SAFETY OF PASTORAL PROCESSED CAMEL MEAT (*NYIRINYIRI*) FOR CONSUMERS ASCERTAINED FROM MICROBIOLOGICAL QUALITY

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ABSTRACT-This study determined the load, type and most common species of molds in 35 samples of fresh camel meat and *Nyirinyiri* obtained at different nodes along the value chain. Molds were detected in the samples: 75% at production, 55.5% at processing and 66.7% at marketing nodes with counts highest at the market (1.2 log cfu/g) and lowest at processing (0.8 log cfu/g) relative to production (1.0 log cfu/g). The most common mold species were *Cunninghamella* (20%) and *Syncephaalastrum* (17.1%) relative to *Fusarium* (14.3%), *Alternaria* (11.4%) and *Paecilomyces* (11.4%) while *Aspergillus* (5.7%), *Penicillium* (5.7%) and *Mucor* (2.9%) were least common. The study established that both spoilage and pathogenic molds were present in the camel *Nyirinyiri* and therefore the product could be unsafe for human consumption due to the risk of *mycotoxins.* However, there is room for improved hygiene standards along the camel *Nyirnyiri* value chain.

Key words: Camel, molds, *Nyirinyiri*, processing, species, value chain

1.0 BACKGROUND OF THE STUDY

Camel meat, fresh or processed, is an important food component in the diets of pastoral households. It is their major protein source of high biological value and rich in fat, B vitamins, Iron, Zinc and Vitamin A and essential and non-essential amino acids needed to build, maintain and repair body tissues[10] However, fresh meat is highly perishable due to its high moisture and protein contents, which are utilized by microorganisms. The processed meat is therefore a substitute to fresh meat in the arid and semi-arid areas where pastoral communities are found. Pastoral women process camel meat into *Nyirinyiri* product, which they prepare by cutting meat into thin strips, then sun drying and comminuting into small cubes before deep frying in cooking oil. The processed *Nyirinyiri* is stored in the same oil and is consumed little by little as required. It is a ready to eat dehydrated meat product that substitutes fresh meat where refrigeration facilities are not accessible. *Nyirinyiri* confers great convenience because of its long shelf life with desirable taste which pastoral households serve as a snack or combined with other foods as part of their daily diet. However, the processing involving deep fat frying and unhygienic storage conditions pose food safety and hygiene concerns to urban consumers of camel *Nyirinyiri.* Previous studies on *Nyirinyiri* from northern Kenya concentrated on *Nyirinyiri* from sheep and goat (Mathenge, 2005) and there is little or no available information on camel *Nyirinyiri* meat value chain from Isiolo County or elsewhere. The objective of the present study therefore, was to analyze the load, type and most common species of molds present in camel *Nyirinyiri* along the camel meat value chain in Isiolo County, in order to enhance food safety, quality and market acceptability of camel *Nyirinyiri* for consumers and for income security of the pastoral processors.

2.0 METHODOLOGY

2.1 STUDY SITE

The topography of Isiolo county is generally arid and semi-arid low lying plains on most parts of the region. Ewaso Nyiro is one of the main sources of water for both domestic and agricultural purposes. The average altitude of Isiolo County is between 200 - 300m above sea level and it receives very low precipitation. There are two rainy seasons in most years (April-June and October-December) and annual rainfall ranges from 150 to 650mm. Day time temperatures vary from 12^{o}C - 28^{o}C. The most predominant type of vegetation is shrubs and acacia plant species that are well adapted to the high temperatures. Camels are the most abundant livestock species in this area, with camel milk and meat marketing being an important income earning opportunity for the pastoral households.

2.2 SAMPLING

The sampling of the camel *Nyirinyiri* was conducted along the value chain mapped from Isiolo County where camels are produced and *Nyirinyiri* processed to urban markets in Nairobi where the product is sold to urban consumers. A total of 35 samples of fresh camel meat and *Nyirinyiri* were collected at different nodes along the value chain by simple random sampling.

2.3 ISOLATION OF MOLDS

The dilution plate method was used to determine the load and type of molds present in the camel *Nyirinyiri* product. Dilutions of 10^{-1} up to 10^{-6} were pour- plated. 1ml from each dilution bottle was pipetted and poured into each duplicate sterile petri dish. 15-20 ml of media (prepared by dissolving of Potato Dextrose Agar in 500ml distilled water and sterilizing at 121^{0}C for 15 minutes then cooled) was poured into the plates. The media and the sample were mixed gently and incubated at room temperature for 7 days. All colonies were counted and colony forming units/gram (cfu/g) calculated by multiplying the average number of colonies by the reciprocal of the dilutions. Successive hyphae tip were transferred until pure cultures of each of fungus was obtained. The fungi were identified by their cultural and morphological features[2] using a microscope.

