

Effect of Animal Species on the Quality and Quantity of *Kilishi* Meat Products in Mubi North Local Government Area of Adamawa State

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Abstract— *The effect of Animal Species on the Quality and Quantity of Kilishi Meat Products was studied. Fresh meat of cattle, sheep, goats and camel were purchased from Mubi abattoir and were used to prepare kilishi using slurry prepared from groundnut cake, pepper, maggi, ginger and other spices. Proximate composition of all the meat samples were carried out, storage yield of kilishi product was determined, sensory evaluation was also done. The results revealed that there was no significant ($P > 0.05$) difference in yield of Kilishi prepared from different animal species. However, after one month of preservation, the yield of Kilishi from the various animal species differed significantly ($p < 0.05$). Camel meat yields the highest quantity of Kilishi; both of initial (0.50kg) and final (0.61kg) weight. However beef (cattle meat) produced the best Kilishi. Also the result of the taste panel revealed that there was no significant difference ($p > 0.05$) between the models, species, weeks, replication and their interaction.*

Keywords— *kilishi meat product, animal species, Quality, Quantity and Mubi north.*

I. INTRODUCTION

Kilishi is an intermediate moisture meat that has a suitable concentration of dissolved solids that binds the moisture in it sufficiently to inhibit the growth of spoilage organism, thus it is a ready-to-eat convenience meat product possessing excellent shelf life stability at room temperature. Making handling and marketing of the product 'convenient for consumers and retailers alike. (Igene J.O. 1990; Olusola, 2006). It is a traditional, sun dried Nigerian and Saharan African meat product processed using lean beef in combination with plant ingredients. It contains about 46% meat and 54% non-meat ingredients. A finished product contains about 50% protein, 7.5% moisture, 18% lipid and 9.8% fibre/ash respectively (Igene, J.O 1988; Igene et al, 1993)

The product came about as a means of preserving meat in the absence of facilities for refrigerated storage, by the early

Fulani and Hausa herdsmen. In Northern Nigeria, the producing states of *kilishi* include: Borno, Kano, Sokoto, Kaduna and Bauchi. This is made possible because the weather is favourable, Consumer demand is high and more than 70% of the Nigerian cattle population of 10 million can be found in these states (Alaku and Igene 1983). However its production in the southern states is limited to the dry season (between October and December). The product has gained popularity even today in all major urban as well as rural centres particularly in the Northern parts of Nigeria where it is sold in the streets and in some supermarkets the only traditional Nigerian meat product to attain such status (Igene et al., 1990).

Meat makes a valuable contribution to diet in developing countries because of its nutritional importance, as a source of protein, having high biological value, an excellent source of many nutrients; especially protein, fat, B-vitamin, Iron, Zinc and Vitamin A and essential and Non-essential amino-acid needed to build, maintain and repair body tissues (Alonge, 1984). Protein malnutrition is a major public health problem in developing world: diets in these parts predominantly starch, the major food crops being roots and tubers (Arberoumand and Deokule, 2009).

Meat deterioration begin soon after it has been slaughtered due to chemical changes, enzymatic action and the action or presence of micro-organisms (bacteria, yeast and mould) which may result in oxidative rancidity, discoloration, moldiness, off flavor, sliminess etc., the major source of these deteriorative changes are the micro-organism and these render the meat unacceptable and unfit for human consumptions (Forrest et al., 2001).

In Nigeria there is a preferential consumption of different types of meat by communities due to a combination of factors bordering on religious belief, culture, food habits, sex of animal, age at slaughter, socio-economic factors and individual variation (Ajiboye et al., 2011). Meat being nutritious, with high moisture content and nearly neutral pH is a good culture medium for many micro-organisms

(bacteria, yeasts and moulds) and as such, classified among perishable foods whose contamination with spoilage organisms are almost unavoidable (Ikeme, 1990). This makes meat preservation more difficult than other types of food as it may result in oxidative rancidity, discolouration, off flavour, sliminess etc. The kind and amount of spoilage organisms in meal depends upon the availability of nutrients, presence of oxygen, temperature, pH at storage and generation interval of the spoilage micro-organism under given environment etc. (Forrest *et al.*, 2001). It is necessary to minimize deterioration in order to prolong the time during which acceptable levels of quality are maintained. This depends upon the processing and preservative method used and the inherent properties of the meat in question (Forrest *et al.*, 2001).

