

The Present Status of Meat Processing and Preservation in the Pastoral Regions of Kenya

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Abstract

The meat value chain in pastoral regions is characterized by large post-slaughter losses due to lack of appropriate preservation technologies. Reports indicate that sun-drying, salting and deep frying have been practiced for meat preservation in the pastoral regions but there is limited empirical information on the manner and extent of practice of these methods. This study was therefore designed to collect and authenticate information on meat preservation technologies practiced in the pastoral areas. Using a structured questionnaire, key informants interviews and focused group discussions, data was collected from four pastoral counties, namely Marsabit, Turkana, Garissa and Kajiado counties, in a cross-sectional survey. Data was also collected from processors and handlers in Nairobi County to provide reference of modern handling and processing. Results revealed that different communities in the pastoral areas have adopted preservation technologies based on deep frying, salting and sun-drying while cooling and curing are practiced in the modern processing facilities in Nairobi. The main storage containers used in the pastoral districts are wooden, metallic and plastic containers. Meat handling was done by men, while by-products handling was by women, the two processes are usually separated in the production floor. Deep-frying, salting and sun-drying were predominantly done to extend the shelf life and to impart the distinct flavor of pastoral meat products. Where wooden containers were used, the containers were fumigated with smoke from burned wood (*Adung*). Meat quality deterioration was caused mainly by unhygienic handling practices which results to microbial contamination. Spoilage was aggravated during sun-drying which is a slow process. The study concludes that there are technologies of meat processing and preservation in the pastoral areas with the potential for upgrading in terms of process hygiene and product quality to reduce post-harvest loss and make the products competitive.

Keywords: indigenous technologies, meat products, pastoral regions

1. Introduction

Beef is the main source of red meat (EPZA, 2005) and represented about 73 per cent of the total meat consumed in Kenya in 2009 (FAOSTAT, 2012). Approximately 67% of red meat is from the arid and semi-arid lands under pastoral production system. Red meat in Kenya accounts for over 80 per cent of all the meat and is derived mainly from cattle, sheep, goats and camels. Indigenous cattle meats are among the main agricultural commodities in Kenya with a potential in terms of economic growth, food security, poverty reduction and creation of employment (FAOSTAT, 2011). Kenya has an estimated livestock resource of 14.1 million indigenous cattle as compared to 3.4 million exotic cattle (KNBS, 2009). Almost 66% of the national meat production goes through formal slaughter process, while the rest uses inform channels.

Post-harvest losses can be as high as 50 per cent of the meat produced, which may cause food insecurity and reduced profit margins to value chain actors (MOLD, 2010, Lewa 2010). Most of these losses are caused by inappropriate post-harvest handling, processing and preservation techniques. Slaughter post-harvest losses can be reduced by increasing efficiency along the chains and value added products development. Meat is highly perishable; hence the importance of preservation (Aymerich et al., 2008). Post-harvest meat handling and preservation in the pastoral regions is poorly understood. Few authors have written on how different communities prepare and preserve meat products using indigenous technologies. This study was designed to document and assess the diversity of meat preservation technologies used in pastoral regions, to identify the weakness of this technologies and opportunities for upgrading these technologies. Such knowledge can be used by players along the value chain to develop products so as to reduce losses incurred by stakeholders. The objective of this research was to describe the meat products, handling and preservation technologies used in pastoral regions.

The main preservation techniques in pastoral/ nomadic regions of Africa are sun-drying and deep frying (Heinz and Hautzinger, 2007). Sun-drying can lead to higher microbial counts since the meat is exposed to the sun and also the drying rate takes long. Drying in the pastoral areas utilizes heat radiation (from the sun) and draft to remove water from the interior of the raw meat (Apata et al., 2013). Mechanical energy has been used to remove water from the meat surface mostly through drip as the meat is hung. Deterioration of meat products depends on factors that increase growth of microorganism such as temperature, reduction-oxidation potential, endogenous enzymes, water content, and UV radiation among others (Faustmann and Cassens, 1990). Physio-chemical changes such as proteolysis, lipolysis and oxidation can also cause deterioration of meat

products besides microbial degradation (Esmer et al., 2011). Processing meat impart significant desirable changes on the quality attributes of meat and meat product. However, meat products development poses some technological challenges, mainly with regards to optimizing the formulation, processing, and subsequent storage. The technological feasibility of achieving the desired composition with optimum palatability depends mostly on the product type, composition, and processing done.

