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PROCESSING VARIATIONS, NUTRITIONAL AND SENSORY QUALITY OF ETHNIC DEEP-FRIED MEATS FROM KENYAN PASTORAL COMMUNITIES

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ABSTRACT

Deep-frying of meats has been done by indigenous pastoral communities from time immemorial for the unique taste, flavor, and exceptional shelf-stability. Traditional pastoral deep-fried meats have great potential as snacks in the global food basket due to their unique nutritional qualities and high satiety. Lost and weakening cultural ties have led to disparities in the deep-frying processing hurdles within and between different communities. The goal of this research was to study the peculiarities and uncover processing variations of ethnic deep-fried meats from indigenous people of the pastoral semi-arid lands and to explore how this translates to nutritional and sensory attributes of selected products from Kenya. A cross-sectional survey was conducted in Turkana, Kajiado, and Marsabit counties with data collected using Focus Group Discussions (FGDs). From each focus group, samples of the deep-fried meats were analyzed for nutritional and sensory characteristics using standard methods. Notable variations in the deep-frying process observed were the size of chunks, pre-drying techniques prior to deep-frying, and choice of deep-frying media. Shelf stability was achieved by oil-encapsulating the chunks in solidified deep-frying media, fumigation of traditional packaging containers with smoke, and the use of spices. Variations on proximate contents were observed with moisture ranging between 8.1% and 28.5%, protein between 42.6% and 46.9%, lipids between 15.4% and 37.9%, ash between 3.1% and 4.3%, and energy between 424 Kcal/100g and 542 Kcal/100g. Differences in processing hurdles and storage contributed to variations in sensory attributes with pre-drying, smoking, and choice of deep-frying media contributing to the greatest variabilities. This notwithstanding, the study revealed a limitation on use of semi-trained panelists to bring out deep-cultural rooted ties that play a big role in the sensory acceptability of these indigenous products calling for caution before the interpretation of sensory data. In conclusion, variations in size of chunks, pre-drying technique, choice of deep-frying media, oil-encapsulation, and smoking among ethnic communities during the deep-frying process significantly contribute to differences in nutritional and sensory characteristics of deep-fried products.

Key words: pastoral meat, ethnic meat, indigenous, deep-fried meat, nutrition quality, sensory quality

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INTRODUCTION

Indigenous pastoral communities have relied on deep-fried meats for time immemorial not only to preserve meat but also for the unique taste, flavor, and aroma associated with the products [1, 2]. Globally, there exists documented reviews on indigenous meat products; notably among the Himalayans [3], Asian [4], Mediterranean and North Africa [5], West African [6], South Africa [7], Russia [8], and North America [8-9]. In Eastern Africa, sun-dried and deep-fried meat are indigenous to pastoral communities with common examples being Nyrirnyiri, Koche, Ngamorumoru, Olpurda and Enyas [10-13].

Cultural ties among pastoral communities have been lost or weakened for various reasons. Consequently, variations exist in processing steps hurdles among different ethnic communities during deep-frying meat with the common hurdles being the addition of spices, smoking/ fumigation, encapsulating with oil, and submerging in syrup/ honey [3, 5, 6, 12, 13, 14]. These variations in processing hurdles could be caused by differences in the flow of indigenous knowledge among pastoral communities and availability of raw materials/ingredients needed for processing [2, 14]. Indigenous knowledge has been described as a body of knowledge built up by a group of people living in close contact with nature [15]. Urbanization has also significantly influenced the process hurdles with slight but significant variations within a community. For instance, the use of sanitized plastic containers to replace traditional wood-hide containers that had to be fumigated for sanitizing and replacement of rendered animal fat with vegetable oils which have been considered healthier [2].

Variations in the processing hurdles contribute to differences in nutritional and sensory properties of ethic meats, notably in beef jerky [9], semi-dried pastrami [16], the indigenous Mediterranean and North African meat [5], deep-fried beef chunks [11], South African biltong [7], Kenyan Koche [10, 14], among others. The goal of this research is to study the peculiarities and uncover deep-frying processing and preservation techniques of goat meat by indigenous people of Kenya's pastoral lands. Variations in processing hurdles are brought out and how these influence the nutritional and sensory attributes of pastoral deep-fried meat products.

METHODOLOGY

Study design

The study design was cross-sectional consisting of a survey in three counties in Kenya, that is, Turkana, Marsabit, and Kajiado. Figure 1 shows the map of Kenya bringing out the study area.

