed thoroughly with boiling water to wash away the acid. About 200ml of boiling 1.25% of NaOH was added in the washed residue and the same process above repeated. The residue was washed with alcohol and ether then dried in an oven at 100ºC and cooled to room temperature and weighed (W1). The residue in the glass filter was incinerated in a muffle furnace at 500ºC for 1 hour, cooled in a desiccator and final weight (W2) taken. The crude fibre content was then calculated.

$$\textbf{Crude Fibre } \% = \frac{\mathbf{w1 - w2}}{\mathbf{w}} \mathbf{x100}$$

Where;

W_1= Weight before incineration

W_2 = Weight of after incineration

W = Weight of sample

5.2.3.6 Carbohydrate was calculated by difference

The contents of total carbohydrates were calculated by subtracting the sum of moisture, protein, fat, ash and crude fibre from 100. (AOAC (1995). :

$$\text{Carbonhdrate \%} = \{100 - (\text{WF\%} + \text{WP\%} + \text{WM\%} + \text{WA\%} + \text{WCF})\}$$

Where;

WF=Weight of fat

WP=Weight of protein%

WM=Weight of moisture%

WA =weight of ash%

WCF=weight of crude fibre%

5.2.3.6 The gross energy (GE)

Gross Energy (GE) was calculated according to WHO/FAO (2002) by the following formula.

$$\text{GE} = \{(\text{protein x } 4) + (\text{lipids x } 9) + (\text{carbohydrates x } 4)\}$$

5.2.3.7 Determination of mineral composition

Mineral elements iron, zinc, calcium, magnesium, potassium and sodium content were measured after sample mineralization; this was done according to AOAC (1995).

About 2 g sample was accurately weighed and ashed in the muffle furnace at a temperature of 550^{o}C for 2 hrs. 5 ml of 50 % Nitric acid was added and the sample was heated on a hot plate to dryness. The sample was ashed again for 6 hrs. at a temperature of 550^{o}C. After cooling, 20 ml of 50 % HCl was used to transfer it to a 100 ml volumetric flask and 1 % HCl used to dilute to the mark. A Shimadzu Atomic Absorption Spectrophotometer (Shimadzu Corp, Kyoto, Japan, and Model AA6200) was used to determine the mineral content of each of the elements. The appropriate

hollow cathode lamps were used. The readings from the spectrophotometer were used to calculate the total content of the mineral elements using the standard curves (Appendix IX) obtained by running appropriate standard solutions.

5.2.3.8 Determination of vitamins composition

5.2.3.8.1 Determination of group B-vitamin: Thiamine (B1), Riboflavin (B2), Niacin (B3) and pyridoxine (B6)

A reversed-phase HPLC method by Ekinci and Kadakal (2005) was used. The sample treatment consisted of SPE (Solid-Phase Extraction) with Sep-Pak C18 (500 mg) cartridges that enabled separation of water soluble vitamins and removed most of the interfering components. 20 g of water were added to 5 g of the sample. The mixture was homogenized using a homogenizer at medium speed for 1min. The homogenized samples were centrifuged for 10min at $14x10^3$g (Centrifuge Model H–2000C Shimadzu Corp., Kyoto, Japan). The stationary phase preparation involved flushing with 10ml methanol and 10ml water (pH 4.2) to activate it. The homogenized and centrifuged samples were then loaded. The sample was eluted with 5 ml acidified water (pH 4.2) then 10ml methanol at a flow rate of 1ml min^{-1}. The eluent was collected in a bottle and evaporated to dryness. The residue was dissolved in mobile phase and then filtered through 0.4µm pore size filters. Approximately 20 µl of samples was injected into the HPLC column. The column elute was monitored with a photodiode-array detector at 234nm for thiamine, 324 nm for pyridoxine, and 261nm for niacin. The vitamins were analysed in a HPLC (Model SCL-10A, Shimadzu Corp., Kyoto, Japan) using a column of inertsil ODS 5 µm 4.6 × 250 mm 5LI0101Z with 0.1 mol /L KH2PO4 (pH 7.0)–methanol, 90:10 mobile phase (filtered through 0.45µm membrane and degassed by sonication), flow rate of 0.5 ml/min, a photodiode-array detector (Model Waters 2996, Waters Corp., Mailford, USA), oven temperature of 25ºC, and a sample volume of 20 µl. Identification of compounds was achieved by comparing their retention times. Concentrations of the water-soluble vitamins were calculated from integrated areas of the sample and the corresponding standards. (Appendix X) Vitamins content expressed as (mg/100g)

5.2.3.8.2 Determination of Riboflavin by HPLC

10g of sample was weighed and pH adjusted to 3 using concentrated acetic acid glacial while stirring, shaken for 5 minutes and centrifuged at 10,000 rpm for 20minutes. The supernatant was transferred into a 25ml volumetric flask and the sediments washed with 5ml of 2% acetic acid solution. The washings was combined and centrifuged. The second supernatants were added into the first supernatant and volume made to the mark using 2% acetic acid. The solution was filtered using 0.45µm filter. The sample was ready for HPLC. (Centrifuge Model H–2000C Shimadzu Corp., Kyoto, Japan). Preparation of standard solution. Riboflavin stock solution of 50 mg/ml in 2% aqueous acetic acid was prepared. Working standards of 1, 2, 4, 6, 8 mg/ml in the aqueous acetic acid was prepared by serial dilutions. A volume of 10µl of each standard was injected into the HPLC and the corresponding peak areas recorded. HPLC condition: column inertsil ODS (C18) 5µm 250x4.6mm; mobile phase, Methanol, water acetic acid (40: 59:5:0.5) Detector; UV, 270nm 0.02 sensitivity; Flow rate: 0.5-1/0ml/min; Injection volume: 10-20µl. Calibration curve (Appendix X) was plotted and Riboflavin concentration in the samples calculated and expressed in mg/100g.

5.2.3.8.3 Determination of retinol content

The retinol content was determined by a method described by Zahar and Smith (1990). To a 50ml glass stoppered centrifuge tube, 2g of ground sample were added followed by 5ml of absolute ethanol containing 0.1% (wt/vol) ascorbic acid followed by 2ml 50% (wt/vol) KOH. Tubes were stoppered, agitated carefully and placed in a water bath at 80ºC for 20min. During this period, tubes were agitated periodically to ensure complete digestion of fat. After saponification the tubes were cooled with running water and then placed in an ice water bath. Twenty millilitres of hexane containing 0.01% (wt/vol) BHT was added. Tubes were again stoppered and mixed vigorously with a vortex for 1 min, allowed to stand for 2 min, and again vortexed for 1 min. fifteen millilitres of cold water (1ºC) were added to each other and tubes inverted 10 times. Centrifugation was at 1000 x g for 10 min. Ten millilitres of the upper, organic layer was accurately removed by pipette into a tube and the solvent was evaporated under vacuum at 40ºC using a rotary evaporator. The residue was immediately redissolved in 1ml of methanol. For retinol standard solutions, the same procedure was

followed as for samples but with the following modifications: 1 ml of standard solution was used and 0.1ml peanut oil added before saponification (to protect retinol from oxidation); 5 ml of the upper phase was used and residue in 5 ml of methanol. The samples and the standards were then injected into HPLC. (Centrifuge Model H–2000C Shimadzu Corp., Kyoto, Japan). The conditions were: mobile phase, methanol: water (95:5); flow rate, 0.8ml/min; UV detector 325 nm filter, volume injected, 20ul. Retinal content in the samples calculated and expressed in µg/100g

5.2.3.8.4 Determination of vitamin E by HPLC

About 20g of the sample was weighed and 20ml of Hexane was added to dissolve the mixture was shaken for 15 minutes transferred to 50 ml flask and centrifuge at 5000rpm at 4oC for 10 min and samples was micro filtered using 0.45µm syringe filters. 20µl was injected into HPLC. (Centrifuge Model H–2000C Shimadzu Corp., Kyoto, Japan) For preparation of Standard of Vitamin E; 100mg of Vitamin E was weighed and dissolved in 100ml of Hexane (1000ppm) the stock solution was diluted to make working standard range of 10-100ppm. The standard Vitamin E was injected to make a calibration curve (Appendix X). Condition of HPLC; Mobile phase; Hexane+Isoprppanol (98+2) Column: Normal phase Silica 60 Oven Temperature: 25C Flow rate: 1-1.5ml per min; Injection Volume: 20µl. Vitamin E. content in the samples calculated and expressed in µg/100g

5.2.3.9 Determination of fatty acid composition

Fatty acid analysis was determined using Gas Chromatography AOAC (1990) method. About 40mg of the sample was weighed into the conical flask and 8ml of Methanolic HCl solution was added and mixture heated under reflux for 1.5 hours. After cooling the sample, fatty acid methyl esters were extracted and the solution transferred into a separating funnel and 8ml of hexane added and shaken vigorously and left to stand. Hexane layer was collected and the aqueous layer returned. Extraction was repeated one more time. The hexane fractions were combined and washed with 3-4 portions of distilled water to remove acid. It was filtered using defatted cotton wool and anhydrous

Sodium Sulphate to remove water. The filtrate was concentrated using rotary evaporator at 40°C and sample was injected into the GC.

Separation of constituent fatty acids by GC was done under the following conditions.

Capillary Column: Omegawax TM 530 dimensions 30M x 0.53mm x 0.5µm film thickness

Carrier gas; Nitrogen @ 100kg/cm2; Detector: Air-H- FID @ 260°C; Injection Temp @ 240°C; Column temperature 170°C (2 Min.)

The spectrum of each sample was noted and the fatty acids composition were identified and calculated by using standard reference spectrum and peak areas of major fatty acids

Sum of Saturated Fatty Acids (SFA) (C14:0, C15:0, C16:0, C17:0, C18:0); Monounsaturated Fatty Acids (MUFA),C16:1, C17:1, C18:1, C20:1) and polyunsaturated fatty acids (PUFA) and other traces (C18:2, C18:3, C20:2, C20:4) were calculated for the four traditional products.

5.2.4 Data Analysis

The data obtained were subjected to analysis of variance (ANOVA) When significant difference were observed between the samples for a parameter, the ANOVA was complemented by LSD (Least Significant Difference) test to identify the means that are different. Statistical significance was measured at ($P < 0.05$) using IBM SPSS Version 19.0 software and Microsoft office excel was also used to generate graphs. The data were expressed as means ± standard error of mean.

5.3 Results and Discussion

5.3.1 Proximate Composition

Table 5.1 shows proximate composition of traditional meat products. Results revealed the moisture content in the processed meat products of ranged from 3.3-6.1% while protein content in the processed meat products ranged from 56.8-71.5%. The gross energy values in the processed meat products ranged from 399.5 to 435.2 kcal/100 g.

Table 5. 1: Proximate composition (%) of traditional meat products

Proximate profile	Beef *koche*	Goat *koche*	Beef pounded *(fonntuma)*	Mix Beef and barley *(Fontuma garbu)*	Fresh meat
Ash %	1.79^{a} ±0.14	3.41^{b} ±0.21	1.95^{a} ±0.16	2.70^{b} ±0.63	1.01^{c} ±0.00
Crude fibre %	1.80^{a} ±0.24	1.61^{a} ±0.22	2.17^{b} ±0.28	4.24^{b} ±0.41	0.12^{c} ±0.00
Protein %	65.71^{a}±3.36	71.49^{b} ±2.23	65.19^{a} ±1.96	56.12^{a} ±1.36	20.60^{c} ±0.04
Moisture content %	5.87^{a} ±0.84	4.82^{a} ±0.29	3.27^{b} ± 0.38	6.12^{a} ±1.84	76.36^{c} ±0.12
Crude fat %	10.49^{a} ±1.29	9.18^{a} ±0.97	13.33^{a} ±0.87	10.26^{a} ±0.84	2.25^{c} ±0.04
Carbohydrate %	13.57^{a} ±2.41	8.7^{b} ±1.63	14.10^{a} ± 1.47	21.6^{d} ±2.50	0.0^{c}±0.13
GE: Kcal/100g	413.92^{a} ±5.91	404.71^{a}± 5.86	435.20^{b} ±4.59	399.36^{a} ±8.45	102.03^{c}± 0.45

Means of samples analysed in triplicate ± standard error of mean. Values in the same row with different superscript are significantly different at ($P< 0.05$).

The drying process facilitated the reduction of moisture content to less than 7% in all the processed products compared to fresh meat which had 76% moisture content. Such low moisture level is effective in preventing spoilage, and hence facilitating preservation. Dried meat and meat products can be defined as whole muscle or ground and formed meat products which have been subjected to dehydration, resulting in unique sensory properties and enhanced stability (Tiganitas et al., 2009).

The proximate composition shows that traditional meat products are a shelf stable product as it has low moisture content of less than 6%, similar with the study done by Ogunsola and Omojola, (2008) reported that profile of the proximate composition of the *danbunama* produced from three oil types proved the product to be a very shelf stable product, its low moisture content of 6-7% promotes its ability to stay at room temperature in spite of its high level of protein and fat combined. Pounded meat had

lower moisture content similar to Soydan et al. (2014) who reported that the minced meat samples gave lower moisture than the lean meat; this might be due to the destruction of fiber structure, which also reduced the extent of diffusion, while preparing the minced meat samples

The traditional meat products have high protein content due to processing which has increased the dry matter while there was reduction in moisture content. Kisembe et al. (2017) indicated that processing camel meat into *Nyirinyiri* improves the percentage protein of the product thus increasing nutrient density and that water content within the meat myofibrils in the narrow channels between the filaments changes as the meat shrinks within the tissue matrix. Similarly, Badiani et al. (2002) illustrated that cooking caused moisture content decrease resulting in increased nutrient. Other ingredients added to the meat during processing also contributed to enhancing the nutrition value and quality of the traditionally processed meat. The seasonings added to traditional meat products were salt, cardamom and sugar, which are not only important in preservation, but also improved the organoleptic properties of the products and quality. Salt and sugar both have preservative effect. Salt in foods can be a source of osmotic stress by decreasing water activity whereas sugars has the capability to bind with moisture and reduce water activity in foods. They are generally used in dried meat processing as a source of carbohydrates to enhance flavour, reduce harshness of salt and lower water activity (USDA, 2005). Consequently, spices are used for flavour, colour, aroma and preservation of food. The major use of cardamom is culinary purpose for flavouring food due to its very pleasant aroma and taste. (Jadav & Mehta, 2019)

The addition of barley to *fonntuma garbu* contributed to an increase in starch and crude fibre in the processed meat products. Apata et al. (2013) reported high crude fibre content in meat product *(suya)* as a result of high level of fibre in some of the constituents of the ingredient used in preparing the meat products whose source was from plants. Crude fibre is important in diet as it has a number of health benefits. It contributes towards better digestion. Barley is rich partly in soluble dietary fibres, mainly β-glucan and that scientific evidence shows adding whole-grain barley products to food can contribute to lowering serum cholesterol (Aman, 2006). The traditional meat products were prepared by deep frying and addition of sugar, spices

and barley which may have contributed to presence of carbohydrates. This is in agreement with a finding by Adeyeye, et al. (2016) where carbohydrate contents (%) of sun-dried meat *(kundi*) samples were in the range of 10.24–13.94. The gross energy content in cooked traditional meat was also high at 416 kcal/100g which was similar to beef jerky a dried meat products and dried smoked meat (USDA, 2009).

