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EVALUATION OF THE NUTRITIONAL COMPOSITION OF JERKY MEAT (*KILISHI*) SOLD IN JIGAWA STATE

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ABSTRACT

This study was conducted to determine the nutritional composition of jerky meat (*Kilishi)* retailed at some designated locations within Jigawa State. The locally prepared jerky meat samples were obtained from six locations viz, A, B, C, D, E and F and the research was laid out in a Completely Randomized Design. The values obtained from the nutritional composition of *Kilishi* revealed significant ($p<0.05$) differences in all the parameters evaluated across the locations. The lowest and highest dry matter contents of 91.68% and 94.64% were recorded from locations C and E respectively. The highest value (54.87%) of crude protein content was observed from location E while the lowest value (41.83%) was from location A. The lowest value of fat (17.68%) and ash (6.19%) were recorded from location F. The highest value of sodium (360.88mg/l), and potassium (463.62mg/l) were recorded in location D, and calcium (87.75mg/l) and magnesium (26.08mg/l) were recorded in locations F and C respectively, while the lowest values of potassium (333.30mg/l) and calcium (57.39mg/l) were observed in location E. The highest values of Iron (Fe) (48.59mg/l) and copper (Cu) (0.26mg/l) were recorded in location B, while the lowest value of (Fe) (27.37 and 27.44mg/l) was in location A and E. Cu (0.12mg/l) and Manganese (1.53mg/l) least values were recorded in location A and C respectively. It was concluded that local *Kilishi* had high nutrient contents. Good manufacturing practices, proper packaging and storage were recommended to safeguard the nutritional value of *Kilishi* to the consumers.

Keywords: Jigawa, Jerky meat, Mineral, Nutritive value, Proximate composition.

INTRODUCTION

Meat is the edible part of an animal used as source of food obtained after slaughter (Igwe, 2015). According to Kibon, (2016), it is the whole or part of the carcass of animals such as cattle, goat, pig, poultry, rabbit and sheep slaughtered and intended for human consumption. A meat is important to the general well-being of individual and contributes positively to human nutrition and economic growth (Bingham, 2018; Igwe, 2017). Meat is produced into various ready-to-eat snack products such as *Tsire*, *Balangu*, *Dambun-nama* and *Kilishi* in the semi-arid areas were reported to have varying proximate, mineral, physical (texture), sensory (flavour), nutritional values and shelf life (Adeyeye & Jegede, 2017).

Nutritional quality of meat is primarily determined by the chemical compositions present in the muscle tissue (Paul & Southgate, 2018). Connective tissues are the most common tissues in meat, and their relative proportions and properties is responsible for the quality and tenderness of the meat (Adeyeye & Jegede, 2017; Fornias, 2016). The quality of the meat plays a vital role on the consumer's health status, and its important key in meat industry, as the demand of higher quality meat is always increasing with increase in population, the meat industry should consistently produce and supply quality meat that is safe and healthy for the consumer to ensure continued consumption of meat products (Stamler *et al.,* 2016).

Jerky meat is a Nigerian traditional dry meat product that is prepared from beef, mutton and chevon (Igene *et al.,* 2020). It consists of thinly sliced fresh lean strips/slice of muscle of about 0.17 - 0.5cm thick whose processing entails first spreading the sliced meat on racks (made of corn stalk), the strip is turned after 10 minute's intervals to avoid sticking on the mat until it dried up. Then, the dry strips/slices are immersed into slurry made up of defatted groundnut powder, spice and other seasonings. It is then dried again in the sun to reach a moisture level of less 10% depending on the drying conditions (Igene *et al.,* 2020). Jerky meat is reported to consist of 60% meat and 40% non-meat ingredients and is composed of 50% protein, 18% fat, 9.6% ash and 7.6% moisture. *Kilishi* can be stored for over one year in dry environment (Igene, 2018). Curing ingredients used in *Kilishi* production have high levels of triglycerides, phospholipids, polyunsaturated fatty acids and malonaldehyde (Igene, 2018). It is also moderately acidic yet it has stable shelf life, which is enhanced by its low moisture contents and improved storage conditions (Igene, 2018). It is a traditional dried meat product made from meat infused with spices and defatted groundnut paste (Millward, 2019) and is produced widely in most Northern Nigerian States. It has been shown that the quality of *Kilishi* produced by the traditional processors varies from one producer to the other and from one batch to another from the same producer (Adeyeye & Adesina, 2015). Meat from all species contain approximately 1% mineral (Adeyeye & Adesina, 2015). The use of different ingredients such as such as spices, flavourings and defatted groundnut cake in the production process could influence the mineral content of traditionally processed meat preparations like *Kilishi* (Adeyeye & Ayejuyo, 2017). The main objective of this experiment is to determine the nutritional quality of Jerky meat sold in Jigawa State.