2. Methodology

2.1 Study area

A market survey was conducted to describe the diversity of current meat products in the market, both in the pastoral regions and in Nairobi. Four counties in the pastoral area, that is, Marsabit, Turkana, Garissa and Kajiado were purposively sampled to identify diversity of meat products made using rudimentary preservation techniques. Nairobi being the largest city in Kenya provided basis for comparison between modern and pastoral meat handling and preservation technologies. Figure 1 diagrammatically brings out the study region for this study.

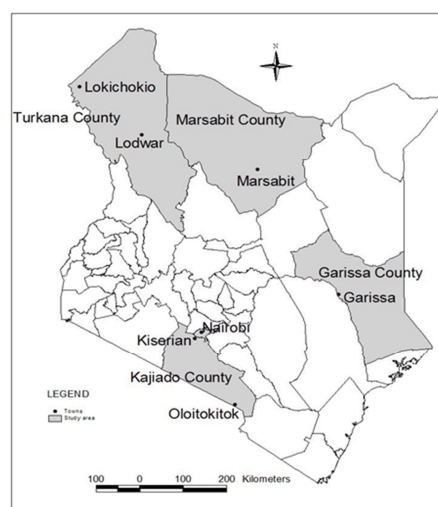


Figure 1: Map of Kenya, highlighting the study areas (made using ArcView GIS 3.2)

2.2 Study design

Purposive sampling was used to identify initial respondents from the pastoral regions and in Nairobi. From the pastoral regions, knowledgeable people were identified with the help of the local government officers in the Veterinary department. Snowballing was done to identify participants for the focused group discussion and the key informants at the communities by asking the officers in the Veterinary department to introduce the knowledgeable people on meat handling and preservation in the communities.

In Nairobi, a visit to the major meat retail outlets including six supermarkets chains, five high end butcheries and two meat processing outlets to provide data on preservation and storage. Four slaughterhouses (Dagorretti, Athi River, Limuru and Kiserian) which are the major suppliers of beef consumed in Nairobi were also visited to provide data on post-slaughter handling and transportation of raw meat.

2.3 Methods of data collection

Focused group discussions and key informants interviews were conducted with officers in the Veterinary department and knowledgeable persons in the pastoral community. All the focused group discussions had between eight to twelve participants of either gender. The data collected was identity of post-slaughter handling of animals including storage, transportation and preservation. Based on these, the challenges were identified. A semi-structured questionnaire provided a guide to data collection on the diversity of meat products in Nairobi, handling and preservation technologies used, and challenges faced. Key informant interviews with officers in Veterinary department were also conducted.

3. Results

3.1 Post-slaughter handling of meat in the pastoral regions

Meat value chain in Kenya can either be formal or informal. Along the formal value chains, the slaughter operation must be conducted in registered slaughterhouses. It's a requirement that meat is inspected both pre-

and post-slaughter by a qualified veterinary officer. Mostly, the slaughterhouses are certified by the government to provide slaughter services at a fee. It's recommended that adequate measures are implemented to ensure hygienic handling post-slaughter through measures such as adequate water supply during slaughter, separation of by-products from main products, protective clothing worn by personnel among others. Usually, meat is transported in metallic boxes, specifically designed for meat products although polythene bags are at times used to carry meat. Mostly meat is not differentiated based on grade/ quality. Table 1 highlights the status of the slaughterhouses in the major towns in the selected pastoral regions.