5.3.2 Minerals

Table 5.2, shows mineral composition of the traditional meat products. The levels of potassium were 701.3- 826.6 mg/100g, iron 4.5- 7.4mg/100g, calcium 35.8 - 110.0 mg/100g and sodium 158.3 - 364.4 mg/100g.

Meat and meat products are also important sources of minerals in the diet. Beef has almost all-important minerals for human nutrition. Ayeb et al. (2016) indicate that goat meat is rich in various major minerals. Potassium had the highest values in addition, the iron in beef which is heme iron is absorbed 3 to 5 times faster than that originating from vegetables non heme iron (Oliveira et al., 2015).

Table 5. 2: Mineral content (mg/100g) of traditional meat products

Minerals	Beef *(Koche)*	Goat *(koche)*	Beef pounded	Mix Beef and barley
Calcium	$184.95^{a}\pm1.65$	$51.80^{b}\pm1.44$	$184.91^{a}\pm2.19$	$35.76^{c}\pm1.73$
Iron	$7.28^{a}\pm0.23$	$4.54^{b}\pm0.14$	$7.35^{a}\pm0.25$	$5.50^{c}\pm0.16$
Zinc	$4.64^{a}\pm0.06$	$5.66^{b}\pm0.28$	$4.75^{a}\pm0.08$	$5.51^{b}\pm0.11$
Potassium	$702.51^{a}\pm8.90$	$773.77^{b}\pm17.30$	$701.29^{a}\pm9.17$	$826.56^{c}\pm4.83$
Magnesium	$52.99^{a}\pm0.60$	$60.72^{b}\pm1.07$	$52.85^{a}\pm0.51$	$59.05^{b}\pm1.08$
Sodium	$264.40^{a}\pm4.84$	$364.40^{b}\pm8.21$	$265.25^{a}\pm4.30$	$94.74^{c}\pm2.16$

Means of samples analysed in triplicate ± standard error of mean. Values in the same row with different superscript are significantly different at ($P< 0.05$).

5.3.3 Vitamins

Table 5.3 shows vitamin composition of the traditional meat products the processed traditional meat also contains vitamins. Thiamin (mg/100 g) were in the rage from (0.06 - 0.19) with higher content in beef pounded; Riboflavin (mg/100 g) were in the rage from

(0.03 -0.19) with higher content in mix beef barley; Retinol (µg/g) were in the rage from (17.40-.36.16) with higher content in goat meat and α-tocopherol (µg/g) were in the rage from (2.52 -5.19) with higher content in beef .Traditional meat is a source of some of vitamins as Pereira (2013) described that meat and meat products are particularly important sources of all the B-complex vitamins including thiamine, riboflavin, niacin, biotin and vitamins B_6. Red meat is an excellent source of bioavailable vitamin B_{12}, providing over two-thirds of the daily requirement in a 100 g serve Duckett et al. (2009) (Williams, 2007). have compared the riboflavin and thiamine content of grass/forage-finished vs. grain-finished beef and have reported nearly twice the riboflavin and three times the thiamine in beef from grass-finished cattle.

Table 5. 3: Vitamin composition (mg/100g) of traditional meat products

Vitamins	**Beef *(Koche)***	**Goat *(koche)***	**Beef pounded**	**Mix Beef and barley**
Thiamin (mg/100 g)	$0.15^{a} \pm 0.01$	$0.06^{b} \pm 0.02$	$0.19^{c} \pm 0.04$	$0.14^{a} \pm 0.01$
Riboflavin (mg/100 g)	$0.07^{a} \pm 0.01$	$0.03^{b} \pm 0.01$	$0.11^{c} \pm 0.03$	$0.14^{d} \pm 0.05$
Niacin (mg/100 g)	$3.69^{a} \pm 0.20$	$3.82^{b} \pm 0.13$	$3.67^{a} \pm 0.09$	$3.41^{c} \pm 0.23$
Pyridoxine (mg/100 g)	$0.48^{a} \pm 0.08$	$0.49^{a} \pm 0.02$	$0.35^{b} \pm 0.04$	$0.35^{b} \pm 0.07$
Retinol (µg/g)	$19.54^{a} \pm 0.35$	$36.16^{b} \pm 0.71$	$17.40^{c} \pm 1.32$	$28.68^{d} \pm 2.38$
α-tocopherol (µg/g)	$5.19^{a} \pm 0.32$	$2.52^{b} \pm 0.12$	$4.72^{c} \pm 0.75$	$3.60^{d} \pm 0.41$

[1]Means of samples analysed in triplicate ± standard error of mean. Values in the same row with different superscript are significantly different at ($P < 0.05$

5.3.4 Fatty Acid Profile

The traditional meat fatty acid composition is presented in (Table 5.3). Among the fatty acid found in traditional meat are palmitic (C16:0) 28.3-35.0%, oleic acid (C18:1) 23.1-39.2%, and linoleic (C18:2) 2.9-13.5% in different products. Beef and goat *koche* was also found to have higher content of oleic 37.2% and 39.2% respectively and linoleic 13.3%and 13.5%, respectively indicating that the traditional meat products do provide important fatty acids. The fat content in meat and meat products is a matter of concern in the diets. In meat it is highly variable depending on species, origin, feeding system, age and the cut (Daley et al., 2010).

Table 5. 4: Fatty acid (%) of traditional meat products

Name	Beef (*koche)*	Goat (koche)	Pounded meat	Beef Barley	Ghee	Vegetable Fat
butyric	0.3	0.0	0.0	0.9	0.0	0.0
caprylic	0.0	0.0	1.2	2.9	0.1	1.4
capric	0.1	0.1	2.7	2.0	3.3	2.8
lauric	0.4	0.4	3.2	2.8	0.1	4.2
myristic	1.4	2.3	11.0	9.1	1.7	12.4
myristiloic	0.0	0.0	1.8	1.9	0.1	1.9
pentadecanoic	0.2	0.2	1.8	1.3	0.1	1.4
cis -10- pentdecanoic	1.3	1.4	0.8	0.3	0.0	0.2
palmitic	33.2	32.3	28.3	35.0	35.6	29.7
palmitoleic	1.1	1.0	2.9	2.4	0.0	2.7
heptadecanoic	0.4	0.2	0.7	0.5	0.1	0.6
cis -10- heptadecanoic	1.3	1.1	0.5	0.3	0.0	0.3
stearic	7.8	5.8	11.6	9.7	2.9	9.2
oleic	37.2	39.2	26.8	23.1	41.5	25.5
Linoleic	13.3	13.5	4.0	2.9	13.1	2.7
linolelaidic	0.0	0.0	0.0	0.0	0.0	0.0
Linolenic	1.6	1.9	1.9	2.0	0.7	2.3
Lignoceric	0.0	0.0	0.0	0.0	0.0	0.0
Trace	0.3	0.5	0.8	3.0	0.8	2.8
Total	100	100	100	100	100	100

The traditional meat products was prepared from Boran cattle and goat which feed by grazing pasture, grass or browse similar to Zebu. A study by Salifou et al., (2013) found that fatty acids C14:0 and C16:0 contents were identical in Lagunaire and Borgou breeds while the highest content was recorded in Zebu Fulani. The Zebu had the highest saturated fatty acids which was thought to cause by bio hydrogenation in the rumen. Shija, et al., (2013) pointed out that because of larger body size, Boran steers tended to deposit more fat content with relatively small amount of muscle.

Similarly, the differences on fatty acid composition between grass-fed and control samples of study done by Leheska et al. (2008) Showed that concentrations of

Saturated Fatty Acids percent as 50.9 and 44.5 respectively and Monounsaturated Fatty acid (MUFA) was lower for grass-fed ground beef than that of control ground beef 47.0 and 39.2 respectively.

The traditional meat products were cooked using Ghee or vegetable oil, products cooked with ghee, beef *koche* and goat meat *koche* had higher levels of oleic and linoleic acid.

Most fatty acids in meat contain between 14 and 20 carbon atoms in the molecule. The total content of saturated fatty acids (SFA) is 30–50 %. The main SFA are palmitic acid (C-16:0), stearic acid (C-18:0), and myristic acid (C-14:0).

Pounded meat and mixed barley had sum of saturated fatty acid of 60.5% and 64.1% similar to Malekian et al. (2014) study which reported higher percentage of the sum of the saturated fatty of 65.2% for goat meat sausage without rice bran.

About 35–50 % of fatty acids are monounsaturated, oleic acid (C-18:1) (30–45 %) (Cobos and Díaz 2015). The fatty acids play an important role in human nutrition; all unsaturated fatty acids are categorized as desirable fatty acids (Moawad et al., 2013).

Table 5. 5: Total fatty acid compostion (%) of traditional meat

	Beef *Koche*	**Goat *Koche***	**Pounding *fonntuma***	***Fonntuma garbu***
∑SFA	$44.21^{a} \pm 3.63$	$41.23^{b} \pm 3.52$	$61.02^{c} \pm 3.05$	$64.32^{d} \pm 3.66$
∑MUFA	$41.54^{a} \pm 2.58$	$43.46^{b} \pm 2.60$	$33.37^{c} \pm 0.75$	$28.07^{d} \pm 0.66$
∑PUFA	$15.36^{a} \pm 2.54$	$16.57^{b} \pm 2.58$	$7.43^{c} \pm 1.95$	$8.22^{d} \pm 2.06$

Means of samples analysed in triplicate ± standard error. Values in the same row with different superscript are significantly different at ($P < 0.05$).

5.4 Conclusion

Traditional meat processing among the Borana was accomplished through heating, drying and addition of salt and sugar. Comparing the four traditional meat products of beef koche, goat koche, pounded meat and beef barley, goat koche was observed to contain high protein, potassium, magnesium, oleic and linoleic levels while beef koche was high in iron and α-tocopherol. In terms of processing pounded meat has the lowest moisture content. These findings indicate that the traditional meat products have the potential to provide important levels of key nutrients including monounsaturated fatty acids which are beneficial to health.

CHAPTER SIX

EFFECT OF TEMPERATURE, STORAGE CONTAINERS AND IMPROVED HYGIENE ON MICROBIAL SAFETY AND CHEMICAL QUALITY OF TRADITIONAL MEAT PRODUCTS

Abstract

Preservation of meat and meat products is important due to its short shelf life and perishability.

The objective of the study was to determine the microbial safety and chemical quality of traditional meat products. The samples were collected immediately after processing and transported in a cool box to the Department of Food Science and Technology at Jomo Kenyatta University of Agriculture and Technology for microbial analysis and the determination of changes related to lipid oxidation during storage for seven weeks at room temperature and at low temperature (5^{o} C). Microbiological quality of the samples were determined by Total Viable Count (TVC), *Escherichia coli* count, *Staphylococcus aureus* Count and yeast and mold count.

Result showed that *Staphylococcus aureus*, yeasts and mold were detected in the products and there was increase of *Staphylococcus aureus* count from (1.44 $\log_{10}$ CFU/g) to (2.28 1.44 $\log_{10}$ CFU/g) during storage at room temperature for seven weeks. Samples stored at cold storage at 5^{o}C showed less counts of microbial load associated. The peroxide value, acid value and thiobarbituric acid levels were below the value associated with meat spoilage during the expected shelf life. Reduction of moisture during drying of traditional meat products and cooking of meat at high temperature contributed towards reduction of microbial load. However, poor handling and post contamination may lead to poor microbial quality of traditional products.

6.1 Introduction

The Borana women prepared traditional meat products from beef or goat meat which is striped, dried and deep fried. It has a high cultural and economic importance to Borana people which warrants the efforts to ensure quality and microbial safety. The processing and preparation of these traditional meat products was an elaborate process where the meat parts used are selected carefully by removing fatty tissues, tendons and only lean meats parts are used. The meat was then striped and suspended to dry for one to three days to lower the moisture content. According to Zaier et al. (2011) meat

products, when not consumed immediately, are often processed using a range of traditional techniques involving salting, drying, cooking, smoking and marinating, or a combination of these operations to lengthen their shelf life.

Due to handling and preparation environment of traditional meat, microbial contamination can arise from post handling even after high temperature has been used to kill the microorganisms during processing. Food handlers can act as vectors for food contamination leading to the transmission of enteric and respiratory pathogens to food, e.g., through aerosol droplets from coughing near the processing line. They can also favor cross-contamination through the skin if hand-washing is not properly done. (Valero, et al., 2016).

Because microbial quality of meat products is of public health concern all over the world it is important to determine the microbial safety of these products. Processed meat foods are more prone to contamination with pathogenic microorganisms during the various stages of processing (Datta et al., 2012) Moreover, since these products are preserved in oil, the possibility that lipid oxidation and the associated rancidity and production of harmful lipid oxidation products should be considered. Microbiological assessment on safety, storage stability, and sanitary quality of traditional meat product was carried out to test for the presence of some pathogens (e.g., *Staphylococcus aureus),* different microbial groups (e.g., total viable counts and yeast and moulds), and indicator bacteria (e.g., *E-coli* as an indicator of sanitation). The variation in bacterial count between different types of meat products could be attributed to difference of ingredients and steps involved in their formulation and preparation (Hassanien et al., 2015).

The objective of this study was to determine microbial safety and rancidity indicators to ascertain their safety and quality during storage.

6.2 Materials and Methods

6.2.1 Study Area

This study was conducted in Marsabit County, Northern Kenya. The samples were collected from study sites; Sagante, Obbu, Sololo and central wards of Marsabit County.

6.2.2 Preparation of traditional meat products and collection of samples

Meat products were striped and dried for one to three days at prevailing temperature conditions and later deep fried as shown in (Figure 6.1) below. A total of seventy samples were collected from the meat traditional products that were prepared.