MATERIALS AND METHODS

Study Area

The study was conducted in Dutse. Dutse is located in the semi-arid area of Northwestern Nigeria. The state is located between Latitude 11°42' and 13° 04' North of the equator and Longitude 8° 20' and 10.35° 29' east of the Greenwich meridian and as such is part of Sudano-sahelian zone of Nigeria (Olofin, 2008). The means monthly weather parameters: temperature (°C) and total rainfall (mm) for the years 2021 and 2022 were reported in Table 1:

Table 1: Dutse, Jigawa State weather reports for the years 2021 and 2022.

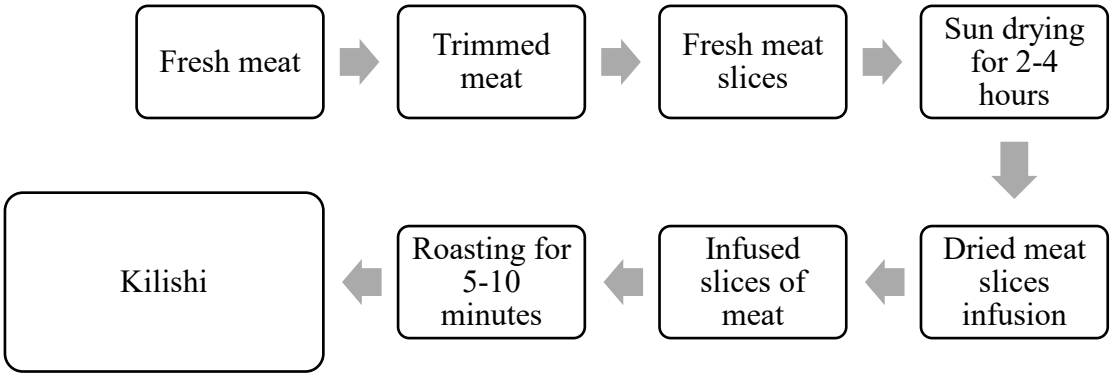
Months	2021		2022	
	TP (°C)	TR (mm)	TP (°C)	TR (mm)
March	37.6	0	36.9	0
April	40.5	0	40.3	8
May	40.5	11	39.7	0
June	36.6	108	35.0	142
July	31.3	219	31.4	151
August	31.6	173	29.4	460
September	33.6	64	30.3	253
October	36.7	26	33.2	8
November	36.6	0	33.7	0
Total	-	601	-	1022
AVR	36.1	-	34.4	-

TP=Temperature, TR=Total Rainfall
Source: Dahiru *et al.* (2024).

Traditional Processing of *Kilishi*

This starts with trimming off of all visible fats from the procured raw meat. This is followed by thin slicing of the meat to flat thin sheet of about 20mm thickness. There are first and second stage drying. Producers of *Kilishi* reported that the drying time for *Kilishi* varies with season of the year. They dry faster during the dry season when compared to the rainy season. After slicing, the first stage drying is usually completed in 5 - 10 hours depending on the humidity, temperature and air flow within the drying environment. After first drying stage, the meat slices will infuse with condiment made of defatted groundnut powder, water, seasoning cubes, salt, garlic and spices such as pepper, ginger and onion through dipping. This provides the desirable taste and flavour of the *Kilishi*. The spices therein also function as antimicrobial agents. The treated slices will then spread for the second and final drying. This drying phase is usually completed in 2 - 4 hours depending on the drying conditions. These meat slices will be finally roasted over a glowing fire for 4 - 5 minutes (Igene *et al.,* 2020).

Processing flow chart



Sample Collection

Forty-eight (48) samples of Jerky **(***kilishi***)** were purchased from six (6) different vendors in Jigawa State. Jigawa State was divided into three (3) strata based on the senatorial zones of the state as followed, North central, North west and North east. Two (2) local government areas were randomly picked from each senatorial district respectively as followed; Gwaram (A), Jahun (B), Ringim (C), Gumel (D), Hadejia (E) and Kafin Hausa (F). The samples obtained from these locations were placed into a labelled container and were taken immediately to Food and Nutrition Labouratory in the Department of Biochemistry, Federal University Dutse, Jigawa State for the proximate analysis and the filtered solution obtained after ashing and was taken to

Bayero University Kano Biochemistry Laboratory for mineral determination.