In the pastoral areas, informal value chains are found further away from the major towns or at the household level. Slaughter operation is not inspected by a veterinary officer. Mostly, sheep and goats are slaughtered; most of which is sold fresh to the neighbours while the rest is preserved. Due to the long distances and poor infrastructure, veterinary services are inaccessible.

Table 1: Hygiene status of slaughterhouses along the formal meat value chains in pastoral regions




	Garissa		Marsabit,		Turkana		Kajiado		Nairobi
	Garissa	Marsabit	Lodwar	Lokichokio	Kiserian	Oloitokitok	Nairobi		
Slaughterhouse enclosed	-/+	+	-	+	+	-/+	+		
Inspection by Veterinary officer	+	+	+	+	+	+	+	+	
Adequacy of water	+	-/+	-/+	-/+	+	-/+	+	+	
Workers use protective clothing	-/+	-/+	+	+	+	-/+	+	+	
Cooling meat before dispatch	-	-	-	+	-/+	-	-/+		
Separation of meat from by-products	-	+	-	+	+	-	+	+	
Hygiene of mode of transport	-/+	-/+	-/+	+	+	-/+	+	+	
Grading meat	-	-	-	-/+	-	-	-/+		

Key: - represents Never, -/+ represents At times or rarely, + represents Always

3.2 Meat processing in the pastoral regions

In the pastoral regions, the main preservation techniques by the different communities were salting, sun-drying and deep frying. Common salt was used to extend shelf-life by reducing the water activity. Sun-drying by hanging slender meat stripes directly under the sun was done while hanging in a windy area accelerated removal of water from the meat. Deep-frying was used to longer shelf-life products; around two to six months based on degree hygienically handling during storage. Sun-dried meat products that resembled South African biltong were made in Turkana and Marsabit Counties by conventional and small-scale processors. These products were occasionally marinated to improve on acceptability. All the communities deep-fried the meat. Table 3 summarizes the characteristics of some of the deep- fried products in the selected pastoral regions.

Table 3: Characteristics of meat products preserved using indigenous technologies by different communities in selected pastoral regions

County	Community	Local name	Characteristics of meat products	Photo of final product	Estimated shelf-life
Garissa, Marsabit	Somali, Borana,	<i>Nyirinyiri</i>	Appearance: <ul style="list-style-type: none"> • evenly granular, • oil oozing out from the surface of the product About 4mm*4mm*4mm Taste: Spicy		2 months
Turkana	Turkana	<i>Enyas</i>	Appearance: <ul style="list-style-type: none"> • Uneven • Fibrous, • oil oozing out from the surface of the product Taste: salty		2 months
Kajiado	Masaai	<i>Olpurda</i>	Appearance: <ul style="list-style-type: none"> • oil oozing out from the surface of the product • solid at 20°C storage • Unevenly granular • Particle: range 4 mm-10 mm Taste: meaty		3 months

Differences in the final quality of the products were caused by type of meat used, extent of sun-drying, extent of size reduction, type of fat/ oil used, amount of salt and spices, time of frying, container used for storage and extent of smoking. Figure 3 summarizes the steps used to preserve meat by different communities in the pastoral area.

