

Full Length Research Paper

Qualitative evaluation of Kilishi prepared from beef and pork

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Kilishi is an intermediate moisture meat product of the tropics, prepared from sun-dried lean beef infused with spices and defatted groundnut paste (DGP). This study evaluates the quality traits in Kilishi prepared from beef and pork. The proximate composition and the organoleptic characteristics of Kilishi from beef and pork were studied in a completely randomized design. The effect of three different packaging materials [polyvinyl chloride (PVC), aluminium foil (ALF) and plastic container (PC)] on microbial isolates of both Kilishi after 36 week storage at room temperatures were also evaluated. The result revealed that Kilishi from beef and pork differed significantly ($P > 0.05$) in colour and juiciness. Kilishi from pork gave higher ($P < 0.05$) values of 3.70 ± 0.32 and 3.93 ± 0.21 as against values of 2.33 ± 0.22 and 2.93 ± 0.30 for Kilishi from beef in respect to colour and juiciness, respectively. Kilishi from beef and pork had similar values ($P > 0.05$) for moisture, protein and fat while Kilishi from beef gave a higher ash value ($P < 0.05$) of 8.78 ± 0.13 than Kilishi from pork (6.96 ± 0.24). The ash and protein content of Kilishi were more than those of dried raw meat samples. However, Kilishi from beef and pork gave lower moisture values of 10.00 ± 0.15 and $9.92 \pm 0.22\%$ as against 35.85 ± 0.24 and $46.51 \pm 0.30\%$ for dried raw beef and pork respectively. In the packaging experiment, five bacteria species were identified. *Bacillus* spp. constituted the highest while *Staphylococcus* spp. and *Proteus* spp. were the least. The foil packaged products gave the highest microbial load.

Key words: Kilishi, packaging, organoleptic properties, beef, pork.

INTRODUCTION

The present day techniques of meat preservation are sophisticated, requiring reliable power supply as found only in the developed countries. However, for developing countries, appropriate technologies that are affordable, simple and applicable are needed to suit the local environment in terms of social and economic conditions. Traditionally, solar drying and or salting are used to preserve meat, fish and sea foods. This acted as some sort of curing to retain the quality of the meat. The oldest forms of meat preservation which are salting and drying date right back to the early man, who realized that raw meats must be quickly processed to preserve them for consumption at a later date. These two methods of meat preservation are employed by Kilishi processors.

Kilishi is a tropical intermediate moisture meat product that is prepared essentially from beef slices, infused in slurry of defatted groundnut paste and spices and sun-dried. The ability of the product to keep for several

months at room temperature is fast making the product a house-hold name. It is a rich nourishing snack and a source of supplementary animal protein formulated using hurdle technology, a concept described by Leistner (1987). Salting, dehydration or sun-drying and packaging are hurdles applied in sequence to inhibit deteriorating microorganisms (Biscontin et al., 1996).

With increasing awareness and consumption of Kilishi coupled with the skyrocketing price of the product in both local and international market as a result of the high price of beef, it therefore become imperative to produce Kilishi from other meat types. This study was designed to evaluate the nutritive and eating qualities of Kilishi from beef and pork.

MATERIALS AND METHODS

Meat preparations

The semimembranosus muscle from hot bonned beef and pork carcasses were used for the study. The meat was trimmed free of fat and excess connective tissues. The chunk of meat was cut into

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Table 1. Composition of ingredients used for slurry (kg/100 kg).

Ingredients	Other names	Composition
Ginger	<i>Zingiber officinale</i>	3.80
Cloves	<i>Eugenice caryophyllceta</i>	2.60
Black pepper	<i>Piper guineense</i>	3.40
Red pepper	<i>Capsicum frutescens</i>	1.90
Sweet pepper	<i>Capsicum annum</i>	1.90
Alligator pepper	<i>Afromomum meleginata</i>	2.10
Onion	<i>Allium cepa</i>	8.40
Garlic	<i>Allium sativum</i>	0.10
African nutmeg	<i>Monodora myristica</i>	0.40
Curry	<i>Fagara xanthoxyloides</i>	0.70
Salt	Sodium chloride	0.70
Magi seasoning	Monosodium glutamate	5.80
Sugar		3.50
Groundnut paste	<i>Aradus hypogea</i>	28.50
Water		36.20
	Total	100.00

Table 2. Proximate composition (g/100 g DM) of dried raw beef and pork and Kilishi produced there from after slurry infusion.