This study therefore aimed at assessing the proximate composition, storage yield of *Kilishi* from different animal

species and also examines the consumer sensory ratings of the *kilishi* meat products.

II. METHODOLOGY

Experimental Site

The study was conducted at the meat science laboratory Adamawa State University, Mubi within the north eastern guinea savannah zone of Nigeria located on latitude 10° North and between longitudes 13° 30 east at latitude of about 305 meters above sea level.

The dry season of the area commences early October and last April while wet season begins from May and attains peak between July and August and declines in September. The mean annual rainfall is about 1050 mm. The relative humidity is extremely low (20-30%) between January and March but reaches peak of about 80% in August and September. The maximum temperature 40% particularly in April while the minimum temperature is about 1 °c between December and January (Adebayo and Tukur. (1999).

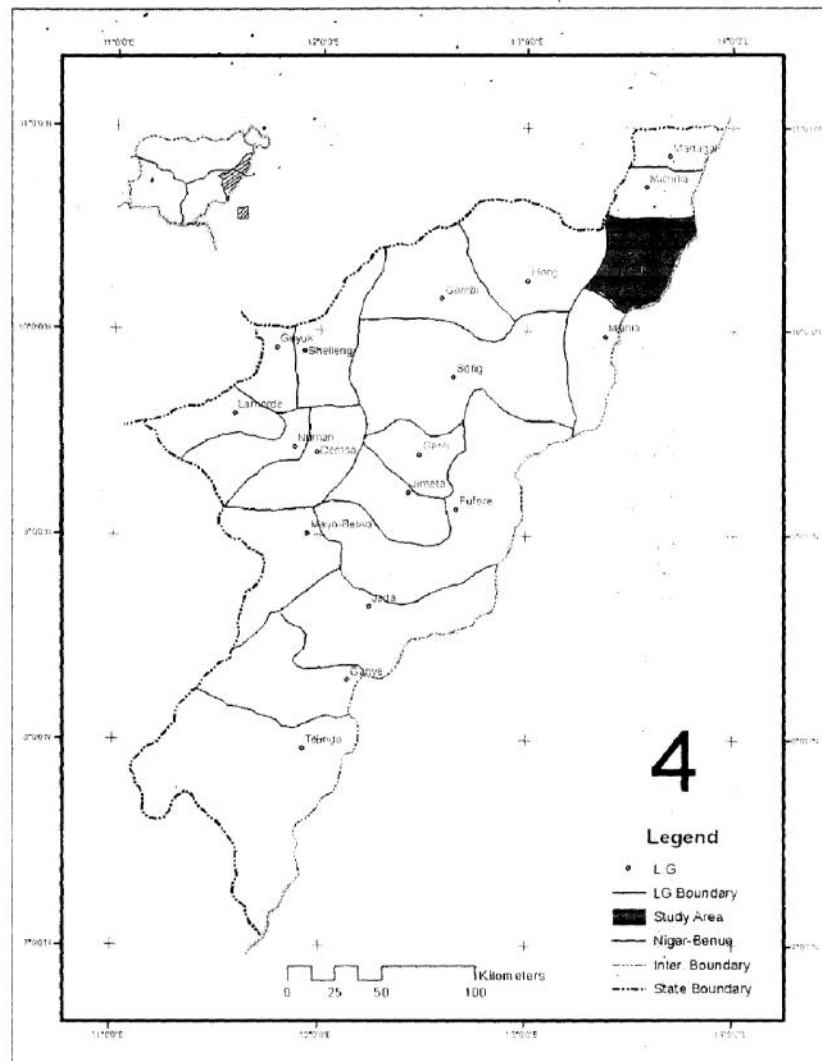


Fig.1: Map of the Study Area

Source: Adebayo and Tukur (1999).

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Kilishi Preparations

A sharp knife was used to trim off visible fats, nerves, blood vessels and connective tissues. It was then sliced into a very thin continuous sheet of 0.5-1mm length and 0.5-2mm thick.

The meat was then spread on a wire mesh and allowed to dry for 24 hours. This is followed by soaking the dried

sliced meat into the already prepared slurry. The meat is then spread again on the wire mesh and was allowed to be sun dried for 10 hours and this roasted for 5 minute at temperature of 85⁰ C, finally it was sun dried again for 10 hours and weighed (fig. 2).