The women also prepared products under improved condition where basic hygiene of washing hands at critical stages was observed. The basic hygiene practices applied to improved products included observation of personal hygiene, washing of hands, cleaning and sanitizing of knives, pots and other utensils used.

The samples were then collected in universal bottles, stainless steel containers and traditional storage containers. The samples were then transported in a cool box immediately after collection to the Department of Food Science and Technology at Jomo Kenyatta University of Agriculture and Technology (JKUAT). At the laboratory samples were stored at different treatment condition, room temperature and cold temperature at $5^{o}C$ and analysed for microbial load and rancidity indices.

Microbiological assessment was done to ascertain the microbial safety and chemical quality of traditional meat as microorganisms are the main cause of spoilage in meat. Aerobic colony count was done as count of total viable bacteria employed to indicate the sanitary quality of food. Indicator organism, *Escherichia coli* was tested for any direct or indirect faecal contamination. Specific pathogen counts of *Staphylococcus aureus* was done to check presence of microorganisms that may cause food borne illness while yeast and mould counts was done as an indicator of food spoilage. Quality indices such as peroxide value, acidity, free fatty acid, Thiobarbituric acid (TBA) and pH were also assessed to evaluate development of rancidity in traditional meat products.

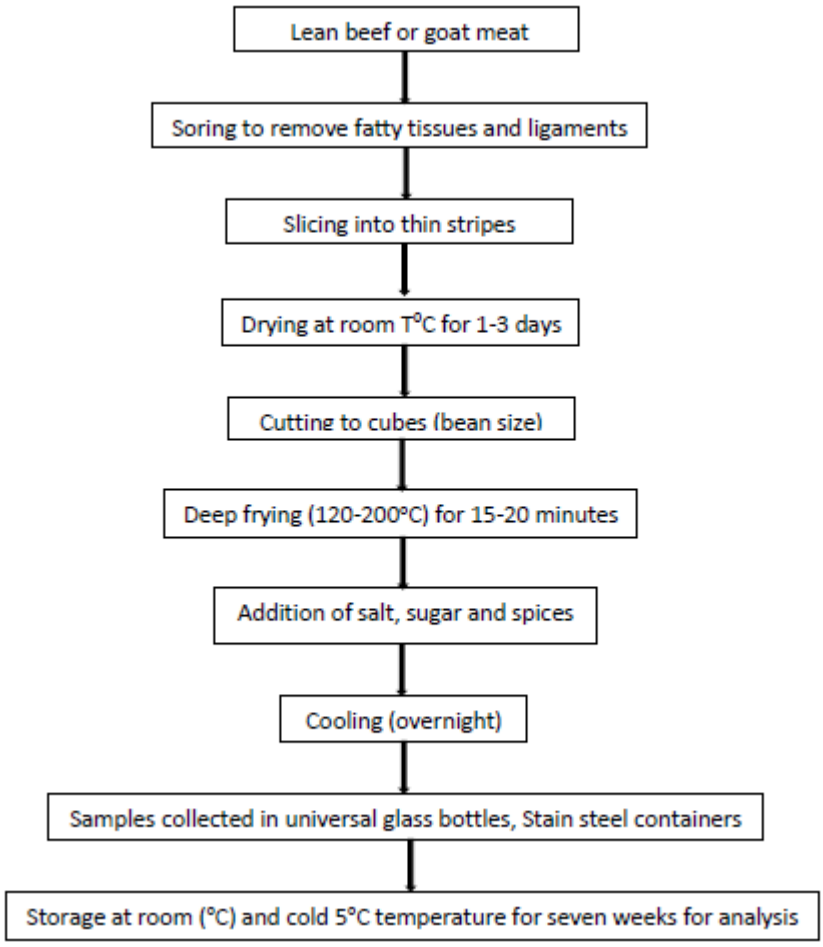

Figure 6. 1: Preparation of traditional meat products

The conditions which were tested were time (seven weeks) bi-weekly, temperature (room and cold), different storage containers (universal glass bottles, traditional containers, and stainless steel containers) and products prepared under improved conditions

6.2.3 Microbiological analysis: (AOAC 1995).

Ten grams of each sample and 90ml of normal sterile saline water was homogenized in a stomacher bag blender for 1-3 minutes to concentrate the suspended micro flora in them to form a food homogenate. Thereafter, different microbial flora from homogenate was isolated using several specialized isolation culture media. 0.1ml samples of appropriate dilutions were spread on the following media for microbial count. Nutrient agar (Oxoid), MacConkey agar (Oxoid), mannitol salt agar (oxoid) and

potato dextrose agar (oxoid) for the enumeration of total viable count, E-*coli*, *Staphylococcus aureus* and yeast and moulds respectively.

6.2.3.1 Total viable count: (AOAC, 1995).

For total bacterial counts, 0.1ml of relevant dilutions was inoculated onto sterile nutrient agar plates and spread on the surface using sterile bent glass rod. Inoculated plates were incubated at 37^{o}C for 48hr before colonies were counted and reported as colony forming units/g (CFU/g).

6.2.3.2 *Escherichia coli* count: (AOAC, 1995).

0.1ml of relevant dilution was spread on surface of McConkey agar plates. The plates were then incubated for 24hr at 37^{o}C. Colonies were counted and reported as colony forming units/g (CFU/g)

6.2.3.3 *Staphylococcus aureus* count: (AOAC, 1995).

0.1ml of relevant dilutions was spread on mannital salt agar plates using sterile bent glass rod on. The inoculated plates were incubated at 37^{o}C for 48hr. Colonies were counted and reported as colony forming units/g (CFU/g)

6.2.3.4 Mould and yeast count: (AOAC, 1995).

Yeasts and moulds were enumerated by the surface plate method using potato dextrose agar (PDA). 0.1ml of appropriate sample dilutions were spread onto PDA agar and incubated at 25^{o}C for 3-5 days. Colonies were counted and reported as colony forming units/g (CFU/g)

6.2.4 Quality Indices

The peroxide value, free fatty acid, pH, thiobarbituric acid (TBA) and the acid value were analysed to determine the quality of traditional meat products.

6.2.4.1 Determination of Peroxide Value (PV)

Two grams of sample were weighed into a glass stoppered flask. Twenty-five millilitres of acetic acid- chloroform mixture (in ratio 3:2) was added and the sample dissolved. One millilitre of saturated potassium iodide (KI) solution (4 parts KI in 3 parts distilled water) was added, mixed and placed in the dark for 10 min. Thirty millilitres of distilled water was added, mixed and followed by addition of 1ml of 1% starch indicator. The mixture was titrated with 0.01N sodium thiosulphate until the blue colour disappeared. A blank test containing all the reactants other than sample

was carried out at the same time. The peroxide value of each sample was calculated as follows:

$$\text{PV } \% \left(\frac{\text{meq}}{100\text{g}}\right) = (\text{B} - \text{A}) \text{ X } 1000 \text{ X N } / \text{W}$$

B= 1st titre

A= blank

N = Normality of $Na_2S_2O_4$.

W= Weight of samples (g).

6.2.4.2 Determination of pH

The pH of meat was measured by mixing 5g of sample with 20ml of deionized water and stirred for 5minutes and measured using pH meter (Hanna pH meter 213).

6.2.4.3 Determination of free fatty acid

Free fatty acid (% of oleic acid) were analyzed by using standard method: 2g of sample was weighed into a 250 ml conical flask and 10ml of ethanol (95%) was added, the resulting mixture was titrated with sodium hydroxide (0.1 M) using phenolphthalein as indicator. The titration was done with constant shaking until a pink colour persisted for 30 seconds. The %FFA was then calculated from the following equation:

$$\% \text{ FFA } = (\text{ 1st titre X } 282 \text{ X N}) / (\text{F X W})$$

Where;

W = Weight of sample (g)

N = Normality NaoH,

F = Factor, (10)

282 = conversion factor for m/w (oleic acid)

6.2.4.4 Determination of Acid value

About 2.5g of meat sample slurry was weighed out into a 100 ml beaker and 50 ml of distilled water added. The sample was then titrated with 0.1 N NaOH in the presence of phenolphthalein indicator until the end-point was reached, signified by a change of indicator colour to pink. The volume (ml) of NaOH used was recorded and used in determining % acid.

Acid value% = ml of NaOH x 0.1N NaOH x milliequavalent factor x 100/ (W).

Where;

W = Weight of sample (g)

N = Normality NaoH

M/w (oleic acid)

6.2.4.5 Determination of Thiobarbituric Acid Reactive Substances (TBARS)

Analytical Procedure: The standard malondialdehyde (MDA) solution (1 ml) was taken in a 10 mL test tube and mixed with Thiobarbituric Acid ((TBA) (1 ml). The mixture was heated in a boiling water bath at 95°C for 60 minutes. The test tubes were cooled at room temperature and absorbance was measured at 532 nm using UV-visible spectrophotometer model PharmaSpec 1800 (Shimadzu, Japan). Each standard for the calibration was repeated according to the above procedure. A blank sample was repeated

Preparation of malondialdehyde (MDA) and Calibration Standards: Standard stock solution of MDA (1 mM) was prepared in glacial acetic acid. MDA (31.35 mg) was accurately weighed and dissolved in 100 mL solvent. From the stock solution, different concentrations of 0.1, 0.2, 0.4, 0.6, and 0.8 mM were prepared. The calibration curve was constructed in the concentration range of 0.1 to 1.0 mM.

Extraction of ThioBarbituric Acid Reactive Substances (TBARS) in Samples: One gram of ground meat sample was taken in 25 mL test tube and 5 mL of the solvent. The solvent was either 100% glacial acetic acid (AA) or 50% glacial acetic acid in water (AW). The extract of each sample (1 ml) was mixed with 1 ml TBA reagent and the above procedure was repeated five times. The TBARS was calculated using the formula as M/g of the sample: where the amount is determined from the calibration curve and the weight of the sample taken

The TBARS was calculated using the formula in µM/g of the sample as:

$$\text{TBARS in } (\mu M/g) = \frac{\text{Ac x V}}{\text{W}}$$

Where;

Ac is the amount determined from the calibration curve

W is the weight of the sample taken

V is volume in ml or dilution factor of the total extract prepared.

6.2.5 Data Analysis

The data obtained were subjected to analysis of variance (ANOVA) to evaluate microbial and chemical quality characteristic of traditional meat products. When significant difference was observed between the samples for a parameter. LSD (Least Significant Difference) test to identify the means that are different. Statistical significance was measured at ($P < 0.05$) using SPSS Version 19.0 software and Microsoft office excel was also used to generate graphs. The data were expressed as mean count ± standard error of mean.

6.3 Results and Discussion

6.3.1 Changes in microbial populations during storage at different temperature conditions

Result presented in (Figure 6.2) showed that there was viable microorganisms as indicated by the total viable count, *Staphylococcus aureus* and yeast and mould for the period of seven weeks observed at room temperature. The result further indicates that, there was significant ($p<0.05$) increase of S*taphylococcus* from (1.28 $\log_{10}$ cfu/g) to (2.28 $\log_{10}$ cfu/g) over the observed period at room temperature. However, for all the microorganisms analysed the counts were within acceptable limit as stated by KEBS (2003) that require any cooked food to contain no more than 10^6 viable counts per gram upon analysis. From all the samples tested *Escherichia coli* was not detected (ND). The presence and increase of microbial count during the time observed could be attributed to cross and post handling contamination. Raji (2006) observed that the application of high temperature during roasting and the process of drying of the meat were expected to have reduced the bacterial load of the meat product. However, the presence of bacterial counts despite these processes suggest possible post-production contamination. Yeast and mould can cause spoilage of jerky a dried meat products

during storage of the product acquires moisture from the environment (Sperber & Doyle 2009).

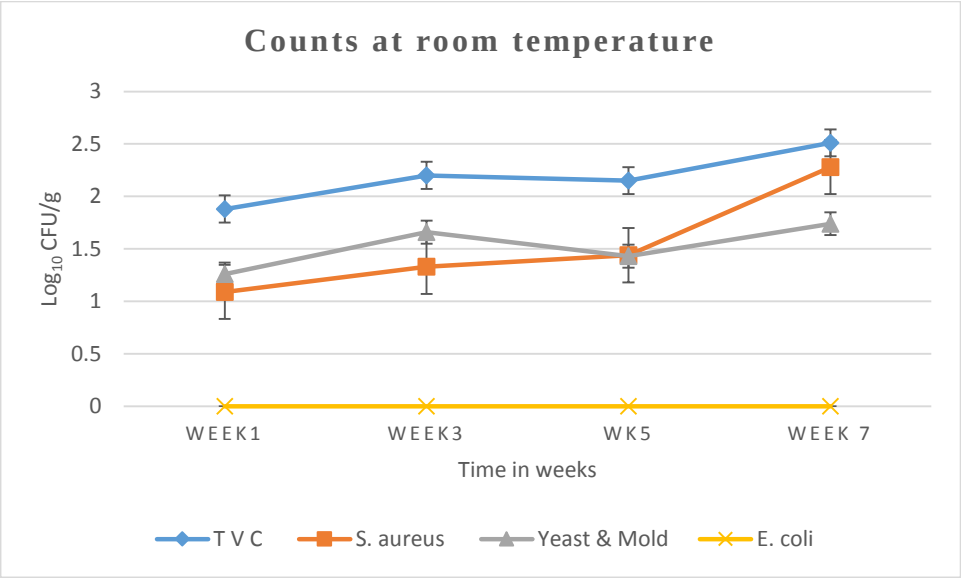

Figure 6. 2: Changes in counts at room temperature biweekly

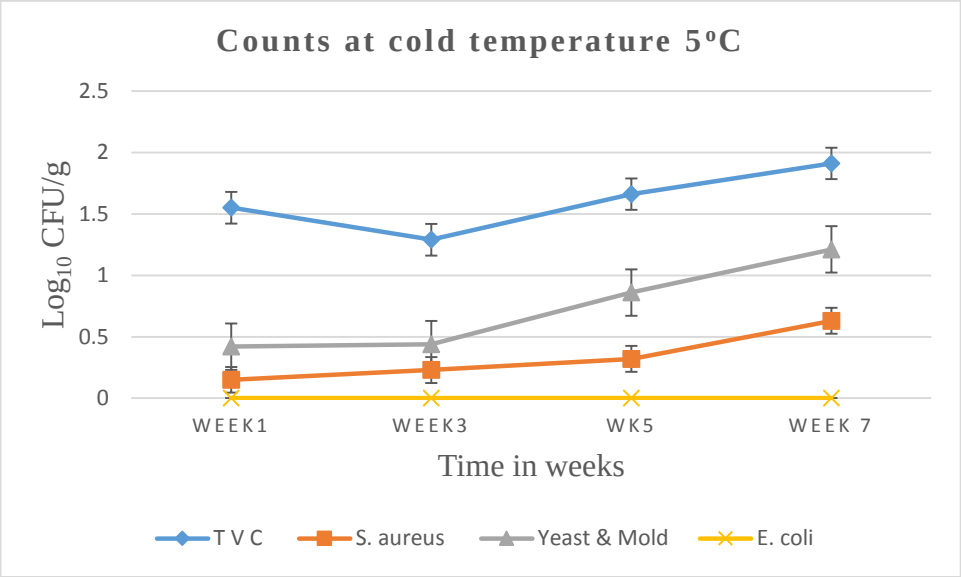

Figure 6. 3: Changes in count at cold temperature 5ºC

Comparing the samples stored at room temperature and cold temperature(5^{o}C) (Figure 6.2 and 6.3), showed that there was decline in counts observed at week seven

for total viable count, *Staphylococcus aureus* and yeast and mould.(2.51 to 1.91 $\log_{10}$ cfu/g; 2.28- 0.63 $\log_{10}$ cfu/g; 1.74-1.21 $\log_{10}$ cfu/g) respectively . This shows that temperature condition during storage do have an effect on microbial growth and keeping quality of this traditional meat products. Cool (or chill) storage refers to storage at temperatures from about 16 to -2°C. Chemical reaction rates decrease as temperatures decrease. (Montville, 2008).