Parameters	Dried raw meat		Kilishi	
	Beef	Pork	Beef	Pork
Moisture	35.83±0.24 ^b	46.51±0.30 ^a	10.00±0.15 ^c	9.92±0.22 ^c
Protein	45.22±0.22 ^b	33.88±0.3 ^c	60.33±0.05 ^a	59.41±0.63 ^a
Fat	14.53±0.23 ^b	16.72±0.22 ^a	14.24±0.10 ^b	13.33±0.13 ^b
Ash	4.42±0.23 ^c	3.78±0.50 ^d	8.78±0.13 ^a	6.96±0.24 ^b

Means in the same row with common superscripts are not significantly different ($p > 0.05$).

smaller portions of about 150 – 200 g. Slicing was effected along the fibre axis of each portion giving very thin slices of about 2 mm thickness in continuous sheets. The pieces of sliced meat were then thinly spread on silver trays and sun dried at a temperature of 29 - 31°C. The first stage of drying lasted for 7 h spanning over one or two days depending on the relative humidity, intensity of the sun and air velocity. The meat slices were turned over every hour to allow for even drying and to prevent them from getting stuck to the drying surface. The weight of the fresh meat slices were taken before and after the first stage drying. The dried pieces were kept in airtight containers for the next step in processing.

Groundnut paste preparation

The key ingredient in processing Kilishi is the groundnut paste. The groundnut paste was obtained from the dehaulled groundnut seed. The dehaulled seed was roasted for 2 min at 85 - 100°C and cooled. The testa was removed and cleaned. The groundnut was milled into a paste, the milled paste was put in a bowl on a table and kneaded, and the oil was extracted as the kneading proceeded. The paste obtained after the extraction was used in Kilishi preparation.

The paste was measured and placed in a bowl and other ingredients were measured and added to it with salt to taste (Tables 1 and 2). The ingredients were then mixed with 36.20% (w/w) of

water to make slightly thick slurry for the dried meat pieces to absorb when soaked in it.

Kilishi preparation

The pieces of dried meat were soaked in the slurry for 1 h after which they were removed and carefully spread out one by one on trays (a closed space mosquito net was thinly spread over the closely touching trays to keep off houseflies from perching on the meat slices). After drying for 5 - 6 h, the infused meat slices were slightly roasted for 2 min to heat-seal the ingredients in the products. After cooling in trays, the product was packaged until needed for consumption.

Packaging and microbial studies

The Kilishi prepared from beef and pork was paired and packaged in three different media. The packaging was done to evaluate the keeping quality of both products. Packaging was done with thick transparent polyvinyl chloride bags (PVC), Aluminium foil paper (ALF) and plastic containers (PC) with tight lids. The microbial status was determined by isolating (Meynelle and Meynelle, 1970), identifying and characterizing the organisms after 36 weeks of storage.

Nutrient evaluation

Nutrient composition of dried raw meat and Kilishi were carried out using the standard procedure of A.O.A.C. (1990).

Sensory evaluation

A group of ten-trained panelist (60% male and 40% female) with age range between 25 and 35 years old were used to evaluate the beef and pork Kilishi. A nine-point hedonic scale where 1 = disliked extremely and 9 = liked – extremely was used for scoring. Organoleptic properties evaluated included colour, tenderness, juiciness, flavour, hotness, saltiness and overall acceptability. Sensory evaluation was done on freshly prepared samples of Kilishi.

Statistical analysis

Data collected were subjected to analysis of variance (ANOVA) of SAS (1987). The Duncan multiple range test subjected treatment means to comparison.