Nutritional Analysis

Proximate determination

Jerky **(*kilishi*)** samples were subjected to proximate analysis according to the procedures of AOAC (2007). Moisture content was determined through drying Jerky samples by taken 5g from each sample and oven dry at 100-105^{o}C until constant weight is obtained. The crude protein of Jerky meat samples was obtained using Kjeldahl methods which included digestion, distillation and titration of the distillates. The value of crude protein was derived by converting nitrogen (N) content of the distillates with a constant (6.25) thus, crude protein was obtained as (6.25 x N). Crude fat was determined by Soxhlet extraction method using petroleum ether. The samples were dried in an oven for 4 hours and fat was extracted. Ash contents of the samples were determined by igniting Jerky samples in a Muffle furnace at 550-600^{o}C for 24 hours until ash is formed (AOAC, 2007).

Minerals element determination

The minerals were analyzed from the solution obtained by initially dry ashing the samples at 550^{o}C AOAC (2007). The filtered solutions were used to determine Na, K, Ca, Mg, Cu, Mn and Fe by means of atomic absorption spectrophotometer (Buck Scientific Model-200A/210, Norwalk, Connecticut 06855).

Experimental Design and Statistical Analysis

The experiment was designed using Completely Randomized Design, the date collected from the analyzed samples were subjected to analysis of variance (ANOVA) and the means was separated using Duncan's Multiple Range Test at 5% level of probability using SAS statistics package.

RESULTS AND DISCUSSIONS

Proximate analysis

Table 2 shows the proximate composition of Jerky meat *(Kilishi)* sold at different locations in Jigawa State. The values obtained revealed significant ($p<0.05$) differences in all the parameters evaluated across the locations. Location E has the highest value of dry matter (94.64) and crude protein (54.87). The highest values of moisture (8.93) and ash (9.12) were recorded in location C, while highest values of ether extract and nitrogen free extract were recorded in location A (23.02) and B (20.82) respectively.

Table 2: Proximate composition of Jerky meat (Kilishi) sold in Jigawa State

Parameters (%)	Locations						EMS	P-Value
	A	B	C	D	E	F		
Moist	7.23^{b}	7.39^{b}	8.93^{a}	6.88^{b}	5.56^{d}	6.37^{c}	0.18	0.0001
CP	41.83^{d}	42.32^{d}	46.87^{c}	52.55^{b}	54.87^{a}	54.79^{a}	1.62	0.0001
EE	23.02^{a}	22.09^{a}	20.25^{b}	19.95^{c}	19.08^{bc}	17.68^{bc}	1.53	0.0001
ASH	7.70^{bc}	8.02^{b}	9.12^{a}	7.28^{c}	6.33^{d}	6.19^{d}	0.29	0.0001
NFE	20.63^{a}	20.82^{a}	15.44^{b}	13.34^{c}	14.36^{bc}	14.77^{bc}	1.54	0.0001
DM	92.86^{bc}	93.31^{b}	91.67^{c}	93.32^{b}	94.64^{a}	93.43^{ab}	0.86	0.0019

Means along the same row having different superscripts ($p<0.05$) differ. Moist= Moisture, CP= Crude Protein, EE= Ether extract, ASH= Ash, NFE= Nitrogen free extract and DM= Dry matter

Different levels of moisture in Kilishi have been reported by many researchers. Moisture values of 9.87%, 10.00% and 12.5% were recorded by Apata *et al.* (2013), Olusola *et al.* (2012) and Abbo and Raji, (1999) respectively. Other values reported include 10.02 - 12.02% (Iheagwara & Okonkwo, 2016) and 11.6 to 12.1% (Mgbemere *et al.,* 2011). Lower moisture contents ranging from 5.56% and 8.93% were reported in the current study. The different may be from age, sex and also from marbling of the meat as in dry matter.

The dry matter value of Jerky meat obtained from this study is higher than the value reported by Olumu (1995). The difference could be due to the age, sex, and marbling of the meat.

The protein content (41.83% - 54.87%) of the Jerky meat from the different sampling points were observed in this study to be lower than the protein value reported by Daminabo *et al.* (2013) and Olusola *et al.* (2012). The differences in values reported in the current and previous study may be due to the use of a different source of protein use as ingredient and age, presumably meat with higher protein contents than this was used in their study.