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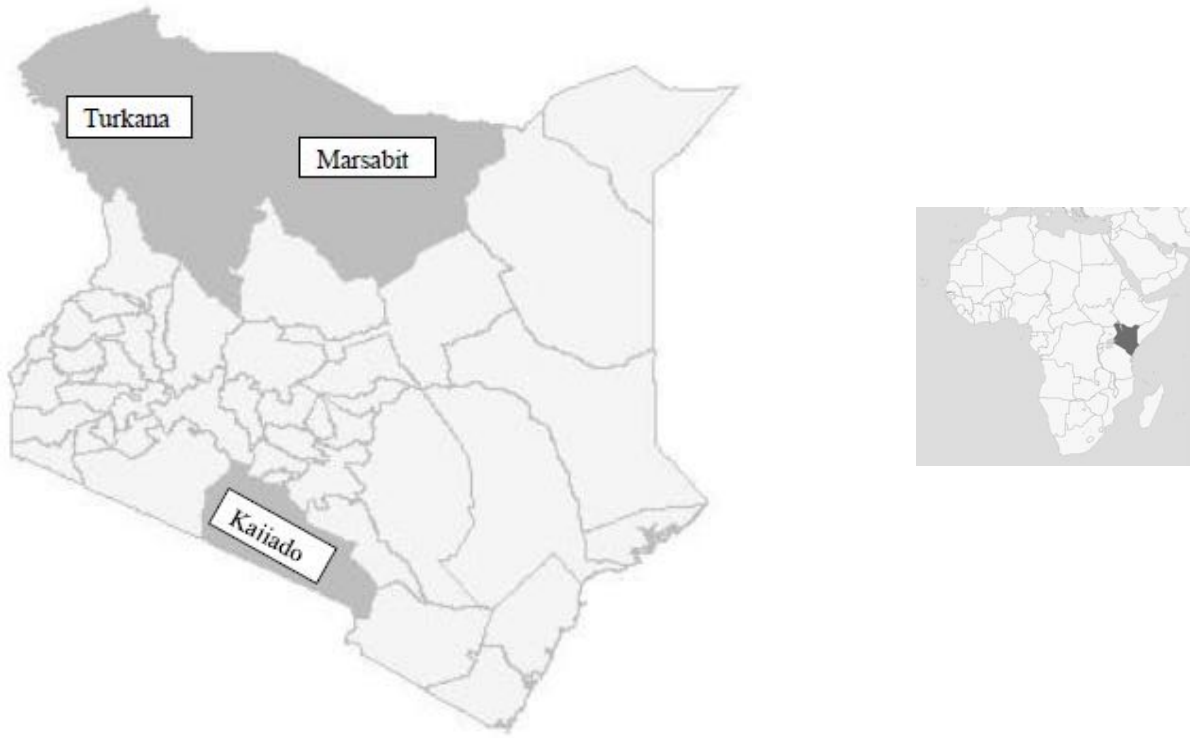

Figure 1: Map of Kenya showing the study areas

Data was collected using Focus Group Discussions (FGDs) and observations. From each county, five FGDs were conducted for each product. Homogeneous sampling scheme was used to randomly identify eight to twelve participants for the FGDs based on age, gender, and occupation as recommended [17]. Each group was provided with three kilograms of goat meat steak (mature Small East African breed) from the hind limb purchased from a local slaughterhouse. The choice of the breed was recommended based on existing data on goat breeds in arid and semi-arid areas in Kenya [18]. With the three kilograms, each group was required to make a specific indigenous deep-fried meat product. The researcher recorded the processing steps, time-taken, and amounts of other ingredients added. Besides, Key Informants Interviews with commercial indigenous meat processors were used to validate the processing steps and to provide information on the critical points with regards to product quality.

Description of sample preparation by FGDs

Nyirirnyiri was prepared in Marsabit Counties, Enyas and Ngamorumoru in Turkana County while Olpurda in Kajiado County. Five sets for each product were prepared with each set treated as a separate treatment group. Three replications were done for each product by having the same focus group prepare the same product on three different occasions (each one week apart). The deep-fried chunks were packed in plastic containers (Plastic #5 - Polypropylene (PP) for delivery to the laboratory for analysis. Enyas was divided into two portions; one portion was packed in the plastic container while the second portion was packed in a fumigated traditional wooden-leather container. Figure 3 shows the packaging containers for the smoked Enyas sample.