Proportion of ingredients and spices used for slurry preparation

Ingredients/spices (Common name)	Scientific name	Reference formulation (F _e)		Treatment (proportion %)		
		Weight (g)	Proportion (%)	F ₁ (High) High	F ₂ (Medium) Medium	F ₃ (Low) Low
Defatted groundnut dough		1980	66.0	56.0	46.00	36.00
Onion	<i>Allium cepa</i>	420	14.0	18.11	22.24	26.36
Ginger	<i>Zingiber officinale</i>	180	6.0	7.76	9.54	11.30
Dried (hot) pepper	<i>Capsicum frutescens</i>	90	3.0	3.88	4.76	5.65
Cloves	<i>Eugenia caryophyllate</i>	60	2.0	2.59	3.18	3.76
Candle wood	<i>Fagara zanthoxyloides</i>	60	2.0	2.59	3.18	3.76
Black pepper	<i>Piper guinensis</i>	90	3.0	3.88	4.76	5.65
Salt	Sodium chloride	30	1.0	1.30	1.58	1.88
Curry powder		30	1.0	1.30	1.58	1.88
Magi cube		60	2.0	2.59	3.18	3.76
Ratio (Groundnut dough: spices)				1.3:1.0	1.0:1.2	1.0:1.8
Total			100	100	100	100

Source: Igene (1995)

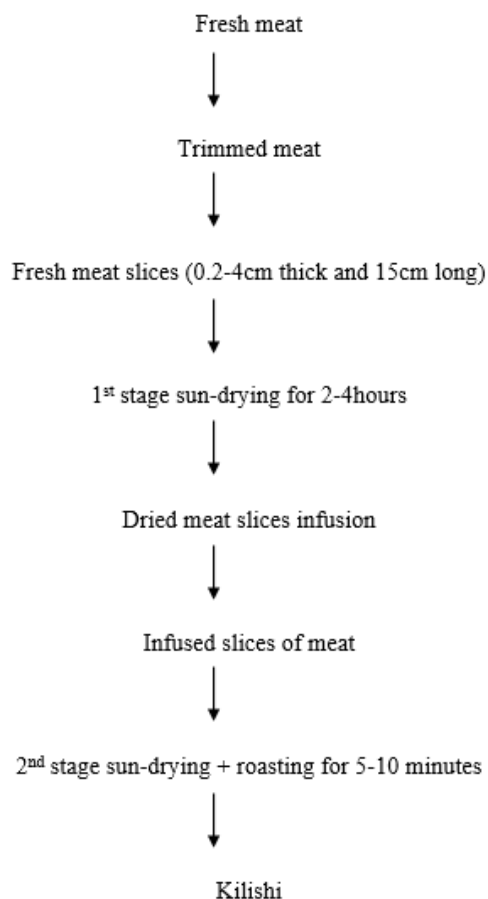


Fig. 2: Flow chart of the preparation of kilishi

Proximate Analysis of meats from different animal species

Equal weight (1kg) each of fresh boneless meat from camel, beef, sheep and goat was purchased from Mubi abattoir was used in the preparation of *Kilishi*. Part of this was also used to determine the dry matter content by oven drying at 72⁰C for 48 hours, protein, fat, and ash content as described by Association of Official Analytical Chemist (AOAC, 1990).

Determination of the quantity of *Kilishi* produced from meats of various animal species.

The prepared *kilishi* from each of the four animal’s species were roasted at room temperature and were then weighed and recorded separately. After one month in storage they were weighed again before the final evaluation by the taste panellist. Any change in colour and appearance was monitored up to the end of the experiment.

Sensory evaluation

A fifteen persons taste panel was constituted to rate the quality of the *Kilishi* based on each characters as palatability, tenderness, juiciness, flavour, colour and acceptability. Structural questionnaire was administered. Marks were awarded and designated as follows: 1, 2, 3 and 4 for poor, fair, good and very good respectively.

Statistical Analysis

Data on yield of *Kilishi* and palatability scores obtained from taste panel were statistically analysed using the model

that depends on species, replication, species/replication (SAS, 1981).

III. RESULTS

Proximate composition of meat from four animal species

Table.1: shows the proximate composition of meat from four animal species.

