Parameters determining the quality of ('Kundi') an intermediate moisture meat, from beef and camel meat

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Abstract
'Kundi' a typical Nigerian meat product obtained from smoking beef and camel meat. Meat from 2 to 3 years old male camelus dromedarous and white Fulani were used for this study. The lean hindquarter of both animals was used (semimenbranosus muscles). The meat chunks was trimmed free of all fat nerves blood vessels and excess connective tissues. The chunks were cuts into smaller pieces about 6cm to 8cm long and kept overnight for 24 hours at 4°C. Three different cooking methods were used: boiling, air drying and smoke drying method, while seasoning used was added during boiling. Result shows that proximate composition of 'Kundi', observed showed that moisture content obtained in 'Kundi' beef had lower ($p<0.05$) value 30.21 % than 35.09 % for camel 'Kundi'. The protein content followed the same trend with that of moisture content. Ether extract had on significant difference ($p>0.05$) for both 'Kundi' samples. The microbiological value obtained had significant ($p<0.05$) differences for both samples for seasoned and unseasoned products. Microbes identified at 6 months storage interval were significantly ($P<0.05$) higher than microbes identified at 0, and 3 months respectively. The pH values obtained had no significant differences ($p<0.05$) at 0, 3 and 6 months of storage for both meat type respectively.

Key words: 'Kundi', camel meat, beef, pH value and seasoning.

Introduction

Meat and meat products are extremely perishable; meat for human consumption needs to undergo some form of preservation if it is not to be consumed immediately. The microbiology safety of food products have been a major focus of regulatory agencies and consumers (Stillmunkes *et al.*, 1993). Deterioration of meat begins soon after bleeding, as a result of microbial invasion which makes such meat unfit for consumption. It is therefore necessary to minimize deterioration in order to prolong the time during which an acceptable level of quality is maintained.

Among the factors that affect microbial growth in meat and meat product include: pH, moisture content, relative humidity, presence and absence of oxygen and nutritive values (Hedrick *et al.*, 1994). pH is important to meat because it influences its shelf life. Meat with high ultimate pH is generally very susceptible to microbial growth even under the best management condition and practices (Hedrick *et al.*, 1994). Microorganism may find it difficult striving at a low pH. Lawrie (1991) stated that all micro organisms will not grow well below pH of 4.0 and above pH of 9.0 The focus of this study is therefore to investigate the parameters determining the quality of 'Kundi' like the pH valve, microbiology and chemical evaluation of 'Kundi', an intermediate moisture meat.

Material and methods

Source of meat

The beef used for this study was obtained from the slaughter slab of the department of Animal Science, University of Ibadan, Ibadan Nigeria. Meat weighing 6 kg from 2 to 3 year's old male *Camelus dromedarous* and Sokoto Gudali animal were used. The age of camel animal was determined using the animal dentition. The camel meat was purchased from Agege abattoir in Lagos State Nigeria, soon after slaughter. The semimembranous muscles from hindquarter of the cow and camel were used.

Meat Processing (cleaning and cutting)

The meat was trimmed of all external fats, blood vessels, nerves, excess epimysial connective tissues and deboned with a sharp knife and later washed with clean water. The chunks were held overnight for 24 hours at 4 °C and later cut into sizeable smaller portion within the range of 70 – 90 grams of 6 cm to 8 cm wide.

Preparation of 'Kundi' boiling method

The cut samples (2 kg) from both beef and camel muscles were separately boiled in water (5 times weight of meat sample). The meat samples were boiled in a pressure cooker for 30 minutes at 100 °C and stirred at intervals for uniform doneness. The liquid broth was drained and the meat samples were allowed to equilibrate to room temperature.

Ingredient inclusion

Ingredients used for 'Kundi' production includes: onions, thyme, curry powder, maggi (monosodium glutamate) and salt. The ingredients were added during the boiling process.

Table 1: Ingredients inclusion in 'Kundi' production. (g / 100 g)

Spices	Description	Percent Inclusion (%)
Onion	fresh bulb of Allium cepa	75.6
Thyme	Thyme Vulgaris	3.0
Curry powder	Zingiber officinale	
	Fromonium Meleguata	3.0
	Capscum fruitescens	
Maggi	Monosodium glutamate	9.8
Salt	Sodium chloride	8.6
Total		100

Air drying method

Boiled samples were air dried for 10 to 20 minutes on trays in the laboratory to dry off the broth on the surface of the meat.