Byarugaba & Kisame, (2011) stated that *Escherichia coli* was the best faecal indicator organism to assess sanitation conditions during processing because of their high prevalence in the faeces of healthy animals. The fact that there were presence of S*taphylococcus aureus* and yeast and mould in traditional meat products indicate that there was post cooking contamination at ambient temperature. *Staphylococcus aureus* may be present in small numbers in dried meat and is frequently introduced into foods by way of abscesses or the nasal cavity of food handler's (Garg & Mukerji 2010).

6.3.2 Different storage containers and temperature

For the storage containers, (Figure 6.4) Results indicate that there were microbial counts observed in all the three-container type at room temperature. However, stainless-steel containers had higher counts for total viable count, *Staphylococcus aureus* and yeast and mould more than the universal glass bottle and traditional containers. This could have attributed to pre-drying of meat products and that the traditional container was fumigated and smoked by special kind of stick. It was reported pastoralist normally fumigate their food containers for preservation of meat and milk. Smoke constituents play an important role in preserving the product against microbial spoilage. (Fakolade & Omojola 2008).

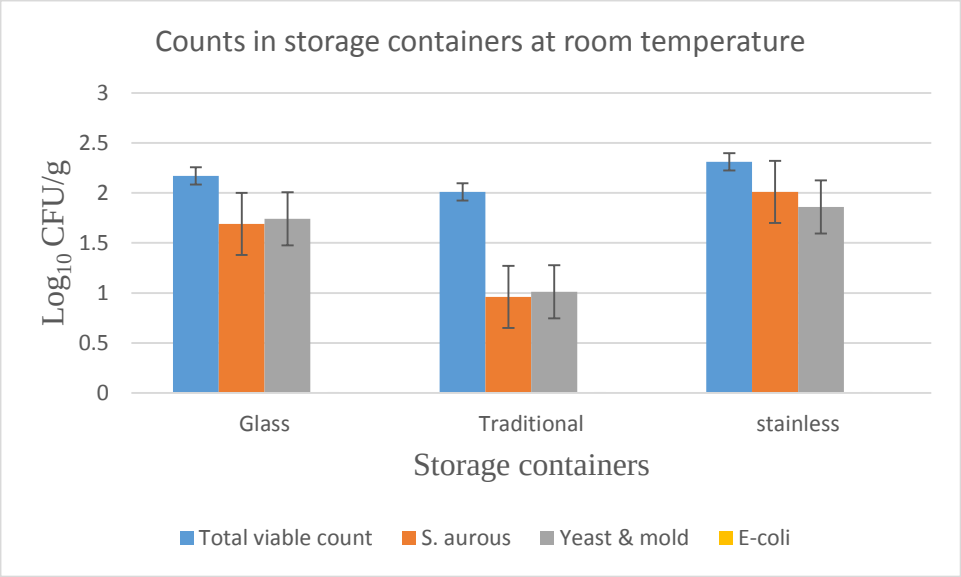

Figure 6. 4: Counts in different storage containers at room temperature

Result in (Figure 6.5) for storage containers stored at cold temperature, revealed that there was significant ($p<0.05$) decline in growth of *Staphylococcus aureus* count for all the three containers for at cold temperature 5^{o}C. However, there was presence of viable microorganisms and yeast and mould counts. Although cooking destroys *Staphylococcus aureus*, the toxin it produces is heat stable. Refrigeration of raw and cooked foods will inhibit the growth of *Staphylococcus aureus* out of foods (Wagner, 2001). A significant difference in microbial load reduction was observed with different storage temperatures conditions and improved products. Dave & Ghaly (2011) observed proper handling, pre-treatment and preservation techniques can improve the quality of meat and meat products and increase their shelf life.

A study by Tajkarim et al (2010) found that aerobic plate count for jerky which is sold as heat treated ready to eat meat products was detected at levels considered safe for human consumption at 3.21-3.45 $\log_{10}$ cfu/g over ambient storage of 28 days. Mhlambi, et al (2010) also reported that biltong, a dried salted beef product in South Africa, had aerobic bacteria (6.4-7.0 $\log_{10}$ cfu/g), *staphylococcus aureus* (3 $\log_{10}$ cfu/g) and *E. coli* (1 $\log_{10}$ cfu/g) counts, yeast and mould 6 $\log_{10}$ cfu/g. This indicates that total bacterial count, *staphylococcus aureus*, yeast and mould in traditional meat is lower at 2.51 $\log_{10}$ cfu/g 2.28 $\log_{10}$ cfu/g and 1.74 $\log_{10}$ cfu/g respectively than has been reported for biltong and jerky

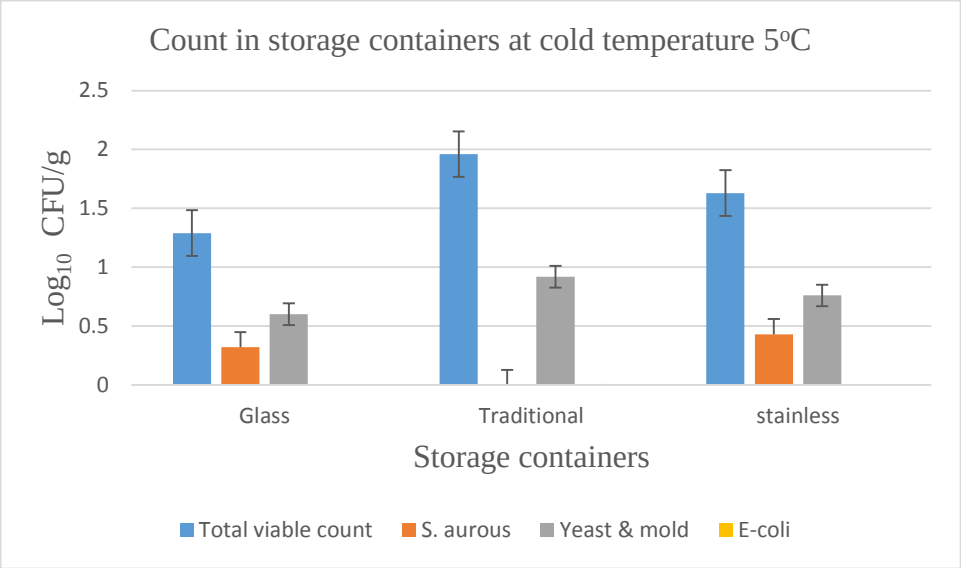

Figure 6. 5: Counts in different storage containers at cold temperature 5ºC

6.3.3 Different storage containers and improved processing conditions

(Figure 6.6) shows result of storage containers with samples prepared under traditional conditions and improved condition where basic hygiene of washing hands at critical stages were observed. There was significant ($p<0.05$) decline in growth of S*taphylococcus aureus* counts for all the three storage containers in improved samples. Total viable count and yeast and mould count were also lower in improved products. Purnomo (2011) described that the art of preserving meat by a combination of salting, spicing and exposure to the sun for drying has been practiced for centuries in nearly every country, especially in developing countries where refrigeration is limited or unavailable. Moisture and temperature developments during drying are indicators of the quality and safety of foods (Soydan et al., 2014).

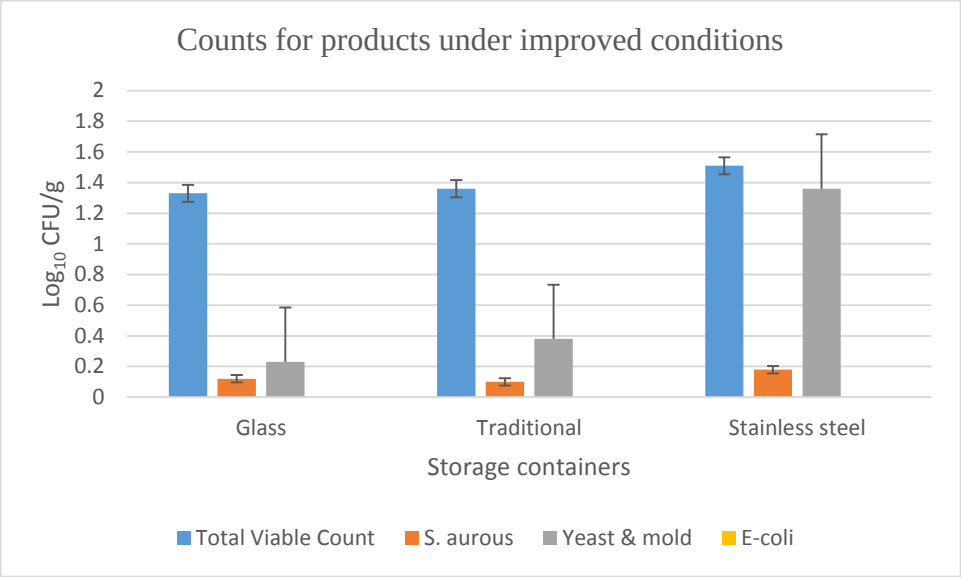

Figure 6. 6: Counts in storage containers for improved conditions at week one

6.3.4 Effect of different processing conditions on microbial populations

Comparing the traditional meat prepared under traditional condition by women and improved condition where basic hygiene was observed, the result in (Figure 6.7) shows low counts in all the three, total viable count at (1.23 $\log_{10}$ cfu/g) and lower counts for S*taphylococcus aureus* and yeast and mould at seven weeks. This was attributed to the basic hygiene and monitoring critical meat preparations stages (before and during) processing of traditional meat products

Preventive measures can be applied at the most critical stages of preparation, storage or display and wherever control is feasible. Home preservers should always wash their hands and sanitize utensils and work surfaces before and after processing (Nummer et al., 2004). *Escherichia coli* was not detected in any samples of traditional meat products. Dried meat products are shelf stable at ambient temperature. As a loose reference to determine approximately where spoilage will occur, preserved meat should have aerobic colony count less than 6 $\log_{10}$ cfu/g, *Escherichia coli* none detected, yeast and mould less than 3 $\log_{10}$ cfu/g and *Staphylococcus aureus*< 1.3 $\log_{10}$ cfu/g (Garg & Mukerji 2010).

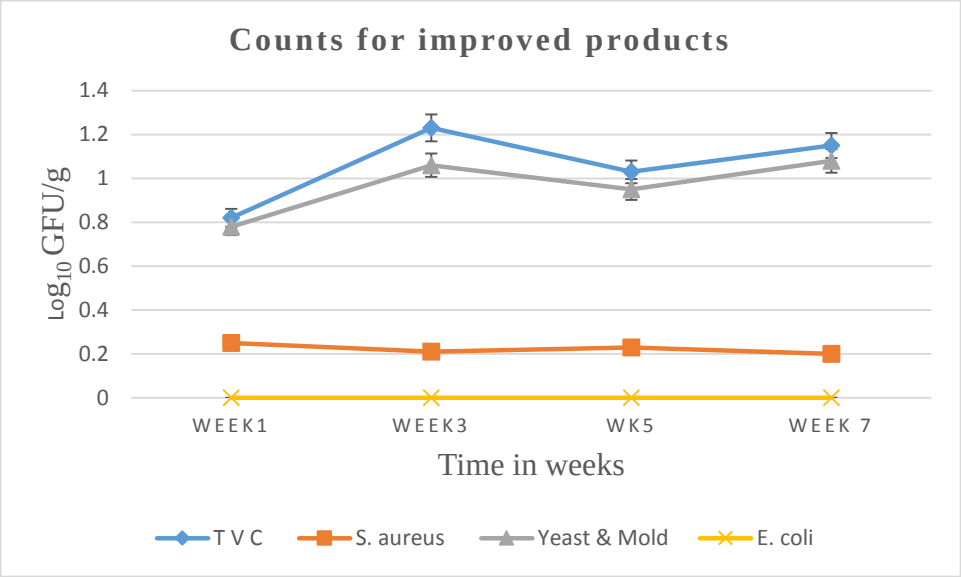

Figure 6. 7: Changes in counts for improved conditions biweekly

6.3.5 Quality indices

(Table 6.1) contains the quality indices of processed traditional meat products. There was no significant difference observed in pH values (5.9-6.0). Ratsimba et al. (2019) reported that pH of beef *kitoza* ranged from 5.26 to 6.22) similar to the pH of salted/dried beef products such as *pastirma* (5.7–6.1.) The acid value is the number of milligrams of sodium (or potassium) hydroxide necessary to neutralize the free acids in 1 gram of sample. The acid value is a measure of the amount of free acids present in a given amount of sample. The Acid value was constant and there was no variation noted.

In this study, the Peroxide Value (PV) of the processed samples was 1.8 – 2.7 mEq/kg. These values are within the value for prevention and control of rancidity development in meat. The peroxide value is a useful method to determine the early stages of fat oxidation and the product is considered rancid when PV of 20-40 meq $kg^{-}1$ is reached. (Nummer et al., 2004).

Free fatty acids values of processed meat products were 0.14-2.62%. These values are below the threshold for rancidity detection in dried cooked meat. Thiobarbituric acid (TBA) values expressed as mg of malondialdehyde (MDA)/kg of processed products were 0.33-0.54 (MDA)/kg hence, it was within the acceptable range. TBA value is routinely used as an index of assessing lipid oxidation in meat products during storage.