2.4 DATA ANALYSIS

Data collected were subjected to analysis of variance (ANOVA) using SAS program version 9.1. The least significant difference (LSD) was used for mean separation.

3.0 RESULTS AND DISCUSSION

Table 1 indicates the total mold count/gram and percentages detected from the samples obtained along the *Nyirinyiri* value chain. Molds were detected in the samples at production (75%), processing (55%) and marketing (67%) nodes of the value chain. Mold count was highest at the market (1.2 log cfu/g) and lowest at processing (0.8 log cfu/g) relative to production (1.0 log cfu/g).

Table 1 Total molds count/gram and percentages in samples of camel meat and *Nyirinyiri* obtained along the value chain

Node of the value chain	Samples (n)	No. positive	Percent positive (%)	Mean (log_{10} cfu/g)
Production	8	6	75	1.0a
Processing	18	10	55.5	0.8a
Marketing	9	6	66.7	1.2a

Means in the same column followed by the same superscript are not significantly different ($p< 0.05$)

At the production stage of the value chain, presence of molds could be attributed to poor handling practices of the meat post slaughter. Camels were slaughtered in the open air, at a location which is quite separate from the slaughterhouse used for cattle. The slaughter takes place on the ground, so the meat is soon contaminated with dust and dirt. The slaughterhouse lacks technical facilities for carrying out the hygiene measures that are urgently needed. Inadequate energy and water supplies often make it difficult to clean and disinfect the slaughterhouse and equipment and dispose of offal and effluent. This means there is a very high risk of contamination of the meat. Cold storage rooms are unavailable. This is why fresh meat is many times of poor quality and has a short shelf life. Camel meat after slaughter was mainly transported from slaughter slabs to butcheries using donkey drawn carts. However, the carts were poorly designed hence offering difficulty in cleaning and are not dust proof. The material used to make the carts was not the recommended type in contravention of the public health requirements, predisposing consumers to unnecessary health risks. A rusting bottom was observed in one of the carts. The decrease in mold count (though not significant) at the processing stage of the value chain is attributed to the heat treatment of the cooking oil used in processing of *Nyirinyiri* which could have contributed to the destruction of mold spores that were present at the production stage. *Penicillium* spore death in water occurs at 54.4^{o}C for 30 minutes [5]. However, the increase in load of molds (though not significant) at the marketing stage of the value chain could be due to the hygienic level of the environment in which the product is marketed. *Nyirinyiri* was sold beside the roads in the open air and the packaging was done in light transparent polythene paper. These practices did not only predispose consumers to health risks but also hasten spoilage of the meat product [9].

From the fresh camel meat and *Nyirinyiri* samples examined, the most common mold species (Figure 1) in general were *Cunninghamella* (20%) and *Syncephalastrum* (17.1%) relative to *Fusarium* (14.3%), *Alternaria* (11.4%) and *Paecilomyces* (11.4%) while *Aspergillus* (5.7%), *Penicillium* (5.7%) and *Mucor* (2.9%) were least common. All these species were present in *Nyirinyiri* samples from the processing node while *Nyirinyiri* samples from marketing had only *Cunninghamella*, *Aspergillus* and *Syncephalastrum* species. *Paecilomyces*, *Fusarium*, *Syncephalastrum* and *Cunninghamella* were isolated in the fresh camel meat samples (production node), each at a level of 12.5%. Fresh camel meat was sold from butchers designated at different locations within Isiolo town. The butchers sampled from lacked refrigeration facilities, implying that fresh camel meat was exposed to ambient temperatures for long hours hence the risk

of microbial (fungal) proliferation. The ambient temperatures ranged from 12°C - 28°C which are ideal for growth of mesophiles such as *Cunninghamella* species. *Nyirinyiri* was sold besides the road in an open environment hence exposing the product to contamination with fungal spores from the air. It was dispensed from a plastic bucket using a plastic mug and the packaging was done in clear polythene papers. These practices did not only predispose consumers to health risks but also hastened spoilage of the meat by re-contamination every time it is dispensed and also the ambient temperature of about 25°C provides a conducive environment for growth of mesophilic organisms such as *Aspergillus* and *Paecilomyces*. The frequent occurrence of molds in meat indicates poor hygienic measures adopted in the slaughterhouses and in processing and handling of fresh and processed meat.