Smoking method

The boiled meat samples were smoked using charcoal as the heat source at 200 °C – 360 °C (using the oven thermometer) for 6 hours. The drying samples were covered with a tray to impact the smoky compound from the heat source to the surface of the meat samples.

pH determination

The pH of fresh meat and 'kundi' products were determined according to the method described by Bendall (1973). The pH was measured in the aqueous extract in 1g of the dried samples were homogenized in 10 ml distill water. The pH was measured using checker pH meter. The pH of the fresh meat was measured by immersing the pH meter into the muscle.

Microbial analysis

The microbial status was determined by isolating, identifying and characterizing the organism according to the method describe by Meynelle and Meynelle (1970) and Norris and Ribbon, (1971).

Statistical analysis

Data collected were subjected to analysis of variance using SAS (1999) significant means were separated using Duncan (1975) multiple range F - test of the same software in a completely randomized design.

Result

Table 2: Proximate composition, product yield and rehydratability of commercially prepared 'kundi' and laboratory prepared camel and beef 'kundi' (g / 100gDm)

Parameter	Treatment			
	C.K	LPCK	LPBK	SEM
Moisture	23.29^{c}	30.21^{b}	35.09^{a}	0.42
Ash	4.82^{a}	1.86^{c}	2.40^{b}	0.21
Ether extract	5.43^{a}	4.86^{b}	4.41^{b}	0.65
Protein	66. 79^{a}	63.07^{b}	58.10^{c}	0.25

^{abc}: means in the same row with different superscript are significantly (P<0.05) different.
CK – Commercially prepared 'Kundi'
LPCK – Laboratory prepared camel 'Kundi'
LPBK – Laboratory prepared beef 'Kundi'

Table 2: pH value of 'kundi'

	Meat under storage				
	Beef		Camel		
Period	Seasoned	Unseasoned	Seasoned	Unseasoned	SEM
Raw meat	6.20^{ax}	6.20^{ax}	6.07^{bx}	6.07^{bx}	0.11
0 month	5.43^{ay}	5.32^{by}	5.33^{by}	5.11^{cy}	0.01
3 Month	5.43^{ay}	5.33^{by}	5.34^{by}	5.11^{cy}	0.02
6 Month	5.43^{ay}	5.33^{by}	5.34^{by}	5.11^{cy}	0.02
SEM	0.03	0.02	0.02	0.01	

ab: Means in the same row with different superscript are significantly different (p<0.05).
xy: Means in the same column, with different superscript are significantly different (p<0.05)

Table 3: Spoilage and xerophilic fungi isolated from smoked 'Kundi' incubated at 73 °C for 6 month intervals

Microbes	Description
Aspergillus flavus	Large bright - green colonies with yellowish centuries. Sterigmata. Uniserate
Aspergillus niger	Black radiating colonies with large conidia heads was seen.
Penicillium spp.	Had distinct blue – green white at first then coloured after conidial matures.
Rhizoppus spp.	The fungus quickly filling the culture plate with a dense colony aerial mycelium at first white and later becomes grey.
Mucor spp	Fast growing fungus filling a Petri plate with colony aerial mycelium at first white. and later becoming dark grey brown or yellow.
Fusarium spp.	This fungus was at first white in collony or woody then it frequently becoming pale in the hyphae or in the substrate.
Bacillius spp	Gram positive bacteria whitish in colour.

Table 4: Microbial Plate count (x10^4) of fungi in stored 'kundi'

	Meat sample				
	Beef		Camel		
Storage time	Unseasoned	Seasoned	Unseasoned	Seasoned	SEM
0 Month	3.00^{abz}	2.00^{bz}	4.00^{az}	2.00^{bz}	0.19
3 Month	5.00^{aby}	4.00^{by}	6.00^{ay}	5.00^{aby}	1.13
6 Month	9.00^{ax}	6.00^{cx}	9.00^{ax}	7.00^{bx}	1.22
SEM	1.21	1.12	1.22	1.10	

^{ab}: Means in the same row with different superscript are significantly different ($p<0.05$).
^{xyz}: Means in the same column. with different superscript are significantly different ($p<0.05$)

Discussion

The results obtained for moisture content of 'Kundi' fell within the range of 30 – 40 % reported by Alonge (1984). The CK value fell in the range of 21.6 - 26.8 % for moisture in Majoran Sausage and Salami as reported by Fernandez – Salguero (1993). The values were however higher than 8.2 % - 11.1 % observed for moisture of oven dried and sun dried 'Kilishi' reported by Egbunike and Okubanjo (1999) and 3.4 – 3.5 % reported by Cosenza *et al.* (2003) for Cabrito smoked sausage formulated with soy protein concentrated.