RESULTS AND DISCUSSION

Nutrient composition

The nutrient composition of the raw dried beef and pork and that of the Kilishi produced gave the moisture content of the raw dried pork ($46.51 \pm 0.30\%$) to be significantly ($p < 0.05$) higher, followed by that of Kilishi from beef ($35.83 \pm 0.24\%$), while Kilishi from the two meat types were significantly lower ($p < 0.05$). The values of 10.00 ± 0.15 and $9.92 \pm 0.22\%$ were obtained for beef and pork, respectively. The low moisture content of the product compared to that of the dried raw meat could be attributed to the step-wise drying in Kilishi processing technique. Drying fresh lean meat to 20% moisture inhibit most bacteria, yeast and molds, while a level of 15% moisture is needed to inhibit some species of fungi (Ingram and Simonsen, 1980). Water activity is related to moisture reduction in a product. Banwart (1979) reported that a_w plays a critical role in the fungal spoilage of meats.

The crude protein values obtained in this study ranged from 33.88 ± 0.36 to $60.33 \pm 0.05\%$. The dried raw pork gave the least ($p < 0.05$) value followed by a value of $45.22 \pm 0.22\%$ by dried raw beef. The corresponding Kilishi from beef and pork gave higher ($p < 0.05$) values. This indicates that processing meat as in Kilishi production improves the percent protein of the product thus making it nutrient dense. Igene et al. (1990) reported a value of 50.02% crude protein for traditional Kilishi after roasting. The major part of the protein comes from the groundnut cake, which has 55.85% crude protein (Badau et al., 1997).

The fat content of 16.72% in the raw dried pork meat was highest and significantly ($p < 0.05$) differed from the fat level of all others. The observations in the lipid content

of *kilishi* products did not follow an expected trend. The Kilishi from pork gave a slightly lower fat content than that of beef despite the fact that raw dried pork gave the highest value. Igene (1988) noted that Kilishi is very high in lipid content on dry matter basis (25.23%). This consisting mostly of triglycerides while the level of fat in fresh meat was less than 10.0%. The final product usually contains a very high level of fat, contributed principally by the groundnut cake powder which represents a considerable proportion of the product (Igene, 1988). A study of the traditional processing of Kilishi elicited a fat percentage of 17.8% (Igene et al., 1990). Jones et al. (2001) reported a fat content as high as $25.36 \pm 1.35\%$. Ockerman and Li (1999) reported that the level of lard addition in a dehydrated meat product is the main effect that influences the meat flavour. The type of oil as well as the level of inclusion could also influence flavour positively or negatively.

An ash content of $8.78 \pm 0.13\%$ was obtained in Kilishi from beef as against $4.42 \pm 0.23\%$ obtained from dried raw beef. In a similar manner, Kilishi from pork showed ash content value of 6.96 ± 0.24 as against $3.78 \pm 0.50\%$ obtained from dried raw pork. High ash content is indicative of the individual mineral levels of the spices to give a cumulative mineral level minus the loss during processing. In this study the ash content of the final Kilishi from beef and pork differed significantly from that of the raw dried meat. An ash content of 6.72 ± 0.13 was reported for traditionally prepared Kilishi (Jones et al., 2001) while Igene et al. (1990) reported a value of 9.6% for the finished product and 7.83% for the dried infused product prior to roasting. Kilishi supplies a significant proportion of desirable nutrients as far as minerals are concerned.

Packaging and microbial growth

In the packaging experiment for Kilishi from beef and pork, five bacteria species were identified. *Bacillus* spp. constituted the highest while staphylococcus and *proteus* spp. were the least. The polyvinyl chloride (PVC) bag packaged *kilishi* from beef had *Bacillus* and *Staphylococcus* spp. while the PVC packaged Kilishi from pork had *Bacillus*, *Staphylococcus* and *Streptococcus*. The foil packaging encouraged the growth of *Bacillus* and *Streptococcus aureus* and *Streptococcus* spp. for Kilishi from beef while *Bacillus* and *Streptococcus* spp. were present in the foil packaged Kilishi from pork. Only yeast were isolated from the plastic packaged Kilishi from beef while the plastic packaged Kilishi from pork had *Bacillus*, *Streptococcus* and *Proteus* spp. isolated from them.