Species	Dry matter %	Protein %	Fat %	Ash %
Cattle	15.00	28.93	15.21	8.0
Sheep	13.30	27.88	14.00	7.20
Goat	18.50	28.00	10.45	7.11
Camel	20.80	28.61	11.32	0.50

Dry matter content

The dry matter value of 20.80% obtained on camel meat in this study is lower than the value reported by Oguntana and Akinyele (1995) and Olumo (1995) respectively. The difference could be due to the age, sex, and marbling of the meat. The mutton dry matter value (13.30%) is similar to the value recorded by Olomu (1995).

Protein content

The protein content obtained on cattle, goat and camel meat in this study is similar to the value obtained by Igeneet al., (1990) and Farruk (1991) respectively. The crude protein (27.88%) obtained from sheep compared favourably with the value of 27.21% reported by Olumo (1995).

Fat extract

The fat extract content of 15.21% obtained on cattle meat is similar to the value of 15.31 reported by Oguntola and Akinyele (1995). The ether extract content of goat (10.45%) is higher than the value of 9.86% reported by Oguntola and

Akinyele (1995) while value on mutton and camel tend to be similar to value reported by Olumo (1995).

Ash content

The ash content value of 8.5% obtained on cattle meat is higher than the value of 8.0% reported by Igene and Farruk (1990). The ash value 7.20% and 7.11% on sheep and goat meat in this study a similar to the values of 7.40 and 7.90 reported by Igene and Tukur (1986) which could be due to the age and sex of the animal.

Storage yield of Kilishi

The result in this study shows that there is no significant difference ($p > 0.05$) in yield between *Kilishi* obtained after roasting and after one month in preservation. This is due to the loss in moisture content which occurs at a faster rate during the first month and then occurs slowly. This is in accordance with Adaku et al (1985) who reported that *Kilishi* is a traditional intermediate meat product.

Storage yield of Kilishi

Table.2: shows the storage yield of Kilishi from four animal species

Species	Kilishi weight before preservation (kg)	Mean weight after one month preservation (kg)
Cattle	0.42	0.37
Sheep	0.42	0.34
Goat	0.43	0.24
Camel	0.45	0.45

The result on the storage yield of *kilishi* show that there is no significant difference ($p < 0.05$) in yield between the *kilishi* of all species obtained after roasting and after one month in preservation. The highest mean weight of 0.45 kg was obtained on camel *Kilishi* while the lowest mean weight of 0.24 kg was on goat *Kilishi*.

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Sensory Evaluation

Table.3: Mean Score by the taste panel over five months

Species	1	2	3	4	5	Mean
Camel	373.33	273.33	286.67	333.33	286.67	290.87 ^b
Cattle	240.00	266.67	260.00	400.00	373.33	327.33 ^a
Sheep	313.33	333.33	366.67	266.67	253.30	306.6 ^{ab}
Goat	333.33	353.33	373.33	266.67	273.33	320.10 ^a
Mean	315.00 ^a	305.83 ^a	321.67 ^a	306.67 ^a	296.67 ^a	

Note: figure with the same letter are not significantly different ($p > 0.05$)

From the table above, it can be observed that *Kilishi* from cattle meat scores significantly higher ($p > 0.05$) than the *Kilishi* from camel meat and there is no significant difference ($p > 0.05$) between cattle, sheep and goat *Kilishi*.

Sensory evaluation of different meat products

From the result of the taste panellists, it can be observed that *Kilishi* from cattle meat scores significantly higher ($p > 0.05$) than *Kilishi* from other products which could be due to bread differences as reported by Igene et al (1995). The result also indicates that the longer in storage period the better the taste of the *Kilishi* up to the fourth month but in the fifth month the quality of the *Kilishi* of all the species dropped. This is probably due to the increased in the toughness of the *Kilishi* in the fifth month. The result increased of this study was in accordance with the findings of Adaku et al., (1985) who reported that *Kilishi* if well dried could be stored for sixth month without spoilage. The groundnut cake and pepper are partially responsible for the colour of *Kilishi* which is the reddish brown.

IV. SUMMARY AND CONCLUSION

Conclusively the study revealed that *Kilishi* from the large animal (camel and cattle) are usually tougher than that of the smaller animals (sheep and goat). It has also been established that *Kilishi* could be stored a longer period and be a very good traditional technology of meat preservation. Therefore improvement of this indigenous knowledge of meat preservation need to be further investigated.