Smoking of meat causes a marked decrease in moisture content as reported by Okonkwo *et al.* (1991). Egbunike and Okubanjo (1999) reported that IMM are low in moisture content and are shelf stable under tropical climates without refrigeration and that IMM may be eaten directly with or without rehydration. The lowest moisture content obtained for commercial 'Kundi' could probably be due to sun drying and air drying methods practiced by the 'Kundi' sellers in the open market in order to reduce infection or growth of microorganism.

The mean ash content obtained in the present study agreed with that reported by Igene and Ekanen (1985). These authors found that the ash content of meat increased with heat application. Sheard *et al.* (1998) reported 2.8 – 3.8 % of ash content for meat products while (Fernandez – Salguero *et al.*, 1993) reported a higher mean ash content of 10.6. 15.2 and 7.4 % for cure ham. meat vegetable extract and jerked beef respectively.

The highest ash content for commercial 'Kundi' may be due to resultant dirt on the meat pieces when sun drying on the ground in the open market. Torres *et al.* (1994) reported that ash content at the end of storage differ significantly to that at the onset. Kinsman (1982) reported that the vitamin and mineral contents on IMM remain unchanged and the nutritional quality of freshly prepared meat was similar to that of ordinary cooked meat. Apart from the effect of concentration due to moisture removal, the increase in ash contents of the products was also partly attributed to the ash content contained in the smoking compounds.

The result obtained in the present study for fat content were observed to be lower than the range of 10.9 -29.6 % obtained for fat of alheria (Vania, 2006). The rise in fat contents of the products upon processing may be due to the effect of concentration due to moisture loss. The highest fat content obtained for CK might be due to the continuous sprinkling of groundnut oil on the products. Oil is usually applied with a view to keep the products glossy and attractive to prospective buyers and to avoid the onset of micro organism in order to prolong its shelf life.

The relationship between fat level and loss during cooking is an interesting one and has been investigated by Tornberg *et al.* (1989). It appeared that as the fat content increased, the mean free distance between fat cells decreased, raising the livelihood of fat leaking from the products (Sheard *et al.*, 1998) thus, high fat products tends to lose large amounts of fat during cooking whilst low fat meat products lose relatively little fat, an observation that becomes clear only when fat levels are reported on an absolute basis rather than the commonly used percentage basis (Chappel, 1986).

The level of protein found in the 'Kundi' product was within the range of 69.8 -72.1 % reported by Soniran and Okubanjo (2002) for protein content of pork loin roast cooked to three internal temperatures at 65 ^{0}C, 75 ^{0}C and 85 ^{0}C respectively. Also Kumar and Aalbersberg (2006) and Egbunike and Okubanjo (1999) reported protein content with range of 68.1 - 71.8 % for sundried and oven dried 'Kilishi, which appeared superior to the values obtained in this study. The values obtained for protein content were superior to 34.6 – 44.6 % reported by Paleari *et al.*, (2003) for protein content of cured meat products.

The increase in protein content observed for 'Kundi' product was in agreement with the report of Egbunike and Okubanjo (1999) that intermediate moisture meat are meats low in moisture content and contain three to four times the raw protein equivalent ; hence they are less bulky. The increment in the protein value could be due to the conformational changes of proteins occurring on heating which is known as denaturation, followed by structural changes which occur on heating which is refer to protein - protein interactions, resulting in the aggregation of proteins (Tornberg, 2005). The lowest value of moisture in the commercial 'Kundi' may explain the apparent gain in the protein due to higher concentration effects (Igene and Ekanem, 1985).

pH is a widely used method of expressing acidity or alkalinity of all sort of products, especially in food and food processing industry. Byrne *et al.* (2000) reported that the pH of meat tissue is widely used as a means of monitoring meat quality. Thus pH has become an essential parameter for judging meat and meat product quality.

Fresh meat of animal prior to slaughtering has pH value of 7.1 (Eutech, 1997). Eskin (1990) stated that production of lactic acid causes the pH of the muscle tissue to drop from the physiological pH of 7.1 - 7.4 in warm blooded animals to the ultimate postmortem pH of around 5.3 - 5.5 which result into a Pale Soft Exudates PSE). Normal fresh muscle has a pH of 5.3 - 5.7, some pH values remains stable at a relatively high level, giving an ultimate pH in the range of 6.5 – 6.8 (Hedrick *et al.*,1994).