Isolation of *Bacillus*, *Streptococcus*, *Staphylococcus*, *Escherichia*, *Proteus*, *Pseudomonas* and *Klebsiella* was reported from raw and freshly roasted "tsire" subjected to different storage treatment (Igene and Abudu, 1984). According to Linko et al. (1985) and Okonkwo et al. (1992) *Bacillus* spp. has been reported as the most up-

Table 3. Bacteria and fungal isolates of beef and pork Kilishi under different packaging media.

Packaging media	Beef Kilishi	Pork Kilishi
Polyvinyl chloride (PVC)	<i>Bacillus</i> and <i>Staphylococcus</i> spp.	<i>Bacillus</i> , <i>Staphylococcus</i> and <i>Streptococcus</i> spp.
Aluminium foil (ALF)	<i>Bacillus</i> , <i>aureus</i> and <i>Staphylococcus</i>	<i>Bacillus</i> , <i>streptococcus</i> spp.
Plastic container (PC)	Yeast	<i>Bacillus</i> , <i>staphylococcus</i> and <i>proteus</i> spp.

*Packaged for 36 weeks under room temperature.

setting organism that can survive intermediate moisture meat (IMM) thermal processing and osmotic equilibration because it is aerobic together with the fact that no anaerobes have been isolated from IMM. It is advocated therefore that appropriate packaging of the product to eliminate air and subsequently lengthen the shelf life is indispensable. Care should be taken to avoid raw meat from being contaminated by *Bacillus* spp. and *Clostridium* spp. before processing into Kilishi because their spores are known to endure heat treatment. Busta and Foegeding (1986) for example showed that the ability of *Bacillus* and *Clostridium* spp. to cause spoilage and public health problems in food is frequently a result of the ability to form spores which have high resistance to processing and control procedures.

A high microbial load in the product does not necessarily indicate that the products are of poor sanitary and edible quality. This hypothesis seems to be supported by the results obtained from anaerobic and aerobic mesophilic counts which were within the limit for acceptable standard (Joffin and Joffin, 1999). However, Solberg et al. (1976) reported bacteria count exceeding 10^5 /g or coliform count of 10^2 /g in delicatessen food products are indicative of dangerous contamination.

Colour

The sensory evaluation rating as affected by meat types showed that beef Kilishi differed significantly from pork *kilishi* in only two attributes, colour and juiciness (Table 3 4). In the fresh muscle, the colour of meat is related to the level of pigmentation (myoglobin) present in the muscle, when meat is processed however, it changes the characteristics of fresh meat. Levy and Hanna (1994) contended that the amount of visible fat is the strongest visual cue for consumer considering purchasing pork at retail indicating that first impression reinforces their perception of how good it is. In Kilishi production, a colour change is a result of the drying process and the use of plant ingredients and spices in the infusion slurry, giving it a final dull (brownish) colour. A Kilishi product that has a bright colour must have had colourants added to it, to appeal to the consumers. The colour of Kilishi from pork which was moderately dark, was significantly ($P < 0.05$) lighter than that of Kilishi from beef which was very dark.

Tenderness

Fernandez et al. (1999) reported that pork tenderness and taste are enhanced by intramuscular fat levels of up to 3.25%. The sensory evaluation score for tenderness in beef Kilishi (2.77 ± 0.37) and pork Kilishi (3.77 ± 0.31) did not differ significantly ($p > 0.05$). This is partly due to the fact that lean portions were used in Kilishi preparation. Novakofski (1987) stated that while low levels of intramuscular lipids are detrimental to palatability, levels over the threshold do not result in linearly increasing beneficial effect. In the same vein, Devol et al. (1988) found that tenderness was significantly correlated with intramuscular fat ($r = 0.34$) when evaluated by trained taste panelist. The tenderness of meat can be defined as the sensory manifestation of the structure of meat and the manner in which this structure reacts to the force applied during biting and the specific senses involved in eating (Moloney, 1999).

