COMMERCIAL VIABILITY OF AN UPGRADED KOCHE, A TRADITIONAL MEAT PRODUCT PREPARED IN PASTORAL REGIONS OF KENYA

BY

GRACE WERIKHE

Bsc. Food science and Technology (Hons), University of Nairobi)

A56/87986/2016

A THESIS SUBMITTED IN PARTIAL FULFILMENT OF THE REQUIREMENTS FOR THE DEGREE OF MASTER OF SCIENCE IN FOOD SCIENCE AND TECHNOLOGY OF THE UNIVERSITY OF NAIROBI

DEPARTMENT OF FOOD SCIENCE, NUTRITION AND TECHNOLOGY

Faculty of Agriculture

2019

DECLARATION

Student

I, **Grace Werikhe,** declare that this is my original work and has not been presented for a degree award in any other University.

Signature…………………………….. Date:……………………………………..

This thesis has been submitted for examination with our approval as university supervisors.

Signature……………………………. Date:……………………………………..
Dr. Catherine.N. Kunyanga
Department of Food Science, Nutrition and Technology

Signature…………………………… Date:……………………………………..
Prof. Michael .W. Okoth
Department of Food Science, Nutrition and Technology

Signature……………………………. Date:……………………………………..
Dr. Hassan.G. Roba
Research Scientist, National Museums of Kenya.

UNIVERSITY OF NAIROBI

COLLEGE OF AGRICULTURE AND VETERINARY SCIENCES (CAVS)

PLAGIARISM DECLARATION FORM FOR STUDENTS

Name of Student**: GRACE WERIKHE**

Registration Number: **A56/87986/2016**

College: **COLLEGE OF AGRICULTURE AND VETERINARY SCIENCES**

Faculty/School/Institute: **AGRICULTURE**

Department**: FOOD SCIENCE, NUTRITION & TECHNOLOGY**

Course Name: **MASTERS OF SCIENCE IN FOOD SCIENCE & TECHNOLOGY**

Title of the work : **COMMERCIAL VIABILITY OF AN UPGRADED KOCHE, A TRADITIONAL MEAT PRODUCT PREPARED IN PASTORAL REGIONS OF KENYA**

DECLARATION

1. I understand what Plagiarism is and I am aware of the University's policy in this regard

2. I declare that this **thesis** is my original work and has not been submitted elsewhere for examination, award of a degree or publication. Where other people's work or my own work has been used, this has properly been acknowledged and referenced in accordance with the University of Nairobi's requirements.

3. I have not sought or used the services of any professional agencies to produce this work

4. I have not allowed, and shall not allow anyone to copy my work with the intention of passing it off as his/her own work

5. I understand that any false claim in respect of this work shall result in disciplinary action, in accordance with University Plagiarism Policy.

Signature _____Date: _____

ACKNOWLEDGEMENT

TO GOD BE THE GLORY

DEDICATION

I dedicate this work to my loving mum, my eternal cheerleader and life coach. She worked

tirelessly to set me off in starting my academic journey and has remained my inspiration

enabling me to sustain my academic achievements to date. I owe it all to you '*Mama*'.

LIST OF ACRONYMS

FAO- Food agriculture organization

KMC- Kenya meat commission

GDP- Gross domestic product

KNBS- Kenya bureau of statistics

FGD- Focus group discussion

KII- Key informant interview

MM- Marketing margin

CPP- Consumer paid price

PRP- Producer's paid price

FAQ- Fair average quality

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF APPENDICES

GENERAL ABSTRACT

Commercialization of indigenous meat products is one of the major strategies for promoting and preserving indigenous knowledge. Commercialization of indigenous meat products can contribute to increased incomes and non-income benefits for processors and marketers. However indigenous meat products lack a competitive advantage along the formal meat value chains due to challenges in regards to processing, handling and storage. *Koche* is an indigenous ready to eat meat snack prepared from beef, camel or goat meat by the Borana community in Northern Kenya. The potential commercialization of *Koche* is largely dependent on the processing and market development. It was against this background that the project was conceptualized. The main objective was to determine the commercial viability of *Koche* with a view of mainstreaming the product into the formal meat chains. To accomplish this, the study was designed to assess the current status of processing and process analysis of *Koche* . This study also sought to evaluate the market potential of *Koche*. Focus group discussions and key informant interviews were used to collect data from 10 processors. Structured questionnaire interviews were also used to collect data from 196 consumers and 30 traders. The findings show that the processing of *Koche* relies largely on traditional techniques often with low competitiveness. Lack of equipment to ease processing of *Koche* (100%), lack of credit facilities (100%), insufficient capital (90%) and high cost of inputs (90%) were some of the main challenges facing *Koche* processors. Analysis of *Koche* returns to labour and variable cost were Kshs 12.1 and Kshs 0.92 respectively. The market outlets for *Koche* include sale in stalls (20%), street vending (73.3%) and Hotels (6.7%). Strict regulations by city council (30%), poor product quality (60%), and poor packaging material (46.7%) affected the marketability of *Koche*. According to the traders, the average number of consumers buying *Koche* was 5 to 10 per day.

The pastoral communities (89.3%) were the main consumers. At the same time other communities were reported to consume *Koche*. *Koche* was mainly bought since it was a cultural food and also due its health benefits. Significant predictors *(p< 0.05)* in the quantity of *Koche* purchased included income, ethnicity and household size. The process analysis of *Koche* was used to upgrade the indigenous meat product to a commercial level. The physicochemical and microbial qualities of *Koche* were within the acceptable limit up to day 5 of accelerated storage at 55°C. *Koche* packed in glass jars exhibited better keeping quality. The study concludes that promoting commercial *Koche* processing and marketing is one of the most important approaches for increasing the market share of *Koche* . This can support sustainable development of *Koche* through increased incomes for processors and marketers thus improved livelihoods. It can also ensure the enhancement and conservation of indigenous knowledge. However, to augment these objectives the challenges facing processors and traders should be seriously addressed.

CHAPTER ONE: GENERAL INTRODUCTION

1.1 Background information

Food and Nutrition Security is global concern. It is a challenge to the human welfare and economic growth. Food losses have an impact on food and nutrition security. Globally, around one third of the food is lost. In Sub-Saharan Africa, the estimate is 37 percent or 120-170kg/ year per capita (FAO, 2011). Food losses may occur during production, processing stages and post – harvest. Losses are a result of inappropriate post-harvest handling, processing and preservation (Parfitt *et al*., 2010).

The valuable contributions of indigenous knowledge to food security cannot be ignored. In Africa, people have utilized indigenous knowledge to ensure food security (Oniango *et al.,* 2006). Indigenous knowledge is accumulated knowledge of the local people through interaction with the local environment (Mapara, 2009). This knowledge often relies on intuition and is passed down from one generation to the next (Awour, 2011). In a community, women are particularly one group who hold enormous indigenous knowledge and play a significant role to ensure food security (Brown, 2011).

In sub-Saharan Africa, there are about 20 million pastoralists. About 6 million of them are in Kenya's ASALS. The pastoralists include the Somali, Maasai, Borana, Turkana, Rendille, Samburu and Pokot (KNBS, 2009). Their economic activities and main diets depend entirely on livestock and livestock products (Wellard-dyer, 2012; Kirkbride and Grahn, 2008). The pastoral communities overtime have relied on indigenous knowledge of food processing with a view of preventing meat loss and ensuring its stability. Sun-drying ,deep frying ,salting and use of spices

are some of the techniques that have been practised. The oldest technique used is sun-drying (FAO, 1995).This has led to development of different meat products (Gichure *et al.,* 2014).

Previous studies on indigenous meat products produced by the pastoral communities indicated that majority are made for home consumption with little in the way of commercialization (Gichure *et al*., 2017). Women who are the main processors lack enough resources and knowledge on good manufacturing practices. In addition, chances of product contamination are high since the meat is suspended on ropes to dry under the sun. Other challenges include presence of too much oil in the products, improper packaging system and quality variation. As a result, the products lack a competitive advantage thus not able to access the formal markets (Gichure *et al*., 2017).

1.2 Problem statement

Koche product is an appropriate functional food when viewed in terms of nutritional content. *Koche* product can provide the much needed source of protein and other nutrients. Being a dehydrated food product it makes handling and marketing convenient for consumers and retailers (Dabaso *et al*., 2018). Despite this potential, most of the households in the ASALs do not view *Koche* processing as a commercial undertaking and as such practice it for home consumption (Dabaso *et al*., 2018) .Therefore, they do not harness the commercial benefits associated with it. In addition, studies have documented a number of challenges hindering commercialization of *koche* product including poor quality and hygiene, lack of standardization, lack of knowledge in good packaging material, lack of branding and trademark, inadequate resources by processors and lack of competitiveness in the formal market. Hence the product only dominates the informal markets (Gichure *et al*., 2014).

1.3 Justification

Meat is important in the human diet. It contributes valuable nutrients required for growth and maintenance for health (Apata *et al*., 2013). Consumption of meat and meat products is higher especially in developing countries (Anjaneyulu *et al*., 2007). Hence this study seeks to determine the commercial viability of *koche* product to enable product mainstream into the formal market for increased incomes by processors thus improved livelihoods. Commercialization of *koche* product and adequate marketing can cater the pallete of this population and address the huge demand. It will help in converting the local industry into global industry thus generate employment opportunities and self-sustainability. It will also enhance entrepreneurship development and ensure quality ethnic products to the consumers. Commercialization of *koche* product may also serve as an incentive to the younger generation and help in preservation of indigenous knowledge. Finally, the study findings may be used to formulate policies by relevant policy makers.

1.4 Study aim

The aim of the study is to contribute to the reduction of postharvest losses in the meat value chain and to wealth creation through commercialization of *koche* by value addition.

1.5 Study objectives

1.5.1 Main objective

The main objective is to evaluate the commercial viability of *koche*, a traditional pastoral meat product prepared in Kenya.

1.5.2 Specific objectives

1. To assess current status of processing and analysis of *koche* product to understand challenges and opportunities for commercialization.

2. To evaluate market potential of *koche* product for commercialization in Kenya.

3. To optimize the production of *koche* under ideal processing conditions for its commercialization.

CHAPTER 2: LITERATURE REVIEW

2.1 Meat value chain

A value chain is a set of activities through which products pass in sequence and at each activity value is added (Russel *et al*., 2012). Meat value chains comprise of many actors that are interdependent. The actors include forage producers, pastoral producers, livestock traders, ranch owners, slaughterhouses, butcheries, meat packers and processors. Meat value chains have the greatest potential for poverty reduction. The potential does not only stem up from generation of income from the meat sales but from the number of actors who earn income at the different stages in the meat chain. The value chains are primarily geared towards the domestic market which consumes approximately 99 per cent (Farmer and mbwika, 2012).

2.1.1 Meat production

In Kenya, Meat production is an important subsector. Meat production including sheep, cattle, pigs, goats, camels and poultry contribute significantly to food security, income, and the national economy (Irungu *et al*., 2008)**.** Meat production is diverse with divisions such as, pastoral, ranches and highland system. In each of the agro-ecological zones, the breeds and production methods are different. Kenya vision 2030 specifically aims at transforming the sector through planning and implementation of processing facilities and 4-5 disease free zones thereby increasing the productivity of the livestock. Pastoral production system uses local breeds. It is mainly practiced in the arid and semi-arid lands (ASALs). In Kenya, more than 80% of the land is classified as arid or semi-arid with the main population being the pastoralists' .The pastoralists include the Maasai, Rendille, Kalenjin, Samburu, Gabra, Orma and Boran. Livestock is a primary source of livelihoods for 6 million pastoralists living in the arid and semi-arid lands**.**

Statistics show that the largest share of the ruminant in the country is from the arid and semi-arid informal sector. Ownership of livestock depends on the pastoral groups with the Kalenjin,Maasai and Samburu owning mostly cattle and Turkana and Rendille mostly camels. However, pastoralists especially from the northern zone are exposed to droughts causing them to lose about 50% of their livestock.   Thus most of the livestock sales often occur during the dry seasons. Cattle ranching are mainly practiced in the Laikipia plateau. Most of the ranches are owned by settlers but now they are in the hands of the local elite. Some of the ranches such as *olpejata, loisaka*, *sosian*, *el karama* are owned by the government. The ranches play both role of a producer and fattener. The cattle produced are usually of high quality and safety. The highland production system is mainly based on british beef and dairy breed. The highland cattle are estimated at 5,311,800 with an estimated off-take rate of 7.9% (Farmer and Mbwika, 2012).

Table 2. 1: Kenya statistics for livestock numbers in millions of animals.

Year	2000	2005	2010	2012
Cattle and buffaloes	11.44	13.02	17.86	19.13
Sheep and goats	17.74	23.92	45.74	47.58
Poultry birds	26.29	26.86	30.40	32.87
Pigs	0.31	0.32	0.35	0.35

Source FAO, Statistics

2.1.2 Traders

Traders are either primary or secondary. Primary traders purchase animals in small scale from the producers and re-sale to large traders, exporters, butchery owners, while secondary traders buy larger numbers of livestock from producers as well as primary traders and sell in terminal markets. Trucks are used in transportation of the animals. The market concentration of secondary traders is higher compared to primary traders. Most of the secondary traders form partnerships to

share costs. However most of the traders buying in primary markets face a number of constraints such as high capital requirements, limited business skills, illiteracy and weak legal back up (Farmer and Mbwika, 2012).

2.1.3 Slaughterhouses/ abattoirs

Slaughtering of livestock is conducted in slaughter houses, abattoir and slaughter slabs. Slaughterhouses slaughter animals at a fee, while abattoirs slaughter their own animals as well as providing slaughter services for a fee. In addition, they also process the meat. Most of the abattoirs are located in major towns and cities such as Nairobi, Mombasa. Slaughter slabs are linked to rural areas and small towns. Kenya has both export and domestic abattoirs and slaughterhouses. The distinguishing feature between the two is the licensing procedure and type of license offered as indicated in the meat control act cap 356. Both the slaughterhouses and abattoirs operate under slaughterhouse regulations under the meat control act cap 356. Apart from Kenya Meat Commission, all slaughterhouses and abattoirs are privately owned (Farmer and Mbwika, 2012).

.

Table 2. 2: Licensed local abattoirs

Abattoir	Location	Type of animals slaughtered annually
KMC Athi River	Athi river	Sheep,goats
KMC Mombasa	Mombasa	Cattle
Hurligham	Nairobi	Cattle
New Mombasa mnangoni	Mombasa	Cattle
Farmers choice	Nairobi	Pigs
Choice meats	Nairobi	Sheep,cattle,goats

(Farmer and Mbwika,2012)

2.1.4 Processors

Many of the abattoirs such as Kenya Meat commission (KMC), Farmers choice and choice meats are also processors. KMC was established by an act of parliament, CAP 363 laws of Kenya in 1950. Its mandate is to provide a ready market for livestock farmers and process meat and meat products for local and export markets (Kenya Meat Commission Audit Report, 2008). Some of the products processed include corned beef, corned ox-tongue and bone meal. They also grade the meat into grades such as commercial, prime, standard, choice and fair average quality (FAQ). The commercial grade is the lowest and used for canning and manufacture of sausages. Farmer's choice is private meat processor specializing in pork and pork products such as sausages, burgers, bacon and ham. Choice meat is a subsidiary of Farmer choice specializing in processing of cattle, goat and sheep of high quality (Farmer and Mbwika, 2012).

2.1.5 Markets

Retailing of meat and meat products is done in local markets, butcher shops, supermarkets and cooked meat outlets (Farmer and Mbwika, 2012). Local markets represent the largest share of meat market. Meat on bone, green and white offal is mainly displayed without refrigeration (Gichure *et al*., 2014). Middle market is mainly patronized by medium income group. It mainly offers steak and meat on bone. Refrigeration and chilling is occasionally done to extend the shelflife (Gichure *et al*., 2014). High end markets are characterized by high quality meat grades such as choice and Fair average quality (FAQ). The meat is supplied fresh and displayed under refrigeration facilities. High end markets charge a premium for their meat since their source of supply is mainly the ranches and their buyers include the high income consumers (Gichure *et al*., 2014).

2.1.6 Consumers

In Kenya, 44.6 million people have a strong culture of meat consumption (Kenya Market trust, 2014). More than 80% of the meat consumed is from cattle, chicken, goat, sheep and camel. However beef represents the most consumed meat. For red and white meat, consumption is estimated at 10.8kg and 1.1kg (MAL and F, 2015). An average of 16kg to 19kg per capita/year is consumed in urban low and low income areas respectively (USAID, 2012). Nairobi and Mombasa largely consume estimated total volumes of 17% (Kenya Market trust, 2014). Consumers buy different cuts such as meat on bone, boneless, minced, offals, liver and head.

2.2 Losses reduction through meat value addition

The issue of food loss is of great concern. Food loss refers to reduction of the edible mass of food throughout the supply chain (Parfit *et al.,* 2010). Food loss results in food insecurity. It is a waste of resources such as water, and also loss in economic value of food .In developing and industrialized countries more than 40% of food losses occur at post-harvest and consumer levels respectively. In general, post-harvest losses in meat account for 29.7% (FAO, 2011). In the arid and semi-arid lands of Kenya, post slaughter losses occur due to lack of technical facilities, technical skills for processing, packaging and storage ,capacity for new product development and diversification as well as information on postharvest losses (Pavahello, 2010; Gichure *et al*., 2014). Strategies such as use of sanitary procedures and value addition can be used to reduce the meat losses (Mathi *et al*., 2016)

2.3 Indigenous meat products

Meat is highly perishable at ambient temperature thus the importance of its preservation (Apata *et al*., 2013). Traditionally, preservation of meat has been practiced using techniques such as sun

drying, deep frying, smoking, spicing and under oil preservation (FAO, 2007). As a result different dried, salted, smoked and fried meat products have been developed and are widely found in Africa (FNISF, T2008). Some of the indigenous meat products include the following;

2.3.1 Biltong

Biltong is a traditional meat product prepared from beef, ostrich or game meat in South Africa. The popular muscles used are thick flank (rectus abdominus), eye of round (semitendinosus), top side (semimembranosus), fillet (psoas) and silverside (biceps femoris) (CSIR, 2001; Van Wyk, 2007; Strydom and Zondagh, 2014). The meat is cut into long strips. Salt, spices and vinegar is then added. The meat strips are hung on hooks and air dried for one or two weeks. After drying, the biltong is packed and stored (Jones *et al*., 2017).

2.3.2 *Kilishi*

Kilishi is an indigenous meat product prepared from beef or goat in Nigeria. Meat is cut into slices and dried for six hours. Semi-dried meat slices are soaked in marinades that contain water, garlic, onions and spices. After immersion, the wet meat products are heat treated by roasting for 5 mins (FAO, 1990).

2.3.3 *Suya*

Suya is roasted indigenous meat product of Nigeria prepared from mutton, beef or goat meat. The meat is seasoned with powdered groundnut cake, spices, vegetable oil, salt, flavours and then roasted around a glowing smokeless fire. (Omojola, 2008).

2.3.4 *Koche*

Koche is a traditional deep fried meat product made from particular/specific muscles of sirloin or silverside steak of beef, camel or goat carcass by women among the Borana community in Kenya. It resembles *nyirinyiri* in appearance. First step in preparation involves removal of fat from the meat. Lean meat is stripped. The meat strips are mixed with salt and suspended on ropes to dry. According to the processors, the inclusion of fatty meat does not make the best *koche.* After drying, the meat strips are comminuted into small cubes and deep fried in oil. Cardamom spice is added during frying to impart flavor. It is then cooled and stored in the oil used for frying (Dabasso *et al*., 2018).