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Analytical methods

About 500 grams of raw meat, pre-dried meat, and deep-fried meat samples were cooled to 1° C and delivered to the laboratory within 24 hours in a cooled icebox. Nutritional analysis was based on AOAC standard methods (AOAC, 2008) while sensory analysis was based on ISO standard methods (ISO 8587:2006).

Moisture content was determined after dehydration at 105 °C using an air oven to a constant weight according to the AOAC methods (967.08), crude protein (total protein, N = 6.25) content determined using the Kjeldahl method (988.05) while the Soxhlet method was used to determine the fat content according to standard AOAC methods (2003.06). Dietary fiber was determined using the gravimetric method (958.06). About 10 g of the sample was weighed, put into a 500 ml flask and 50 ml of acid detergent fiber added. The mixture was boiled for one hour, after which it was filtered over a Buchner funnel connected to a vacuum pump using a sintered glass. The sinter glass crucibles were oven-dried at 100°C for 45 minutes. Dietary fiber was obtained as the difference between the weight of the empty sinter-glass and that after removal from the oven.

For the ash content, approximately 10 g of the meat products sample was minced and combusted in a muffle furnace at 550°C for 5 h according to standard AOAC methods (942.05). Ash was calculated as follows:

$$\frac{weight\ of\ ash}{weight\ of\ sample\ (10g)} * 100$$

Soluble carbohydrates were determined as the difference between 100 and the sums of the other food constituents, that is:

=100 - (moisture content+ proteins content + fats content + fibre content + ash content)

For the energy values, carbohydrates, proteins, and lipids content values were used to estimate the calorific values (kcal/g) based on a modification to the Pearson formula [19]:

Calorific (energy) value= 3.75 × carbohydrate level + 4 × protein level + 9 × fat level

Sensory evaluation

Samples were warmed in a water-bath at 50°C for 3 minutes, encapsulating oil drained off and about 20 grams placed on uniform clear 20 ml plastic containers. Eleven semi-trained panelists were asked to evaluate the products' overall acceptability as well as acceptability with respect to appearance, color, convenience during scooping, size of meat chunks, oiliness, odor, taste, and chewiness, based on ISO 8587:2006 as recommended [20].

Random digits were used to code the samples for identification and each panelist was requested to evaluate all the products. Color, appearance, convenience during scooping, size of meat chunks, and oiliness were evaluated by looks and touch while aroma, taste, and chewiness were evaluated through taste, smell and touch. The semi-trained panelists

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evaluated one sample based on the given attributes before receiving the next sample. Warm water was provided, and panelists were asked to expectorate and rinse their mouths between each sample. The sensory evaluation room had similar florescence lighting to maintain similar light intensity through the tests. The panelists were requested to evaluate the same samples in three sessions on the same day, that is, at 10:00 AM, 12:00 PM, and 3:00 PM. The sample order was randomized across the sessions to minimize bias due to positional effects. After the three sensory sessions, the sensory scores were averaged for each panelist. A 7-point hedonic scale where 7 was like very much, 6 was like moderately, 5 was like slightly, 4 was neither like nor dislike, 3 was dislike slightly, 2 was dislike moderately while 1 was dislike very much was used.

Data analysis

Data were subjected to Analysis of Variance (ANOVA) while Duncan's Multiple range test at $p \leq 0.05$ was used to compare the means and least significant differences of the scores for the attributes. Data analysis was done using Genstat version 12 for windows.

RESULTS AND DISCUSSION

Processing Variability for the pastoral products

The main variations observed on processing included; use of common salt, pre-drying in either under direct sunlight or under a shade, use of either vegetable oil, ghee or rendered tallow as deep-frying media, addition of spices and herbs to products, smoking of the packaging container prior to filling in the products, cooling products in oil to encapsulate meat chunks with oil and use of locally made containers. Table 1 brings out the variations in intermediate steps along the deep-frying process of pastoral meat products. Similar processing variations have been described in previous research (1, 10, 13, 14). Figure 2(a-d) are images of the four pastoral deep-fried products made by the FGDs.