Juiciness

According to Moloney (1999), meat juiciness is an important component of meat tenderness and palatability and it has two major components; the first is the impression of wetness produced by the release of fluid from the meat during the first few chews, while the second is the more sustained juiciness that apparently results from the stimulating effect of fat on the production of saliva and the coating of fat that builds up in the tongue, teeth and other parts of the mouth. The juiciness of Kilishi from pork was significantly higher ($p < 0.05$) than that of beef Kilishi. Fernandez et al. (1999) reported that highly marbled chops were more juicy and tender than lean chops, therefore as intramuscular fat increased from $<1.5\%$ to $>3.5\%$ juiciness increased.

Flavour

Physiologically, the perception of flavour involves the detection of four basic sensations including saltiness, sweetness, sourness and bitterness by the nerve endings on the surface of tongue (Forrest et al., 1975). The chemical components responsible for meat flavour *per se*

Table 4. Sensory evaluation (n = 10) rating of Kilishi as affected by meat types.

Organoleptic properties	Meat type	
	Beef Kilishi	Pork Kilishi
Colour	2.33±0.22 ^b	3.70±0.32 ^a
Tenderness	2.77±0.37	3.77±0.31
Juiciness	2.93±0.30 ^b	3.93±0.21 ^a
Flavour	3.93±0.41	4.47±0.29
Hotness	3.60±0.48	3.70±0.42
Saltiness	4.27±0.27	3.97±0.25
Overall acceptability	3.97±0.40	4.30±0.31

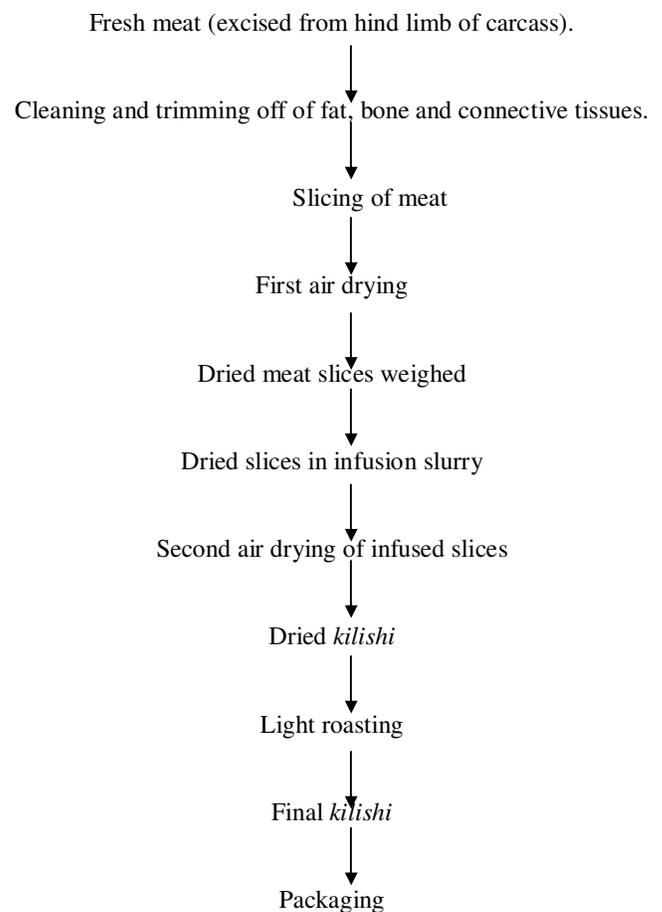
Means with different superscripts on the same row are significantly different ($p < 0.05$).

are in the water soluble fraction and this flavour is essentially the same for all meat types (Moloney, 1999). The several spices used in Kilishi production also added to the flavour of the product.