2.3.5 *Enyas*

Enyas is a deep fried fibrous meat product prepared from beef or goat meat by the Turkana community in Kenya. During preparation, fresh beef or goat meat steak is sliced into several strands, mixed with salt and sun-dried on wooden sticks. After drying, the strands are cut in to cubes. The meat cubes are deep fried in ghee for 90 mins. After frying, it is cooled and stored (Gichure *et al* ., 2014).

2.3.6 *Olpurda*

Olpurda is an indigenous meat product prepared from beef or goat meat by the Maasai community in Kenya. Fresh beef or goat meat steak is cut into small cubes ranging from 4mm* to 10mm in size. The meat cubes are then boiled in water for 120 minutes. After boiling, the water is drained off and the cubes deep fried in kneaded animal fat (Gichure *et al*., 2014).

2.3.7 *Fonn tumma*.

Fonn tumma is a traditional pounded meat product of Kenya. It is prepared from beef or goat meat by women among the Borana community. Fresh beef or goat meat is cut into strips, mixed with salt and suspended on ropes to dry under the sun. After drying, the meat strips are roasted and pounded with addition of barley then deep fried in oil. The product is cooled and stored (Dabasso *et al*., 2018).

2.3.8 *Guba*

Guba is a deep fried and fatty meat product prepared from beef or goat by the Borana community in Kenya. It is similar to *koche* in preparation. However, fatty meat is not trimmed off. Meat from the hind legs is cut into strips. Amount of salt is added on the strips. The meat strips are then suspended to dry on ropes. The dried meat strips are cut into small pieces and deep fried in oil. Spices such as cardamom are added during frying and the product finally stored in fat *(*Dabasso *et al*., 2018).

2.3.9 *Kataweel*

Kataweel is a shallow fried meat product prepared from beef or goat meat by the Borana community in Kenya. Meat from the hind legs is cut into strips. Fatty meat is removed. Amount of salt is added on the strips. The meat strips are suspended on ropes to dry. After drying, they are cut into small cubes and shallow fried. Cardamom spice is added to impart flavor. After frying, the product is cooled and stored in fat (Dabasso *et al.*, 2018).

2.3.10 *Fonnqadabbe*

Fonnqadabe is a traditional dried meat product prepared from beef or goat meat steak by the Borana community in Kenya. The meat is cut into strips and mixed with salt. The meat strips are then roasted over charcoal fire. After roasting, the product is cooled and stored in fat (Dabasso *et al*., 2018).

2.4 Indigenous meat product packaging

Packaging of the meat products is done in different wooden, metallic and plastic containers. Wooden containers are covered with a leather base made from hides and skin. Fumigation with smoke is done prior to use. Due to scarcity and high cost, metallic and plastic containers are common. However, design of the packaging is inappropriate especially when removing meat products for consumption and may result to product cross contamination (Gichure *et al*., 2014).

Figure 2. 1: Wooden containers

Figure 2. 2: Metallic container

2.5 Informal markets

Rapid urbanization has led to the rise of the informal sector. Informal markets are common in developing countries. They consist of small producers, traders and service providers involved in legal as well as illegal activities (FAO, 2007). The informal market is a survival strategy used by the urban poor in a bid to survive in difficult economic circumstances (FAO, 2007). Informal markets are large making a significant contribution of about 39% to the GDP. Limited work opportunities in the formal sector have resulted in the expansion of the informal markets (Gadaga *et al*., 2014). They are characterized by many actors, easy entry and traditional products are predominantly sold (Makita *et al*., 2010).

2.5.1 Street Food vending

Street food vending is significant part of the informal sector. It includes selling from fixed kiosks, carts, mobile stands and cloth put on the streets (Walsh *et al*., 2010). It is an easy entry business due to the small capital outlay required and most of the vendors are female (Iyenda, 2001; Acho-chi, 2002; Muyanja *et al*., 2011) .Street food vending contributes significantly to the economy (Iyenda, 2001; Acho-chi, 2002). In Kenya, about 70% of the population in urban areas depends on street foods (World Bank Report, 2005). Street food vendors are often found in commercial areas of the city such as outside bus terminal and shopping centers where there are ready and numerous customers (Roever, 2007). This exposes them to contamination thus are normally associated with food containing hazards (Makita and Kangethe, 2010).

2.6 Formal markets.

In developing countries, market formalization has become a reality. However, small holder integration into formal market requires investments and pro-active policies (World Bank, 2005).

Interventions such as effective policies, creation of suitable environment can help reduce market barriers to market participation.

2.6.1 Supermarkets.

Supermarket industry is the most developed growing at a rate of 18% per annum (Neven and Reardon, 2004). The emergence of supermarkets and hypermarkets culture has greatly increased (Wells *et al*., 2007). They reflect a change in the way food products are supplied to consumers (Omiti *et al*., 2005). Supermarkets have an attractive shopping atmosphere; products are well packaged, premises are very clean and consumers willingly pay a premium for these attributes (FAO, 2013). However, high income consumers are the major buyers. A study by Gichure and others (2014) discovered a great variety of meat products in supermarkets. Meat products arrangement on the fridge shelf depends on the preservation and processing technique employed during production.

2.7 Conceptual framework of commercialization of food products.

Based on literature review commercialization is a complex process. However, they are certain pathways when adopted success is guaranteed (Ismael *et al*.,2015). According to Amran and Aslan, (2012) success will depend on the type of products commercialized. Commercialization pathway should be identified at the onset of research and development. Creation of value through commercialization will depend before product development (Hamzah *et al*., 2011). Idea creation is the first stage. Idea generated should have a strong demand in the market. Market analysis will generate information regarding existing problems and demand of the product, target market segments and potential areas for growth of market and consumers. Lack of understanding of local markets may compromise the effectiveness of commercialization. During product

development, technical skills, use of appropriate facilities and relevant technology is important to ensure products of good quality are developed and subsequently commercialized. Product should be able to compete well with existing products in the market. Product packaging and promotion is also an important element to be considered before commercialization. Suitable packaging will prevent contamination of the product whereas promotions will create awareness to the target consumers in the market thus ensuring successful commercialization (Ismael *et al*., 2015).

2.8 Cost benefit analysis of a food product

Cost benefit analysis is a systematic approach to estimate the strengths and weaknesses of project investments. (Rodreck *et al.,* 2013). It is done to determine whether an investment is worth by verifying its benefits against the costs involved. It also provides a basis for comparison of projects. It is related to cost effective analysis. However, in cost benefit analysis, benefits and costs are expressed in monetary value and adjusted for the time value money so that all flows of benefits and project costs overtime are expressed in terms of their net present value (Weimer *et al*., 2005).

2.9 Challenges in commercialization of indigenous meat products

Indigenous meat products are a significant element and heritage of a country. In recent years, consumers' interest in traditional meat products has increased (Kardivel *et al*., 2017). However, commercialization of indigenous meat products is constrained by a number of factors such as;

2.9.1 Poor quality and hygiene

Quality and hygiene is an important primary factor for commercialization (Kardivel *et al*., 2017).However, Traditional meat handlers are ignorant about maintenance of quality and hygiene requirements in the preparation of indigenous meat products. Several authors (Kisembe

et al., 2015; Gichure *et al*., 2014) have identified poor hygiene in processing of traditional meat products.

2.9.2 Lack of standardization

Standardization of indigenous meat products is a step forward towards commercialization. Standardized procedure can help the indigenous meat products to access markets (Kardivel *et al*., 2017). However, indigenous meat products lack standardization in product quality thus not properly mainstreamed into the formal markets (Gichure *et al.*, 2017).

2.9.3 Lack of knowledge in good packaging material

Packaging is an essential component of a food system. Packaging helps to ensure quality and safety of the food product. Packaging is also an important marketing strategy. It is used as a competitive tool to bring about competitive advantage during marketing of a food product. (Kardivel *et al*.,2017). However, packaging of indigenous meat products is not attractive and it exposes the product to vagaries of the weather.

2.9.4 Lack of branding and trademark

Branding is a strategy for market segmentation and product differentiation (Kapferer, 2004). A brand is a bundle of intangible and tangible features which makes the product attractive beyond its functional value. Branding instills confidence in the consumer. Therefore, it is imperative that indigenous meat products are branded so as to make them more competitive. And also help in the development of the product image in the minds of the consumer thus deeper penetration into the market (Kardivel *et al*., 2018).

2.9.5 Inadequate resources by processors to expand production

Processing and preservation of indigenous meat products is mainly done by women. Women involved in processing have low income thus not able to participate in the formal meat market chain. Only 5% of their products are marketed in the informal markets with the rest consumed at home.

2.9.6 Lack of competitiveness in the formal market

Competitiveness can be approached from two perspectives, consumer and organizational perspective. From the consumer perspective, quality is important in assessing competitiveness while organizational perspective depends on the ability to maintain market share. Processing and preservation and low engagement of indigenous meat products into the formal market limit their competitiveness in the formal markets. Processing and preservation of indigenous meat products is done using rudimentary technologies. Thus the meat products are not mainstreamed into the formal market (Gichure *et al.,* 2017).

CHAPTER THREE: STATUS AND PROCESS ANALYSIS OF *KOCHE*, A TRADITIONAL PASTORAL MEAT PRODUCT IN KENYA.

3.1 Abstract

Meat is an important dietary component of the pastoral communities living in marginalized regions of Kenya. Indigenous meat processing and in particular *koche* processing plays a significant role in economic and social life of the borana community. It contributes to animal source protein as well as income generation as a livelihood activity by the borana community. However, traditional processors face a number of challenges hindering further conventional development. The study was designed to assess the status and process analysis of *koche,* costs and returns of *koche* production and constraints limiting *koche* processors. A cross-sectional survey was therefore carried out in Isiolo and Marsabit towns to assess and analyse processing of *koche* product. Purposive sampling of all *koche* processors was used to identify study cohorts. Qualitative data were collected using key informant interviews and focus group discussions. Results revealed that all processors were women who largely relied on traditional techniques often with low competitiveness and poor efficiency. The major constraints facing processors were lack of equipment to ease processing (100%), lack of credit facilities (100%), insufficient capital (90%) and high costs of inputs (90%). The return to labour and variable costs was Kshs 12.1 and Kshs 0.92 respectively while the marketing margin was estimated as 20.8%. Based on the findings of the gross margin and analysis of returns, processing of *koche* product is a profitable business thus a good investment opportunity. However, there is need to overcome the challenges to enable the expansion of *koche* processing for better commercialization. Besides, addressing the challenges will help reduce post-production losses and remove market barriers of

koche product. This will expand the market access of *koche* product and thereby increase incomes of pastoral communities.

Key words: indigenous meat products, commercial viability, processing, profitability

3.2 Introduction

Pastoralism is an economic activity that is based on animal production. It is largely practiced in the arid and semi-arid lands (ASALs) and has shaped livelihoods for millennia. Livestock, labour, access to grazing areas and water resources are key requirements for pastoralist production (Homewood *et al.*, 2012). In Kenya, pastoralism is a way of life for about 6 million people living in the ASALs. The pastoral communities include the Somali, Maasai, Borana, Rendille, Gabra and Turkana with an estimated livestock worth of US$ 800 million per year (Lindqvist and Verba, 2009). Pastoral systems contribute significantly to the economy. About 70% of beef cattle in Kenya are from the ASALs under pastoral production systems (EPZA, 2005).

Overtime, pastoralists have relied on indigenous knowledge to add value to beef and beef products. Local preservation techniques such as drying, salting, use of spices, deep frying were employed for the sole purpose of increasing shelf life, prevent spoilage and enhance flavor and taste (Rai *et al.*, 2009; Bora and Bam, 2014 ; Gichure *et al.*, 2014). As a result, a variety of indigenous meat products have been developed including *enyas*, *olpurda*, *nyirinyiri and koche.* The indigenous meat products are region specific and have unique substrates and preparations.

Preparations depend on culture, climate, process and availability of materials (Gichure *et al*., 2014).

Koche, is a dried traditional meat product which undergoes various stages of processing. *It* is made from beef, camel or goat muscle particular from the sirloin or the silverside steak. It is a dehydrated food product as moisture is reduced in different ways during processing. As a way of preservation, women among the borana community cut meat into thin strips to dry under the sun for two or three days. Additionally, they deep fry the meat to evaporate more moisture (Dabasso *et al*., 2018).

In the context of human nutrition, food processing is important. Food processing adds variety and convenience in order to meet various lifestyle requirements. It also plays an important role in the national economic development (Sharma and Kondaiah, 2005). However, current research has shown that indigenous meat processing by the pastoral communities faces a number of constraints hindering further development. Though many of the traditional meat products have great potential they are made only for human consumption with little in the way of commercialization (Gichure *et al*., 2014). This study was hence conducted with the ultimate aim of assessing the status of processing of *koche* product to highlight challenges and opportunities for the industry's development and prosperity.

3.3 Materials and methods

3.3.1 Study Area

The study was conducted in Marsabit and Isiolo counties. The two counties were purposively selected since majority of the residents are of pastoral origin and depend largely on meat and

milk products for their basic food needs (Homewood *et al*., 2012). Marsabit County has a population density of about 291,166 people. The area receives an annual rainfall range of 200mm to 1000mm. Temperature ranges from a minimum of 10°C to a maximum of 30°C with an average of 20°C (KNBS, 2009). Isiolo County has a population density of about 143,294 people (KNBS 2009).The area is typical semi-arid. It receives an annual rainfall of 418mm (Mati *et al*., 2005). The area receives annual rainfall of 418mm (Mati *et al*., 2005). The rainfall pattern is bimodal and erratic in distribution. Average annual temperatures range from 24°C to 30°C (Herlocker *et al*., 1993). Figure 3.1 shows the counties and towns visited.
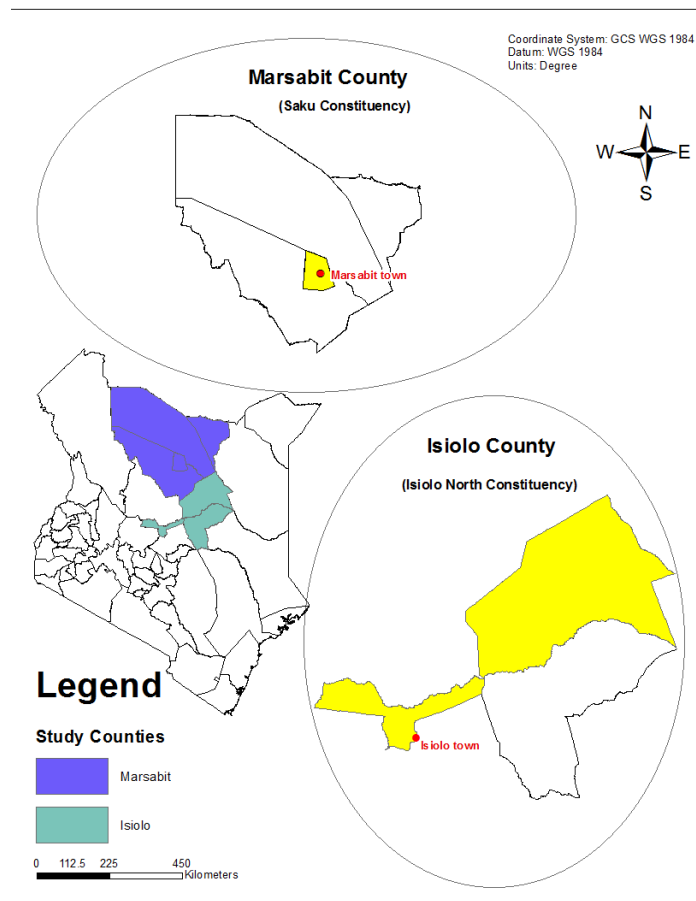
Figure 3. 1: Map of Kenya showing the study areas.

3.3.2 Study design

The design was cross sectional consisting of a survey in the two counties.

3.3.3 Sampling and data collection

A total of 10 processors were purposively identified as study cohorts. The selection of the processors was based on knowledge of indigenous meat processing and those involved in commercial processing. Focus group discussions were conducted with processors to assess the current status of processing of *koche* product. The focus group discussions had eight to ten participants. A checklist guide was used to guide the data collection. The questions focused on traditional processing and preservation, challenges and benefits. To triangulate data received from (FGDs), Key informant interviews (KIIs) were conducted with the processors. Unstructured interview guides were used to guide the data collection. The questions in the guide were focused on socio-economic characteristics of *koche* processors, traditional processing and preservation, inputs used in *koche* processing, quantities used, unit prices, production output, challenges and opportunities. Observations of processing and hygiene was also done and recorded in the field notebook.

3.3.4 Data Analysis

Qualitative data collected through (FGDs) and (KIIs) were entered in Nvivo application, grouped and analysed to bring about the proportions and narratives. Observations were also recorded in the application and summarized in paragraphs. Inferential statistics such as gross margin analysis and marketing margin analysis were used. Descriptive statistics such as percentages was used to represent the input variables used and returns obtained.

3.3.4.1 Gross margin model

Gross margin analysis was used to determine the profitability of *koche* processing in the study area. It was expressed as follows:

GM = GR – TVC

Where: GM = Gross margin of meat used (Kshs)

GR = Gross revenue (Kshs)

TVC = Total variable costs of meat used (Kshs) (Iliyasu *et al*., 2013)

Gross margin was used because the fixed costs of processing of *koche* product are negligible (Iheanacho and Philip, 2002).

3.3.4.2 Marketing Margin Analysis

Percentage marketing margin is the difference between the sales revenue and the cost price divided by the cost price and multiplied by 100 (Iliyasu *et al*., 2013).

 The formula is expressed as follows:

$$MM = \frac{CPP - PRP}{CPP} \times 100$$

Where MM = Marketing margin

CPP = Consumers paid price

PRP= Producer's received price (Iliyasu *et al*., 2013)

3.4 Results

3.4.1 Socio-demographic characteristics of the processors

Ten major commercial processors were identified in the study area. All the processors were women. Majority of them (70%) had an age range of 46 and above years. Processing of *koche* product was the main source of income. Majority of the processors (50%) had a processing experience of 4-9 years. In addition, most of them (80%) were illiterate only a few (20%) had achieved the primary level education (Table 3.1). However, this did not deter them from participating in the processing activities which were done individually. The study results also show that the main source of finance for the business was personal savings. The processors did not belong to any co-operatives or associations.

Table 3. 1: Socio-demographic characteristics of *koche* processors

Variables	Percentage (%)
Age	
26-35yrs	0
36-45yrs	30
46 and above years	70
Production Experience	
4- 9yrs	50
10-15yrs	30
16-21yrs	20
More than 21yrs	0
Education level	
No education	80
Primary level	20
Secondary level	0

3.4.2 Processing of *koche* product

The study shows that processing of *koche* product was largely carried out in individual households. The process analysis shows that *koche* was prepared using multiple steps as highlighted in Figures 3.2 and 3.3. The amount of *koche* product processed depended on the

orders received from traders. The average quantity processed per day was 50 kg. The raw material used was camel or beef meat sourced from the butchery establishments. Salting was a technique used with ingredients such as sodium chloride added (0.25%). Salting was done prior to drying. Salting is a method of preservation that acts by reducing the water activity so there is less water available for microbial growth thus increased shelf life. Drying allows the migration of water from the product to the external environment leading to a decrease in water activity and distribution of salts and other compounds in the product. Deep frying was done at 100^0C oil temperature for 30mins to further reduce the water activity. Addition of spice such as cardamom (0.045%) was done during deep frying to impart flavor. After deep-frying, the product was finally cooled and the quality evaluated based on taste and color only.

However, processors did not observe good manufacturing practices, often there was no running water at the processing sites, and personnel involved in processing did not wear appropriate protective clothing. Additionally, during drying of the product chances of contamination from flies and dust was very high.