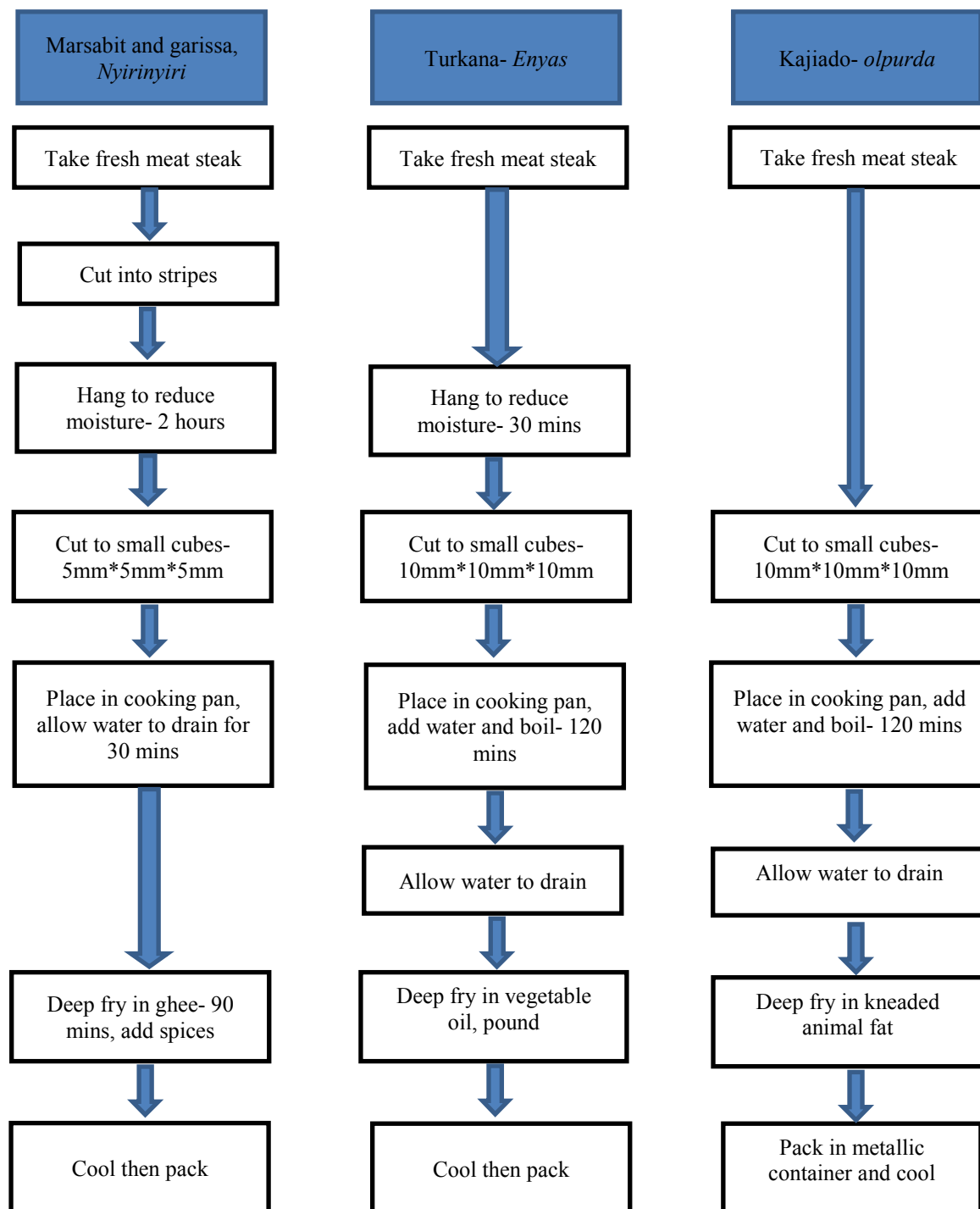


Figure 1: Summary of processing steps for different meat products in the pastoral regions

3.3 Meat products packaging

In the pastoral areas, each community use specific containers to pack the meat products. The packaging material is used to prolong shelf-life of the products and to minimize contamination by external agents. Traditionally, wooden containers with leather base and lid were used by all the communities. However, due to scarcity coupled up with the high cost of these containers, metallic (similar to those used to transport milk) and plastic (recycled cooking oil) containers are now used. Wooden containers are still used in Turkana County (Lodwar); it is fumigated using smoke from (Elamach and Adung) trees to sanitize the containers and impart flavor to the products stored. The meat products was packed into the metallic containers in Kajiado County while still hot, hence minimize contamination thereby prolonging shelf-life; however, the product solidified during storage in the container. The main challenge with these packaging containers is the difficulty to remove meat during

consumption. Figure 2 show the metallic and wooden containers used to preserve traditional meat products.