Raja et al. (2014) reported that the rancid flavour is initially detected in meat products at TBA values of 2.0 a threshold value of 2 mg/kg

Table 6. 1: Quality indices of traditional meat products

Quality Indices	Beef (*Koche)*	Goat *(koche)*	Beef pounded	Mix Beef and barley
pH	5.93 [a] ±0.18	6.18[a] ±0.08	5.71[a] ±0.05	5.85 [a] ±0.03
Peroxide value mEq/kg	2.41 [a]±0.81	2.56 [b] ±0.80	2.68 [b] ±0.82	1.81 [c] ±0.81
TBA mg MDA/kg	0.53 [a] ±0.01	0.42 [b] ±0.02	0.54 [a] ±0.02	0.33 [c]±0.02
Acid value %	0.01 [a] ±0.00	0.01 [a] ±0.00	0.0 [0a] ±0.00	0.00 [a] ±0.00
Free fatty acid %	2.62 [a] ±0.01	1.41[b]±0.02	0.84 [c] ±0.02	0.14[d] ±0.00

Means of samples analysed in triplicate ±standard error of mean. Value with different superscripts within a row were significantly different at (P<0.05).

The result of quality indices, the pH, peroxide value (PV), Acid value, FFA (free fatty acid) and TBA (Thiobarbituric acid) are presented in (Figure 6.8) it was monitored at week one as basis to compare at week seven during storage period to observe changes in the keeping quality which shows no significant variation (p>0.05) for pH, acid vale and TBA

Peroxide value (PV) were used as indices to assess the level of lipid oxidation and it is widely used for the estimation of oxidative rancidity in fats and oils. (Aksu, 2007). There was significant increase (p<0.05) for peroxide value 2.26 to 4.45 mEq/kg at week 1 and week 7. Soyer et al. (2010) reported significant changes in peroxide value (p<0.01) due to storage period in meat samples.

Free fatty acids are the products of enzymatic or microbial degradation of lipids. The mean values of the free fatty acids (% oleic acid) of samples increased significantly (p<0.05) from 0.97% to 2.05% at week 1 and week 7 respectively. Idowu et al. (2010) reported that FFA level of *kilishi* during 14 days' storage was about 1.8%, which implied that *kilishi* maintain a good quality at a considerably long period of storage.

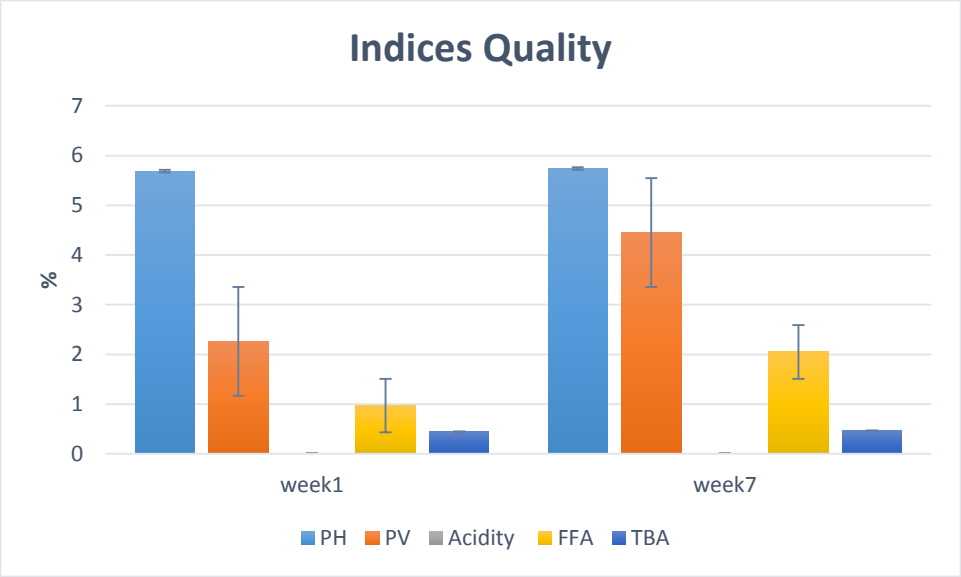

Figure 6. 8: Changes in counts for quality indices at week one and seven

6.4 Conclusion

Results obtained from microbiological and rancidity indices were within acceptable range throughout the storage. Drying and cooking of meat after drying contributed towards reduction of microbial load. However, poor handling and post contamination leads to proliferation of microbes. Low moisture, low temperature and observation of good hygiene practices prior and during processing of traditional meat products was observed to enhance the shelf life and quality of traditional meat.

CHAPTER SEVEN

CONSUMER KNOWLEDGE AND PERCEPTION OF TRADITIONAL MEAT PRODUCTS IN MARSABIT KENYA

Abstract

Pastoralist women have skills and knowledge in traditional meat products both for use at the household to diversify diet and for income generation. They have indigenous knowledge and skills that they accumulated overtime from their predecessors to process and preserve livestock products. The objective of of study was to to determined consumer of knowledge and perception of traditional meat products in Marsabit County. The data collection took place in Marsabit County, where a household survey using a semi structured questionnaire and sensory evaluation was done on two traditional meat products of beef and goat meat *koche*. The result showed the traditional meat products were well known to respondents who have had prior experience of consumption at household levels. This was so, because the products are yet to be made available commercially. The organoleptic properties of the products were highly regarded and well-liked by respondents who evaluated the products. The sensory evaluation done on perception of these products revealed that the products are preferred a lot as special food in the community and respondents were willing to buy if ever availed for sale.

7.1 Introduction

Marsabit County is situated in Northern part of Kenya which comprises mainly pastoralist who keep livestock and depend on livestock and livestock products for their livelihood. As described in a report by MacOpiyo (2014) northern Kenya is largely a pastoral production system where pastoralists keep variety of livestock mainly goats, sheep, cattle, camel, chicken and donkeys. The livestock reared represent their wealth while most of their cash needs are derived from the sale of the livestock and livestock products. However, due to various factors such as continuous drought which have reduced their livestock population and changes in social economic practices, pastoralists in northern Kenya have diversified means of livelihood in adapting the dynamism of modernization. Pastoralist societies have undergone further changes due

to urbanization, an increase in population and the state-imposed policy of sedentarisation that is attempting to integrate the pastoral economies into national and international markets (Guyo, 2017).

In Marsabit county, women play an important role in the livestock value chain especially management of livestock and livestock products particularly milk and meat at household level. Pastoralism in the arid and semi-arid areas of northern Kenya is nomadic in nature and livestock represent the key source of livelihood across most arid and semi-arid land households (Mudhe et al., 2009). Pastoralist women have indigenous knowledge and skills that they accumulated overtime from their predecessors to process and preserve livestock products. Rural women use diversified simple and traditional food processing techniques to make variety of traditional food products. These traditional food processing techniques are simple and low-cost and aim at long storage of foods (Ibnouf, 2012). Milk and meat are normally used for subsistence though during seasons of glut, excess are sold to improve house hold income. Njaja et al. (2003) noted, utilization of livestock and their products are mainly for subsistence while its sales contributed to the cash economy thus the system need improvement for commercialization.

Women in these areas are learning the importance of coming together and working in groups in producing and promoting their traditionally made products during cultural shows and events to get more income from their indigenous knowledge and skills. MacOpiyo (2014) indicated that commercialisation and access to money from income generation activities has been positively embraced as communities and women in particular seek economic empowerment. These efforts are manifested through social aspects such as meetings to enhance social interactions and chances for exchange of information. These traditional meat products are important especially in terms of food culture in as far as being regarded special foods within the community, ensuring its continued survival. Food habits are slow and difficult to change because food has important psychological associations with the family and the community. Familiar food is satisfying and reassuring, particularly the traditional foods of childhood, which evoke a deep-seated emotional response (Oniango et al., 2003). Finally, this being a food product, the traditional meat products begin from preparation at household level to final consumer. It is important to evaluate the consumer perception to identify their

preferences and expectations in regards to sensory and commercialization aspect of these traditional meat products. Preference tests, are designed to give the understanding of consumer perception on sensory attributes of food products (Bruzzone et al., 2011).

Therefore the objective of this part of this chapter was to find out current status of traditional meat products and general consumer acceptability of traditional meat products

7.2 Materials and Methods

7.2.1 Study design

The research design used was cross sectional as it gave the snap shot of practices in a fairly uniform population at a certain point in time. For the current status of artisanal meat, general household survey was conducted while for consumer evaluation, respondent's ranked two artisanal meat products - beef *koche* and goat meat *koche*. Sixty evaluators/respondents consisting of men and women were guided by five-point likert scale questionnaire to evaluate the products. The respondents were interviewed to characterize artisanal meat attributes - organoleptic properties and preferences.

7.2.2 Study site

This part of the study was conducted in Marsabit County in Central and Sagante wards of Saku Sub County, Obbu and Sololo wards of Moyale Sub County

7.2.3 Study population

Given that the study focused on consumer knowledge and perception of traditional meat products, respondents were men and women found at the households at the time of interview. For sensory evaluation, it targeted stand visitors amongst festival attendees.

7.2.4 Sample Size and Sampling Procedure

A household survey on consumer knowledge and perception of traditional meat products was conducted. A cluster sampling technique was used, where household-based personal interview surveys were conducted in the cluster survey sites. Data were collected using a semi structured questionnaire (Appendices V) the questionnaire was

pre-tested with five respondents in the area similar to study sites to make improvement in content in line with the objective of the study.

To get a representative sample size, this study used Fishers formula (Mugenda and Mugenda, 2003).

Since the target population was less than 10,000, the final sample estimate (n*f*) was calculated as follows: n*f*= (n/1+n/N)

Where: n*f*= the desired sample size (when the population is less than 10, 000).

n = the desired sample size (when the population is more than 10,000)

N = the estimate of the population size.

200 study participants were recommended as the desired sample size and to cater for those households that would decline to participate or drop out during the process. The accessible population was 3000 households in the study sites.

Sample size was calculated using the formula as follows;

$$\mathrm{n} = \mathrm{n0}/\{\,1 + \frac{\mathrm{n0} - \mathbf{1}}{\mathrm{N}}\}$$

Where n_o is the desired sample size, N is the population size.

Using the above formula, sample size was calculated as follows:

$$n = \ 200/\,\{1 + \ \{200 - 1)/3000\} \ = \ 188$$

7.2.5 Data Collections Methods

7.2.5.1 Household interviews

Household interviews were conducted using semi-structured questionnaires (Appendix V) with persons found at home preferably the mother/female respondent because of the nature of the study. The data collected were;- information on socio-demographic characteristics including age, gender, education, and income status, knowledge and perception on processing and preservation of traditional meat products. The interviews were conducted in Borana language by enumerators who were from the community. The enumerators were trained before the actual collection of the data. In a households where female respondents were not present at the time of the visit, effort was made to revisit the household.

7.2.5.2 Sensory Evaluation

For sensory evaluation, two traditional meat product samples were prepared by women groups during the Kalacha cultural festival in Marsabit County. The two products were beef koche and goat meat koche. The festival was in an open market place where the women had a stand to show case their products and many people were in attendance. Respondents who were pop-in visitors to the stand were asked to rate the two products for preference on a five point likert scale questionnaire (Appendices VI) to evaluate sensory attributes coded (5 for like a lot ….to 1 for dislike a lot) to determine organoleptic attribute of taste, aroma appearance, tenderness and flavour. Samples were presented in disposable plates and spoons. Water was provided for mouth rinsing in between tasting of the two samples. Percentage of respondents on utilization of traditional meat products as special food or family meal was assessed. The respondents consisted of different people with varying background. Social economic and demographic factors were looked at and sensory perceptions of the products were assessed by coding of the samples. Sixty respondents participated in evaluating the samples.

7.2.6 Data Management and Analysis.

The data obtained from the house hold questionnaires were coded and analysed using Statistical Package for Social Sciences (SPSS) Version 19 for means, percentages frequencies and standard error. The data was presented in tables, and bar graph for knowledge and perception of consumers on traditional meat products. For sensory evaluation, social-economic data was analysed by using descriptive analysis to understand the perception of consumers in terms of age, gender, ethnicity, location and occupation. Analysis of variance (ANOVA) and frequency was carried out on each meat sample to evaluate consumer's organoleptic perception of the evaluated products. Results were expressed as means ± standard error of mean and the confidence interval was set was at 95%.

7.2.7 Ethical Consideration

Permission to work in the study area was sought from chiefs and village elder's Utmost respect of cultural practises were observed. Verbal consent from respondents ho were willing to participate was sought before interviews commenced .All information

collected during the study from the respondents were treated as confidential and was used solely for the research purposes.

7.3 Results and Discussions

7.3.1 Social demographic characteristics of household interviewed

A total of 200 respondents were interviewed, but 10 questionnaires were found to have had some missing data, thus eliminated. The respondents of the household questionnaire were all female as traditional meat product are regarded as women domain. The ages below 29 have shown less participant respondents to questionnaire at 4%, whereas the ages between 30-49 years and above 50 years significantly participated in the survey at 95% as shown in (Figure 7.1). This depicts the level of interest by ages where older women showed deep and perceived highly the traditional meat products

Marital status of the respondents shows that those of married is 74%, whereas 14% of girls (unmarried women) responded, with 11% widows amongst the respondent. This implies middle-aged women were active and entertained guests and visitors. Grillos (2014) explained that traditional division of labour is that pastoralist men are highly mobile with their livestock, while women often remained in semi-settled communities. Many of the respondents have pastoralism as their main economic occupation at 86%, with a meagre 2% pursuing formal employment while 8% are just casual labourers. This signifies how much pastoralism is at the heart of Borana community. The Borana economy is based on pastoralism. Livestock is, therefore, an important resource for the Borana. It plays an essential role in ritual and religious sacrifices. Most importantly, livestock is a major food source (Muyaka, 2018).

The level of formal education of the respondents is generally negligible at 6.3% since traditional knowledge is with the largely uneducated women at 90.5%, as it was acquired informally by doing the activities. Evidently fewer participants who have had some formal education harbour this tacit knowledge as shown in the in (Figure 6.1). The low levels of education could be attributed to the age of the respondent who are mostly over 30 years and its only recent that pastoralist started taking girls to school.

Nyamongo (2000) reported that interviews within the communities showed that children especially in the rural villages of Marsabit County lived with family members who had little or no formal education.