Meat **(Camel or beef)**

⬇

Trimming **(to remove visible fat)**

⬇

Addition of salt (0.25%) ⟹ Size reduction **(cutting into strips 20mm thickness size)**

⬇

Drip-drying **(3 hours)**

⬇

Size reduction **(Cutting into cubes 1cm x 1cmx1cm)**

⬇

Addition of cardamon ⟹ Deep frying (**100^0C, 30mins)**
(0.045%)

⬇

Air cooling **(6hours)**

⬇

Packaging **(in plastic buckets)**
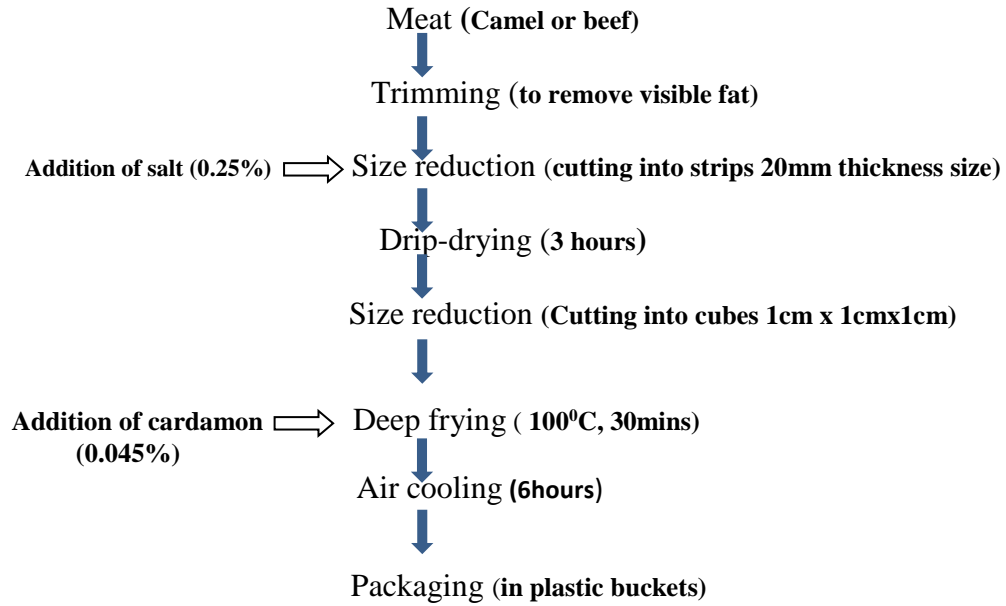
Figure 3. 2: Process analysis *of koche*, a traditional pastoral meat snack

Figure 3. 3: Pictorial representation of traditional processing of *koche* product. a **Size reduction(cutting meat strips).**b **Drip-drying of meat strips.** c **Size reduction (cutting of meat strips into cubes).** d **Deep-frying of meat cubes.**

3.4.3 Labour division for processing *Koche* product

Depending on the amount of *koche* product processed, processors employed workers on a daily basis to assist in processing. The daily wage paid was 400-500 Kshs per laborer. (Table 3.2) shows the labour division for processing 50 kg of *koche* product. Majority (71%) of the employed personnel were involved in the cutting process. According to the processors interviewed, cutting of meat into strips is a tedious process thus requires a lot of personnel (Figure 3.3: part 1).

Table 3. 2: Labour division and time required for processing 50kg of *koche* product

Activities	Number of personnel required	Percentage (%) of personnel	Time spent/day
Cutting	5	71%	4hrs
Drying	1	14%	5hrs
Frying	1	14%	2hrs

3.4.4 Costs and returns of *Koche* product

The results of the study presented in Table 3.3 show that the costs of the major variable inputs used in *koche* processing included the cost of meat (71.7%), ingredients (0.354%), cooking oil (13.34%), transport (1.77%), firewood (2.66%), labour (7.56%) and packaging material (0.03%). The cost of meat constituted the highest cost of processing. The findings also show that for 20kg of meat processed, 18kg of *koche* product was produced and the total revenue of 18kg of *koche* product was Kshs 21,600. The total gross margin was Kshs 10,360. Analysis of the returns to show that for every shilling invested on variable inputs in producing *koche* product, a gross margin of Kshs 0.92 was realized, while the return to labour was Kshs 12.1. The study revealed that the producers' received price for *koche* product was Kshs 950, while the consumers' paid

price for *Koche* product was Kshs 1200. Thus the marketing margin for *koche* product was estimated as 20.8%.

Table 3. 3: Average costs and returns of processing 20kg of camel meat into *koche* product

Category	Quantity (Kg)	Unit price (per kg)	Value (Kshs)	Value (USD)	Percentage (%) of the total cost
Returns	18	1200	21600	216	
Koche produced					
Variable costs					
Meat	20	400	8000	80	71.17
Ingredients					
Salt	0.05		10	0.1	
					0.088
Cardamom (spice)	0.09		30	0.3	0.266
Cooking oil	10		1500	15	13.34
Transport			200	2	1.77
Firewood			300	3	2.66
Labour			850	8.5	7.56
Packaging material			350	3.5	0.03
Total Variable costs			11240	112.4	100
Gross Margin			10360	103.6	
Marketing margin %					20.8
Return to variable costs			0.92	0.0092	
Return to labour			12.1	0.121	

3.4.5 Challenges faced by *koche* processors

The problems facing *koche* processors in the study area are presented by multiple responses in (Table 3.4). Challenges were related to capital, transport, equipment, market, payment, inputs and credit facilities. The major constraints identified were lack of equipment to ease processing (100%), lack of credit facilities (100%), insufficient capital (90%) and high costs of inputs (90%).

Table 3. 4: Challenges faced by *koche* processors

Challenges	Number of processors reporting the problem	Percentage%
Insufficient capital	9	90
Poor transport system	5	50
Poor market access	7	70
Delayed payment upon supply.	6	60
Lack of equipment to ease processing	10	100
Lack of credit facilities	10	100
High cost of inputs	9	90

3.5 Discussion

The present study provides evidence that processing of *koche* product is a source of livelihood for the women processors. The socio-economic characteristics of the processors clearly showed that processing was mostly done by older women with the majority lacking formal education. Similar observations were made by Madete *et al*., in Kenya (2015) who found out that most actors involved in indigenous meat product *nyirinyiri* processing had an age bracket of 40-60 years with no formal education. Survey of processing techniques employed showed that processors used simple indigenous knowledge in processing of *koche* product. This reflects the women's skills and creativity but also their capability to sustain the dynamics of life and ecosystem. In fact, Asogwa and Okoye (2017) noted that women in Africa have used indigenous knowledge in processing of food, thus generating income and employment opportunities.

However, the existing level of processing hygiene was poor. This corroborates the results of Kardivel and others (2018) who reported similar observations in India in regard to hygiene and quality practices of traditional processors.

In addition, several authors (Kisembe *et al*., 2017; Gichure *et al*., 2014) in Kenya have identified poor hygiene of indigenous meat products as a major concern. Therefore, the subjective assessment of safety and quality of the final product based on taste and colour was inadequate in addressing the hygiene issues observed in processing and unlikely to meet the quality and safety requirements of consumers.

According to Hudson and Hite (2003), socio demographic factors such as educational level, age and poverty are important predictors in the understanding of food quality and safety. Therefore, the low levels of education of the processors influenced lack of adoption of food quality and safety standards. Nevertheless, Khan (2005) reported that effective communication strategies and access to institutional services and input supply markets can facilitate adoption of food safety and quality standards by processors, thus improving on hygiene.

The findings on gross margin analysis indicate that *koche* processing is a profitable business mainly influenced by the cost of meat, as in Nigeria (Ahmadu *et al*., 2004 and Ahmadu *et al*., 2008a; Iliyasu *et al.*, 2013). According to the findings, the processors strongly agreed that lack of credit facility was a major challenge which consequently had an adverse effect on the capital. As a result, the processors were constrained to expand production. The high costs of inputs were attributed to the high cost of meat. Poor market access was highly attributed to insufficient product and market promotion. These findings therefore concur with other studies that reported similar challenges in small scale meat production enterprises (Ahmadu *et al*., 2004; Ahmadu *et al*., 2008b).

3.6 Conclusion

Based on the results presented, *koche* processing is still in extremely infant stages despite the potential. Being labour intensive, it can be a tool for poverty eradication and economic empowerment for women and youth as ascribed in Kenya Vision 2030 (GoK, 2007).

CHAPTER FOUR: EVALUATION OF MARKET POTENTIAL OF *KOCHE,* A TRADITIONAL PASTORAL MEAT PRODUCT FOR COMMERCIALIZATION IN KENYA

4.1Abstract

The goal of this objective was to guide *koche* processors with an assessment of market opportunities for *koche* product. Pre-tested semi-structured questionnaires were administered to traders (n=30) and consumers (n=196) to establish their perception on *koche* product. Descriptive statistics such as percentages, frequencies and logit model were used for data analysis. The findings indicate that the market outlets for *koche* product included sale in stalls (20%), hotels (6.7%) and street vending (73.3%). Street vending represented the highest percentage (73.3%). The main constraints affecting *koche* product marketability were poor product quality (60%), strict regulations by city council (30%), and poor packaging material (46.7%). The results also revealed that majority (87%) of the households consume *koche* product while only 13% did not consume *koche* product. Taste (90.8%) was the most important quality criterion used by consumers at the point of purchase. Age, ethnicity and household size were found to be significant predictors ($p<0.05$) in the quantity of *koche* product purchased. It was concluded that consumers' preferences associated with consumption patterns is affected by disposable income, cultural background and household size. Therefore, to enhance marketing of *koche* product, processors and traders must target individuals with a higher propensity to consume *koche* product.

Key words: Commercialization, Market potential, Pastoral meat products**.**

4.2 Introduction

Koche processing is widespread among the borana communities in Northern Kenya and is regarded as a way of poverty alleviation especially among the rural households. *Koche* has been prepared using local knowledge and therefore linked to it. Culturally, it is most valuable food product. Previous research has shown that based on chemical and sensory parameters, it can be processed into snack like product both at commercial or household level (Gichure *et al*., 2015; Gichure *et al*., 2016). Currently, it is sold as a ready to eat meat snack by street vendors. (Gichure *et al.,* 2014 ; Dabasso *et al.,* 2018).

Street food vending is a livelihood strategy especially for the urban poor. Actors in this market do not comply with legal standards, requirements and procedures similar in formal markets (Chambwera, 2012). In addition, processors/ marketers sell their products at unprofitable and low prices (Soinaya, 1992). It is, however, important to ensure product mainstream into the formal market since over the decades the demand for processed and convenience food has increased considerably (Kardivel *et al.,* 2018). A change in socio-economic status has contributed to consumption of convenience meat products presenting an opportunity for commercialization of *Koche*.

However**,** today's food market has become buyer market rather than seller market. Research has shown a positive relationship between market orientation and business performance. Technological advancements have triggered the need for a shift of food industry sectors orientation from production to market. Understanding market information is effective in product

development process. Market information combined with technical knowledge can help generate successful products with a competitive advantage (Grunert *et al.,* 1996; Slater and Narver, 2000). To ensure product mainstream into the formal market, it is of outmost importance to evaluate its potential in the market. Therefore the main objective of this study is to evaluate market potential of *koche* for commercialization in Kenya.

4.3 Materials and Methods

4.3.1 Study Area

The study was conducted in Nairobi County. Nairobi County has 17 sub-counties. Kamukunji sub-county was selected and the study focused on Eastleigh North as depicted in Fig.4.1 Eastleigh North has a population size of about 98,277 (KNBS 2009).
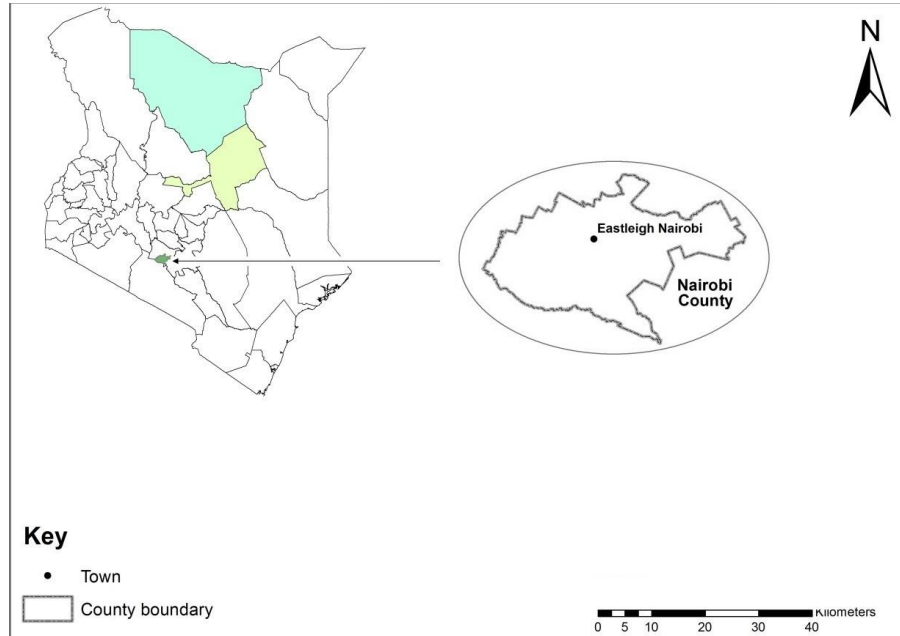
Figure 4. 1: Study regions for *koche* market potential

4.3.2 Study design

A cross-sectional design with random and purposive sampling was used to select consumers and traders respectively.

4.3.3 Sampling

4.3.3.1 Consumer survey

A stratified random sampling was used to divide the suburb into low and high density suburb. Ten percent of consumers shopping per day at the shopping center close to the picked suburb were selected by interviewing every tenth person coming to shop.

4.3.3.2 Sample size determination

The desired sample size for the consumers was determined using the formula of Fischer *et al*., 1991):

$$n= \frac{z^2pq}{d^2}$$ Where;n= the desired sample size (assuming the population is greater than 10000)

z= the standard normal deviation, set at 1.96, which corresponds to 95% confidence interval

p= Proportion in the target population estimated to have a particular characteristic. In this study, the proportion was calculated according to the following assumptions; expected *Koche* consumption rate of 85% obtained from pre-tested questionnaires; sampling error of 5% and 95% confidence interval (Ören and Biçkes, 2011; Rodriguez del Aguila and Gonzalez-Ramirez, 2013)

q= 1-p

d= degree of accuracy desired, here set at 0.05, corresponding to the 1.96

In substitution, n = $\dfrac{1.96^2 \text{ x } 0.85 \text{ x } (1\text{-}0.85)}{0.05^2}$ = 195.9216 consumers

4.3.3.3 Traders survey

The trader's survey was conducted in East Leigh market. There were 30 traders selling *koche* product. All the traders were interviewed.

4.3.4 Method of data collection

Data were collected using pre-tested semi-structured questionnaires administered through oral interview. For the traders, data was collected on the socio-economic characteristics, quantities of *koche* product sold, unit prices and problems in *koche* trading. For the consumers, the questionnaires were partitioned into demographics, consumption patterns, quality criteria used before purchase and factors affecting purchase of *koche* product.

4.3.5 Data Analysis

The analysis of the semi-structured questionnaire responses was performed using Statistical Package for Social Sciences (SPSS) Version 20 and descriptive statistics such as percentages and frequencies were used in presenting the results. Chi-square test was also performed to establish relationships between different variables. Regression model was used to assess the association between quantity of *koche* consumed and socio-economic characteristics. Since quantity was categorized into four groups and they are important to the consumers, an ordered logit was used to find the predictor variables in the quantity of *koche* consumed. The model is described as follows;

$$Y = B_0 + B_1(X1) + B_2(X2) + B_3(X3) + B_4(X4) + B_5(X5) + B_6(X6) + B_7(X7) + B_8(X8) + B_9(X9)$$

Y= Response variable= Quantity of *Koche* consumed.

X (1-9) = Explanatory Variables= Socio economic characteristics

4.4 Results

4.4.1 Socio-economic characteristics of the traders.

Table 4.1 shows the socio-economic characteristics of the traders in *koche* marketing. Traders interviewed were female. Forty percent had primary education and also (40%) had no formal education. Very few (20%) had secondary education. Sixty three percent of the traders were married, (17%) were divorced, (13%) were widowed and (7%) were single.

Table 4. 1: Socio-demographic characteristics of traders in *koche* marketing

Variables	Frequency (n=30)	Percentage (%)
Sex		
Male	0	0
Female	30	100
Education		
No education	12	40
Primary	12	40
Secondary	6	20
Marital status		
Single	2	7
Married	19	63
Divorced	5	17
Widowed	4	13

Figure 4.2 shows distribution of the traders based on age. The findings show that (50%) were aged 46 and above years, whereas (26.7%) were aged 36-45 years and (20%) were aged 26-35years. Only (3.3%) were aged 18-25years.

38
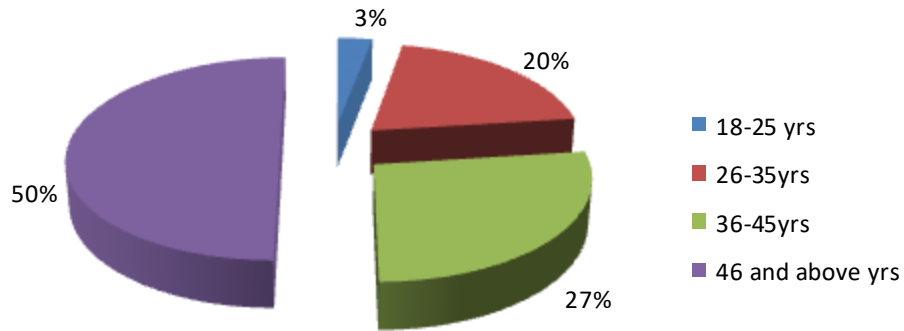
Figure 4. 2: Distribution of *koche* traders by age (years)

Figure 4.3 shows distribution of traders based on experience in the activity. The highest proportion (33.3%) had an experience of 3 to 5 years, and (26.7%) and (16.7%) had an experience of 9 to 10 years and 6 to 8 years respectively. About (13.3%) had an experience of less than 3 years and a few (10%) had an experience of more than 10 years.
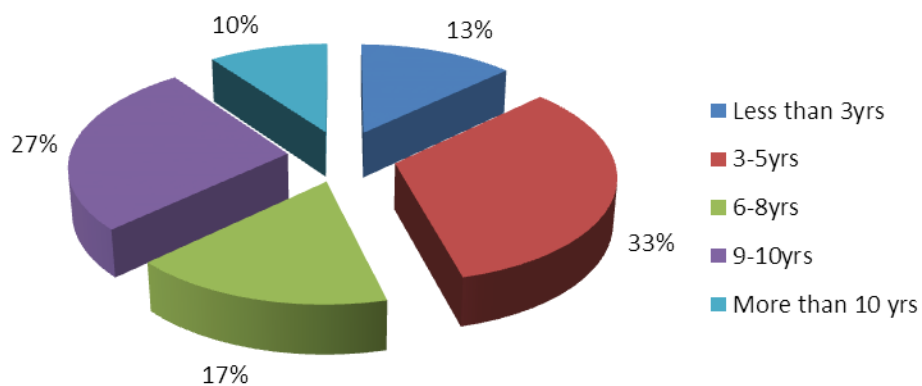
Figure 4. 3: Distribution of the traders based on their experience in years.

4.4.2 Marketing channel of *Koche* product

Table 4.2 shows the channel of *koche* product during marketing. Majority of the traders (76.7%) were supplied with *koche* product from Isiolo and (23.3%) of the traders were supplied with *Koche* product from Garissa. Most of the traders (73.3%) sold *koche* product on the streets. About (20%) sold *koche* product in stalls/shops and only (6.7%) sold in hotels. Majority of buyers (100%) were household consumers.