The sensory score of Kilishi from pork rated higher for flavour (4.47 ± 0.29) than for Kilishi from beef (3.93 ± 0.41) even though there were no significant ($p > 0.05$) difference in the values obtained (Table 4). The result obtained supports the observation of Melton (1990) that as the fat of meat increases so does the flavour. In general, flavour released from the oil fat phase of meat proceeds at a lower rate (as in dried meat products) than from the aqueous phase (as in stewed or boiled meat). Because of the delayed release of the fat soluble flavour compounds in the mouth, the maximum flavour intensity of these compounds is perceived at a later moment than that of their water soluble counterparts Hedrick et al. (1994). Consequently, there is a change in flavour character and intensity with time, resulting in the perception of two or more flavour characters in succession (De Roos, 1997).

Other attributes that did not differ significantly in Kilishi from both meat types include hotness, saltiness and overall acceptability (Figure 1). The hotness of Kilishi is an evaluation of the pungency of the product. Different spices in their different proportions released their pungency differently into Kilishi; however any of the spice mixture could be omitted without a marked difference in the degree of hotness of the product (Omojola et al., 2003). While the spices contribute a little to pungency, it can be conclusive to say that the chilies have a greater contribution. Chilies have been widely used throughout the world as a pungent spice for domestic, culinary purposes (Purseglove, 1981; Coon, 2003).

Salt in Kilishi was added to taste not solely for preservative purpose. The percent inclusion on spice formulation was 0.7%. At low concentrations, salt helps to improve the flavour and colour of meat (Meyer, 1978) but at higher concentrations, especially when used alone, sodium chloride gives a dry harsh, dark coloured and unattractive product (Kramlich et al. 1980).

**Figure 1.** The flow chart summarizing Kilishi production process.

Conclusion

Evaluation of shelf life stability of Kilishi product in different packaging media showed the foil packaged product gave the highest microbial load while polyvinyl chloride bags and the plastic packaged Kilishi had lower

microbial loads. Processing meat into Kilishi improves the nutrient composition, especially, the protein and ash thus making it nutrient dense. Kilishi from pork had similar ($p > 0.05$) protein, fat and moisture content with that of beef. The organoleptic study revealed consumer preference ($p < 0.05$) for Kilishi from pork in terms of colour and juiciness. Kilishi can therefore be produced from other meat types aside beef.