Fat content of Jerky meat was also examined by Jones *et al.* (2001) and Igene *et al.* (1988) which were found to be significantly higher when compared with the current study. The differences might be due to the type/source of spices used. Protein sources with higher fat contents such as in the full fat state will introduce higher fat levels.

The ash contents of the *Kilishi* reported by Jones *et al.* (2001), Abbo and Raji (1999) and Igene *et al.* (2020) were observed to be similar when compared with the result of this research work.

Macro and Micro Minerals Composition of Kilishi

Table 3 shows the Mineral Composition of Jerky meat *(Kilishi)* sold at different locations in Jigawa State. The values obtained revealed significant ($p<0.05$) differences in all the parameters evaluated across the locations. The highest value of Sodium (360.88) and Potassium (463.62) were reported in location D. Location F was recorded with

highest value of Calcium (87.75), while least values of magnesium were recorded in location E (23.61).

Table 3: Macro Minerals composition of Jerky meat (Kilishi) sold in Jigawa State

Parameters (mg/l)	Locations						EMS	P-Value
	A	B	C	D	E	F		
Na	190.27^{d}	283.83^{c}	282.59^{c}	360.88^{a}	167.15^{e}	328.94^{b}	2.063	0.0001
K	337.88^{b}	343.22^{b}	341.73^{b}	463.62^{a}	333.30^{b}	336.69^{b}	2.063	0.0001
Ca	64.13^{c}	78.96^{b}	78.52^{b}	77.21^{b}	57.39^{a}	87.75^{a}	2.063	0.0001
Mg	24.69^{c}	25.86^{ab}	26.08^{a}	25.51^{ab}	23.61^{c}	24.90^{abc}	2.061	0.0123

Means along the same row having different superscripts ($p<0.05$) differ. Na = Sodium, K = Potassium, Ca = Calcium, Mg = Magnesium

Table 4 shows the Micro Mineral Composition of Jerky meat *(Kilishi)* sold at different vendors in Jigawa State. The result showed there was significant ($p<0.05$) differences in all the parameters measured across the locations. Location B has the highest values of iron (48.59) and copper (0.26), while the lowest value of manganese (1.53) was recorded in location C.

Table 4: Micro Minerals composition of Jerky meat (*Kilishi*) sold in Jigawa State

Parameters (mg/l)	Locations						EMS	P-Value
	A	B	C	D	E	F		
Fe	27.44^{d}	48.59^{a}	24.02^{e}	38.06^{c}	27.37^{d}	45.86^{b}	1.023	0.0001
Cu	0.12^{d}	0.26^{a}	0.17^{c}	0.27^{a}	0.17^{c}	0.02^{b}	0.001	0.0001
Mn	2.84^{a}	2.73^{b}	1.53^{c}	2.09^{c}	2.15^{ab}	2.81^{ab}	0.005	0.0001

Means along the same row having different superscripts ($p<0.05$) differ.
Note: Fe= Ion, Cu=Copper, Mn=Manganese

Meat from all species contains approximately 1% mineral. The use of different ingredients such as such as spices, flavourings and defatted groundnut cake in the production process could influence the mineral content of traditionally processed meat preparations like *Kilishi* (Daminabo *et al.,* 2013). The result of the mineral analysis of *Kilishi* by Jones *et al.* (2001) revealed that it contained Ca 55.69 (mg/l), Mg 24.76 (mg/l), (mg/l), Na 210.98 and P 392.42 (mg/l). The current study recorded virtually similar levels of these macro minerals. Daminabo *et al.* (2013) reported the result of mineral composition of *Kilishi* from Abuja as Fe 38.7 (mg/l), Cu 0.17 (mg/l), Mn 2.15 (mg/l) which are similar to current work when compared.

CONCLUSION AND RECOMMENDATION

Conclusively, the study revealed that Kilishi from Jigawa North East (Hadejia and Kafin Hausa) are usually good in nutritive value compare to those from North Central (Gwaram and Jahun) and North West (Ringim and Gumel). Jerky meat is a highly nutrient dense ready-to-eat meat product but its nutritive value could be depleted at the retail outlets. Therefore, the following recommendations were made based on the research output;

1. Meat of high nutritive value should be obtained from healthy slaughtered animal and ingredient to be used and should be of higher value in preserving the meat quality and nutrients and also should be healthier for the consumers.
2. Similarly, efforts should be geared towards educating jerky **(***kilishi***)** processors in Jigawa State on the importance of nutritive value, proper packaging and preservation, since nutrient can be depleted due to improper handling and preservation which may lead to serious health problems.

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