Table 4. 2: Channel of *koche* product during marketing

Factors	Variables	Frequency (n=30)	Percentage (%)
Suppliers	Isiolo	23	76.7
	Garissa	5	16.7
	Other (process on their own)	2	6.7
Selling place	Stalls/shops	6	20
	On the streets	22	73.3
	Hotels	2	6.7

4.4.3 Pricing and economics of *koche* marketing.

Analyses of the marketing characteristics of *koche* product revealed that a kg of *koche* product was sold at 1200Kshs. However, the price varied among the traders from 1200 to 1400Kshs. The monthly profit obtained from the sales of *koche* product also varied from one trader to another. Ten percent of the traders made a monthly profit of less than 5000Kshs, (33.3%) made a monthly profit of 5000-10000Kshs, (33.3%) made a monthly profit of 10000-15000Kshs while only (23.3 %) made a monthly profit of more than 15000Kshs (Figure 4.4).
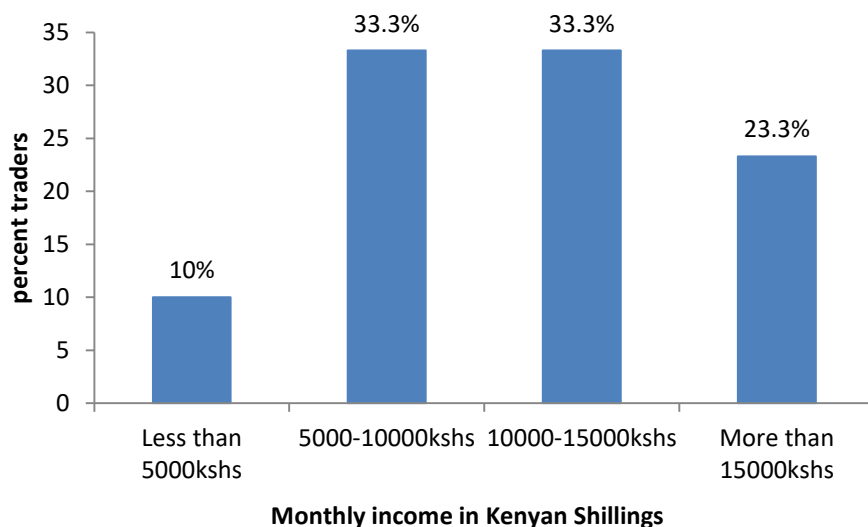
Figure 4. 4: Monthly profit declared by the traders interviewed

4.4.4 Challenges faced by *koche* traders.

Despite the socio-economic importance of trading of *koche* product, the traders were faced by various challenges. Table 4.3 summarizes the importance of the challenges. The most important challenges specified by the traders were inadequate market and storage space (73.3%), harsh climatic conditions (73.3%) and strict regulations by city council (70%).

Table 4. 3: Challenges faced by *koche* traders

Challenges	Most important		Least important	
	Frequency	**Percentage**	**Frequency**	**Percentage**
Inadequate market and storage space	22	73.3	8	26.7
Hot climate	22	73.3	8	26.7
Strict regulations by city council	21	70	9	30
Poor packaging material	16	53.3	14	46.7
Poor product quality	12	40	18	60

Table 4.4 shows association between selling place of *koche* product and the type of challenge experienced. Significant differences ($p < 0.05$) were found between selling place and inadequate market and storage space, hot climate and strict regulations by city council. No significant difference ($p > 0.05$) was observed between selling place and poor packaging material and poor product quality.

Table 4.4: Association between selling place and challenges facing *koche* traders

Challenges	Selling place(percentage %)			
	Stalls	**On the streets**	**Hotel**s	*p*-**Value**
Inadequate market and storage space				
Most important	0	100	0	< 0.05
Least important	75	0	25	
Hot climate				
Most important	0	100	0	
Least important	75	0	25	< 0.05
Strict regulations by city council				
Most important	0	100	0	
Least important	66.7	11.1	22.2	< 0.05
Poor packaging material				
Most important	12.5	75	12.5	> 0.05
Least important	28.6	71.4	0	
Poor product quality				
Most important	25	75	0	> 0.05
Least important	16	72.2	11.1	

 Significant at *p* < 0.05

Table 4.5 shows association between demographic characteristics and monthly profit obtained. A significant association ($p < 0.05$) was observed between monthly profit and trading experience. However, no significant association ($p > 0.05$) was observed between monthly profit and the age groups, education groups and marital statuses.

Table 4.5: Association between demographics and monthly profit obtained by the traders

Variables	Monthly profit in Kenyan shillings				
	5000Kshs	5000-10000kshs	10000-15000kshs	>15000kshs	*p*- Value
Age					
18-25yrs	0	100	0	0	
26-35 yrs	0	50	50	0	> 0.05
36-45yrs	25	37.5	25	12.5	
46 and above	13.3	33.3	26.7	26.7	
Education					
No education	16.7	41.7	16.7	25	
Primary	8.3	41.7	33.3	16.7	> 0.05
Secondary	16.7	33.3	50	0	
Trading experience					
Less than 3yrs	25	50	25	0	
3 to 5yrs	12.5	50	37.5	0	
6 to 8 yrs	0	33.3	66.7	0	< 0.05
9 to 10 yrs	11.1	22.2	22.2	44.4	
More than 10yrs	0	0	0	100	
Marital status					
Single	0	100	0	0	
Married	15.8	36.8	31.6	15.8	> 0.05
Divorced	20	0	40	40	
Widowed	0	75	25	0	

Significant at *p* < 0.05

4.4.5 Association between Socio-demographic characteristics of consumers.

Table 4.6 shows association between socio-demographic characteristics of consumers. Chi-square tests revealed a significant association ($p<0.05$) between the age groups, marital status, education level, gender and size of family. Among the age group 18-24yrs, 46.2% were male, 53.8% female, 46.2% were married, 53.8% were single, 30.8% had primary education, 65.4% had secondary education , 3.8% had college education, 53.8% had a family, 56.2% had no family. Among the age group 25-34yrs, 28.7% were male, 71.3% were female, 87.2% were married, 12.8% were single, 7.4% were iliterate, 48.9% had primary education, 38.3% had secondary education, 5.3% had college education. Among the 35-44yrs, 19.5% were male, 80.5% female, 95.1 % were married, 4.9% single, 31.7% were illiterate, 51.2% had primary education, 14.6% had secondary education, 2.4% had college education, 97.6% had a family,

2.4% had no family. Among the 45 and above yrs, 45.7% were male, 54.3% were female, 97.1% were married, 2.9% single, 48.6% were illiterate, 28.6% had primary education, 22.9% had secondary education.

Table 4. 6 : **Association between age groups and Socio-demographic characteristics of consumers**

Characteristics	Age in years				
	18-24	25-34	35-44	45 and above	*P*-value
Marital status					
Single	53.8	12.8	4.9	2.9	< 0.05
Married	46.2	87.2	95.1	97.1	
Gender					
Male	46.2	28.7	19.5	45.7	
Female	53.8	71.3	80.5	54.3	< 0.05
< 0.05					
Education level					
No education	0	7.4	31.7	48.6	
Primary	30.8	48.9	51.2	28.6	< 0.05
Secondary	65.4	38.3	14.6	22.9	
College	3.8	5.3	2.4	0	
Family					
Yes	53.8	91.5	97.6	97.1	< 0.05
No	46.2	8.5	2.4	2.9	

Figure 4.5 shows the monthly income distribution of the consumers. Majority of the consumers (49.5%) earned 25000-30000Kshs per month, (40.8%) earned 15000- 20000Kshs per month, and (7.1%) earned 35000-40000Kshs per month while very few (2.6%) earned more than 40000Kshs per month.
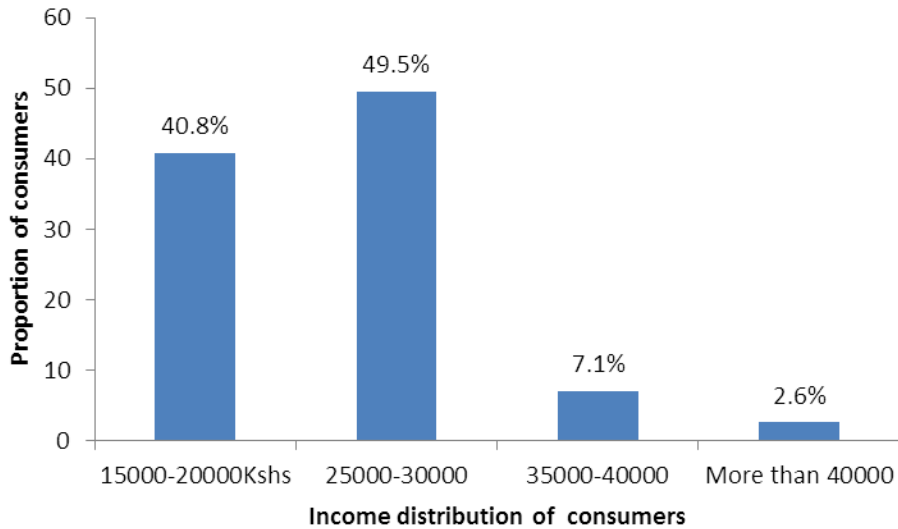
Figure 4. 5: Income distribution of *koche* consumers

4.4.6 Reasons for consumption of *koche* .

Figure 4.6 shows the reasons of consumption of *koche*. Majority of the consumers (54%) indicated that they consumed *koche* since it was their cultural food. Twenty-one percent indicated that they consumed *koche* due to health benefits, (6%) indicated that they consumed *koche* since it was ready to eat, (10%) indicated that they consumed due to good taste and (9%) were indifferent.
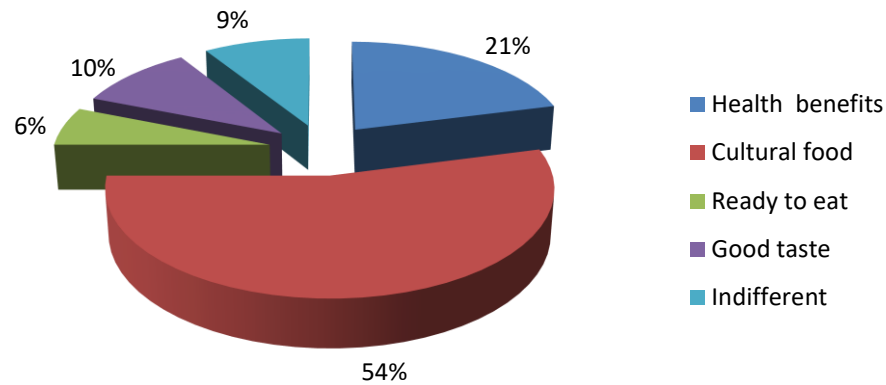
Figure 4. 6: Reasons for consumption of *koche*.

4.4.7 Purchase points for *koche* .

Figure 4.7 shows the purchase points in the study area. Majority of the consumers purchased on the streets (64.8%). The reason given was that street vending was the dominant market outlet for *koche* . However, (20.8%) of the consumers purchased in the stalls, (4.4%) purchased in hotels and (10%) prepared at home.
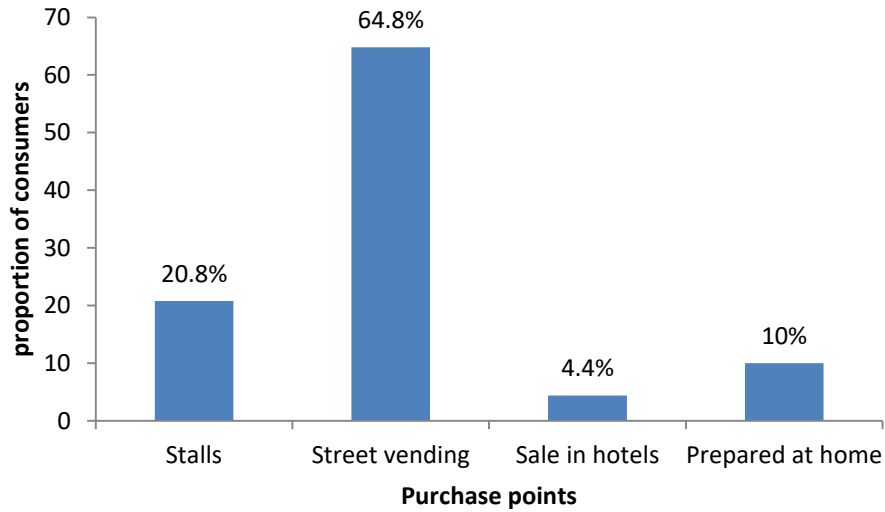
Figure 4. 7: Purchase points of *koche*.

4.4.8 Quantity of *koche* purchased by consumers.

Figure 4.8 shows the average quantity of *koche* purchased by consumers on a monthly basis. Majority of the consumers (49.7%) purchased 2-3 kg, (23.3%) of the consumers purchased more than 3 kg, (14.5%) of the consumers purchased 1-2 kg and (12.6%) of the consumers purchased less than 1 kg.
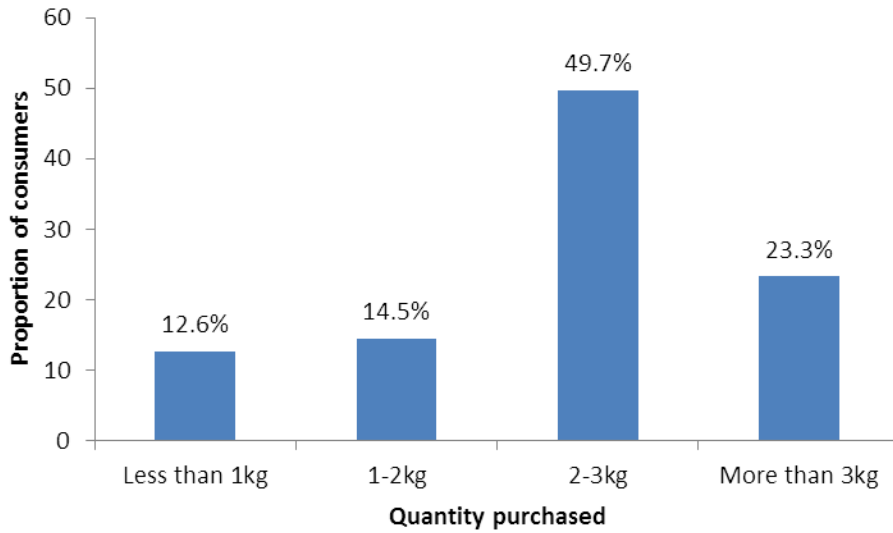
Figure 4. 8: Quantity of *koche* purchased by consumers.

4.4.9 Frequency of purchase of *koche* by consumers

Figure 4.9 shows the frequency of purchase of *koche* by consumers. Majority of the consumers (33.3%) purchased once a month, (24.5%) of the consumers purchased 1 to 3 times a month, (16.4%) of the consumers purchased more than once a week, (22%) of the consumers purchased once a week and only (3.8%) purchased every day.
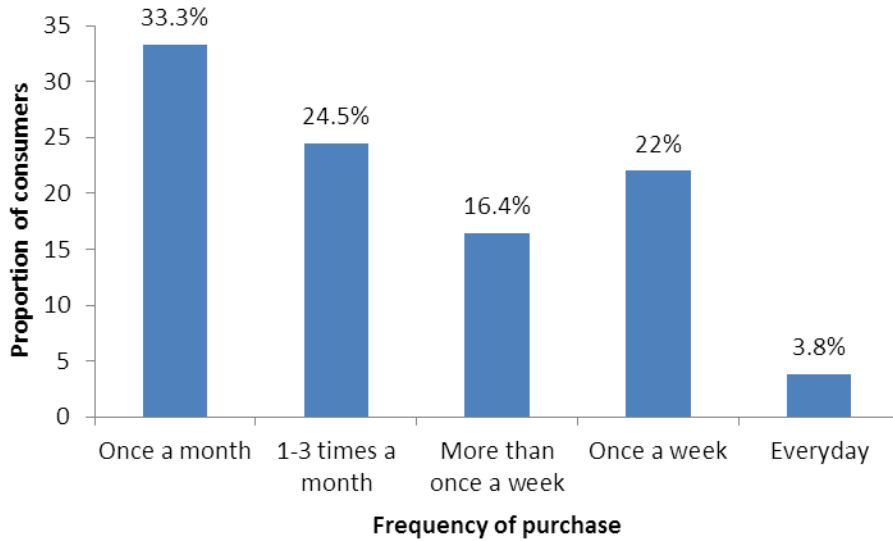
Figure 4. 9: Frequency of purchase of *koche*.

4.4.10 Quality criteria used by consumers to purchase *koche*

Majority of the consumers (90.8%) used taste as the most important quality attribute at the point of purchase. However, (83.2%) used flavor, 73.2%) used fat content, (61.3%) used chewiness, (61.3%) used appearance and (22.4%) used size of meat chunks (Figure 4.10).
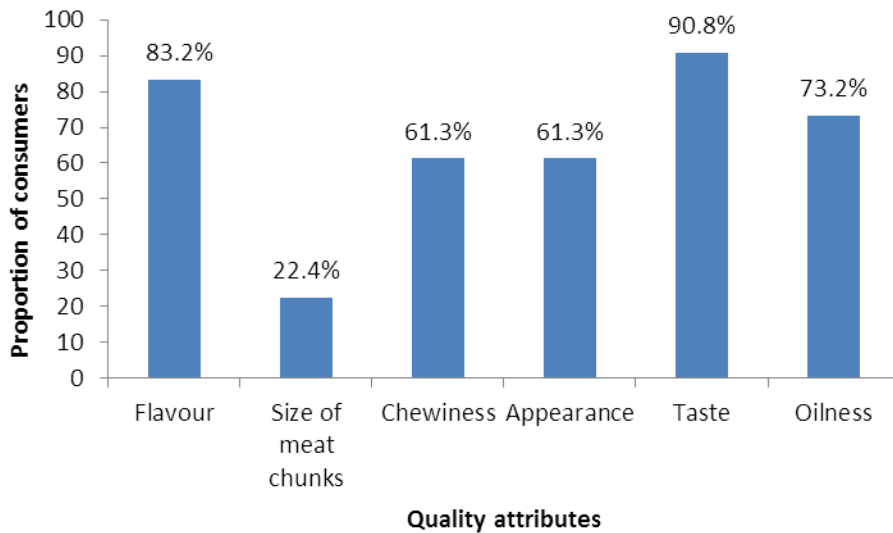
Figure 4. 10: Quality criterion used by consumers at the point of purchase of *koche*.