REFERENCES

- [1] A.O.A.C., (1990). *Official Methods of Analysis*. 10th editions Associ. Offic. Analyt. Chem.
- [2] Adaku, A. C. and Olukosi, J. O. (1985). *Animal Products Processing and Handling in the Tropics*. Living Books Series CV. publications Abuja. Nigeria, 264 pp.
- [3] Adaku, A. C. and Olukosi, J. O. (1995). *Animal Products Processing and Handling in the Tropics*. Living Books Series CV. publications Abuja. Nigeria, 264 pp.
- [4] Adebayo, A. A., Tukur, A. L (1999.). *Adamawa State In maps*. Department of Geography, Federal University of Technology, Yola Adamawa State. Paraclate publishing House, Yola, Nigeria, Pp. 27 - 87.
- [5] Adegbola, T.A. Mba, A.U., and Olubajo, F.D. (1997). *Studies on West African Dwarf sheep. 2. Concentration of nitrogen and amino acid, composition of (Trinidad)* **54** (4) 339-348.
- [6] Ajiboye, and S. S. Deokule, (2011). *Moisture sorption characteristics of Dambunama- A Nigeria dried meat product*. Nig. Food J., 30(1).
- [7] Akande, and Odogbo, (2005). *Nutritional evaluation of dehydrated shredded meat product*. Danbu-narna. Pak. J. Nutr., 7(4): 554-556.
- [8] Akinola, (2013). *Smoke preservation of meats in Nigeria: Quality and public health aspects*. Ph.D. Thesis, University of Ibadan, Ibadan.
- [9] Alaku, O, Igene J. O. (1983). *Seasonal variation in volume of trade cattle moved from Sahelian to the equatorial zone of West Africa with particular reference to Nigeria*. World Rev. Anim. Prod., 19: 69-74.
- [10] Alaku. O. and Igene. B.O. (1986). Factors influencing trade movement of sheep and goats in Nigeria. *Annals of Borno* 4: 80-85
- [11] Alan, Carrot. R. D. and Ellias, K. W. (2006). Comparison of carcasses and meat Join steers, short scrotum bulls and intact bulls. *Journal of Animal Science* 41: 627-1632
- [12] Alonge D.O. & Hiko A.A., (1980). Traditional methods of meat preservation and preparation in Nigeria, West Africa Farming, March/April, 19-20.
- [13] Alonge, D.O. and Hiko, A.A. (1981). Traditional methods of meat preservation and preparation in Nigeria. West African Farming, March/April, 19-20.
- [14] AOAC (1990). *Official Methods of Analysis* 15th Edition, Volume I. Association of Official Analytical Chemists, Washington D.C.
- [15] Arberoumand and Deokule (2009). Utilization of unconventional feedstuffs for sustainable livestock