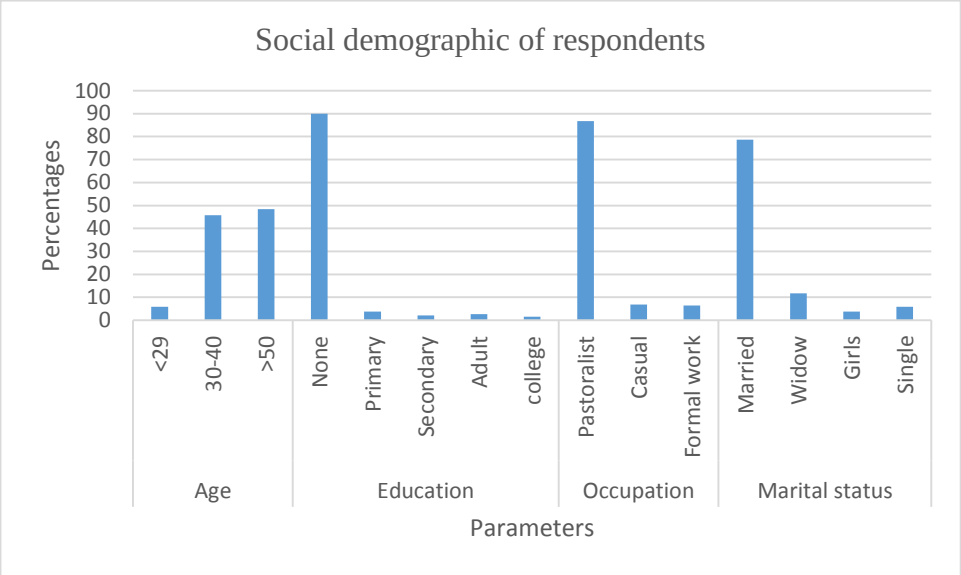

Figure 7. 1: Social demographic characteristic of respondents

7.3.2 Traditional meat knowledge and Practices

At the time of interview, 92% of respondent admitted knowing or being aware about the products. While only 16% had responded in affirmative to have traditional meat products available in their houses while majority 84% responded that they did not have the traditional meat products at the time of interview as shown in (Figure 7.2)

Traditional meat products are special kind of delicacy usually prepared for a reason. Majority of respondents stated that they prepared the products for special occasions and when they have guests as shown in (Figure 7.3) this points to the fact that traditional meat products are prepared for special occasion and events.

Traditionally, the Borana just slaughtered their own animal as and when need arises, however, there are butcheries in towns and community centers which would cater for meat demand. In this regard, the responses was analyzed by education variable comparing to source of meat, reason for obtaining, seasons and knowledge

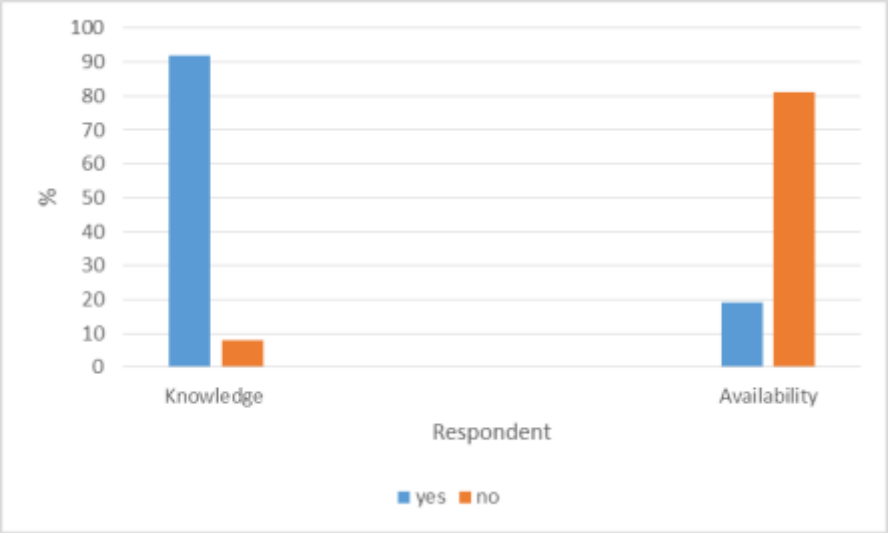

Figure 7. 2: Traditional meat processing knowledge of respondent

89 % of the respondent who have gone to school said they sourced meat from the butcheries when they wanted to make the artisanal meat products (Figure 7.3). The higher number of 90% of none educated, those who slaughtered their own livestock could be attributed to the fact that the traditional meat products were for reasons and seasons as shown in the (Figure 7.3). Borana buy live goat from traders to slaughter or buy raw meat from butchers to meet needs for some special occasions (Hussen et al., 2013).

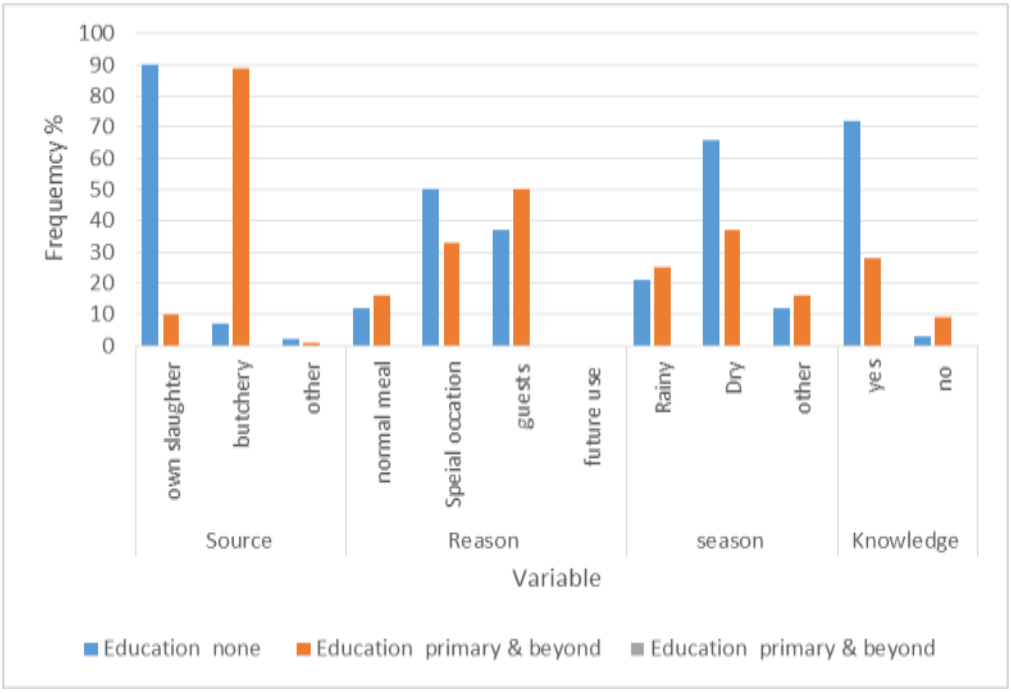

Figure 7. 3: Traditional meat processing knowledge by education

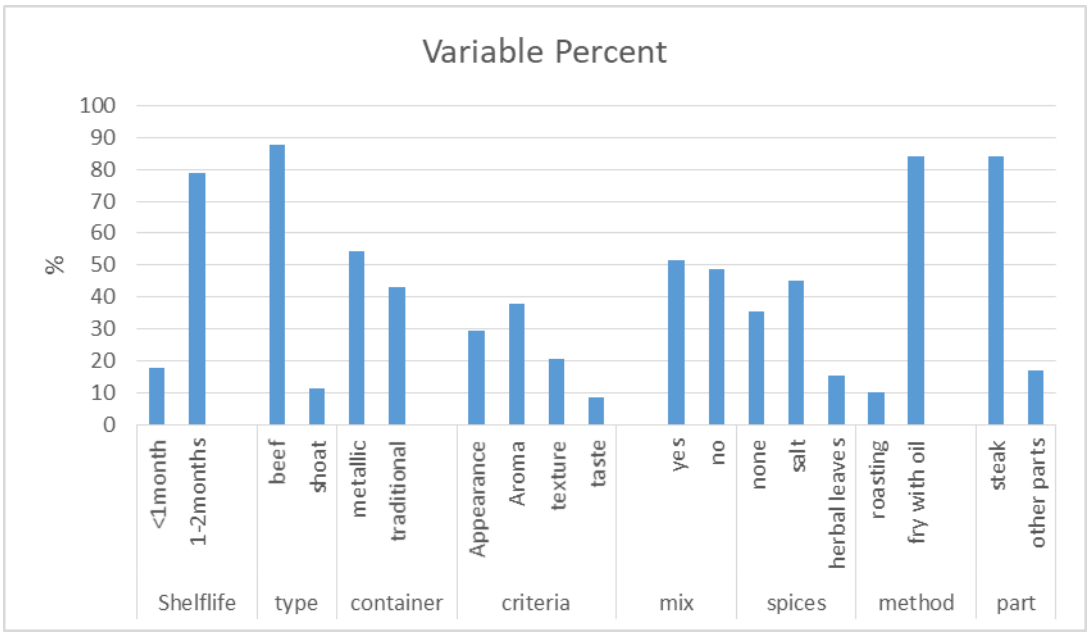

Figure 7. 4: Traditional meat processing attributes

The type of meat used for the traditional meat product was mainly beef from cattle, as shown by the respondents at 89%, while 11% showing preference for goat meat. (Figure 7.4).

Also, 79% of the respondents shared from their experience that artisanal meat products have shelf life of about 1-2 months, while only 17% stated that the shelf life was below 1-month period.

7.3.3 Sensory Evaluation

Social demographic questions were administered to understand the different perspective of respondent as shown in (Table 7.1). Sixty people, participated in the evaluation of the meat products, where participants' gender were 52% females and 48% males. Age profile showed participants between 20 to 40 years were slightly higher than participants of over 40 years of age. The locals who participated were 75% compared to the few visitors who participated in the evaluation.

Table 7. 1: Social demographic characteristics of respondent in sensory evaluation

Parameters	**Goat meat *koche***		**Beef *koche***	
	N=60			
Age	**Frequency**	**Percentages**	**Frequency**	**Percentages**
20-40	35	59	32	53
Above 40	25	41	28	47
Total	60	100	60	100
Gender				
Male	29	48	28	46
Female	31	52	32	54
Total	60	100	60	100
Education				
None	29	48	28	46
Primary	9	15	11	18
College/University	22	37	21	36
Total	60	100	60	100
Ethnicity				
Local	44	74	45	75
Other Kenyans	13	21	11	18
Foreigner	3	5	4	7
Total	60	100	60	100
Occupation				
Pastoralist	26	44	30	50
Casual	5	8	5	9
Formal	16	26	13	21
Business	13	22	12	20
Total	60	100	60	100

Sensory evaluation of traditional meat for taste aroma, appearance tenderness and flavour, are shown in (Table 7.2 there was no significant differences observed for sensory attributes of aroma, appearance tenderness and flavour. However, taste had significant differences in both samples beef and goat *Koche* compared to other parameters scored a mean of 4.5 to 4.6 an indication that the products were liked for all variables tested. Both products were liked moderately and liked very much and thus there was no significance difference between them in terms of preference.

Table 7. 2: Organoleptic result of sensory evaluation

Variables	Beef *koche*	Goat *koche*
Taste	4.57^{b}±0.178	4.62^{b}±0.104
Aroma	4.38^{a}±0.125	4.34^{a}±0.114
Appearance	4.3^{a}±0.137	4.38^{a}±0.175
Tenderness	3.96^{a}±0.171	4.07^{a}±0.178
Flavour	4.27^{a}±0.152	4.28^{a}±0.121

7.3.4 Assessing the utilization of traditional meat

Consumers were asked consumption frequency and if they would purchase depending on availability (Table 7.3). The participants reported that both products were prepared during special occasion only that beef is preferred and frequently prepared more than goat meat at 61%). Seventy-two percent of consumers also responded that they are ready to buy the traditional meat products if it's available for sell (Table 7.4). This indicate the potential that these traditional meat products have to generate income, should it be exploited commercially.

Table 7. 3: Respondent on utilization of traditional meat products

	Goat *koche*			
	Family food		**Special food**	
Variable	Frequency	Percentages	Frequency	Percentages
Frequently	2	4	31	52
Sometimes	4	7	18	30
Rarely	18	30	7	11
Not At All	36	59	4	7
Total	60	100	60	100
	Beef *Koche*			
Variable	**Family food**		**Special food**	
Frequently	7	11	37	61
Sometimes	7	11	11	18
Rarely	12	21	4	7
Not At All	34	57	8	14
Total	60	100	60	100

Table 7. 4: Respondents on willingness to buy traditional meat products

	Willingness to buy			
	Goat *koche*		**Beef *koche***	
Variable	Frequency	Percentage	Frequency	Percentage
As family food	16	28	21	35
As special food	44	72	39	65
Total	60	100	60	100

7.4 Conclusion

Traditional meat products among the Borana people of Marsabit County are a relish and loved food, for occasions and for good reasons, coupled with attachment of prestige particularly for *Koche*. The product was highly regarded and the women have skills to process the products. The sensory evaluation done on perception of these products revealed that the products are preferred a lot as special food, however, due to its restriction to consumption at household level the products availability for commercial purpose was limited. There is need to encourage women who showed interest, possessed skills and knowledge to exploit this potential for income generation and diversify their income

CHAPTER EIGHT

GENERAL CONLUSIONS AND RECOMMENDATIONS

8.1 Conclusion

With regard to the first objective of the study, it has been established that the preparation of traditional meat products among the Borana community is an artful activity, one that required skill and knowledge. The study has documented the tacit knowledge of the Borana women, where the elderly shared their knowledge in a way that this study was able to preserve for the future generation and use. Fourteen traditional meat products were documented, but only four products which were currently in practice were prepared, methods observed and documented. Process flow chart and recipe for the four traditional meat products were developed. Five traditional meat preservation techniques were also documented, where objective and activities entailed in the technique was recorded.

The documentation of the study as described above will help avail further information to the existing literature on traditional meat preparation and preservation techniques, and further boost the knowledge sought by academicians, practitioners, entrepreneurs and guide policy makers.

Livestock and livestock products, as required by the second study objective, was established to have played a very important role in Borana community, going by thematic discussions of the study. Apart from providing food, livestock played vital roles in defining the social cultural ways of living among the Borana.