4.4.11 Factors influencing consumers likelihood to purchase different quantities of *koche*

Table 4.7 shows the predictor factors of the quantity of *koche* purchased. Age, household size and ethnicity were found to be statistically significant ($p < 0.05$) in influencing the probability of a certain consumer being in a particular *koche* purchase category. The odds of 18-24 yrs age consumers group compared to 44yrs and above age group was 0.15times less likely to have an increasing purchase of *koche*. The odds of 24-35yrs consumers compared to 44yrs were 0.3times less likely to have an increasing *koche* purchase. The odds of household size of 1-3 consumers compared to above 6 was 0.03times less likely to have an increasing purchase of *koche*. The odds of household size of 4-6 consumers compared to above 6 was 0.05times less likely to have an increasing purchase of *koche*. The odds of Rendille consumers compared with other tribes were 5times more likely to have increasing purchase of *koche*. The odds of Borana consumers compared to other tribes were 6.7times more likely to have an increasing purchase of *koche*. The odds of Somali consumers compared to other tribes were 100 times more likely to have an increasing purchase of *koche*

Table 4.7: Predictor factors of quantity of *koche* purchased by consumers

Variable	B	Std Error	Wald
Age (in yrs)			
1. 18-24	-1.842	0.782	5.542**
2. 25-35	-1.302	0.602	4.687**
3. 35-44	-0.775	0.640	1.465
4.44and above [a]	0	-	-
Income size			
1.15000-20000kshs	-1.056	1.113	0.900
2.25000-30000kshs	0.216	1.109	0.038
3.35000-40000kshs	1.969	1.735	1.288
4.Morethan 40000kshs[a]	0	**-**	**-**
Religion			
1.Muslim	0.654	0.832	0.618
2.Christian[a]			
Household size			
1.1-3	-3.517	0.576	37.264**
2.4-6	-2.933	0.550	28.427**
3.Above 6[a]	0	-	-
Gender			
1.Male	-0.183	0.415	0.194
2. Female[a]	0	-	-
Marital status			
1.Married	-2.025	1.086	3.474
2. Single[a]	0	-	-
Ethnicity			
1.Somali	1.625	0.674	5.810**
2.Borana	1.912	0.818	5.469**
3.Rendille	4.651	1.965	5.605**
4.Others[a]	0	-	-
Education			
1.No education	-0.929	1.077	0.745
2. Primary	-0.135	0.980	0.019
3. Secondary	-0.302	0.991	0.093
4. College[a]	0	-	-
Quantity			
1.Less than 1kg	-7.693	2.148	12.828**
2.1-2kg	-5.941	2.120	7.856**
3.2-3kg	-2.410	2.050	1.382
4.More than 3kg			

**Significant at (*p* <0.05), [a] Reference category

4.4.12 Factors affecting purchase decisions by consumers.

Figure 4.11 shows factors affecting purchase decisions by consumers. Majority of the consumers (29%) identified price as an impediment towards purchase of *koche*. Twenty seven percent identified poor product quality, (21%) identified poor hygiene of traders involved in selling *koche*, (19%) indicated proximity to the market outlet and (4%) identified lack of consumer information.
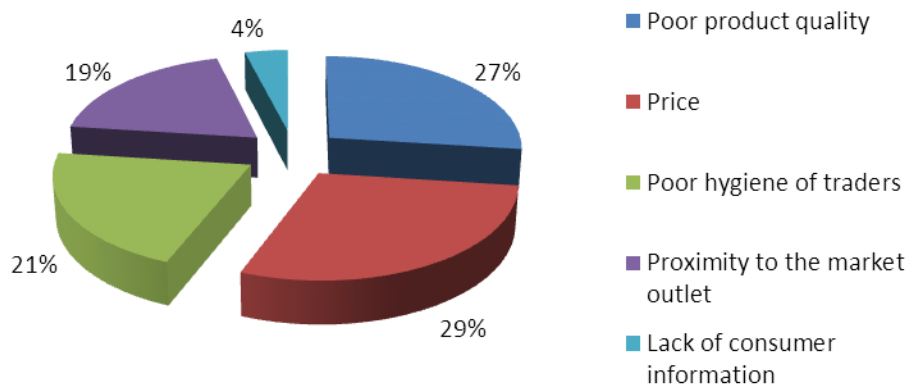
Figure 4. 11: Factors affecting purchase decisions by consumers.

4.5 Discussion

The present study provides greater evidence of trading of *koche* mainly in Eastleigh Town, Nairobi. This reflects a shift towards a market oriented production objective. However, *Koche* marketing system found in the studied areas was dominantly informal marketing. Street vending represented the highest percentage (73.3%) with all the traders interviewed being women. This is in line with the study of (Muyanja *et al*., 2011; Gadaga *et al*., 2014) who reported that in any street food activity women pre-dominate. Majority of the traders (50%) were aged 40 and above

years and had either primary or no education. Similarly, (Montcho *et al.*, 2018; Muinde and Kuria, 2005) reported that majority of the street food vendors were aged 36-56 years with either primary or no education. The findings also show that selling of *koche* product was an old job for some interviewed. Ten percent of the vendors had more than 10 years' experience in this activity. About the economic profitability, majority of the traders (33.3%) earned a profit of 5000Kshs-10000Kshs. Chi-square tests performed revealed trading experience as a significant factor *(p< 0.05)* for profit .The longer the experience, the higher the net profit. A possible explanation could be due to their good knowledge of the market and higher reputation. This agrees with a study conducted by Montcho and others (2018) that found out that the net profit of grilled meat vendors differed with the experience. However, despite the economic profitability of the business, the vendors faced a number of challenges. In particular, harsh climatic conditions, strict regulations by city council and inadequate market and storage space were significantly (*p< 0.05*) associated with the selling place. Most of the traders (73.3%) who sold *koche* product on the streets were challenged by hot climate, inadequate market and storage space and strict regulations by city council. This is in line with the study of Tshuma and Jari (2013) who reported that storage space was one of the dominant constraints facing street vendors.

This study also indicated that a good percentage of the sampled population consumed *koche* . This suggests that meat is an important component in the diet of the people. A study by Rosegrant and others (2005) observed a high consumption of meat products in Kenya. This study established that the key driver in consumption of *koche* was culture. This supports other findings where consumption of meat products was influenced by culture (Berndsen *et al.*, 2004; York *et al.*, 2004). However, consumption was rare and not habitual. A high proportion of the consumers

53

(33.3%) indicated that they purchased *koche* once every month and the reason was that it was expensive. The consumers associated the quality of *koche* with taste, size of meat chunks, flavor, appearance and fat content. However, taste was regarded as the most important quality attribute when purchasing. This supports the findings of Rodriguez, (2006) who reported that consumer's perceived quality is influenced mostly by taste. However, it contradicts the findings of Troy and others (2010) who reported that consumer acceptability is mostly influenced by product color. Consumer' purchase decisions were influenced by income, ethnicity and household size. In regards to income and household size, these findings were consistent with the results of (Amao and Ayantoye, 2014; Mafimisebi, 2012; Musaba and Namukwambi, 2011) that income and household size is related to the amount of fish consumed. However, it contradicts the findings of Cengiz Sayin and others (2010) who found insignificant relationship between household and income size with the amount of fish consumed. Among the factors affecting purchase, price was considered the most important. This agrees with the findings of Vimiso and others (2012) who observed that most purchases are determined by the amount of cash available. However, it contradicts earlier consumer studies by (Montcho *et al*., 2018; Rheinlander *et al*., 2018) who reported that personal trust in vendors was the most important factor affecting purchase.

4.6 Conclusion

The study reveals a great market potential for *koche* product. A high population of the sampled population consume *koche* product. However, the market is still underexploited since majority of the consumers were pastoral communities.

CHAPTER FIVE: OPTIMIZATION AND UPGRADING OF *KOCHE,* A TRADITIONAL MEAT PRODUCT PROCESSED BY PASTORAL COMMUNITIES IN KENYA.

5.1 Abstract

Koche product has potential commercial value since it is a traditional ready to eat product. However, commercialization of *koche* product is possible if challenges in regards to processing are taken into account. This study aimed at optimizing *koche* product made from camel, beef and goat to meet today's consumers' convenience evaluating its nutrient profile and shelf life stability. Results show that moisture content of the upgraded *koche* product ranged from 32.65 to 33.44%, crude protein ranged from 30.58 to 36.56%, Crude fat ranged from 22.29 to 31.05%, crude ash ranged from 4.58 to 6.92% and energy values ranged from 346.1 to 402.8. From the study, the sensory quality attributes i.e. overall acceptability (4.2) Appearance (4.2) and color (4.2) had the highest mean scores. Overall acceptability of upgraded koche product made from, beef, camel and goat was the same. T he physicochemical properties and microbial quality were within the acceptable limit up to 5th day of accelerated storage at $55^{o}C$. Hence, upgraded *koche* product has the potential for commercialization.

Key words: Commercial viability, new product development, Ready to eat meat product

5.2 Introduction

Demand for quality and safety food products with extended shelf-life is mounting. Participants along the production chain must ensure production of completely safe and quality food. Food quality is a term that includes in addition to safety other intrinsic features such as appearance,

texture, color, flavor, and other extrinsic features such as labelling and certification (Ripol *et al*., 2018). An achievement of food quality and safety is an important marketing strategy. Quality and safety influences consumer's perception and decision making in regards to choice of food (Grunert *et al.,* 2007).

The role of meat processing and preservation is to enhance quality and extend shelf life of meat products (Malik *et al*., 2011). Over the years, traditional meat processing has been practiced manifesting in different ways and localities. Different regions have devised technologies to suit the prevailing environmental conditions in that area. In the pastoral regions of Kenya, a combination of drying (generally in the sun) with processes such as salting, smoking, deep frying have been used in preservation of meat since it is highly perishable (Ayanwale *et al*., 2007). Current research has shown a wide range of products such as *Koche*, *Enyas*, *Olpurda, Fonntumma*, *Kochegarbu* processed (Gichure *et al*., 2014; Dabasso *et al*., 2018). These meat products are highly valued and formed part of the culture of the people (Asogwa and Okoye, 2017). They are prepared mainly for social events such as weddings, and showcased in cultural festivals with some marketed informally. However, these processing technologies have neither been optimized nor standardized to mainstream products into formal markets (Gichure *et al*., 2014).

Koche is made from strips of sundried beef or camel which is salted then deep fried in oil. The moisture content varies from 3.3 to 6.1% (wet basis). Traditionally, it is a common food among the Borana pastoralists. It is stored without special packaging and eaten as a snack. Research on *koche* product has shown that women carry out the processing activities. Despite the dawn of science and technology, production is still craft based. The techniques employed are labor intensive, time consuming and low productivities. One of the challenges of the processing

56

methods is unoptimized and unstandardized product quality (Gichure *et al*., 2014; Dabasso *et al.,* 2018).

To mainstream the product into the formal markets, it is of utmost importance to enhance the quality and consumer acceptability. Contemporary food technology offers many processing methods and tools alongside scientific packaging that can be used to improve the quality and shelf-life of the product thus raising its standards (Andree *et al.,* 2010). Some successes have been recorded in upgrading of traditional technologies (Obadina *et al*., 2013). The objective of this research work was to optimize the production of *koche* product through addition of curing salts and modern packaging to further improve the quality, utilization and acceptance.

5.3 Research design and Methodology

5.3.1 Experimental design

A Completely randomized design was used.

5.3.2 Sample collection and preparation.

Semi-membranous muscles of cattle, camel and goat (3kg each) were obtained at local slaughterhouse which has the authorization in regards to hygiene and health practices. The other ingredients were obtained from an authorized supplier in Nairobi. Sub-cutaneous fat and visible connective tissue were removed from the muscles.

Table 5.1: Salts and spices per kg of raw meat

Ingredients	Percentage (%)
Sodium chloride	0.2
Sodium tripolyphosphate	0.3
Sodium Nitrite	0.015
Monosodium glutamate	0.05
Ascorbic acid	0.03
Ginger	0.03
Nutmeg	0.03
Coriander	0.02

Gichure *et al*., 2017

5.3.3 Processing

The meat was cut into strips (10mm width size) using a meat slicer. The meat strips were then cured in a curing solution containing salts and spices. The ratio of meat to curing solution was 1:3. After curing, the meat was strips were uniformly massaged and kept in a cold room for 24 hours at 4°C after which they were dried using a cabinet dryer (Innotech model, ngenieursgescellschaft mbH, Germany). The drying temperature was set at 40^{0}C for 120 minutes. After drying, the meat strips were cut into 10 mm cube size using a meat cube cutter. The meat cubes were deep fried in palm oil at 170^{0}C for 5mins using an electric fryer (Caterina model, EFIO1CT/109, China). After deep frying, excess oil from the meat cubes was drained off using a stainless sieve for 2 minutes (Fig 5.1). The final product was then cooled to room temperature. Standard methods were used to analyze the physico-chemical, sensory characteristics and shelflife stability (Gichure *et al.,* 2017).

Fresh meat **(Removal of visible fat)**

Size reduction **(cutting meat into strips 10mm width size)**
(Meat slicer)

Curing ⇐ **Addition of salts& spices**

Drying
(Solar drier, at 40^{0}C, 2hrs)

Size reduction ⇐ **(Cutting into 1cm* 1cm* 1cm, cube size)**
(Meat cube cutter)

Deep frying
(Electric fryer, 170^{0}C, 5mins)

Draining

Cooling

Packaging

(Plastic & glass containers)
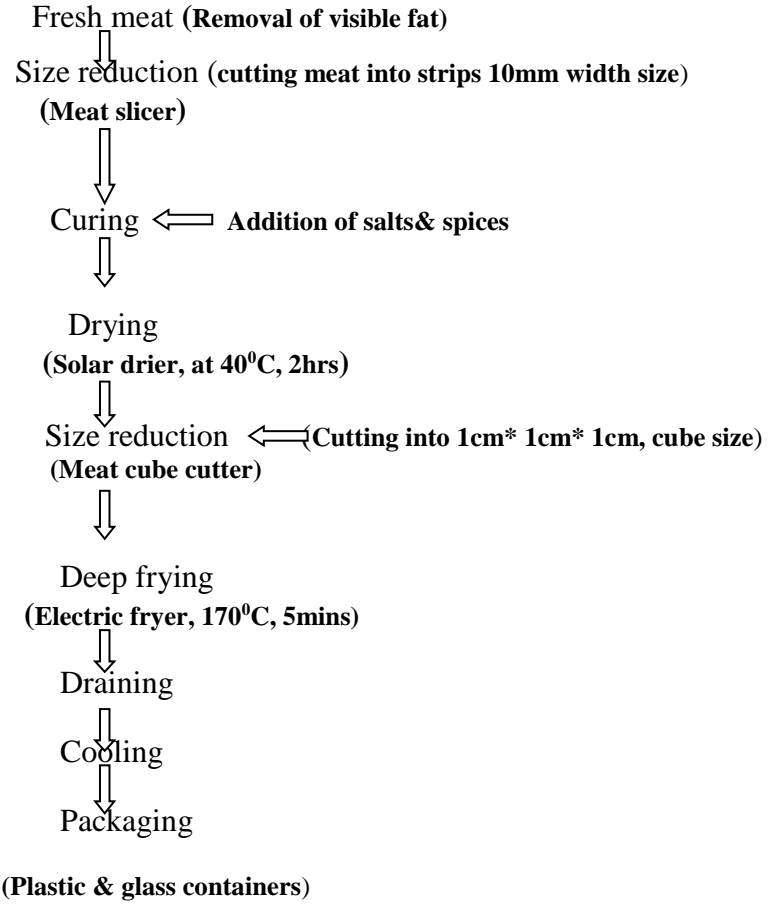
Figure 5. 1: Steps in laboratory scale upgraded *koche* processing

Figure 5. 2: Upgraded *koche* product

5.3.4 Packaging

Glass and plastic jars were used.

5.3.5 Analytical methods

5.3.5.1Chemical composition

5.3.5.1.1 Determination of moisture content

The AOAC standard method 950.46 (AOAC, 2005) was used. Approximately 5g of the sample was weighed in aluminium made dish which was placed in an oven at 105ºC for approximately 5 hours. Cooling followed and both the dish and the residue were weighed. The difference in weight between the original fresh sample weight and the dried sample gave the moisture content. This was expressed as per cent moisture content.

5.3.5.1.2 Determination of crude fat

The soxhlet method as per AOAC standard method954.02 (AOAC, 2005) was used. 5g of pounded sample was weighed into an extraction thimble containing cotton wool which was then transferred into the sohxlet extractor and extraction of the fat done in a tared flask for 8hours using petroleum ether (B.P. 40-60oC). Evaporation of the fat was done in a rotary evaporator. The drying of the residue was done in an air oven at 105ºC for approximately 1 hour and weighed. Determination of the fat content was done and values expressed in form of percentage of the sample dry matter content.

5.3.5.1.3 Determination of crude protein

The approved AOAC (2005) Kjeldahl 992.15 method was used for crude protein determination. 0.5g of the sample were accurately weighed and placed in a Kjeldahl flask, folded in a nitrogen free filter paper. A catalyst tablet and sulphuric acid were carefully added to digest the sample in a fume chamber. Phenolphthalein was used as the end point indicator before the Kjeldahl flask was connected to a distillation unit. 40% NaOH solution was used for back titration against a 0.1N NaOH solution. The standard conversion factor for nitrogen into crude protein was 6.25.

5.3.5.1.4 Determination of ash content

The standard AOAC (2005) Method 942.05 was used. Charred samples were placed in dishes followed by heating for 6 hours at 525ºC till the ash was white in colour. The weight of the obtained ash was divided by the weight of the sample and expressed in percentage.

5.3.5.1.5 Determination of Crude Fibre

Method 978.10 of AOAC (2005) was used. Sample weighing 10g was placed in a heating mantle and digested with 200ml of boiling 0.225N Sulphuric acid for 30 minutes. The contents were then filtered and washed with boiling water to remove the acids. Boiling of the contents was done with pre-heated 200ml of 0.313NaOH for 30 minutes. After boiling, the sample was filtered, dried, weighed and ashed in the furnace at 540˚C.

$$\text{Crude fiber (\%)} = \frac{\text{Weight of crude fiber}}{\text{Sample weight}} \times 100$$

5.3.5.1.6 Determination of Energy

The energy value of the samples was determined by multiplying the protein content by 4, carbohydrate content by 4 and fat content by 9. (AOAC, 2005)

Energy Value = (Crude protein × 4) + (Total carbohydrate ×4) + (Crude fat × 9)

5.3.5.1.7 Determination of peroxide value

The method (AOAC, 2008 – Method 965.33) was used to determine the peroxide value of the samples. Approximately 5g of the sample was weighed and mixed with 30ml of the mixture glacial acetic acid: chloroform (3:1) in a conical flask and the fat dissolved by careful swirling. 0.5ml of fresh saturated aqueous potassium iodide solution was added and the flask stoppered. The contents were shaken for 1 minute and the flask placed in darkness for 1 minute. 30ml of distilled water was added and mixed well with the flask contents. Titration of the iodine with 0.002M or 0.01M sodium thiosulphate solution using 1% starch solution as an indicator then followed. A reagent blank determination (V0) was carried out using 0.5ml of 0.01M thiosulphate solution.

5.3.5.1.8 Determination of free fatty acids value

The free fatty acids were determined based on (ISO 660:2009 method). Twenty five millimeters of diethyl ether and 25Ml of ethanol were mixed. The solution was neutralized with 0.1N sodium hydroxide solution. About 5g of the sample was weighed and placed into the neutral solution and titrated with 0.1N Sodium Hydroxide solution. Phenolphthalein was used as indicator. Free fatty acids were expressed as the g of sodium hydroxide required to neutralize free acid in 100g of sample.

5.3.6 Instrumental methods

5.3.6.1 Determination of color

A hand held colorimeter (CR -200 model Japan 75043055) with an 8mmm diameter measuring area was used. Before the readings were taken, samples were placed on the flat surface. Care was taken to ensure there was no gap between sample and surface. The lens of the colorimeter was put against the plate. Three consecutive readings were taken and averaged. $L*$, $a*$ and $b*$ values were determined. The hue angle (h^0) and Chroma ($C*$) which represents the color and brightness respectively were calculated using the following equation 1 & 2 (kayaardi and Gok, 2003).

$$h^0 = \frac{\tan^{-1} (b*)}{a*} \quad \dots\dots\dots\dots\dots (1)$$

$$C* = a*^2 + b*^2 \quad \dots\dots\dots\dots\dots\dots (2)$$

5.3.6.2 Determination of texture

Texture measurements for the upgraded *Koche* product were done using a Texture analyzer TA.XT plus Texture analyzer (Stable microsystems, surrey, UK) with volodkevich bite jaws (HDP/VB*) fixture (Hansen, Hansen, Aaslyng & Bryne, 2004). The deformation rate was performed at 300mm/min to give the maximum shear force (N). The pre-test speed, test speed and post speed were set at 5.0mm/s, 5.0mm/ and 2.0mm/s respectively, while the compression distance was set at 25%. Height was calibrated as 10mm above the sample. Samples were put parallel to the surface of the compression plate and compressed using a 50kg load cell.