REFERENCES

- AOAC (1990). Official methods of analysis (12th ed). Association of Official Analytical Chemists, Washington, D.C.
- Badau MH, Igene JO, Collison EK, Nkama I (1997). Studies on production, physicochemical and sensory properties of a standard Kilishi ingredient mix powder. *Int. J. Food Sci. Nutri.* 48: 165-168.
- Banwart GJ (1979). Basic food microbiology pp. 22-84. West part, Connecticut. AVI Publishing Company Incorporated.
- Biscontinini TM, Shimokomaki M, Oliverira SF, Zorn TM (1996). An ultrastructural observation on charquis, salted and intermediate moisture meat products. *Meat Sci.* 43(3-4): 351-358.
- Busta FF, Foegeding PM (1986). Spore-forming Bacteria; In 'Advances in Meat Research Vol. 2 Meat and Poultry Microbiology, A.M. Pearson and T.R. Dutson (Eds). Macmillan Publishers.
- Coon D (2003). Chile peppers; 'Heating up Hispanic foods' in developing foods. *Food Technol.* 57(1): 39-43.
- De Roos KB (1997). How lipid influence food Flavour. *Food Technol.* 51(1): 60-62.
- Devol DL, McKeith FK, Bechtel PJ, Novakofski J, Shanks RD, Cor TE (1988). Variation in composition and palatability traits and relationships between muscle characteristics and palatability traits in a random Sample of pork carcasses. *J. Anim. Sci.* 66: 385-392.
- Fernandez X, Monin G, Talmont A, Mouro J, Lebret B (1999). Influence of Intramuscular fat content on the quality of pig meat – 1, Composition of the lipid fraction and sensory characteristics of *M. Longissimus lumborum*. *Meat Sci.* 53: 59-65.
- Forrest JC, Aberle ED, Hedrick HB, Judge MD, Merkel RA (1975). Principles of meat Sciences, W.H. Freeman and Co., San Francisco, p. 320.
- Hedrick HB, Aberle ED, Forrest JC, Judge MD, Merket RA (1994). Principles of meat science, 3rd ed. Kendall Hunt Publishing Co. Dubuque, Iowa.
- Igene JO (1988). Lipid, fatty acid composition acid storage stability of Kilishi; a sun dried meat product. *Trop. Sci.* 28: 156-161.
- Igene JO, Abulu EO (1984). Nutritional and bacteriological characteristics of tsire type suya, a popular Nigerian meat product. *J. Food Prot.* 47: 193-196.
- Igene JO, Farouk MM, Akanbi CT (1990). Preliminary studies on the traditional processing of Kilishi. *J. Sci. Food Agric.* 50: 89-98.
- Ingram M, Simonsen B (1980). Meat and meat products. In microbial ecology of foods. 2: 333. Academic Presss, N.Y.
- Joffin TE, Joffin TW (1999). Total plate and coliform counts for fast food service sandwiches. *J. Food Sci.* 45: 262-266.
- Jones MJ, Tanya VN, Mbofung CMF, Fonken DN, Silverside DE (2001). A microbiological and nutritional evaluation of the West African dried meat product, Kilishi. *J. Food Technol. Afr.* 6(4): 126-129.
- Kramlich WE, Pearson AM, Tunber FW (1980). "Processed meat deterioration". In "Processed meats ; 3rd edition. The AVI Publishing Coy. West port Connecticut, pp. 331-341.
- Leistner L (1987). Shelf stable products and intermediate moisture foods based on meat. In "Water Actuity; Theory and Application to Foods", (Rockland LB, Beuchat LR eds). pp. 295-327. Dekker, New York.
- Levy S, Haanna M (1994). Consumer quality audit summary. Des Monines, I.A. National Pork Producers Council.
- Linko P, Kervinen, R, Karppinen R, Rautalinna EK, Vainion Paa J (1985). Extrusion cooking for cereal based intermediate moisture products. In ' Properties of water foods'. Simantos D, Multon JL (ed), Martinus Nijhoff Publishers, Dordrecht. pp. 465-479.
- Melton SL (1990). Effects of feeds on flavour of red meat, a review. *J. Anim. Sci.* 68: 4421-4435.
- Meyer LH (1978). Food chemistry. The AVI Publishing Co., Inc. Westport. Conn.
- Meynelle GG, Meynelle E (1970). Theory and practice in experimental Bacteriol. 2nd ed. Cambridge University Press, p. 347.
- Moloney A (1999). The quality of meat from Beef cattle – is it influenced by diet? In R & H Hall Tech. Bull. issue No 4.
- Novakofski J (1987). Repartitioned pork. Sensory quality and consumer acceptance. In. Proc, University of Illinois Pork. Ind. Comf. (p. 84). Urbana; I. L.
- Ockerman HW, Li CT (1999). The evaluation of the palatability of a dehydrated meat product. *Meat floss.* The Ohio State University, Dep. Anim. Sci. Res. Rev. 172-179.
- Okonkwo TM, Obanu ZA, ledward DA (1992). The stability of some intermediates moisture smoked meats during storage at 30°C and 38°C. *Meat Sci* 31: 245-255.
- Omojola AB, Isah OA, Adewumi MK, Ogunsola OO, Attah S (2003). Evaluation of the effects of various additives on the acceptability of Kilishi. *Trop. J. Anim. Sci.* 6(2): 97-101.
- Purseglove JW (1981). Spices Vol 1. Longman Scientific and Technical, New York, pp. 1-813.
- SAS (1987). SAS/ STAT Guide for personal computers (Version 6 Edition) Cary, N.C.
- Solberg M, Miskinuri DK, Martin BA, Page G, Golderer S, Libfeld M (1976). What do microbiological indicator tests tell us about safety of foods? *Food Prod. Dev.* 10: 27-30.