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a) Nyirinyiri

d) Olpurda

b) Enyas

c) Ngamorumoru

Figure 2(a-d): Photographs of selected pastoral deep-fried products prepared by the FGDs

Process description of the main pastoral deep-fried meat products

Product 1: Nyirirnyiri

Using the 3 kg steak from the hind leg of mature Small East African goat, thin strips approximately 1 cm by 1 cm by 30 cm were made and sun-dried done for about 3 hours. The average ambient temperature during the research period was about 37°C. After sun-drying, the strips were cut into small cubes (1cm by 1 cm by 1 cm) and placed in a hot pan for about 5 minutes to evaporate excess water. About 10 grams of crushed cardamom seeds (*Elettaria cardamomum*) and 10 grams of common salt were added to the deep-frying media. Five FGDs deep-fried the chunks in about 1500 ml palm oil for about 21 minutes. It was noted that traditional ghee is also a common deep-frying media and

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therefore the FGDs were provided with 1 liter of traditional locally made ghee. Deep-frying time using ghee was about 27 minutes. Similar processing description has been reported for Nyirinyiri [13] with observed close resemblance with *Koche* which is an equivalent product from other pastoral communities [1, 10, 14]. The products were packed in plastic containers (Plastic #5 - Polypropylene (PP), then cooled for 10 minutes at ambient temperature, then placed inside iced cool-boxes.

Product 2: Enyas

Using 3 kg steak from the hind leg of mature Small East African goat, irregular large slices, each about 500 grams were made and hang in the shade for about 2 hours. Thereafter, small cubes (2 cm by 2 cm by 2 cm) were made, placed onto a pan and about 10 grams of common salt (NaCl) added. Enough water was added to the pan to completely submerge the meat chunks and boiling was done for about 150 minutes. Throughout the boiling process, continuous stirring was done to enhance evaporation. After the water had dried up, about 1500 ml of palm oil was added, and the meat chunks deep-fried for about 40 minutes. During the deep-frying process, the chunks were continuously pondered with a wooden rod to a fibrous/filament-like appearance. Similar processing description has been reported for pounded meat products [13] with slight variations from Fonntumma/fontuma, which is also pounded deep-fried meat products but roasted to pre-dry prior to deep-frying [1]. The samples were divided into two equal portions. One portion was packed in plastic containers (Plastic #5 - Polypropylene (PP), then cooled for 10 minutes at ambient temperature, before placing inside iced cool-boxes. The other portion was packed in traditional wooden-leather containers locally known as *ebur*. Figure 3 shows the wooden-leather packaging containers used to fumigate and package Enyas. Similar ethnic packaging containers have been reported in other pastoral communities and referred to as dhibe and dhool in other dialects [1, 13]. The wooden container had been fumigated for about 10 minutes using smoke from *Balanites rotundifolia*, locally known as *Ebei* in the local dialect prior to packaging the deep-fried Enyas.

Figure 3: Traditional wooden-leather packaging common for preserving deep-fried meats by pastoralists

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Product 3: Ngamorumoru

Using 3 kg steak from the hind leg of mature Small East African goat, irregular large slices, each about 500 grams were made and hang in the shade for about 2 hours. Thereafter, the meat was cut to small cubes (4 cm by 4 cm by 4 cm) and placed into a pan. About 10 grams of common salt was added and enough water added to completely submerge the meat chunks. The meat chunks were boiled for 90 minutes, and throughout the boiling process, the chunks were continuously stirred to enhance evaporation. After the water had dried out, about 1500 ml of palm oil was added, and then deep-fried for 22 minutes. Similar intermediate processing steps have been reported [2]. The product was packed in plastic containers (Plastic #5 - Polypropylene (PP), then cooled for 10 minutes at ambient temperature, before putting inside iced cool-boxes.

Product 4: Olpurda

Olpurda was prepared using 3 kg steak from the hind leg of mature Small East African goat. The meat was cut into small cubes (4 cm by 4 cm by 4 cm), placed into a hot pan, about 10 grams of common salt added, and submerged with enough water to partially submerge the meat pieces. The meat chunks were boiled for 30 minutes, after which, excess water was drained off. The chunks were further heated to evaporate excess water for about 4 minutes. Thereafter, 1 kg rendered Small East African goat belly fat was added and the chunks deep-fried for about 18 minutes. Simmering at about 70°C while still in deep-frying oil was further done for an additional 8 minutes for the products to attain the characteristic brown color. Similar processing steps have been described previously [2, 13]. The products were packed in plastic containers (Plastic #5 - Polypropylene (PP), then cooled for about 10 minutes at ambient temperature, then placed inside iced cool-boxes.