5.3.7 Determination of microbiological quality

The microbiological analysis was performed to determine the time period for detectable changes in microbial quality during storage. *Listeria monocytogenes* was analysed using ISO 11290-1:2004 methodology, *staphyloccus aureus* using ISO 6888-1: 1999 methodology, total aerobic count using ISO 4833-2: 2013 methodology, Yeasts and moulds using ISO 21527-2:2008 and Lactic acid bacteria using ISO 15214: 1998. Approximately 25g of the meat product was aseptically mixed with 225ml of saline water for 2 minutes. Serial dilutions were made using saline water. For each dilution, two replicate plates were prepared. Pour plating was done for yeasts and moulds and total aerobic count while spread plating was done for *Listeria monocytogenes*, *staphylococcus aureus* and Lactic acid bacteria. The microbiological data were expressed as Log CFU g^{-1}.

5.3.8 Sensory Evaluation

Sensory evaluation was done by ten untrained assessors in the sensory evaluation laboratory. *Koche* product was randomly coded and served to each assessor. Rinsing water was provided between the samples tasting for mouth rinsing. Eight attributes, color, appearance, taste, aroma, chewiness, oiliness, size of meat chunks and overall acceptability were evaluated. The interpretation of the attributes was done among the assessors prior to tasting. A five point hedonic scale was used for scoring. The scale ranged from 1(Dislike extremely) to 5 (Like extremely).

5.3.9 Accelerated shelf life analysis

To estimate the shelf-life of the product, accelerated shelf life testing according to the method of Fu and Labuza, (1997) with slight modification was done. The upgraded *Koche* product was

packed in two types of packaging material, glass and plastic jars stored at 55°C in an incubator for 6 days (1day=1month). Physicochemical and microbiological characteristics were used to quantify the quality of the upgraded *Koche* product during the storage time.

5.3.10 Cost Analysis

The cost analysis of production of *Koche* was done by listing down the variable and fixed costs involved. The variable costs considered included; raw material, ingredient, labour, packaging, electricity, water and transport, while the fixed costs included; Machines, Licenses, Taxation and Marketing. It was assumed that facilities such as building, machines are already available. However, the depreciation cost was calculated using the straight line method (Konstantinos and Dimitrios, 2015);

Annual Depreciation = Cost of the asset – Residual value / Useful life of the asset

5.3.11 Statistical Analysis

The data obtained from the various experiments were subjected to analysis of variance (Anova), least significant differences ($p<0.05$) and Duncan multiple test for comparing means using Statistical software (Genstat Version 15).

5.4 Results

5.4.1 Nutritional composition

The data pertaining to nutritional composition of raw meat samples (control) and upgraded *koche* samples made from camel, goat and beef are presented in Table 5.2. The nutritional composition showed significant differences ($p< 0.05$) between the raw meat samples. Moisture content was the most abundant corresponding in average to 63.61 and 67.81 %. Protein fraction varied significantly between 27.79 and 28.30 %, fat content between 1.18 and 1.52%, ash content

between 2.815 and 3.06%, carbohydrate content between 0 and 7.995% and energy values between 121.83 and 153.18%. In upgraded *koche* samples significant differences ($p<0.05$) were observed in the moisture content, protein content, fat content, ash content and energy values. The protein fraction was the most abundant with values between 31.87 and 36.57%. Moisture content varied between 32.90 and 34.42%, ash content between 4.69 and 6.95%, energy values between 346.32 and 404.19%. However, there were no significant differences ($p > 0.05$) in the carbohydrate content.

Table 5. 2: Nutritional composition of raw meat samples (control) and upgraded *koche* samples

Raw meat samples	Beef	Goat	Camel
Moisture	63.61 +0.42 [a]	67.19+ 0.02[b]	67.81+ 0.10[b]
Protein	25.76+ 0.18[a]	28.28 +0.02[b]	27.61+0.18 [c]
Fat	1.27+ 0.15[a]	1.5+ 0.02 [c]	1.17+0.01 [b]
Ash	2.755+0.06[b]	3.03+ 0.03[a]	3.225+ 0.04[a]
CHO	7.995+1.52[b]	0[a]	0.15+ 0.21 [a]
Crude fibre	Nil	Nil	Nil
Energy	146.5+ 6.68[b]	126.7+ 0.08[a]	121+0.83[a]
Upgraded *koche* samples			
Moisture	33.44+ 0.30[a]	32.65 + 0.25[b]	34.41 + 0.01[c]
Protein	30.58+0.29[a]	36.12+ 0.89[b]	36.56+0.01[b]
Fat	31.05+0.03[c]	27.07+ 0.07[a]	22.29+0.03[b]
Ash	4.91+0.01[b]	4.58+ 0.11[c]	6.92+ 0.03[a]
CHO	0.015+0.02[a]	0[a]	0.01[a]
Crude fibre	Nil	Nil	Nil
Energy	402.8+1.39[c]	388.1+4.23[a]	346.1+0.22[b]

Values with different superscript letters within a column are statistically different ($p < 0.05$) according to Duncan test.

5.4.2 Consumer acceptability.

From the study significant differences ($p<0.05$) existed in the products taste, color, oiliness, appearance, chewiness and overall acceptability. However, there was no significant difference ($p >0.05$) in oiliness and size of meat cubes.

Table 5.3: Sensory scores of *koche*

Sample	Color	Chewiness	Taste	Aroma	Appearance	Size of meat cubes	Oiliness	Overall acceptability
ADF	4.4±0.52^a	4.1±0.99^a	4.5±0.70^a	4.2±0.63^a	4.5±0.53^a	3.6±0.84^a	4.2±0.79^a	4.5±0.53^b
CBM	4.1±0.99^a	4.5±0.70^a	4.0±0.82^a	3.9±0.74^a	4.4±0.69^a	3.9±0.99^a	4.1±0.74^a	4.4±0.69^b
KCP	4.3±0.67^a	4.0±1.05^a	4.3±0.67^a	4.0±0.82^a	4.4±0.69^a	3.4±1.17^a	4.0±0.67^a	4.4±0.69^b
XFY	3.7±0.99^b	3.5±1.22^b	3.7±1.06^b	3.3±0.92^a	3.5±0.85^b	3.2±1.13^a	3.9±1.34^a	3.5±0.85^a
Means±SE	4.2±0.37^a	4.1±0.45^a	4.1±0.37^a	3.9±0.35^a	4.2±0.31^a	3.5±0.47^b	3.9±0.41^a	4.2±0.31^a

Means followed by the same letter are not significantly different from each other ($p<0.05$)

Legend

ADF- *Koche* product made from beef.

CBM- *Koche* product made from camel.

KCP- *Koche* product made from goat.

XFY- Traditional *Koche* product.

5.4.3 Shelf life analysis.

5.4.3.1 Effect of packaging and storage time on microbial quality of upgraded *koche* product

Table 5.4 shows the results of microbial quality of upgraded *koche* product packed in plastic jars and glass jars. Total aerobic count showed an increase from log 2.23 to 6.64 during the entire accelerated storage period from day 0 to 6 days. *Listeria monocytogene* increased from log 1.26 to log 2.20. Similarly, *staphylococcus aureus* showed an increase from log 1.53 to log 2.19. Lactic acid bacteria were not detected on day 0 but there was an increase from day 1 to day 6 with values ranging from 1.48 to 2.19 respectively. Yeasts and moulds were not detected on day 0 but showed an increase from day 1 to day 6 of accelerated storage with values ranging from log 1.67 to log 2.22 respectively.

Table 5.4: Effect of packaging and storage time on the microbial quality of upgraded *koche* product

Type of packaging	Period of storage (Days)							Means
	0	**1**	**2**	**3**	**4**	**5**	**6**	
Total viable count								
Plastic jars	2.23±0.11[a]	2.73±0.04[b]	3.70±0.05[c]	4.16+0.21[c]	4.75±0.05[cd]	6.58±0.09[d]	6.64±0.02[d]	4.39±1.66[A]
Glass jars	2.23±0.11[a]	3.48±0.08[b]	3.8 ±0.03[b]	3.82±0.03[c]	4.17±0.06[c]	5.58±0.04[c]	6.41±0.05[c]	4.04±1.45[A]
Staphylococcus Aureus								
Plastic jars	1.53±0.02[a]	1.59±0.04[b]	1.70±0.04[c]	1.74±0.04[d]	1.83±0.04[de]	1.90±0.06[de]	2.19±0.10[e]	1.78±0.22[B]
Glass jars	1.55±0.06[a]	1.56±0.02[b]	1.61±0.01[b]	1.66±0.01[c]	1.87±0.05[cd]	1.87±0.01[d]	2.14±0.02[d]	1.75±0.21[B]
Listeria Monocytogenes								
Plastic jars	1.26±0.04[a]	1.34±0.04[b]	1.40±0.01[c]	1.51±0.08[cd]	1.7±0.06[d]	1.88±0.04[de]	2.20±0.01[e]	1.61±0.32[C]
Glass jars	1.26±0.04[a]	1.33±0.06[b]	1.34±0.06[b]	1.41±0.01[d]	1.67±0.03[de]	1.72±0.01[d]	2.04±0.03[e]	1.54±0.27[C]
Lactic acid bacteria								
Plastic jars	ND	1.48±0.04[a]	1.66±0.06[b]	1.72±0.01[cd]	1.98±0.06[d]	2.08±0.08[de]	2.19±0.16[c]	1.57±0.72[E]
Glass jars	ND	1.26±0.08[a]	1.53±0.11[b]	1.70±0.01[c]	1.73±0.04[de]	1.85±0.07[d]	2.02±0.03[c]	1.44±0.65[E]
Yeasts and moulds								
Plastic jars	ND	1.67±0.04[a]	1.69±0.01[b]	1.71 ±0.01[c]	1.79±0.04[c]	1.94±0.05[cd]	2.22±0.04[d]	1.57±0.69[D]
Glass jars	ND	1.55±0.06[a]	1.65±0.04[b]	1.75±0.03[c]	1.71±0.01[cd]	1.83 ±0.04[d]	2.11±0.09[e]	1.51±0.66[D]

Values with different superscripts, lower case along a row and uppercase along a column, are statistically different at p<0.05.

5.4.3.2 Effect of packaging and storage time on the chemical quality of upgraded *koche* product

Table 5.5 shows the effect of packaging and storage time on the quality of upgraded *koche* during storage. ANOVA indicated a significant effect *(p<0.05)* of packaging and storage time on the moisture content, peroxide value and free fatty acids. Moisture content values ranged from 28.10 to 34.42, free fatty acid value ranged from 0.85 to 1.65. Peroxide value ranged from 0.64 to 3.48

Table 5.5: Effect of packaging and storage time on the chemical quality of upgraded *koche* product

Type of packaging	Period of storage (Days)							Means
	0	**1**	**2**	**3**	**4**	**5**	**6**	
	Free Fatty acids (FFA)							
Plastic jars	0.85 ± 0.3^a	0.93 ± 0.0^d	0.86 ± 0.0^b	0.92 ± 0.0^c	1.06 ± 0.0^d	1.17 ± 0.0^d	1.65 ± 0.0^f	1.06 ± 0.28^A
Glass jars	0.86 ± 0.0^a	0.87 ± 0.0^d	0.84 ± 0.0^b	0.92 ± 0.0^c	0.99 ± 0.0^d	1.12 ± 0.0^d	1.57 ± 0.0^f	1.02 ± 0.25^A
	Peroxide value (PV)							
Plastic jars	ND	0.64 ± 0.0^a	0.86 ± 0.0^b	1.35 ± 0.0^c	1.70 ± 0.0^d	2.89 ± 0.0^e	3.48 ± 0.0^f	1.56 ± 1.22^B
Glass jars	ND	0.46 ± 0.0^a	0.61 ± 0.0^b	1.47 ± 0.0^c	1.69 ± 0.0^d	2.11 ± 0.0^e	3.37 ± 0.0^f	1.38 ± 1.11^B
	Moisture content							
Plastic jars	$34.42\pm0.^a$	$34.12\pm0.^a$	34.06 ± 0.8 b	31.50 ± 0.72^c	30.73 ± 1.03^c	29.11 ± 0.30^c	28.10 ± 0.03^d	31.72 ± 2.49^C
Glass jars	34.42 ± 0.1^a	34.39 ± 0.01^a	34.36 ± 0.01^b	32.19 ± 0.05^b	32.10 ± 0.14^b	31.50 ± 0.89^d	30.41 ± 0.58^d	32.77 ± 1.589^C

Values with different superscripts, lower case along a row and uppercase along a column, are significantly different at p<0.05.

5.4.3.3 Effect of packaging and storage time on the physical quality of upgraded *koche* product

The texture and mean color values of upgraded *koche* as affected by packaging and storage time are presented in table 5.6. Packaging and storage time had a significant effect ($p<0.05$) on texture, $L*$ value, hue angle. However, it was not statistically significant ($p >0.05$) on chroma value. Texture values ranged from 0.67- 3.01kg/cm, $L *$ value ranged from 26.01-19.06. H^o ranged from 59.40-89.12 and chroma value ranged from 12.09-16.07.

Table 5.6: Effect of packaging and storage time on the physical quality of upgraded *koche* product

Type of packaging	Period of storage (Days)							Means
	0	**1**	**2**	**3**	**4**	**5**	**6**	
Texture								
Plastic jars	0.67 ± 0.01^a	1.10 ± 0.01^b	2.49 ± 0.03^b	2.55 ± 0.01^b	2.57 ± 0.01^b	2.98 ± 0.01^b	3.01 ± 0.01^a	2.19 ± 0.89^A
Glass jars	0.67 ± 0.01^a	0.74 ± 0.00^a	0.95 ± 0.10^a	1.17 ± 0.18^a	1.29 ± 0.23^a	1.45 ± 0.07^a	1.48 ± 0.05^b	1.11 ± 0.33^A
L^*								
Plastic jars	26.01 ± 0.01^a	24.20 ± 0.17^b	23.30 ± 0.42^b	22.93 ± 0.38^b	21.33 ± 0.47^b	20.66 ± 0.08^b	19.39 ± 0.55^b	22.55 ± 2.18^B
Glass jars	26.01 ± 0.01^a	21.00 ± 0.57^a	$22.93£\pm0.3^b$	20.34 ± 0.33^a	20.52 ± 0.25^a	19.47 ± 0.38^a	19.06 ± 0.09^a	21.10 ± 2.23^A
Hue								
Plastic jars	59.42 ± 0.00^a	63.43 ± 1.06^a	70.79 ± 1.48^a	79.89 ± 1.09^a	87.99 ± 0.80^a	89.31 ± 0.27^a	89.12 ± 0.13^a	76.71 ± 12.87^A
Glass jars	59.42 ± 0.00^a	61.81 ± 0.19^a	67.31 ± 1.13^b	71.43 ± 0.57^b	79.23 ± 0.10^b	84.00 ± 0.16^b	89.10 ± 0.10^b	73.18 ± 10.91^B
Chroma								
Plastic jars	16.07 ± 2.01^a	14.32 ± 0.69^a	13.23 ± 0.11^a	12.88 ± 0.04^a	12.43 ± 0.00^a	12.28 ± 0.00^a	12.21 ± 0.00^a	13.35 ± 1.48^A
Glass jars	1.65 ± 0.00^a	13.65 ± 0.13^a	12.93 ± 0.12^a	12.40 ± 0.04^a	12.22 ± 0.01^a	12.21 ± 0.00^a	12.21 ± 0.00^a	12.90 ± 0.90^A

Values with different superscripts, lower case along a row and uppercase along a column, are statistically different at p<0.05.

5.4.4 Cost Analysis

Table 5.7 and 5.8 shows the variable and fixed costs of producing upgraded *koche* product.

Table 5. 7: Variable costs of producing upgraded *koche* product

Item	Costs in Kshs (Beef)	Costs in Kshs(Camel)	Costs kshs (Goat)
Meat (2kg)	800	800	1000
Salts	3	3	3
Spices	3	3	3
Cooking oil (10litre)	84	84	84
Packaging (4glass jars (250gm)@40per piece	160	160	160
Labour	5	5	5
Transport	10	10	10
Utility			
• Electricity	1065	1065	1065
• Water	1065	1065	1065
Total costs	**3,195**	**3,195**	**3,395**
Final product cost	**3,195/kg**	**3,195/kg**	**3,3 95/kg**

Table 5. 8 : Fixed costs of producing upgraded *koche* product

Item	Costs in Kshs
Machines	
• Solar drier	24,000
• Electric fryer	1062.5
• Meat slicer	4375
• Meat cube cutter	4375
Marketing costs	5325
Licenses	
• Code of hygiene standards (KS EAS 39)	2670
• Public health certificate	10,000
• Product testing	5800
Total costs	**57,607.5**

5.5 Discussion

5.5.1 Nutritional quality

The general trend observed between the raw meat samples (control) and upgraded *koche* samples

was increased nutrient density (protein, lipid and ash contents) as moisture reduced. It was

similar to data reported by Fernandez-Gines and others (2005).The high moisture content in *koche* samples was attributed to curing and spicing. Similarly, Pinero and others (2008) reported that use of spices reduces moisture loss during deep frying by increasing the water ability of the meat tissues. Therefore, the cooked upgraded *koche* samples would satisfy the today's consumers' preferences for more tender, less dehydrated *koche* product. The fat content in upgraded *koche* samples was considerably high. This may be due to oil absorption during deep frying. As reported by Aprajeeta and others (2015), drying and subsequent deep frying of foods such as meat chunks causes porosity changes thereby increasing oil absorption. Protein content reported an apparent increase after deep frying. During deep frying, water is extracted increasing the dry matter of the final product. The protein content demonstrates the potential value of upgraded *koche* product as a source of high protein food. The ash levels of the *koche* samples were high as compared to the fresh meat samples a reflection of the added salts used in processing. As reported by (Huda *et a*l., 2012; Bourne, 2002) addition salts such as sodium chloride, phosphates during processing increases ash content of a product and influences the textural properties of food. A reduction in carbohydrates and fibres was due to the high temperatures employed during deep frying of the product. Chloe and Min, (2007) reported that high temperatures result in loss of nutritional components.

5.5.2 Consumer acceptability

Consumer acceptability and perception of quality is influenced by sensory characteristics (Simela, 2005).Sensory characteristics are thus pivotal. In this study, deep frying contributed to the sensory characteristics (Saguy and Dana, 2003). Palatability of the deep fried products was influenced by texture, flavor, colour, and appearance, size of meat cubes, oiliness, chewiness and taste. Upgraded *koche* samples made from camel, beef and goat scored highly in regards to

colour, taste, appearance and overall acceptability. Overall acceptability of upgraded *koche* product made from camel, beef and goat was the same.

5.5.3 Shelf life analysis

5.5.3.1 Effect of packaging and storage time on the microbial quality of upgraded *koche* product.

Total aerobic count, yeasts and moulds, *listeria monocytogenes*, *staphylococcus aureus* and lactic acid bacteria were able to grow in the upgraded *koche* samples. Curing increased the water binding ability thus making the environment conducive for microbial growth (Veronique, 2008). Packaging did not have a significant difference *(p>0.05)* in the total aerobic count, *listeria monocytogenes*, *staphylococcus aureus*, lactic acid bacteria and yeasts and moulds. Similar findings have been reported by Gichure and others (2017) in deep fried beef chunks packed in glass and plastic jars stored at 37^0 C for 15 days. In both packaging systems the values were within the range specified for ready to eat meat products by Kenya bureau of standards (KEBS) upto 5th day of accelerated storage. According to Kenya bureau of standards (KEBS) (KS 2455: 2013, KSS59-2:2013) the legal limits for TVC, *staphylococcus aureus*, *listeria monocytogenes* , yeasts and moulds, lactic acid bacteria are 6.0 $\log_{10}$cfu/g, 2.0$\log_{10}$cfu/g, 2.0$\log_{10}$cfu/g,2.0 $\log_{10}$cfu/g, 2.0$\log_{10}$cfu/g respectively.