- production. Abubakar Tafawa Balewa University Bauchi Inaugural lecture series No. 9. 44pp.
- [16] Arnold, R.N., Arp., S.C and Scheller K.K. (1993). Tissue equilibrium and subcellular distribution of vitamin E, relative to myoglobin and lipid oxidation in displayed beef *Journal of Animal Science*, 71(1); 105-118.
- [17] Belkens, S. I. Eadie, I M., Griffiths, I., Jones, P.N. and Hartrc, P.V. (1991) Assessment of the sensory characteristics of meat parties. *Journal of Food Science* 56 (6) : 1470 - 475.
- [18] Bowers..J. R. and Chambers, E.I V. (1992) Effect of internal temperature on eating quality beef cuts. *Journal of American Dietetic Association* 46 (3): 124 -138.
- [19] Boyle, E. (1994) Free amino acids changes in different aged bovine muscles and their relationship to shear values. *Journal of Food Science* 58 (6): 691-697.
- [20] Brewers, MS. and Wu, S.Y. (1993). Display, packaging and meat block location effects on color and lipid oxidation of frozen lean ground beef. *Journal of Food Science* 58 (6): 219- 223.
- [21] Brewers, S., Bharti, K., Argoudelis.L. and Guy.K. (1995). Sodium lactate! sodium Chloride effect on aerobic plate counts and colour of aerobically packed ground meat. *Journal of Food Science*, 6 (1): 88-96
- [22] Cavelt, J. J. (1989). The effects of newer forms of packaging on the microbiology and storage life of meats. poultry and fish *Journal of Food Technology* 43 (1): 46 – 51.
- [23] Chambers, B., Hollingworth, M.G. Bowers, J.R. and Chambers, EJV. (1992a). Consumer attitudes and factors influencing meat use. The Sensory Analysis Centre, Kansas State University, Manhattan, Kansas.
- [24] Chambers, E. IV and Bowers, J.R (1993). Consumer perception of sensory qualities in muscle foods. *Journal of Food Technology*, 47(11): 116-120.
- [25] Chang, S. F. and T. C. Huang, (1991). *Meat Sci.*, 30: 303- 325.
- [26] Chen, C. M. and Trout, O. R. (1991). Sensory instrumental texture profile and cookin² properties of restructured beef steaks made with various binders *Journal of hood Science* 56(6): 1457- 1460.
- [27] Duncan, P. B (1995). *New Multiple range and multiple F-tests*. Biometric
- [28] Ellis, D. L., and Goodacre, R. (2001). *Rapid and Quantitative Detection of the Microbial Spoilage of Muscles foods*: Current Status and future trends. Trends Food Sci. Technology.
- [29] FAO (1990) Manual on simple methods of meat preservation P5. ISBNN 92-5- 102744-7-2.
- [30] FAO (2002). Food and Agricultural organization of the United Nations.
- [31] Farouk M. M. (1985) Traditional processing of some Nigerian meat products. A paper Presented at the 9 annual meeting of the Nigerian Institute of *Food Science and Technology* (NIFST) Kano, Nigeria 27 - 31 October, 1985.
- [32] Farouk, M. M., Price. J. F., Salih, A.M. and Burnett, R.J (1992). Effect of Postexsanguination infusion of beef on composition tenderness and functional properties. *Journal of Animal Science* 70(9): 2773 - 2778.
- [33] Forrest. J. C. Aberie, D.E. Gerard, W.E. Mills, 1-1.B. Hedrick, M.D. Judge and R.A. Merke, (2001). *The Principles of Meat Science*. 4thEdn., Kendall/Hunt Publishing Co.. USA.
- [34] Fuller, F., (1996). *U.S. meat export analysis and trade news*. Meat Export Research Center. Iowa State University. Ames. IA. 4: 1-5.
- [35] Gunter Heinz and Peter Hautzinger (2007) RAP publication meat Processing Technology for small-to medium scale producers.
- [36] Igene J. O. (1988). Lipid, fatty acid composition and storage stability of Kilishi, a sun-dried meat product. *B. Trop. Sci.* 28 :153-161.
- [37] Igene J.O., Farouk M.M. and Akanbi C.T., (1990). Preliminary studies on the traditional processing of Kilishi. *Sd. Food Aic.* 50: 89-98.
- [38] Igene, J. O and Tukura, D. H. (1986). Effect of processing methods on product characteristics, lipid, fatty acid composition and oxidative stability of smoked-dried beef. *Journal of Science, Food und Agriculture*, 37 : 818-824.
- [39] Igene, J. O. (1988). *Lipid, Fatty acid composition and storage stability of kilishi, a sun dried, meat product*. *Trop. Sci.* 28: 156-161.
- [40] Igene, J. O., Abubakar, U., Akanbi, I., Negbenehor, A. (1993). *Effects of sodium tripolyphosphate and moisture level on the drying characteristics and yield of 'Kilishi' a sun dried Beef products*. *J. Agric. Sci. Technol.* 3:(2) 166- 173.
- [41] Igene, J. O., Abulu, E. Q. (1985). Nutritional and bacteriological characteristics
- [42] Igene, J. O., Farouk, M. M., Akanbi, C. T. (1990). Preliminary studies on the traditional processing of kilishi. *J. Sci. Food Agric.*, 50:89-98.
- [43] Igene. J. O. and Farouk, M. M. (1990). Preliminary studies on the traditional processing of Kilishi. *Journal of Science Food and Agriculture*, 50 : 89-98.