The pH value obtained in this study for fresh meat fell within the range of 5.99 – 6.31 reported by Omojola and Adesheyinwa (2006) for pH value of scalded, signed and skinned rabbit. It fell however, outside the range of 5.5 -5.8 for beef, Zebra, Kongoni and Oryx meat reported by Onyango *et al.* (1998). The values obtained were greater than 5.57 and 7.50 for by buffalo and beef stated by Maria *et al.* (2000) and 5.69 - 5.80 for L. dorsi muscles, Semitendinousus muscle and Triceps branchi muscle of camel meat (Babiker and Yosuif, 1989). The values were however lower than 6.60 – 6.90 for Ostrich meat (Rosa *et al.*, 2006).

The values obtained for seasoned 'Kundi' were higher than unseasoned 'Kundi' for both smoked and oven dried products.

The difference could probably be due to the effect of Nacl on meat proteins. Eoin (2006) observed that CL' ion is strongly bound to protein than Na' when salt is used in cooking of meat. This causes an increase in negative charges of proteins. Salt could also cause repulsion between the myofribrillar proteins, which may results in swelling of the myofribrils due to repulsion of individual muscles (Hamm, 1972). The adsorption of CL' ions with positively charged groups of myosin results in a shift of the isoeletric point to lower the pH, causing a weakening of the interaction between the oppositely charged groups at a pH greater than the isoelectric point and therefore result in an increase in pH, swelling of the myofribrils and water holding capacity (Hamm, 1986).

Salt added to meat increase the negative charge of the protein which lowers the protein isoelectric point to about 4.5 while it raises the pH of meat slightly (Hamm, 1960). Oguńsola and Omojola (2003) reported that the pH of freshly salted meat increases with increasing salts levels and that boiling and broiling of meat at different salt level showed an increase in pH.

The results of seasoned and unseasoned (smoked and oven dried) obtained in this work were comparable to 4.83 – 5.99 for pH value of seventeen Intermediate Moisture Meat (Jose *et al.*, 1994), but lower than 6.48 – 7.20 for pH value of smoked meat (Alonge, 1984) and 5.9 for pH value of Bitlong an Intermediate Moisture Meat reported by reported by Vander Riet (1976). The differences could be due to difference in treatments applied (smoke and oven dried mathod). Randall and Bratzler (1970) and Kako (1968) stated that smoking of meat causes the lowering of pH value of meat products. Organic acid in smoke help to preserve meat and causes lowering of pH value of meat products (Wikipedia, 2002).

The higher pH values obtained in this study for both seasoned and unseasoned 'Kundi' products could be due to effect of heat on meat pH. Heat has greater effect on pH value of meat. Vasanthi *et al.* (2007) noticed that there are gradual increase in pH when meat was cooked at 80 °C, 90 °C and 100 °C. The increase in pH value when meat is heated may be attributed to the loss of free acidic group (Lawrie, 1991). Tilgner (1958) stated that cooking of meat at temperatures above 80 °C will cause free hydrogen sulphide increase. The loss of free acidic groups during heating of meat, explain the considerable rise in the pH of meat giving higher pH values. Vasanthi *et al* (2007) revealed that increase in temperature and duration of cooking increase pH.

Meat with higher pH will have higher water holding capacity (Hamm, 1960). Alonge (1984) stated that relative difference in the water holding capacity of fresh meat is retained after heating. For examples fresh meat of high ultimate pH with high water holing capacity, will have higher water holding capacity after cooking (Hamm and Dethatherge, 1960).

It is therefore observed that the pH value of 'Kundi for either seasoned and unseasoned products, were closer to the minimum accepted limit 6.0 suggested by Pearson (1968) for fresh meat, suggesting that meat used was produced from well nourished and rested stock.

The main microbial group of important is this study is the fungus while bacterial was isolated only once (*Bacillus spp*). These findings obtained in this study could be as a result of pH values of the products during storage. As bacteria grow optimally near neutrality (pH 7.0); molds / fungi which were predominately isolated in this study had the widest range of pH tolerance (pH 2.0 - 8.0) although their growth is generally more favoured by acid pH.