5.5.3.2 Effect of packaging and storage time on the physicochemical quality of upgraded *koche* product.
5.5.3.2.1 Moisture content

Packaging did not have a significant effect on moisture content ($p > 0.05$). Moisture content in both packaging conditions showed a declining trend. However, product packed in glass jars had high moisture content than product packed in plastic jars.

5.5.3.2.2 Free Fatty acids (%)

Free fatty acids increased significantly during storage an indication of lipolysis. Packaging did not have a significant effect ($p > 0.05$) on the level of free fatty acid in the product. This is in line with a study by Malik and others (2014) where he found out free fatty acids percent was not significantly affected by the type of packaging. However, product packed in plastic jars had a high level of free fatty acids than product packed in glass jars. From day 1 to day 5 of accelerated storage, the free fatty acid levels in the product were within the acceptable limit of less than 1% (Tiwari *et al*., 2011). The low level of free fatty acids points out minimal hydrolysis of triglycerides, as high deep frying temperatures denatures most lipase enzymes as suggested by Camire and others (1990). However, on day 6, the level of free fatty acids in the product exceeded the allowable limits**.**

5.5.3.2.3 Peroxide value

Detection of peroxide value in meat products indicates rancidity (Jin *et al*., 2009). At day 0, peroxide values were low. Similarly, Charbia and others (2002) reported that at the beginning of shelf life of foods peroxide values are low. However, peroxide values increased significantly throughout the storage period regardless of the type of packaging used. As observed, product packed in glass jars yielded lower scores than product packed in plastic jars. But the difference was not significant ($p>0.05$). In both packaging systems, the peroxide value levels were within the recommended values of between 3- 20meq/kg (Tiwari *et al*., 2011).

5.5.3.2.4 Texture

Texture is the sensory characteristic of food detected through the senses of vision, hearing, touch and Kinesthetics. Its components include toughness/ fibrousness, mealiness /grittness, firmness/

softness, crispness, juiceness (Szczesniak, 2002). The firmness values increased with storage time. Packaging had an influence on ($p < 0.05$) the firmness values of upgraded *koche* product. Upgraded *koche* product packed in plastic jar recorded high firmness values than the one packed in glass jars.

5.5.3.2.5 Color values

Color of meat is an important quality attribute (Feiner, 2006). The $L*$, $a*$ and $b*$ values indicate the source of light variation in light scattering from the surface of meat and degree of browning (Van oeckel, Warnants and Boucque, 1999). The H* and C* values were calculated since they provide greater sensitivity than a* and b* values alone. Packaging significantly affected the color values ($p < 0.05$) except the chroma value. The $L*$ values showed a declining trend during storage irrespective of the packaging type. The lowest $L*$ Value occurred on day 6 of storage. This supports the findings of Aksu and Kaya (2001a, 2001b) where he reported a similar trend in the $L*$ values. Hue angle is the description of color in language (red, yellow, green, blue) (AMSA, 2012). Hue color of upgraded *koche* product in plastic jars was significantly ($p < 0.05$) higher than in glass jars. Larger hue values indicate more metmyoglobin formation (Howe, Gullet and Usborne, 1982).

5.5.3.2.6 Cost analysis

The comparative production for the upgraded *koche* made from camel, beef and goat shows benefit to the processor. All the variable costs were the same, only the cost of meat varied.

5.6 Conclusion

Upgraded *koche* has a high shelf-life and can be conveniently packed in glass jars and stored for 5months at room temperature. The cost of production is also affordable. It is thus possible to upgrade *koche* product for commercialization thus increased incomes.

CHAPTER SIX: GENERAL CONCLUSIONS AND RECOMMENDATIONS

6.1 General Conclusions

From this research, commercial viability of upgraded *koche* product exists. The study established that *koche* processing is a profitable business evidenced by the gross margin values. However, it is still done on small scale by few processors. Several challenges face the processors making the product unable to tap into new market opportunities. The study revealed a great market potential. A high proportion of the study population purchased *koche* product. Upgraded *koche* product exhibited better quality in terms of nutrition and storability thus potential for commercialization.

6.2 General Recommendations

1. Processing of *koche* product as a commercial activity is recommended.

2. Adoption of the optimized and upgraded *koche* processing is much more beneficial to the small scale processors in terms of market positioning and enhancing consumer acceptability of the product.

3. Processors should progressively be trained and equipped with good quality control measures during processing.

4. In addition, any development programs or government policy directed towards improving livestock production to increase meat supply will increase the profit from *koche* processing and lead to the advancement of *koche* industry since the profit realized from *koche* processing is mainly affected by the cost of meat.

5. Promotion should also be done to non-conventional consumers to increase consumption.

REFERENCES

Abou-Charbia, H.A., Shehata, A. A., and Shadidi, F. (2002) .Effect of processing on oxidative stability and lipid classes of sesame oil . *Food research international* ; 33:331-340.

Acho-chi, C. (2002). The mobile street food service practice in the urban economy of Kumba, Cameroon. *Singapore Journal of Tropical Geography;* 23: 131-148.

Ahmadu, J., Erhabor,P.O., Orewa,S.I., and Igene,J.O . (2008 b). Resource use efficiency in traditional *Kilishi* production in Bauchi and Kaduna States of Nigeria. *Journal of Agricultural Research and policies ;* 3 (2): 51 –64.

Ahmadu, J., Alufohai, G.O. Erhabor,P.O. Igene, J.O. (2008 a). Profitability of *Kilishi* Production under traditional and modern technologies in Nigeria. *Journal of Sustainable Tropical Agricultural Research ;* 28:14-21.

Ahmadu,J., Igene,J.O.Ada-Okungbowa,C.I.,and Agboola,H.A.   (2004). Economics of *kilishi* production in Nigeria. *Applied Tropical Agriculture*: *An International Journal;* 9 : 25-33.

Amao. J.O., and Ayantoye, K. (2014). Consumer Preference and Consumption Pattern for selected forms of Fish in Oyo State, Nigeria. *International Journal of Science, Environment and Technology;* 3 (3):841 – 860.

Amran, H. L., and Aslan, A. (2012). Knowledge Determinant in University Commercialization. A case study of Malaysia Public University, Asia*. Pacific Business Innovation and Technology Management ;* 251-257.

Andree, S., Jira,W., Schwind,K.H., Wagner,H., and Schwagele, F. (2010). Chemical safety of meat and meat products. *Meat science* ; 86 (1) : 38-48.

AOAC. (2005).Official methods of analysis of AOAC International. 18th edition. Published by the association of Analytical communities international . Gaithersburg,MD.

Apata, E.S., Osidibo,O.O., Apata,O.C., and Okubanjo,A.O. (2013). Effects of different solar drying methods on quality attributes of dried meat production (*kilishi*). *Journal of Food Research* ; 2(1): 80-86.

Aprajeeta,J., Gopirajah,.R., and Anandharamakrishnan, C. (2015) . Shrinkage and porosity effects on heat and mass transfer during potato drying. *Journal of Food Engineering* ; 144: 119-128

Asogwa, I .S., and Okoye,J.I. (2017). Promotion of indigenous food preservation and processing knowledge and the challenge of food security in Africa. *Journal of Food Security;* 3:75-87.

Awuor, A, Integrating Indigenous Knowledge for Food Security: Perspectives from the Millennium Village Project at Bar-Sauri in Nyanza Province in Kenya. A Paper presented to the African Research and Resource Forum (ARRF) and the Economic Policy Research Centre (EPRC) for held Kampala, Uganda on 16-17, November 2011.

Ayanwale, B.A., Ocheme, O.B., and Oloyede, O.O. (2007). The effect of sun-drying and oven-drying on the nutritive value of meat pieces in hot humid environment. *Pakistan Journal of Nutrition.* 6(4): 370-374.

Behnke, R., and Muthami, D. (2011). The contribution of livestock to the kenyan economy. *IGAD, Livestock Policy Initiative working paper,* (03-11).

Bender Arnold. Meat and meat products   in human nutrition in developing countries. Italy: FAO Food and Nutrition Paper; 1993.

Berndsen,M., and Pligt, J.V.D "Ambivalence towards meat," . *Appetite;* 42(1): 71-78.

Bora, L., and J. Bam. 2014. Traditional milk, meat processing and preservation techniques of the yak pastoralists of Arunachal Pradesh. *Indian Journal of Traditional Knowledge* 131 (1): 216–221.

Bourne, M.   (1992). Calibration of rheological techniques used for foods. *Journal of Food Engineering* ; 16: 151- 163.

Brown, L, (2011). Women and food security; roles, constraints and missed opportunities .In: The role of food, agriculture, forestry and fisheries in human nutrition .Squires, V.R edunesco-eolss e-book. 2011.

Camire,M.E., Camire, A.L., and Krumhar,K. (1990). Chemical and nutritional changes in foods during extrusion. *Critical reviews in Food Science and Nutrition ; 29: 35-57.*

Cengiz, S., Yilmaz, E., Mencet, M.N., Suleyman, K. and Yavuz, T. (2010). Analysis of Factors Affecting Fish Purchasing Decisions of the Household: Antalya District Case. *Journal of Animal and Veterinary Advance*; 9(12):1689-1695.

Chambwera, M. (2012). The informal economy: A threat or driver for the green economy?

Choe, E., and Min, D.B. (2007). Chemistry of Deep –Fat Frying oils. *Journal of Food Science*; 72(5): 77-86.

CSIR, 2001. Investigations on the preparations of biltong. CSIR Food Biological and Chemical Technologies, Pretoria

Dabasso, B.G., Roba, H.G., Makokha, A., Onyango, A., and Maina, J. (2018). Understanding traditional meat processing knowledge among the Borana pastoralist of Northern Kenya. *Journal of Food Research ;* 7: (4) : 30-40.

Delgado, C. L. (2003). "Rising consumption of meat and milk in developing countries has created a new food revolution." *Journal of Nutrition*; 133(11): 3907S-3910S.

EPZA (2005), Meat Production in Kenya. Kenya Export Processing Zones Authority. Nairobi, Kenya. Retrieved from http://www.epzakenya.com/UserFiles/File/MeatIndustry.pdf last accessed on 30/05/2018.

FAO (2007). Manual on meat cold store operations and   management. Agriculture and consumer protection . FAO Corporate Document Repository FAO, Rome.

FAO (1995). *Development and promotion of value added products*. Project Document, FAO, Rome.

FAO (2011). Global Food Losses and Food Waste - extent, causes and prevention. Rome, Food and Agriculture Organization of the United Nations. Accessed March 2017.

FAO, The State of Food and Agriculture 2010-11, Livestock in a balance, Electronic Publishing Policy and Support Branch Communication Division-FAO, Rome, Italy, 2009. Accessed April 2018.

FAO. (2013). *Small holder integration into changing food markets.* Food and Agriculture Organization. Accessed on march 2017.

FAO. 2001. Improved meat drying in Asia and Pacific, FAO Rome. Accessed July 2018.

FAOSTAT (2011), "FAO Statistical Database". Retrieved from http://faostat.fao.org/, accessed March 2017.

Farmer, E., and Mbwika, J. (2012). End market Analysis of kenyan livestock and meat. Usa: USAID.

Feiner, G. (2006). Colour in fresh meat and in cured meat products. Meat products handbook: Practical science and technology. Cambridge, England: Woodhead Publishing Limited.

Fernandez-Gines, J.M., Fernandez-Lopez, J., Sayas-Barbera,E., and Perez-Alvarez, J.A. (2005). Meat products as functional foods. *Journal of Food Science* ; 70: R37-R43.

Fnifst,O.C.A.P (2008). The role of traditional food processing technologies in National development: the West African experience. Retrieved from https:// www.researchgate.net /publication/237218596

Gadaga, T.H., Ntisike,M.M., and Ntuli,V . (2011). Socio-economic and hygienic aspects of street food vending in Maseru City, Lesotho. *USWA Research Journal of Agriculture, Science and Technology;* 15: 28-39.

Gichure, J. N., Kunyanga, C. N., and Imungi, J. K. (2017). Standardization of cut size and pre-drying time to mainstream pastoral beef farming. *Pastoralism,Research,policy and Practice* ; 7: 1-2.

Gichure, J.N.,Kunyanga,C.N.,Mathi,P.M.,and Imungi,J.K. (2014). Present status of meatprocessing and preservation in the pastoral regions of kenya. *Food Science and Quality Management*; 34:42-50

Gichure, J.N.,Kunyanga,C.N.,Mathi,P.M.,and Imungi,J.K. (2016). Chemical and sensory Attributes of selected meat products from Kenyan pastoral communities: Case of Nyirinyiri, Enyas, Ng'amorumoru, and Olpurda. In press.

Gichure,J.N.,Kunyanga,C.N.,Mathi,P.M.,and Imungi,J.K.(2015). Meat preservation technologies in Kenya's Pastoral Areas with Potential for Market Competitiveness Improvement. Paper presented at Conference on Policies For Competitive Smallholder Livestock Production. Gaborone, Botswana,4-6 March 2015.

Government of Republic of Kenya. 2007. Kenya Vision 2030. Ministry of Devolution and planning. Nairobi; Government printer.

Grunert KG (1997) What's in a steak? A cross-cultural study on the quality perception of beef. Food Quality and Preference, 8(3): 157-173.

Hansen, S., Hansen, T., Aaslyng, M. D. and Byrne, D. V. (2004). Sensory and instrumentalanalysis of longitudinal and transverse textural variation in pork longissimus dorsi. Meat Science, 68, 611-629.

Herlocker, D.J., Shaaban, S.B., and Wilkes, S. (1993). Range management handbook of Kenya. Volume II, 5: Isiolo District. Nairobi: Ministry of Agriculture, Livestock Development and Marketing .

Homewood, K.M., P.C. Trench, and D. Brockington. (2012). Pastoralist livelihoods and wildlife revenues in East Africa: A case for coexistence? Pastoralism, Policy and Research Journal 2: 19.

Howe, J. L., Gullett, E. A. & Usborne, W. R. (1982). Development of pink color in cooked pork.Canadian Institute of Food Science and Technology, 15, 19.

http://www.greeneconomycoalition.org/know-how/informal-economy-threat-or-driver-green-economy. Accessed on May 2018.

Huda, N., Alistair, T.L.J., Lim, H.W., and Nopianti, R. (2012) Some quality characteristics of Malaysian commercial fish sausage. *Pakistan Journal of Nutrition*; 11(8):700–705.

Hudson, D., and Hite,D. (2003). Willingness to Pay for Water Quality Improvements: The Case of Precision Application Technology. *Journal of Agricultural Resource Economics* ; 27:433-449.

Iheanacho, A.C., and D.O.A. Philips. (2002). Costs and Returns of Millet-Based Crop Mixtures in the Arid zone of Nigeria. A case study of Borno state, Nigeria. Journal of Arid Agricutural, 12: 131–135.

Iliyasu, A., A.C. Iheanacho, and S.I. Mshelia. (2013). Profitability analysis of three methods of suya production and marketing in Maiduguri Metropolitan Council, Borno State, Nigeria. *Nigerian Journal of Basic and Applied Sciences* 16 (2): 257–262. Available online at https://www.ajol.info.

Irungu P, (2008). Contribution of the livestock sector to Kenya's GDP: A consultancy report to Agriculture Sector Coordinating Unit (ASCU), Ministry of Agriculture and Livestock Development, Nairobi, Kenya.

Ismael, N., Mohd, J. N., and Safiah, S. (2015). A Framework for a Successful Research Products Commercialization*: A case of Malaysian Academic Researchers.*

ISO (2009). Animal andVegetable fats and oils – Determination of acid value and acidity. ISO 660:2009

ISO (2006). International Organization for Standardization. Sensory analysis- Methodology- Ranking. EN ISO,8587,2006.

Iyenda, G. (2001). Street food and income generation for poor households in Kinshasa. *Environment and Urbanisation* 13: 233-241.

Jin, S. K., Kim, I. S., Choi, Y. J., Kim, B. G., and Hur, S. J. (2009). The development of imitation crab sticks containing chicken breast surimi. *LWT-Food Science and Technology* ; 42: 150-156.

Jones,M., Arnaud, E, Gouws,P., and Hoffman.L.C. (2017). Processing of South African Biltong- A Review. South African Journal of Animal Science, 47: 6

Kapferer, J.N. (2004). The New Strategic Brand Management: Creating and Sustaining Brand Equity Long Term. London: Kogan Page.

Kardivel, G., Banerjee,B.B., Meitei,S., Doley,S., Sen,A., and Muthukumar, A. (2018). Market potential and opportunities for commercialization of traditional meat products in North East hill region of India, *Veterinary World; 11* (2): 118-124.

Kenya Market Trust (KMT), (2014). Kenya Livestock & Meat Market Analysis for Cattle ,Goat &Sheep.http://www.kenyamarkets.org/download/get/kenya-livestock-meat-analysis1/35.

Khan, S. A. (2005). Introduction to extension education in Memon, R. A. and E. Bashir (eds.). Extension Methods (3rded.). National Book Found, Islamabad, Pakistan.

Kirkbride, M and Grahn, R. 2008. Survival of the fittest: Pastoralism and climate change in Africa. *Oxfam policy and practice: Agriculture, Food and Land* ; 8 (3) : 174-220.

Kisembe, S.W., Muliro, P.S., Matofari, J.W., and Bebe, B.O. (2017). An evaluation of nutritional quality of traditionally processed camel meat (*Nyirinyiri*): Value chain

assessment and recommendations. *International Journal of Nutrition and Food Sciences* ; 6 (4): 172-174.

KNBS (Kenya National Bureau of Statistics): 2009. Population and housing census. Kenya National Bureau of Statistics; 2010.

Konstantinos, J., and Dimitrios,D.K . 2015. Depreciation methods and life cycle costing methodology; *Procedia Economics and Finance* 19: 314-324

Lin, L.C., and Huang, K.Y. (2004) Comparing of vacuum shrink packaging and vacuum packaging with vacuum shrink packing treatment process on storage properties of Taiwan country chicken during chilled storage. *Journal of Agriculture and Forestry*; 53(3): 251-260.

Lindqvist, A.K., and T. Verba. 2009. Overview of drylands development communication initiatives in Africa. Chicago. http://pubs.iied.org/pdfs/G02494.pdf

Madete, S.K. P., Bebe,B.O., Matofari, J.W., Muliro,P.S., and Mangeni,E.B. (2015). Communicating food quality and safety in the informal market outlets of pastoral *suusa* and *nyirinyiri* products in Kenya. *Agriculture,Forestry and Fisheries;*.4: 216-221.

Mafimisebi, T. 2012. Comparative Analysis of Fresh and Dried Fish Consumption in Rural and Urban Households in Ondo State, Nigeria, IIFET 2012 Tanzania Proceedings. Available at:https://ir.library.oregonstate.edu/xmlui/bitstream/handle/1957/35117/Mafimisebi.pdf?sequence =4 Accessed on 27th March, 2018.

Makita,D.G., Kangethe, E. K., and Bonfoh, B. (2010). Safe Food Fair Food Participatory Risk Analysis For Improving the Safety of Informally Produced and Marketted Food in Sub-Saharan Africa. *Revue Africaine de Santé et de Productions Animales* 8 (2): 3-11.

Malik .A. H and Sharma,B.D. (2014). Shelf life study of hurdle treated ready-to-eat spiced buffalo meat product stored at 30±3 °C for 7 weeks under vacuum and aerobic packaging. *Journal of Food Science and Technology* ;51(5):832–844.