Figure 2: Wooden (left) and metallic (right) containers used to preserve meat products

3.4 Diversity of meat products in high market ends of Nairobi County

There was a great variety of meat products at the supermarkets and high-end butcher shops. The meat products were categorized into three groups based on the processing and preservation technique; cured, smoked and fermented products. Occasionally, more than one preservation methods is used in the same products, for example, bacons and some sausages were preserved by curing and smoking while some sausages were cured and fermented. For curing, salts and spices were added in small quantities to improve the flavour and binding properties. Smoking was done through fumigation of the products using gaseous smoke from specific wood in a cabinet where humidity was increased by pumping steam into the chamber and temperature maintained at 80°C to 90°C for about an hour. Precooking/ cooking was done either through frying (mostly for sausages), steaming at 95°C (for hams) or boiling (for brawns) to make the products palatable. Non-meat ingredients were added to the products to increase functionality: dextrose to regulate the pH, monosodium glutamate (MSG) to enhance flavour in sausages and phosphates to improve binding properties by creating a 3-dimension network. Binders, fillers and meat substitutes were also used to improve acceptability and lower production costs.

From the study, meat and meat products in Nairobi County could also be grouped into three based on palatability; fresh meat, fresh-processed products and precooked/ cooked products. The fresh meats and fresh-processed products require heat treatment to make the products palatable while the precooked/ cooked products were ready-to-eat and comprised of fried sausages, kebabs, meat loafs and hamburgers. High grade fresh meats, mostly prime cuts, meat-on-bone and steak were usually tenderized by chilling meat at 4°C for about 10 days. Table 2 summarizes the preservation techniques for conventional meat products in Nairobi County's supermarkets and high-end butchers.

Table 2: Diversity of modern meat products found in supermarkets and high-end butcher shops in Nairobi County

Basis of preservation	Type of meat product	Source of meat used for processing
Fresh meat	Prime cuts, minced, meat balls	Beef, muttons/ chevron, poultry, pork, others
Frozen meat products	Prime cuts, minced, meat balls	Beef, muttons/ chevron, poultry, pork, others
Cured but uncooked	Fresh sausages	Beef, pork, chicken
Cured and cooked	Ready to eat sausages, hams, brawns, polonies, vienna	Beef, pork, chicken
Cured, smoked and cooked products	Smokies, bacons	Beef, pork
Smoked and fermented	Salami	Beef, pork

3.5 Meat handling and processing in Nairobi's middle and low market butcheries

Unlike the high market ends where there were prime cuts, the carcass was hang into halves and displayed for customers to select the cuts to purchase. Meat was rarely tenderized and was usually sold within 24 hours after slaughter. At the middle market ends, steak and meat on bones were the main products. Refrigeration and chilling were occasionally done to prolong shelf-life of the meat. At the low market ends, in addition to meat on bone, green and white offal were on display. Chilling at the display was not practised although excess meat was usually refrigerated. Occasionally, traditional sausage cased in animal intestines locally known as *mutura* were

prepared and sold. Some outlets roasted or boiled meat chunks, slaughter by-products such as heads, trotters, lungs, green offal and bones. These traditional sausages boiled/ roasted meat and slaughter by-products and soup from boiled products were usually sold along the road.

4. Discussion

Meat is highly perishable; hence the importance of its preservation (Aymerich et al., 2008). In the pastoral regions, sun-drying, salting and deep frying were the main preservation technologies used for meat value addition. Value addition is influenced by availability of resources, labor, infrastructure, technology and customer needs (Kruska et al., 2003). Value addition using modern techniques was minimal in pastoral areas as a result of poor infrastructure, lack of resources, and lack of knowledge on modern technology. Salting was used as adjunct process to deep-frying or sun-drying. Sun-drying was done by placing meat, preferably steak, in the open for the sun's rays to get to the product being dried. To accelerate the drying process, slender strips were cut to increase the surface-area to volume ratio. Sun-drying increased the risk to microbial deterioration as the meat was exposed to the sun, hence more post-harvest losses. In addition, the drying rate was long as the energy from direct sun rays wasn't adequate to dry the product.