- [44] Ikema, H. P. Hassen, E. (1990). Moulds control in meat processing industry. *Fleischwirtschaft*, 75:5 2
- [45] Ipinolu, J. K., J. O. Olopade, R. A. Shehu and W. A. Hassan, 2004. Assessment of consumer acceptance of ki/ishi of African Carp “Labeocoubie, RUEPPELL) and Elephant Snout (*Hyperopisusbebeoccidentalis*, GUENTHER). In: P.A. Araoye (Ed), Proceedings of the 19th Annual Conference of the Fisheries Society of Nigeria (HSON). 29th November-3rd December, Ilorin. Kwara State. pp: 377-381.
- [46] James, G. (1994) Antimicrobials: Assuring food safety. *Journal of Food Technology*, 48 (6) 102-110.
- [47] James, G. (1994). Modern Alchemy: Use of flavours in food. *Journal of Food Technology* 48 (2): 106-116.
- [48] John, B. K. (1993). Flavours measurement. Institute of Food Technology Basic Symposium, Proceedings on the latest chemical, physical, sensors and statistical methods to determine the composition, properties, authenticity, and safety of Flavors. *Journal of Food Technology*, 47 (8): 94- 100
- [49] Koohmaraie, M. and Shackelford, S.D. (1991). Effects of calcium chloride infusion on the tenderness of lambs fed a B-A dremergic Agonist. *Journal of Animal Science* 69 (6) 2463-2471.
- [50] Koohmaraie, (1995). By how much does dietary salt reduction lower blood pressure. 1 - Analysis of observational data among populations. *Brit. Med. J.*, 302: 811-g15.
- [51] Kramlich, W. E., Pearson, A. M. and Taubes. F. M. (1988) Processed Meats 1st Edition Avi Publishing Co. Westport Connecticut.
- [52] Lambert, A. D: Smith, J. P. and Dodds, K. L. (1992). Physical, chemical and sensory changes in irradiated fresh beef packaged in a modified atmosphere. *Journal of Food Science* 57 (6): 1294-1299.
- [53] Lawrie, R. A (1998). Lawrie’s Meat Science. Sixth Edition. Wood head publishing Limited. Abington, Cambridge; England 336 pp.
- [54] Leora, C. H. (1994). Overcoming flavour challenges in low fat frozen deserts. *Journal of Food Technology* 48 (2) : 98 - 105.
- [55] May, S. G., Dolezal, D. R., Gill D. R., Ray, F. K. and Buchanan, D. S. (1992). Effects of day fed, carcass grade traits, and subcutaneous fat removal on postmortem muscle characteristics and beef palatability. *Journal of Animal Science* 70 (2): 444 - 453.
- [56] Mitenhurg, G. A., Wensing. T. Smulders, F. J. M. and Brenkink. H. J. (1992). Relationship between blood hemoglobin, plasma and tissue iron, muscle Heme pigment, and carcass colour of veal. *Journal of Animal Science*. 70(9): 2766-2772.
- [57] Nebenebor, C. A., Igene, J. O.; Maigoge. S. P.; and Collision. EEC (1990) Microbial quality of Ki/i.vli meat product. *Journal of Animal Production Research*, 10 : 91-1 07.
- [58] Neiluard, S., Civile. G. and Carr, T. (1991) “ Sensory Evaluation Techniques” Second Ed. CRS Press. Inc Boca Raton Florida.
- [59] Nour, A.Y.M.; Gamide, C. A. Mills, E.W.; Lereneger.R.P. and Judge.M.D. (1994). Influence of production and post-mortem technologies on composition and palatability of USDA selects grade beef. *Journal of Animal Science* 72 (5) : 1224 - 1231.
- [60] Obanu, J. O. (1986). Raw material maximization as a key to success in meat industry. Paper presented at the national Workshop on post-harvest Food loses and their Control, April 14-26 University of Nigeria Nsukka.
- [61] Obanu, Z. A. Upgrading local technology for meat processing. Proceedings 11th Annual Conference of the Nigerian Institute of Food Science and Technology, Port Harcourt, Oct 25-29, 1986; Aworh. O. C. Ed.; NIFST: Lagos, Nigeria, 1987, 88-110, of tsire type suya, a popular. Nigerian meat product. *J. Food Prot.* 47: 193- 196.
- [62] Oguntona, E.B. and Akinvele, I.O. (1995). Nutrient Composition of Commonly Eaten - Foods in Nigeria Raw, Processed and Prepared. Food Basket Foundation international. Ibadan 131 pp.
- [63] Olukosi, J.O. (1991). Consumer preferences for *Banda*, a Nigerian hot smoked meat product. *Journal of Food Agriculture I* : 51-60
- [64] Olumu, J. M. (1995). Monogastric Animal Nutrition, Principles and Practices 1st Edition. A Jacherm Publication. Benin 320pp.
- [65] Olusola, O. O. (2002). *Quality variations and the nutritive attributes of differently processed and packaged Kilishi products*. PhD Thesis. University of Ibadan.
- [66] Olusola, O. O. (2012). Quality variation of Kilishi from different locations in Nigeria. *Trop. J. Anim. Sci.*, 9(2): 85-92.
- [67] Omitoyin, (2007). *Improvement of Nigerian smoked meat products through intermediate moisture food processing*. Ph.D. Thesis, UNN, Nigeria.
- [68] Omojola, A. B., Isah, O. A., Adewumi, M. K., Ogunsola, O. O; and Atta, S. (2003). Evaluation of Effect of Different Additives on Acceptability of Kilishi, *Tropical Journal of Animal Science*. 6(2): 97-101