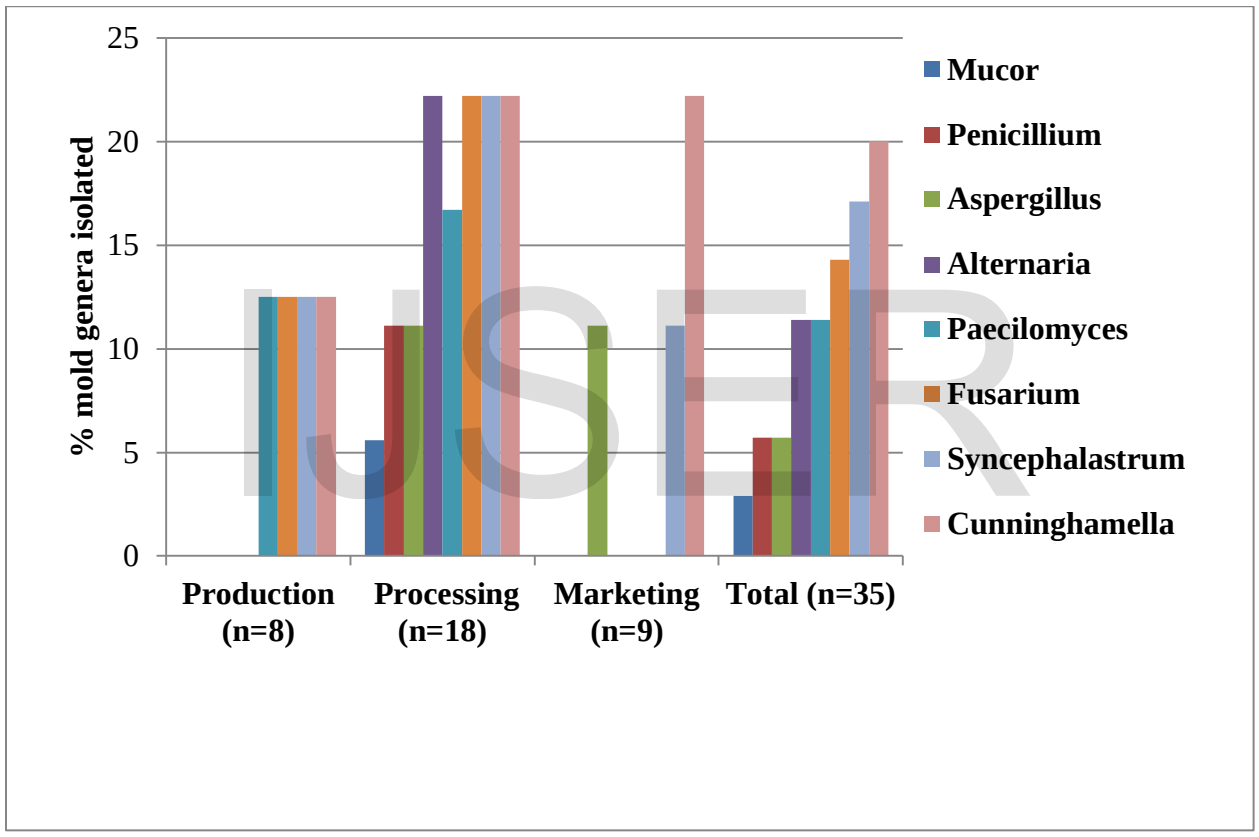

Figure 1: Percent distribution of mold genera isolated samples of camel meat and *Nyirinyiri* along the value chain.

4.0 CONCLUSION AND RECOMMENDATION

Results from this study demonstrate that dehydrated meat products are liable to contamination from different sources with molds during processing, handling and preservation. Aflatoxin forming mold species can grow on dehydrated meat products since they tolerate reduced water activity. The storage of meat products for long periods under ambient conditions and in the absence of hygienic measures leads to the growth of molds. The mold count in

the sampled camel meat and *Nyirinyiri* reflect the hygienic conditions under which it is produced and stored. The load levels of the species of molds isolated were within the critical limits not harmful to human health but also indicate room for improved hygiene standards along the value chain. In order to assure safety and quality of camel *Nyirinyiri*, sanitary rules should be adopted to cover proper transportation of meat as well as periodical cleaning and disinfection of transport vehicle and meat storage areas. The processing areas should be hygienically constructed and supplied with equipment and utensils which can be easily cleaned and disinfected. Educational programs and training courses should be recommended to the meat handlers, processors and marketers. Strict hygienic conditions are to be maintained in the production, storage and distribution of meat products. Research needs to be carried out to ascertain the mycological aspect of camel *Nyirinyiri* with special respect to proteolytic and lipolytic molds that are responsible for the eventual spoilage of camel *Nyirinyiri* under storage conditions as well as determine the actual shelf life.

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