Nutrient content of the deep-fried meat products

The average proximate content of steak from the hind leg of the Small East African goat breed used for the four products was 69% moisture, 19% proteins, 6% lipids, 2% carbohydrates, and 4% ash content. The proximate composition of pre-dried goat meat chunks prior to the deep-frying of ethnic pastoral products is shown in Table 2. Pastoralists either sun-dry or use evaporative drying to pre-dry the meats. Sun-drying was done by cutting meat into thin long strips then hung under direct sunlight as done by Somali and Borana communities. Evaporative drying was done by boiling and occasionally draining off excess water as done by Turkana and Maasai communities. Results show that evaporation was more effective in moisture reduction than sun-drying. Hanging before boiling or during sun-drying facilitated limited drip loss and post-mortem aging thereby increasing moisture loss before deep-frying and thereby decreasing oil absorption during deep-frying as reported in similar studies [11].

Table 3 shows the proximate composition of ethnic pastoral deep-fried goat meats. The range in nutritional content was similar to that from similar studies [6, 11, 14]. Cooling deep-fried meats in the frying media increased fat content, carbohydrates, and caloric value of the products. Similar findings on high crude lipids content have been reported [1, 11, 14, 21]. Furthermore, cooling in the deep-frying oil created anaerobic conditions as the chunks got encapsulated in the solidifying oil thereby increasing shelf-stability by

up-to 90 days. The layer of encapsulating oil increases susceptibility to lipid oxidation as reported in similar studies [11, 22, 23]. The use of indigenous containers, spicing and smoking was used to impart characteristic sensory attributes and to increase stability as reported [14].

The choice of deep-frying media also contributes to variabilities in proximate composition. Deep-frying using rendered animal fat and ghee resulted in lower moisture and higher proteins, fats, and carbohydrates contents when compared to the use of palm oil. This resulted from differences in heat transfer coefficients, mass transfer coefficients, and moisture diffusivity of the deep-frying media as reported in similar research [24]. Similar findings were observed for protein, lipid, and ash contents [11, 14, 25, 26]. The use of uncontrolled heat during deep-frying may have resulted in variations in the degree of cooking. In almost all instances, overcooking was observed and could significantly reduce the organic nutrients, notably carbohydrates, proteins, and fibers as reported in similar studies [24, 27].

Sensory analysis of the deep-fried meat products

Table 4 highlights the sensory score of ethnic pastoral deep-fried goat meat products. Similar findings have been reported with regards to the basic salient features of meat snacks, namely appearance [28], ease of scooping and chunk size [11], oiliness [14], and convenience [6]. Taste, convenience, and color were the most preferred while the texture, size, odor, and oiliness were the least preferred ($p<0.05$). Duncan's Multiple Range Test at 5% significance level revealed significant differences where processing variations had been observed as reported in similar studies [11, 14]. Ngamorumoru and Enyas were most preferred based on oiliness as they appeared less oily as reported in similar studies [11, 14]. All the products scored highly with regards to ease of scooping and preference based on the size of meat chunks. The panelists' preference for smaller meat chunks as compared to larger meat chunks was observed. Enyas was least preferred with regards to appearance and convenience and this could be due to its fibrous appearance.

The choice of deep-frying media significantly contributed to higher scores for color and appearance in Nyirinyiri and Ngamorumoru where the use of palm oil had been used, while the low score for color and appearance in Olpurda was observed when rendered animal fat was used. Furthermore, solidified rendered fat masked the desirable brownish color characteristic of the deep-fried chunks. This was in line with previous research on the use of vegetable oil to improve sensory attributes of deep-fried meats [29]. On the flipside, vegetable oil was seen to significantly reduce the aroma in the products. Rendered animal fat led to firmly held chunks in the solidified fat matrix calling for reheating before eating [13]. This translated into a lower score on convenience to scoop for Olpurda. Traditional ghee and vegetable oils resulted in higher scores on convenience to scoop. Palm oil was preferred because it was cheaper than traditional ghee.

Pre-drying had a positive effect on the color and appearance of the products as having been reported previously [27]. Sun-drying in direct sunlight was seen to significantly improve texture and color, and this was attributed to enhanced postmortem aging process [30].

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The use of spices and smoking significantly contributed to the sensory characterization of the products. Ground cardamom (*Elettaria cardamomum*) seeds were used to spice Nyirinyiri thereby significantly increasing the scores for aroma as reported in similar work [14]. *Elettaria cardamomum* is known as "*iliki*" in Kiswahili dialect and belonging to the Zingiberaceae family.