Deep frying was done to reduce the water activity of the products and was usually done after sun-drying. Deep-fried products contained a lot of fat and the products had to be stored and consumed with that fat/oil used to deep-fry the products. Depending on the fat/ oil used to fry the products and the extent of frying, the products could be stored for up-to six months under room temperature (20°C). The findings further confirm that processing meat chunks of different sizes leads to differences in the rheological, sensory and structural characteristics (Tornberg, 2005). However, previous research highlight that such products are susceptible to chemical deterioration as a result of lipid peroxidation (Du and Li, 2008). The high fat content of such products can cause health implications resulting from high lipids intake (WHO, 2003). In addition, deep-fried products are susceptible to deterioration in texture, flavor, color, and nutritive value in addition to production of toxic compounds (Scollan et al., 2006; Mohamed et al., 2008).

Sensory evaluation is a definitive way of assessing the different physical-chemical characteristics of meat products (Russell et al., 2005). The study brings out the diversity of meat preserved by sun-drying and deep frying and further confirms that acceptance of meat products depends on social-economic, cultural, ethnic and geographical location of consumers (Jimenez-Colmenero et al., 2001). From the study, the products from these selected pastoral regions were oily in appearance. Apart from *nyirinyiri*, the rest of the products had uneven particle sizes. Addition of spices in *nyirinyiri* was used to impart flavor. In addition, these spices could have some antioxidant effect which may retards lipid oxidation as highlighted in previous studies (Karpinska et al., 2001; Kim et al., 1995). Smoke from specific trees was used to sanitize the containers and to impart desirable flavour by some communities. Previous researches bring out the antimicrobial effect of different package materials, spices and smoke on meat (Karpinska et al., 2001; Lee, 2010). Common salt was normally added to meat products to improve flavour and inhibit microorganisms by lowering water activity despite research indicating it may promote lipid oxidation in meat products and discoloration of raw meat by accelerating metmyoglobin formation (Gheisari and Motamedi, 2010). All the deep-fried products from the pastoral communities were brown as the red colour associated with raw meat had been discoloured during the frying process and the salt added had aggravated the discoloration. Sundried products which were similar to biltong from South Africa were produced in some pastoral regions. Occasionally, these products were marinated to improve the flavor.

From Nairobi County, products preserved using modern technologies can be grouped into three based on the processing and preservation technique; curing, smoking and fermentation. These grouping are similar to previous study conducted by Heinz and Hautzinger (2007). In these products, non-meat ingredients are used to enhance functionality. Phosphate is used to enhance water holding capacity and improve yield in processed meat products, monosodium glutamate (MSG) to enhance flavour, while dextrose to regulate pH. In some products, soya protein and blood plasma were used to replace meat protein thereby reducing cost of production while maintaining the protein level. The protein levels and minimum meat content used in production were the major factors that attribute the retail price of the products. In sausages, the viscosity of the emulsion was varied for the different markets with catering packs being less viscous. Other products used as ingredients for functionality were spices, cereal starch, fillers and binders.

5. Conclusion and recommendations

Different communities in pastoral regions have different preservation techniques for meat. The study confirms that preservation in the pastoral region is based on sun-drying and deep frying. The required hygiene standards at the slaughter houses are not keenly adhered to. The preserved meat products from the pastoral area are not standardized; hence the process and products parameters have to be optimized to improve the quality of these meat products which is currently unknown. The study recommends upgrading the processing and preservation

operations in these regions. Once standardized, these products will be produced formally to address losses along formal meat value chains in the pastoral regions. The effect of particle size, type of frying oil/ fat, time of frying, salting, smoking, moisture reduction and spices should be investigated. This will contribute to design of strategies for reduction of post-harvest losses by increasing efficiency along the chains, product development and by- products utilization. Product development along formal beef value chains by upgrading the currently produced products will have the greatest impact as the products produced will be cheap and will be culturally accepted by communities in the pastoral regions.

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