- [69] Oreskovich, D. C. Becthel, P. J. Mckeith, F.K., Novakofski. I; and Basgall.E..J.. Marinade P.11 (1 992) Effects on textural properties of beef *Journal of Food Science*, 57 (2) : 305 – 311.
- [70] Parrish. F. C., Boles, J. A., Rust, R. F. and Olson, D. C (1991) Dry and wet aging effects on palatability attributes of beef loin and rib steaks from three quality grades. *Journal of Food Science*. 56(3): 601 - 603.
- [71] Peng, I. C., Yososkey, J. J. and Judge, M. D. (1989). Sodium retention in pre-rigor and postnear ground beef *Journal of Food of Science* 54 (2) : 297 -298.
- [72] Rao, V. A., Thulasi, G. Ruban, S. W. Meat quality characteristics of non-descript buffalos as affected by age and sex. *World Applied Science Journal*, 2009; 1058-1065.
- [73] Rhee, K. S., Towell, R. N., Quintonilla. M. and Vanderzant, S. R J. (1985). Food Dehydration, Volume 2 (2nd Edition) Avi Publishing Co., Wastport Connecticut pp 34-36.
- [74] Rice, E. E (1988).The nutritional content and value of meat and meat products. In: Science of Meat and Meat Products. (Eds. J. F. Price and B.S Schwengert). McGraw –Hill Publishing Company Ltd. New York 460 pp.
- [75] Robert, T. A. (1989). Combinations of Antimicrobials and processing methods.*Journal of food Technology* 43 (1): 156 – 161.
- [76] Rockland and Beuchat, (1997). ‘*The quality of meat from Beef cattle is it influenced by diet?* In R & H 1-Tall Tech. Bull, issue No 4.
- [77] Russo and R. Sawyer, (1988).Meat Science.6thEdn.Pergammon Press. London.
- [78] SAS (1981).*SAS/STAT Guide for personal computers* (Version 6 Edition) Cary. NC.
- [79] Schaefer, D. M., Arnol, R. N; Scheller K. K.. Arp, S.L. and Williams, S.N. (1991) Dietary vitamin E. modifies beef quality. Proceedings, Holsten Beef Production Symposium.pp 175- 185.NEAES 44 North East Regional Agriculture Engineering Services, Ithaca, NY.
- [80] Usharani, P., Gustavo. V. B. and Barry, G. S. (1993). Magnetic field in activation of microorganism and generating of biological changes.*Journal of Food Technology* 47 (12): 85-93.
- [81] Wagner, M. K. and Moberg. L. J., (1989), Present and future use of traditional antimicrobials. *Journal of Food Technology*, 43 (1): 143- 155.
- [82] Wheeler, T. I. and Koohmaraie, M. (1994).Pre-rigor and post-rigor changes in tenderness of longismus music tissue.*Journal of Animal Science*. 72 (9): 232-1238.
- [83] Wheeler, T. I., Koohmaraie, M. and Crouse, J.D. (1991).Effects of calcium chloride injection and hot-boning on the tenderness of round muscle.*Journal of Animal Science* 69(12):4511 - 4875.
- [84] Whyte et al (2004) - *Occurrence of Campylobacter in Retail Foods in Ireland*.