Smoking imparted a characteristic taste and aroma in Enyas. *Balanites rotundifolia*, locally referred to as *Ebei* in Turkana dialect was burnt to generate smoke for fumigating the wooden-leather packaging containers locally known as *ebur* thereby imparting the desirable taste and aroma. Smoking was also done to sanitize the *ebur* as reported earlier [13]. However, significantly lower scores were reported on aroma and chewiness as the semi-trained panelists disliked the woody and burnt flavor, and the hard texture. This had not been anticipated but it's worth acknowledging the limitation on the use of semi-trained panelists to assess deep rooted ethnic food products [6, 31, 32].

CONCLUSION

The weakening cultural ties have led to differences in intermediate/hurdles steps within and between different communities. Consequently, huge diversity has been observed, and this causes variations with regards to nutritional and sensory attributes. Pastoral meat products have high proteins, lipids, calorie, and ash contents, and serve as nutrient-dense snacks for pastoral communities. These coupled with high satiety make them suit the nomadic lifestyle among pastoralists. Sun-drying either under direct sunlight or through evaporative drying was used to enhance moisture loss during deep-frying thereby improving the nutritional and sensory attributes of the products. Pounding, spicing, oil-encapsulation, and smoking not only brought out the desired characteristic sensory attributes but also increased microbial shelf-stability. Interestingly, the need to clearly define the desired characteristic sensory attributes deeply embedded in cultural roots was not effectively factored by the semi-trained panelists calling for caution before conclusive remarks are made with regards to sensory acceptability. The uniqueness of ethnic deep-fried goat meats creates a big potential for these products, necessitating the need to document indigenous processing and to standardize ethnic deep-fried pastoral meat for enhanced global competitiveness.

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Table 1: Variations in intermediate steps along deep-frying process of pastoral meat products

	Deep-fried products	*Nyirinyiri*	*Ng'amorumoru*	*Enyas*	*Olpurda*
1	Chunk size	1 cm × 1 cm × 1 cm	4 cm × 4 cm × 4 cm	2 cm × 2 cm × 2 cm	4 cm × 4 cm × 4 cm
2	Use of common salt prior to pre-drying	-/+	+	+	-/+
3	Sun drying under direct sun	3 hours	-/+	-/+	-/+
4	Sun drying under the shade	-/+	2 hours	2 hours	-/+
5	Boiling time to pre-dry meat chunks	Not done	90 minutes	150 minutes	30 minutes
6	Pounding	-	-	+	-
7	Addition of spices and herbs in deep-frying media	+	-	-	-/+
8	Choice of deep-frying media	Ghee/ vegetable oil	Animal fat/ vegetable oil	Animal fat/ vegetable oil	Rendered animal fat/ vegetable oil
9	Smoking of the packaging container prior to hot filling	-	-	+	-
10	Oil encapsulation by cooling to solidify the oil over the meat chunks	-/+	+	+	+
11	Preference of locally made container	-/+	-/+	-/+	-/+

Key: - represents Never done, -/+ represents sometimes done, + represents Always done

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Table 2: Proximate composition of goat meat chunks after pre-drying during processing of ethnic pastoral deep-fried products

Sample name	Moisture %	Protein %	Fat %	Fiber %	Ash %	CHO %	Energy Kcal/100g
Nyirinyiri (made with ghee) *	66.8 (2.1)	29.0 (1.2)	1.5 (0.3)	0.0 (0.00)	2.1 (0.2)	0.7 (0.4)	132 (8.9)
Nyirinyiri (made with palm oil) *	66.8 (2.1)	29.0 (1.2)	1.5 (0.3)	0.0 (0.00)	2.1 (0.2)	0.7 (0.4)	132 (8.9)
Enyas (smoked) *	58.1 (0.9)	29.6 (2.7)	9.6 (0.6)	0.0 (0.00)	2.7 (0.1)	0.0 (0.0)	204 (10.6)
Enyas (not smoked) *	58.1 (0.9)	29.6 (2.7)	9.6 (0.6)	0.0 (0.00)	2.7 (0.1)	0.0 (0.0)	204 (10.6)
Ngamorumoru	61.8 (2.7)	30.6 (1.0)	4.6 (0.3)	0.0 (0.00)	2.3 (0.1)	0.7 (0.1)	166 (4.6)
Olpurda	58.0 (4.4)	33.8 (2.5)	5.6 (0.4)	0.0 (0.00)	2.5 (0.2)	0.0 (0.0)	185 (4.2)