The importance, was further demonstrated through the attachment to the traditional meat and meat products, or by and large, the cattle, as entrenched in the community's ways of life through the prestigious song of praise - the "*Sangaa*" song - sang by the Borana women.

The study also observed inherent social cultural value of meat, where *jiffu* meat sharing was commonly practiced. The villages where the *sangaa* was slaughtered always had to partake, with each member of the community making rituals and putting claim to special parts.

The traditional meat value is greatly cherished by Borana women, as it gives them added role only played by women in the community. The knowledge held on meat and

meat products gave women an edge on control of meat resources during ceremonies and special events. Women have largely used this technique to express passion and to gain economic mileage.

The traditional meat technique was used as a drought coping mechanism in the past, to overcome food insecurity. The respondents largely recalled this as key involvement of all members of the community. However, this practice is being threatened by the changing lifestyle and reduction of livestock numbers caused by varieties of factors such as urbanization recurring drought and rural urban migration

According to the third objective, the traditional meat products were established to be nutrient rich products. Comparing the four traditional meat products of beef *koche,* goat *koche,* pounded meat and beef barley, goat *koche* was observed to contain high protein, potassium, magnesium, oleic and linoleic levels while beef *koche* was high in iron and α-tocopherol. In terms of processing, pounded meat had the lowest moisture content and the current cooking method involving addition of sugar and barley increases the carbohydrate content making the product more nutritious and balanced

These findings indicate that the traditional meat products have the potential to provide important levels of key nutrients including monounsaturated fatty acids which are beneficial to health. Thus determined, the nutritional values of the four products analysed in this study will help inform potential food processors to explore opportunities for commercialization.

In line with objective four, the study results revealed that microbiological and rancidity indices were within acceptable range throughout the storage. Drying and cooking of meat contributed towards reduction of microbial load. However, poor handling may have caused some post-processing contamination with microbes. Low moisture, low temperature and observation of prior good hygiene practises and continuously observed hygiene standards during processing of traditional meat products were seen to enhance the shelf life and quality of traditional meat products.

Finally, according to objective five, the study established that the traditional meat products among the Borana people of Marsabit County were relished and loved food, for occasions and for good reasons, coupled with attachment of prestige particularly for the *Koche*. The knowledge of the product amongst the community members is common, and product was seen to be readily acceptable organoleptically.

However, it’s readily availability is tied to occasions or events.

The sensory evaluation done on perception of these products revealed that the products are preferred a lot as special food, however, due to its restriction to consumption at household level the products availability for commercial purpose is limited. Therefore, there is need to encourage women who showed interest, possessed skills and knowledge to exploit this potential for income generation and diversify their income.

In conclusion, the knowledge on processing exhibited by the women established that, traditional meat products could be suitable and appealing not only for home consumption but market-oriented income generating activities. The quality of the traditional meat products was established to be good, as all the rancidity indices including the Peroxide Value, Acid Value and Thiobarbituric acid (TBA) were below the values associated with increased risk of rancidity. Also, the nutritional composition of the traditional products were established to be having all the essential micro and macro-nutrients, making the product suitable for general consumption.

8.2 Recommendations

1. The findings from the study strongly indicated that women have knowledge and skills in preparation and processing of traditional meat products and thus their capability can easily be upscaled for commercial production.
3. There was gap observed in improving the hygiene and sanitation of products during the processing especially at the stages of contacts in cutting and cooking processes. Therefore, there is need to enhance safety guidelines for enhanced sanitation.
4. Further efforts to internalize the meat and meat product knowledge, create awareness and promote knowledge utilization and practice is encouraged.
6. Other actors, such donors, practitioners, entrepreneurs, are encouraged to fund developmental ventures in line with the findings of this study to help women groups exploit these knowledge for commercial gain.
7. Further research is recommended to promote these products as a commercialized local cuisine to contribute towards income generating activities of women group.

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APPENDICES

Appendix I: Narrative interview questions

"You are renowned in traditional meat processing can you tell me all activities involved from your experiences since you started doing it"

"Can you tell me all activities of traditional meat products from your personal experiences?

"Can you tell me traditional meat products you are known for and all activities that entail it?

What mistake can one make that lead to spoilage of the of traditional meat products?

Thank you for your time and all the information, do you have anything else to add or ask?

Appendix II: Participant observation guide

Participant observation to get an in-depth understanding of Borana artisanal meat processing and preservation practices

Why they do what they do; the domain of Borana pastoralist women and their skills of Meat preservation

Locations

Marsabit Central – Adha Jabessa Women group

Manyatta Jillo – Mata Arba women group

Jaldessa-Waldagena Women group

Manyatta Ginda - individual

Sololo – Borolle women group

2. Content

Observing and recording practical demonstrations of meat preparation, processing and preservation techniques

- Names of traditional meat -preservation techniques
- Preparation methods
- Artisanal meat products recipes and ingredients
- Criteria they use in all the stage and process, drying, cutting, heating, time etc. Why they do what they do

Observe as they engage in activities and take notes, Take part in the activities, Informal talks and interaction

Materials

Notebook, video recorder, weighing scale, thermometer, utensils- (knives, pots, spoon, plates, bowls), beef, goat meat, oil, salt, spices, sugar, wooden mortar pestle, barley, firewood

Appendix III: Key Informant Interview guide

1. What makes pastoralist slaughter a livestock?
2. Please explain what you do with the carcass after slaughter
3. What traditional meat product are made from the meat, please identify explain in detailed its importance
4. What is the seasonality and frequency of use?
5. How and in what forms and why are these foods harvested, stored and prepared for consumption?
6. Thank you for your time and all the information, do you have anything else to add or ask?

Appendix IV: Focus Group Discussion guide

Please discuss reasons as to why pastoralist slaughter livestock

1. Please explain what you do with the carcass after slaughter – discuss
2. Explain elaborately importance and value of cattle
3. What traditional are the social cultural importance of meat product discuss among your selves
4. What is the seasonality and frequency of use?
5. Please Discuss describe meat social cultural practices and food security? Discuss
6. Thank you for your time and all the information, do you have anything else to add or ask?

Appendix V: Household questionnaire

Information for enumerator

I am conducting a study that looks at Artisanal meat preservation knowledge and quality assessment with a view of value addition and household income generation among the pastoralist.

The information is strictly used for academic purpose, and information obtained will remain confidential.

The interview will take about 45 minutes; kindly allow me to start the interview

Interviewer: ----------

Day/Month/Year of interview: ___ ___ / ___ ___ / ___ ___ ___ ___

Household Information – demographic data

1. Name of the Area: ----------

Describe the feature

1. Urban
2. Rural

2. County ----------

3. Respondent to HH questionnaire: position in the household

Name: ----------

Gender: 1. Male2. Female

Age: ----------

Education: 1. None 2. Primary 3. Secondary 4. Higher level

Income: 1. Pastoralist 2. Casual work3. Formal work

Marital status: 1. Married 2. Single.3. Widow/widower

A. knowledge and products of traditional meat preservation techniques

1. Do you know of any traditional meat products? Please list
2. Describe the extent to which above products are used/consumed in your house
3. Currently do you have the above products in your house? Please give me the names

4. How often do you eat the following meat products (circle one number for each meat products?

Once a month bi- weeklyweekly 2-4times/week daily

Beef1 2 3 4 5

Lamb1 2 3 4 5

Goat1 2 3 4 5

Camel1 2 3 4 5

Chicken 1 2 3 4 5

5. Where do you get the meat from?
    1. Own slaughter
    2. from butchery
    3. Traditional sharing
    4. Part of relief food
    5. Other
6. What types of meat do your family use to make the traditional meat products?
    1. Beef
    2. Shoat
    3. Camel
    4. Other
7. When do you normally eat meat products?
    1. during normal meal
    2. as a snack with tea or coffee
    3. During special events (naming ceremony, wedding, child birth)
    4. When hosting guest/visitors
    5. Other
8. What time of the year do you normally make traditional meat products?
    1. Rainy season
    2. Dry season
    3. other
9. Why do you make traditional meat products?
    1. for normal household meal consumption
    2. for special occasion (ceremonies, childbirth, circumcision and weddings)
    3. Visitors or guest
    4. To store for later use

B. Process and Preparation of artisanal meat products

10. After slaughter what do you do with the following parts?
    - Blood
    - Skin/hides
    - Hooves, horn, head
    - Intestines
    - Organs(liver, kidney, heart, lungs)
11. Which part of carcass do you use to make traditional meat?

12. What type of meat do you use for traditional meat product?
    1. High fat meat
    2. Low fat meat
    3. red fresh meat
    4. Non fresh pale meat
    5. Meat on bone

13. Do you make traditional meat product when the meat is fresh
    1. Yes
    2. No
14. If no, what do you do before you make the meat products?
    1. slice them in to stripes and hang them
    2. salt them
    3. dry heat
    4. other
15. Why do you do the above procedure before you make your meat product?
16. How long do you dry the meat product?
17. Where do you dry your meat?
18. What kind of heat do you use when making meat product
19. What method do you use to make the meat product?
    1. Roasting
    2. Dry fry

3. fry with oil
4. boiling
5. other

20. At what point do you add oil
    1. Beginning
    2. Middle
    3. End
    4. After removing from heat
    5. Other
21. What other techniques do you apply while you are cooking?
22. How long do you cook the meat product?
23. Do you add spices to the meat product?
    1. None
    2. Salt
    3. Herbal leaves
    4. Modern spices – curry powder, masalas
    5. Other
24. Do you mix meat product with other food type?
    1. Yes
    2. No
25. If yes, which food product
26. When do you mix the two products?
27. Which criteria do you use to know that meat product is ready for consumption?
    1. Colour/appearance
    2. Aroma/smell
    3. Moisture content/shrinking
    4. Texture – hard/soft
    5. Taste

28. When consuming traditional meat product how important are the following attributes in your selection process?

Of little importance highly important

12345

A. Taste

B. Smell/aroma

C. Colour/appeal

D. Texture

29. What type of container do you use for storage?

1. Metallic 2. Plastic3. Traditionally made 4. Other

30. How long does the meat product last before it spoils?

31. How do you know that the product you stored is spoilt?

1. Appearance – change of colour, spots or things on surface
2. Smell
3. Taste has change
4. Other

32. What do you do with spoilt product?

1. Continue eating
2. Mix with other product and utilize
3. Give it to other animals – dogs
4. Throw away
5. Other

Appendix VI: Questionnaire for sensory evaluation

My name is Buke G. Dabasso: I am a student in JKUAT undertaking PhD research Titled: Artisanal Meat Preservation Knowledge/Practices and Quality Assessment among Borana People of Northern Kenya

As part of my PhD, I am testing two traditional meat products to gain a better understanding of consumer expectations. You are asked to taste different meat products, and give your opinion on their organoleptic quality.

Score card, questionnaire rating scale

Name ----------

Age: (1) below 18 (2) 20-40(3) above 40

Gender: (1) M(2) F

Education level: (1) None (2) Primary level (3) Secondary level(4) College/ University level

Ethnicity:(1) Local (state)(2) Other Kenyan (state) (3) Foreigner

Occupation: (1) pastoralist (2) casual work(3) formal work (4) Business

Taste (tasty, sweet, salty, and just right)

In front of you is a sample; you can taste and indicate how much you like or dislike each of the characteristic , you can taste more than once

Organoleptic characteristics

	Taste	**Aroma**	**Appearance**	**Tenderness**	**Flavour**
Like a lot (5)					
Like a little (4)					
Nether like nor dislike (3)					
Dislike a little (2)					
Dislike a lot (1)					

Frequency of consumption

	Family meal	Special meal	At restaurant/hotel
Frequently			
sometimes			
rarely			
not at all			

would buy

Note:

Tenderness (tough, just right, juicy/soft)

Flavour (strong, smoky just right, smoky and spicy)

Aroma (pleasant, aromatic, just right)

Appeal (appealing, just right,)

Thank you.

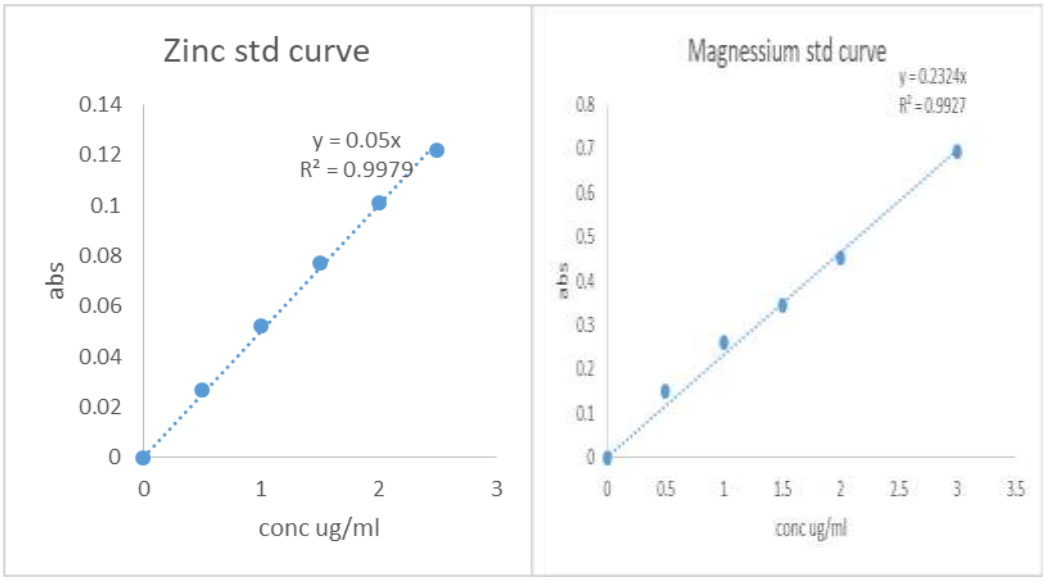
Appendix VII: Coding frame for knowledge