The results of the pH values of 'Kundi' obtained in the last study for both seasoned and unseasoned 'Kundi' for both animals fell between 5.11 -5.91 gave a conducive environment for mold to strive. Yeast were not identify because it strive best in acid environment of pH 4.0 - 4.5 (Alonge, 1984). He also reported that ultimate pH of approximately 5.4 – 5.6 in meat, favour the growth of molds and acidophilic bacteria.

The fungi are able to grow despite the fact that the meat products were deeply smoked and seasoned. According to Barylko – Pikielina (1977) yeast and molds show a relatively high resistance to the inhibiting influence of smoke – curing and flavouring additives at concentration up to 60 ppm.

A visit to the store of the 'Kundi' sellers in the big city markets of Nigeria, reveal that a large percentage of the meats on display for sale are moldy. The climatic environment in Nigeria favours the growth of these fungi and as soon as the 'kundi' seller noticed that mold had grown on the products, they quickly dust it with vegetable oil and sun dried. This method makes it difficult for mold or other microbes to grow on the surface and hence increases the shelf life of products ('Kundi') to 1 – 2 years.

Most of the fungi isolated are xerophilic, which are organism that are capable of growth at low water activity a_w of less than 0.83 and are well adapted to dry and partially dry foods (Pitt, 1975). Some of xerophilic organism can be toxigenic that is able to from mycotoxins. Alonge (1984) screened some fungi isolated from 'Kundi' products for aflatoxins and no toxins were detected. The main reason why aftatoxin was not detected was because, most if not all of the organism identified grow at very low or minimum water activity. For example Aspergillus flavous grows at low moisture conditions and at a minimum water activity a_w of 0.75. Leistner *et al.* (1981) reported that aflatoxins cannot be formed in meat products with water activity below 0.83. Majority of the smoked dried meat study by Alonge (1984) had a_w values below 0.83.

Rihizopus spp and *Mucor* spp were noticed by Alonge (1984) not to be found toxigenic but they are xerophilic organisms because as both of them grow on the meat surface the meat spoilt gradually. The growth of xerophilic fungi on meat increases the a_w of such meat therefore the meat becomes softer thus allowing other microbes to grow on the meat surface, like bacillus spp a gram positive bacterium.

The results of microbial load obtained were in agreement with the report of (Venia *et al.*, 2006) for dehydrated 'Kilishi' stored for 2days post production and also were comparable with 3.25 – 7.27 reported by Kembi and Okubanjo (2002) for raw and steam – cooked beef and beef patties before dehydration. However, the values obtained were higher than the findings of Sankaran *et al.* (1976) for dehydrated minced meat and report of Egbunike and Okubanjo (1990) for meat floss during processing. Ockrman and Li (1999) reported 0.00 – 1.47 for microbial assays of dehydrated meat products and 1.6 - 1.8 microbial counts were recorded for meat floss during processing by Torres *et al.* (1994). The higher microbial load obtained at 6 months of storage may be due to moisture absorption from the air or environment which in turns increases the growth of more microbes on the meat surface. As it was observed that the microbes increase as the storage time increases for both oven and smoked dried products.

The results also shows that seasoned products had lower microbial load count to unseasoned products. Alonge (1984) reported that application of salt, apart from eliminating non- salt tolerant bacterial spp by osmotic extraction of liquids through the cell walls; it also binds water and makes it unavailable to microbes to grow. Curing serves to reduce growth of microbes enhances colour and enriches flavour of meat product (Roderick, 1997).

The microbes observed in stored smoked products were lower which could be due to the effect of smoke compound on the surface of 'Kundi products which acts as bacteriostatic properties. Shapely (1976), reported that smoking of meat prolong the shelf – life of meat products, as the acid in smoke compound act as surface sterilants of meat. Ikeme (1990) also, stated that most of the compounds in wood smoke exhibit either bacterio-static or bactericidal properties; it is believed that formaldehyde (a carbonyl compound) accounts for most of the preservative action of smoke. When smoking is combined with curing, the shelf life of such products is increase and decreases the microbial load especially on the meat surface (Lawrie, 1991). Also the combination of curing and smoking are usually effective in reducing surface bacterial population of the products (Price and Schweigert, 1971). Price and Schweigert (1971) also stated further that, surface dehydration, protein coagulation and the deposition of a resinous material resulting from the condensation of formaldehyde and phenol; produce a reasonable effective chemical and physical barrier against microbial growth and penetration of the finish products. Smoke constituents play an important role in preserving the product against microbial spoilage.

Thus it is possible to produce 'Kundi' with low microbial counts as smoking, seasoning and adequate hygienic conditions are maintained.

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