Figure in parenthesis represent the standard error of mean (n= 5)

Table 3: Proximate composition of ethnic deep-fried goat meat products from pastoral communities in Kenya after deep-frying

Sample name	Moisture %	Protein %	Fat %	Fiber %	Ash %	CHO %	Energy Kcal/100g
Nyirinyiri (made with ghee)	28.5 (2.2)	43.6 (1.7)	15.4 (1.2)	0.01 (0.00)	3.5 (0.2)	9.05 (0.9)	425 (9.3)
Nyirinyiri (made with palm oil)	30.8 (1.9)	43.3 (1.3)	14.9 (1.6)	0.01 (0.00)	3.4 (0.0)	6.82 (0.7)	425 (7.4)
Enyas (smoked)	8.1 (0.7)	42.6 (1.8)	37.9 (0.7)	0.03 (0.01)	3.7 (0.1)	7.69 (0.1)	540 (6.5)
Enyas (not smoked)	8.1 (0.9)	42.7 (1.6)	37.9 (1.2)	0.03 (0.01)	3.7 (0.0)	8.03 (0.6)	542 (4.9)
Ngamorumoru*	17.6 (1.6)	43.8 (1.4)	31.1 (1.2)	0.02 (0.00)	4.3 (0.3)	3.28 (0.2)	455 (9.4)
Olpurda*	13.5 (3.1)	46.9 (1.3)	27.3 (1.4)	0.02 (0.00)	3.1 (0.6)	9.18 (1.0)	470 (5.1)

Figure in parenthesis represent the standard error of mean (n= 5)

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Table 4: Sensory data of ethnic deep-fried goat meat products from pastoral communities in Kenya

Product	Appearance	Color	Convenience to scoop	Size of chunks	Oiliness	Aroma	Taste	Chewiness	Overall acceptability
Nyirinyiri (made with ghee)	5.5 (0.2)^{a}	5.6 (0.1)^{a}	5.2 (0.1)^{b}	5.0 (0.3)^{b}	4.9 (0.2)^{a}	5.6 (0.3)^{a}	6.1 (0.1)^{a}	5.9 (0.1)^{a}	6.0 (0.1)^{a}
Nyirinyiri (made with palm oil)	5.5 (0.2)^{a}	5.3 (0.2)^{ab}	5.6 (0.2)^{a}	5.3 (0.2)^{a}	5.0 (0.2)^{a}	5.3 (0.2)^{ab}	5.8 (0.1)^{ab}	5.7 (0.1)^{ab}	5.6 (0.1)^{b}
Ngamorumoru	5.1 (0.1)^{b}	5.2 (0.2)^{ab}	5.6 (0.1)^{a}	5.5 (0.3)^{a}	5.2 (0.2)^{a}	4.9 (0.1)^{bc}	5.3 (0.0)^{b}	5.3 (0.2)^{b}	5.6 (0.3)^{b}
Enyas (smoked)	4.8 (0.1)^{b}	5.1 (0.2)^{b}	4.5 (0.1)^{c}	3.9 (0.2)^{d}	5.2 (0.2)^{a}	4.5 (0.1)^{cd}	4.5 (0.3)^{c}	4.6 (0.2)^{c}	4.5 (0.2)^{d}
Enyas (not smoked)	4.7 (0.1)^{bc}	4.9 (0.3)^{b}	4.9 (0.2)^{b}	4.2 (0.2)^{c}	5.2 (0.2)^{a}	4.9 (0.3)^{bc}	5.4 (0.1)^{b}	4.2 (0.2)^{c}	5.0 (0.1)^{c}
Olpurda	4.3 (0.1)^{c}	4.2 (0.1)^{c}	5.0 (0.1)^{b}	4.9 (0.2)^{b}	4.2 (0.2)^{b}	4.2 (0.1)^{d}	4.3 (0.3)^{c}	3.3 (0.3)^{d}	4.2 (0.3)^{d}
Mean score	**5.0**	**5.1**	**5.1**	**4.9**	**4.9**	**4.9**	**5.2**	**4.9**	**5.2**

Figure in parenthesis represent the standard error of the mean (n= 5)

Means followed by the different letters are significantly different from each other ($P< 0.05$)

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