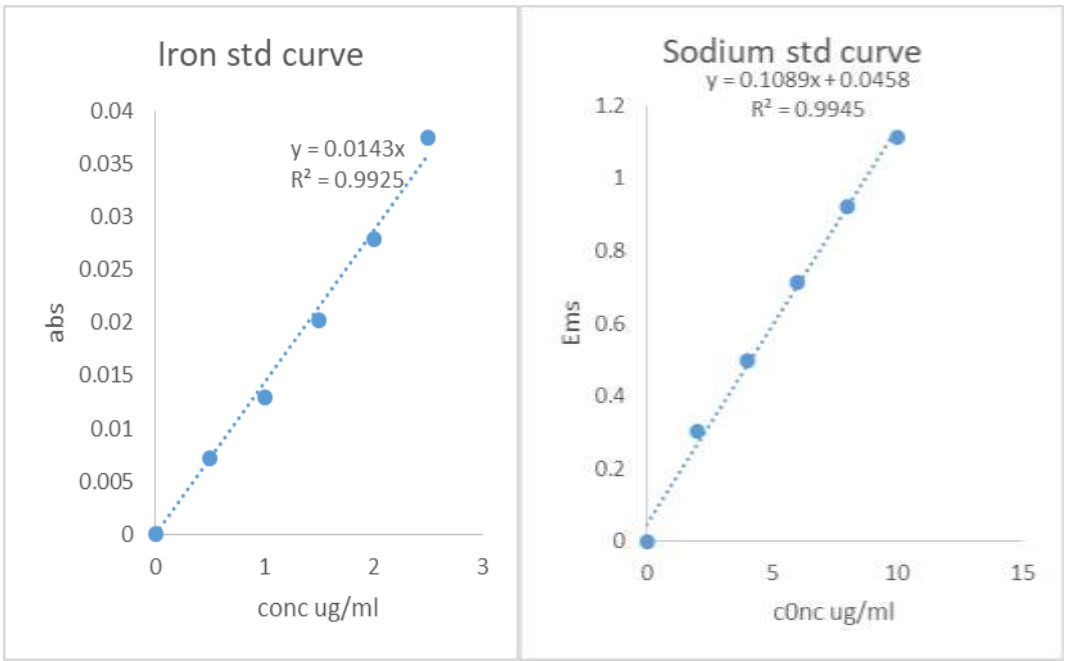
No.	Categories	Code	Activities
01	Knowledge	01_Knowledge_R_General	General knowledge on meat practice and handling
		01_Knowledge_R_tacit	The unspoken knowledge observed
		01_Knowledge_R_action	The unfolding actions while handling meat
02	Processing	02_slaughter_R_	Slaughtering or buying of meat
		02_Separating_R_parts	Separating meat parts for short or long term use
		02_Sorting_R_parts	Sorting fatty and ligaments from meat
		02_Striping_R_meat	Striping meat for drying
		02_Cutting_R_meat	Cutting meat to cubes in readiness for cooking
		02_Deepfrying_R_meat	Meat cooked by deep frying
03	Products	03_Organs_R_parts	Liver, heart, kidney eaten first as appetizer
		03_Offal_R_parts	Intestines and stomach prepared
		03_Meatonbone_R_parts	Meat on bones boiled and eaten for some days
		03_Longterm_R_meat	*Koche, guba, kataweel* for long term preparation
		03_Fatextraction_R_parts	*Chomm, guguble* prepared to extract fat
		03_Hideskin_R_parts	*Radhu* extracted and hide prepared for beddings
04	Preservation	04_Drying_R_meat	Moderate drying of striped meat by suspending
		04_Cutting_R_meat	Reducing meat size to cubes for cooking
		04_Cooking_R_meat	Cooking at high T^0C to remove more water
		04_Smoking_R_containers	Smoking of storage containers
		04_Cooling_R_meat	Cooling meat uncovered
		04_Storing_R_meat	Storing meat in oil in smoked containers

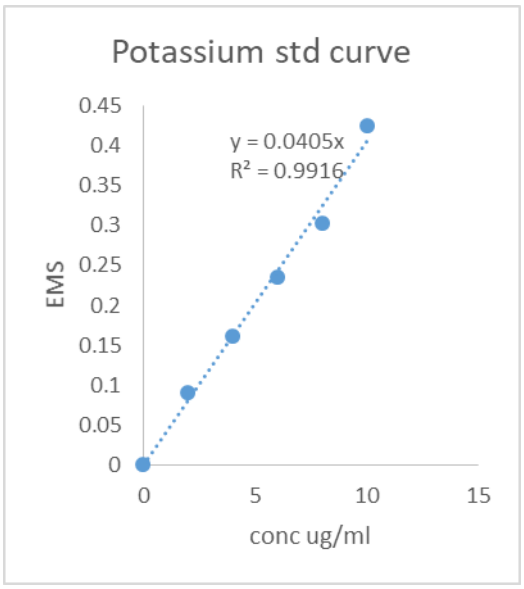
Appendix VIII: Coding frame for social cultural

No.	Categories	Code	Activities
01	Value of cattle	01_significance_R_cattle 01-products_R_parts 01_meat_R_nourishment 01_history_R_Sanga	Importance of *sanga* in Borana Cattle as livelihood and wealth Valuable products from cattle Meat as nutritious and powerful food Meat as food for honor and prestige Intergeneration knowledge on meat
02	Social cultural value	02_events_R_ 02_preparation_R_ 02_rituals_R_parts 02_sharing_R_meat 02_food_R_honor 02_women_R_aspect 02_labour_R_aspect 02_Age_R_aspect	Reason and purpose of slaughtering Announcement and prior preparations Various rituals observed Sharing and who to share with Link between women and traditional meat Importance of meat according to work done
03	Food security	03_changing_R_scenario 03_drought_R_meat 03_foodaid_R_meat 03_emergence_R_butcheries	Changing livelihood Effect of drought The role of NGOS and food urbanization

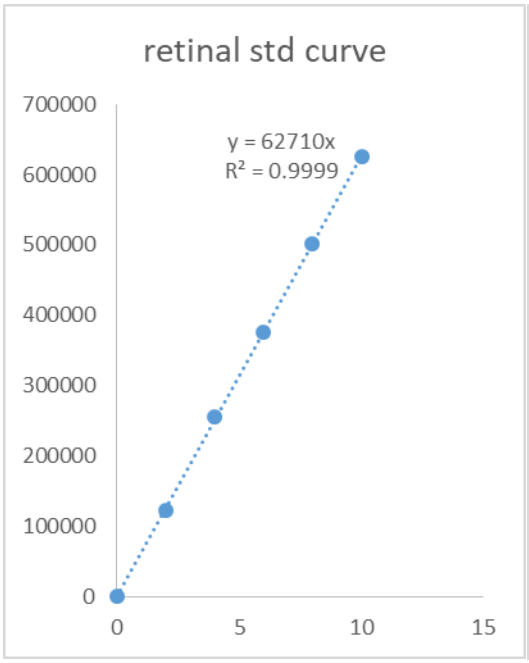
Appendix IX: Standard curve for minerals

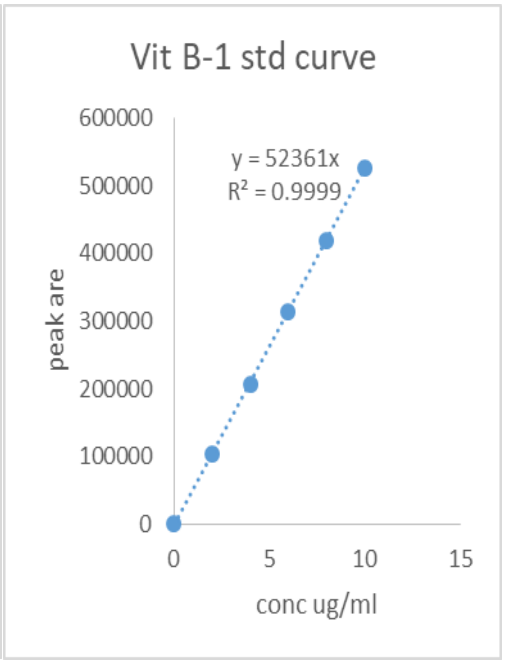


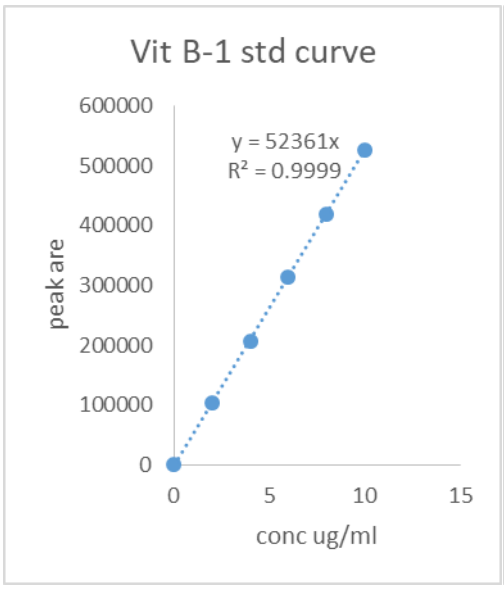


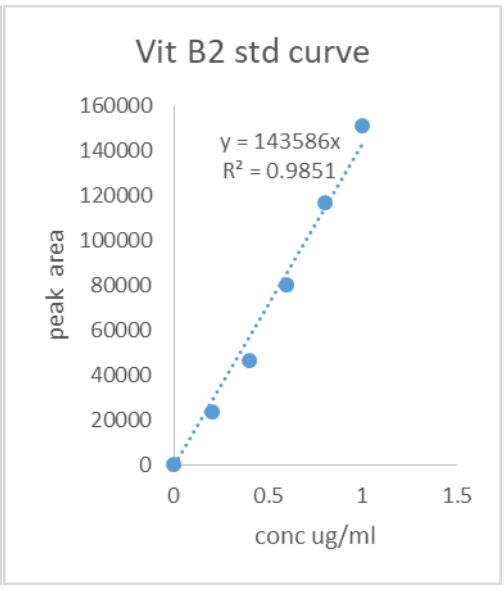


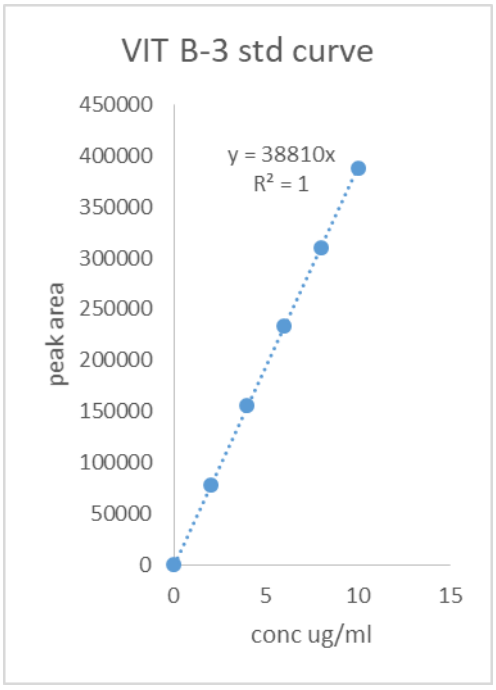
Appendix X: Standard curve for vitamins

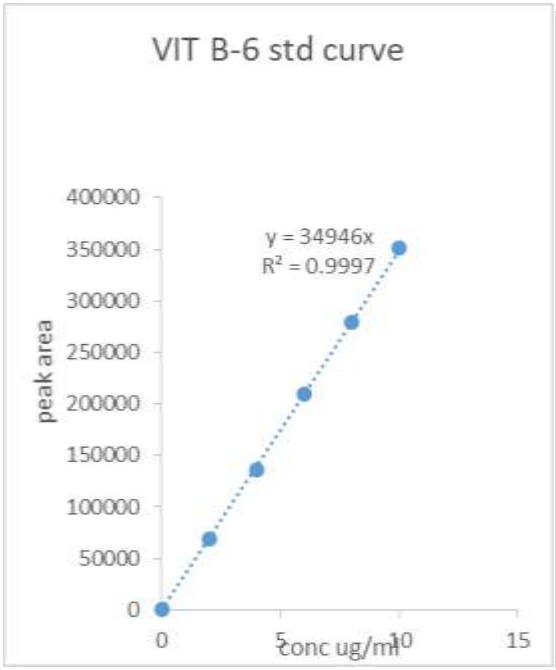


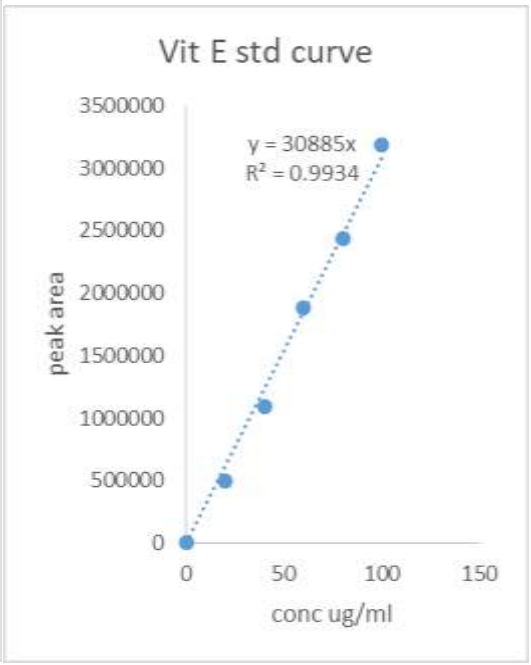



Vit B-1 std curve
y = 52361x
R² = 0.9999
peak are
600000
500000
400000
300000
200000
100000
0
0
5
10
15
conc ug/ml


Vit B2 std curve
y = 143586x
R² = 0.9851
peak area
160000
140000
120000
100000
80000
60000
40000
20000
0
0
0.5
1
1.5
conc ug/ml


VIT B-3 std curve
y = 38810x
R² = 1
peak area
450000
400000
350000
300000
250000
200000
150000
100000
50000
0
0
5
10
15
conc ug/ml


VIT B-6 std curve
y = 34946x
R² = 0.9997
peak area
conc ug/ml
400000
350000
300000
250000
200000
150000
100000
50000
0
0
5
10
15


Vit E std curve
y = 30885x
R² = 0.9934
peak area
conc ug/ml
3500000
3000000
2500000
2000000
1500000
1000000
500000
0
0
50
100
150

Appendix XI: Publications

Publication 1

Dabasso, B., Makokha, A., Onyango, A., Roba, H., & Maina, J. (2018). Process characterization and nutrient profiling of traditional meat products of the Borana communities in northern Kenya. *MOJ Food Processing & Technology*, *6*(2).https://doi.org/10.15406/mojfpt.2018.06.00169

Publication 2

Dabasso, B. G., Roba, H. G., Makokha, A., Onyango, A., & Maina, J. (2018). Understanding Traditional Meat Processing Knowledge among the Borana Pastoralist of Northern Kenya. *Journal of Food Research*, *7*(4), 30. https://doi.org/10.5539/jfr.v7n4p30

Appendix XII: Plates

Plate 1: Drying and pounding of traditional meat products

Plate 2: Cooking of traditional meat products