Mathi, P.M, Kunyanga, C. N. , Gichure, J. N., and Imungi, J. K. (2016). Utilization of beef slaughter by-products among the Kenyan Pastoral communities. *Food Science and Quality Management* ; 53: 80-81.

Mati, B.M., J.M. Muchiri, K. Njenga, F. Penning de Vries, and D.J. Merrey. 2005. Assessing water availability under pastoral livestock sytems in drought prone Isiolo District, Kenya. Working paper 106. Colombo, Sri-lanka international water management institute (IWM).

Ministry of Agriculture, Livestock and Fisheries (MAL&F), (2015). Strategic Plan 20312017 .http://www.kilimo.go.ke/wpcontent/uploads/2015/05/MoALF_Strategic-Plan_2013-2017.pdf.

Montcho, M., Babataounde,S.,Yamego,V.B., Aboh, A.B., and Mensah, G.A. (2018). Socio-economic determinants of away from home grilled meat consumption and typology of grilled meat actors in bobo-Dioulassa, West Burkina Faso. *Journal of Fisheries and Livestock Production* ; 5 (4) : 3-9.

Muinde, O.K., and Kuria,E. (2005). Hygienic and sanitary practices of vendors of street foods in Nairobi, Kenya. *African Journal of Food, Agriculture and Nutrition Development ;* 5: 1-13.

Musaba, E. C. and Namukwambi, M. (2011). Socio-economic determinants of consumer fish purchase in Windhoek, Namibia. *African Journal of Agricultural Research ;* 6(6):1483-1488.

Muthee, A. M. (2006). Kenya Livestock sector study *;* An analysis of pastoralist livestock products market value chains and potential external markets for live animals and meat. AU-IBAR& NEPDP, *consultancy report* : *Deloitte consulting ltd* .

Muyanja, C., Nayiga,L., Namugumya, B., and Nasinyama,G. (2011). Practices, knowledge and risk factors of street food vendors in Uganda. *Food Control*; 22: 1551-1558.

Neven, D., and Reardon, T. (2004). The Rise of Kenyan Supermarkets and the Evolution of their Horticulture Product Procurement Systems. Development Policy Review, 22(6): 669-699

Obadina, A.O, Oyewole, B.O., and Williams,E.O.(2013). Improvement in the traditional processing method and nutritional quality of traditional extruded cassava-based snack (modified Ajogun). Food Science and Nutrition, 1(4): 350-356.

Olsen, S.O. (2001). Consumer involvement in seafood as family meals in Norway: an application of the expectancy-value approach. *Appetite* ; 36: 173-186.

Omiti, J., and Irungu, P., (2002). Institutional and policy issues relevant to pastoral development in Kenya. Discussion paper No. 031, Institute of Policy Analysis and Research (IPAR), Nairobi.

Omojola, A. B. (2008). Yield and organoleptic characteristics of *suya* (an intermediate moisture meat) prepared from three different muscles of a matured bull. *African Journal of Biotechnology* 7 (13): 2254 – 2257.

Oniang'o , R ., Allotey, J., and Malaba, S.J. (2006). Contribution of indigenous knowledge and practices in Food Technology to the attainment of Food Security in Africa. *Journal of Food Science.*

Ören, K., and Biçkes, M. (2011). Effects of personality traits on entrepreneurship potential: A study on higher education students in Nevşehir. *The Journal of Faculty of Economics and Administrative Sciences* ; *16*(3), 67-86.

Parfitt, J., Barthel, M., Macnaughton, S. (2010). Food waste within food supply chains: quantification and potential for change to 2050. Philosophical Transactions of the Royal Society; *Biological Sciences;* 365(1554): 3065-3081.

Pavanello, S. (2010). *Livestock marketting in Kenya-Ethiopia Boarder Areas : A baseline study* Humanitarian Policy Group (HPG), Overseas Development institute (ODI).

Piñero, M.P., Parra, K., Huerta-Leidenz, N., Arenas de Moreno, L., Ferrer, M., Araujo, S. and Barboza, Y.2008. Effect of oat's soluble fibre (β-glucan) as a fat replacer on physical, chemical, microbiological and sensory properties of low-fat beef patties. *Meat Science* ; 80(3): 675-680.

Rai, A., and U. Palni. 2009. Traditional knowledge of the Himalayan people on production of indigenous meat products. *Indian Journal of Traditional Knowledge* 08 (1): 104–109.

Rheinlander, T., Olsen, M., Bakang, J.A., Takyi, H., and Konradsen, F. (2008) .Keeping up appearances, perceptions of street food safety in urban Kumasi, Ghana. *Journal of Urban Health;* 85: 952-964.

Rodriguez del Águila, M. M., and González-Ramírez, A. R. (2013). Sample size calculation. *Allergologia et immunopathologia* ; *42*(5): 485-492.

Roever, S. (2007). Women, Gender, Development:'Women and workplace Insecurity'. Development Issues,9 (1) June.

Rosegrant M. W., S Cline. A., Li, W., Sulser, T.B., and Valmonte-Santos, R.A. (2005). Looking Ahead: Long-Term Prospects for Africa's Agricultural Development and Food Security.2020 Discussion Paper No. 41, International Food Policy Research Institute, Washington, DC, USA.

Russell, B.C., McAlister,G.,Ross,I.S.,and Pethick,D.W. (2005). Lamb and sheep meat eating quality-industry and scientific issues and the need for integrated research. *Australian Journal of Experimental Agriculture* ; 45: 465-467.

Saguy, I.S., and Dana, D. 2003. Integrated approach to deep fat frying: engineering, nutrition, health and consumer aspects. *Journal of Food engineering*; 56(2): 143-152.

Satterwaite, D., Mc Granahan, G., and Tacoli,C. (2010). Urbanization and its implication on food and farming. Philosophical transactions of the royal society of London : *Biological Sciences;* 365(1554): 2809-2820.

Sharma, B.D., and N. Kondaiah. 2005. Development of Buffalo meat samosa and evaluation of its storage in low vacuum family park under frozen condition. *Journal of Veterinary Public Health* 2 (3): 59–62.

Simela, L. (2005). Meat characteristics and acceptability of chevon from South African Indigenous goat. P.h.D. Thesis, University of Pretoria.

Slater, S. and Narver, J.C. (2000), "The positive effect of a market orientation on business profitability: a balanced replication", Journal of Business Research, Vol. 48 No. 1, pp. 69-73.

Sonaiya, E.B. (1992). A development strategy for improving sustainable small-holder rural poultry production. Proceedings XIX World's Poultry Congress, Amsterdam, The Netherlands, 20–24 Sept, 1992.

Strydom, P.E. and Zondagh, B. (2014). Biltong: A major South African ethnic meat product. In: Encyclopaedia of meat sciences, volume 1, second edition.

Szczesniak, A.S. (2002). Texture is a sensory property. *Food quality and Preference*; 13: 215-225.

Thornton, P. K. (2010). "Livestock production: recent trends, future prospects,". *Philosophical Transactions of the Royal Society* ; 365(1554): 2853- 2867.

Tiwari,U., Gunasekaran,M., Jaganmohan, R., Alagusundaram,K., and Tiwari,B.K. (2011). Quality characteristic and shelf life studies of deep fried snack prepared from rice brokens and legume by-product . *Food and bio-process technology* ; 4(7) : 1172-1178.

Troy, D.J and Kerry,J.P. (2010). Consumer Perception and the role of Science in the meat industry, Meat Science , 86,214-226.

Tshuma, M., and B. Jari. (2013). The Informal Sector as a Source of household Income: *Journal of African Studies and Development.*

USAID (2012), End Market Analysis of Kenyan Livestock and Meat– A desk study. Micro Report#184.https://www.microlinks.org/sites/microlinks/files/resource/files/Kenya_Livestock_End_Market_Study.pdf .

Van Wyk, M., (2007). The complete South African cookbook, Third Edition. Struik, Cape Town. 107-108.

Van Oeckel, M. J., Warnants, U., and Boucque, V. (1999). Measurement and prediction ofpork color. *Meat Science* ; 52, 347–354.

Veronique,C. (2008). Bioactive packaging technologies for extended shelf-life of meat- based products. Meat Science, 78 (1),90-103.

Vimiso, P., V. Muchenje, U. Marume, and R. Chiruka. 2012. Preliminary study on consumers and meat traders perceptions of beef quality and how the beef quality is affected by animal welfare practices. Sci. Res. Essays 7:2037-2048.

Walsh, J. (2010). The street vendors of Bangkok: Alternatives to indoor retailers at a time of economic crisis. *American Journal of Economics and Business Administration*, 2(2). 185-8.

Wellard-Dyer, K. 2012. Pastoralism in the Horn of Africa*: Diverse livelihood pathways.* Future Agricultures Consortium Secretariat, University of Sussex, Brighton.

York,R., and Gossard,M.H. (2004). "Cross-national meat and fish consumption: exploring the effects of modernization and ecological context,". *Ecological Economics*; 48 (3): 293–302.

APPENDICES

APPENDIX 1: FOCUS GROUP DISCUSSION GUIDE (PROCESSORS)

1. As commercial processors,what challenges do you experience?
2. What do you think can be done to address these challenges?
3. What are the main operational costs involved in processing?
4. What are the main equipments required in processing?
5. How do you determine the selling price of already processed koche?
6. What is your monthly /daily volume of production?
7. Do you slaughter or buy meat?
8. Where is your end market?
9. In what volumes do you dispense?
10. How do you transport your produce and what are the charges?

APPENDIX 2: KEY INFORMANT INTERVIEW GUIDE

Name of Key in formant_____
Designation _____
Interviewer's name_____
Date of Interview _____
Time ____
Place _____

1. How do you process *koche?*
2. For how long have you been processing *koche?*
3. How do you finance the business?
4. What is the average amount required to start this business?
5. How can you evaluate the demand for *koche*?
6. Aside your household members, do you employ people to help in processing?
7. If yes, how many people?
8. What volumes do you produce monthly/daily?
9. How many times in a week /month do you process?
10. Do you believe the above production can be increased?
11. What is the major raw material used in *Koche* processing?
12. What Ingredients are used in *Koche* processing?
13. Please provide information on quantities and price of the major raw material and ingredients used to process 10kg of *Koche*?
14. Are the raw materials easily available?
15. Are there any substitutes for the raw materials?
16. How do you measure the raw materials/ ingredients used?
17. How long does it take to process 10 kg of *Koche*?
18. What challenges do you experience?

APPENDIX 3: QUESTIONAIRE (ASSESSMENT OF THE CURRENT STATUS OF MARKETING OF *KOCHE* PRODUCT IN EAST LEIGH TOWN IN NAIROBI)

Name of seller_____

Interviewer's name_____

Date of Interview _____

Time ____

Town _____

General introduction of researcher/recorder. Introduce topic. Inform of intention to record.

Section 1: Socio- demographic Characteristics

 1. Age of seller in years.   1. 20- 25 [ ]   2. 30 -35 [ ]   3.35-40 [ ]   4.40 and above [ ]

 2 .Marital status. 1 Single [   ]   2. Married [ ] 3. Divorced [ ] 4. Widowed [

 3. Level of Education. 1. Primary [ ] 2. Secondary [ ] 3. College [   ] 4. No education [ ]

Section 2: Marketing Potential

4. For how long have you been selling *Koche* Product? 1. Less than 3yrs [ ] 2. 3 to 5yrs [ ]

  3.6 to 8yrs [   ]   4.9 to 10 yrs [   ] 5.More than 10 yrs [ ]

5. How is the sell method? 1. On contract basis [ ] 2. On daily sell basis [ ] 3. Both [ ]

6. Where is the selling place? 1. Stalls/shops [ ] 2.On the streets [ ] 3. Restaurants/hotels

4. Others [ ]

7. How has been the demand *of Koche* over the years? 1. Increasing [ ] 2.Decreasing [ ] 3.Fluctuating [ ]

8. Who are your main buyers? 1. Individual customers [ ]. 2. Retailers [ ] 3.Others [ ]

9. What is the most important market outlet selection criterion? 1. Price [ ] 2.Product quality and safety [ ] 3.Market reliability [ ] 4.Distance of Market for Indigenous meat products.

10. Tick your reasons for engaging in selling *Koche* product using a scale of 1-4 where 4= to a very great extent, 3= to a great extent, 2=low extent and 1= not a reason.

e	Reasons	1	2	3	4
1	Major source of income				
2	Supplementary income				
3	Others (specify)				

11. Who are your main suppliers? 1. From Isiolo [ ] 2.From Garissa [ ] 3.Others please specify [

12 .Do you buy on informal contractual arrangement from the supplier? 1 .Yes [ ] 2 NO [ ]

13. How many buckets of *Koche* do you sell in a month? 1. Less than 5 buckets [   ] 2. 5- 10 buckets [ ] 3. 10-15 buckets [ ] 4.15- 20 buckets [ ] 5. More than 20 buckets. [ ]
14. In what proportions/weights do you sale *Koche*?

15. What is the price of 1kg of *Koche?*

16. How do you determine the unit selling price of *Koche*? 1. I cost the raw materials/ ingredients and decide how much to sell [ ] 2. Price is set by the processors [ ] 3. I accept the price offered by the consumer [ ]   4. Others (specify)

17. How much profit do you earn----------------- on average per month? 1. 5000 kshs [ ].   2. 5000-10000 kshs [ ]   3.10000- 15000kshs [ ]   4. More than 15000 kshs [ ]

18. Indicate the needs met in the household with the profit generated from selling *Koche* using a scale of 1-4 where 4 = to a very a great extent, 3= to a great extent, 2= to a low extent, 1= not a reason.

S/No	Needs Met	1	2	3	4
1	Feeding				
2	School Fees				
3	House rent				
4	Expanded business				
5	Buying land				

6	Building houses				
7	Others (specify)				

19. Indicate the challenges you face as a seller of *Koche* using the a scale of 1-4 where 4- to a very great extent, 3- to a great extent, 2- to a low extent , 1- not a reason.

S/No	Challenges faced	1	2	3	4
1	Financial Constraints				
2	Few customers.				
3	Market space.				
4	Others (please specify)				

APPENDIX 4: QUESTIONAIRE (CONSUMER SURVEY)

Section 1: Demographic Information

1. Age in years 1. 18 to 24 [ ]   2. 25 to 34 [ ]   3. 35 to 44 [ ]   4. 45 and above [ ]

2. Gender 1. Male [ ]   2. Female [ ]

3 .Marital status 1. Single [ ]   2. Married [   ]

4. Level of Education. 1. Primary [ ] 2. Secondary [ ] 3. College [   ] 4. No education [ ]

5. Ethnicity 1. Somali [   ] 2. Borana [ ] 3. Rendille [ ] 4. Others (please specify) [ ]

6. Religion 1. Muslim [ ]   2. Christian [ ]   3 .Others. [ ]

7. What is your average household income size? 1. Less than 20000kshs per month [ ]

    2. 20000 – 30000 kshs per month [ ]   3.More than 30000kshs per month [ ]

8. Do you have a family? 1. Yes [ ]   2. No [ ]

Section 2: Consumption and purchase patterns of 'Koche' product.

9. How many people in your household consume *Koche?* 1. All family members [ ] 2.Only children [ ] 3.Husband only [ ]. 4 Only adults [ ]

10. How many times do you consume *Koche?* 1. Rarely (once every month) [ ] 2. Sometimes (1 to 3 times a month [ ] 3. About once per week [ ]   4. More than once per week (2 to 4 times a week [   ] 5. Every day (5 to 7 times a week) [   ]

11. Where do you buy *Koche* Product?   1. I make orders to processors [ ] 2. Street vendors [ ] 3. Others (Please specify) [ ]

12. How many times do you purchase *Koche?* 1. Rarely (once every month) [ ] 2. Sometimes (1 to 3 times a month [ ] 3. About once per week [ ]   4. More than once per week (2 to 4 times a week [   ] 5. Every day (5 to 7 times a week) [   ]

13. How much do you buy? 1. 1 cup [ ] 2. More than 1 cup [ ] 3.1 jug [ ] 1- 2jugs [ ]

    4. More than 2 jugs [   ]

14. How much do you pay?

15. What is the main reason for consumption/ why do you like *koche*? 1. Nutritional/ health benefits [ ] 2.Cultural food [ ] 3. Ready to eat [ ] 4. Good taste [ ]

16. What factors may limit your purchase of *Koche* product? 1. High price/ high purchasing power [ ] 2. Product unavailability [ ] 3. Poor Product quality and safety [ ]   4. Proximity to the market outlet [ ] 5.Poor product packaging [ ] 6. Others (Please specify)

17 .When you make a decision to purchase *Koche* you may take several things into consideration such as trust in the seller, proximity to the market outlet , product quality and safety considerations ,cleanliness of the premise .Please evaluate how important are these factors in your decision to purchase *Koche* Product?.
Importance scale:

1 = of no importance   (no)

2 = of little importance   (li)
3 = Important   (Im)
4 = Very important   (Vi)

	Importance				
Factors	**No**	**Li**	**Lm**	**Vi**	**Response**
Know/Trust in the seller	1	2	3	4	
Proximity to the market outlet	1	2	3	4	
Product quality and safety considerations	1	2	3	4	
Clean premises	1	2	3	4	

18.How important are the following sensory attributes fat content, taste, appearance, Chewiness, size of meat chunks, flavour in your choice, use and acceptability of *Koche* Product?
 Importance scale:

 1 = of no importance   (no)
2 = of little importance   (li)
3 = Important   (Im)
4 = Very important   (Vi)

	Importance				Response
Sensory Attributes	**No**	**Li**	**Lm**	**Vi**	
Fat content	1	2	3	4	
Taste	1	2	3	4	
Appearance	1	2	3	4	
Chewiness	1	2	3	4	
Size of meat Chunks	1	2	3	4	
Flavour	1	2	3	4	

19. If *Koche* is to be sold in the supermarket which packaging system would you prefer? 1. Vacuum packaging [ ] 2. Glass jars [ ] 3 .Plastic jars [ ] 4. Others (please specify)

20. With assured quality, labeling, certification and safety of *Koche* product how much more are you willing to pay? 1. Not willing to pay [ ] 2. 5% more [ ] 3. 10% more [ ] 4. 15% more [ ] 5.20% more [ ]

APPENDIX 5: SENSORY EVALUATION SCORE SHEET.

Score sheet number …………………………………………

Date of analysis…………………………………………………

You are provided with coded samples of *Koche* product. Please evaluate the samples presented to you for the following sensory attributes namely: Colour, texture, taste, oiliness, size of meat chunks, aroma, appearance and overall acceptability using the hedonic scale provided.

1- **Dislike extremely**
2- **Dislike very much**
3- **Neither like nor dislike**
4- **Like very much**
5- **Like extremely**

Samples	Colour	Texture	Taste	Aroma	Appearance	Size of meat chunks	Oilness	Overall acceptability
ADF								
CBM								
KCP								
xyF								

Comments……………………………………………………………………………………
…………………….

Thank you!!!!!!!

APPENDIX 6: CONSENT FORM

I am ………………………………………. a student at the University of Nairobi studying

MSc in Food Science and Technology. In order to have a commercially viable product based

koche processing, generate information that may benefit the processors to better meet the

preferences/ requirements of consumers, development of marketing strategies that can increase

the demand of *Koche,* I am conducting this survey in Marsabit, Isiolo and Nairobi County among

the processors, marketers and consumers of *Koche* as well as potential consumers and I am

pleased to have you take part in the study.All information you give is confidential. The

information will aid in the preparation of a general report but no names will be included. There

will therefore be no way to identify that you are the source of information. I encourage you to

participate in the study and your cooperation will be highly appreciated.

If it is okay with you, may I proceed to ask you some questions related to processing of *Koche*

I accept to take part in the study: Yes…………. No………………

Name of the interviewer……………………………………

Signature of interviewer …………………………………

Date……………………………………….........