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Effect of dietary garlic powder as additive on quality of Kilishi: A dried meat produced from west African dwarf ram

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Abstract
The study was conducted to investigate the effect of dietary garlic powder as additive in *Kilishi* a dried meat product derived from West African Dwarf (WAD) rams. Forty yearling West African Dwarf rams were randomly allotted to five dietary treatments at the inclusion of 0% (control), 2%, 4%, 6% and 8% into diets 1,2,3,4 and 5 respectively. At the end of feeding trials of 90 days, three WADS rams were randomly selected from treatment groups, weighed, slaughtered and muscles dissected. *Bicep femoris* of each carcass was trimmed of all adhering and processed to *kilishi*. *Kilishi* samples were analyzed for chemical properties, sensory evaluations and lipid stability at different display days. The study showed that dietary treatments influenced significantly ($p<0.05$) crude protein, moisture content, shear force and Thiobarbituric acid reactive substance (TBARS) values. Ether extracts, ash content and sensorial properties of *kilishi* were not significantly ($p>0.05$) influenced by the diets. However, TBARs values of treatment 5 fed WAD rams were significantly ($p<0.05$) lower than other dietary treatments as storage period advanced. The study revealed that garlic powder as additive up to 8% in WAD rams' diets may improve chemical characteristics, organoleptic properties and delay lipid oxidation in derivable products.

Keywords: kilishi, garlic, bicep femoris, meat product

Introduction

Meat is prone to quick deterioration as result of its composition immediately after slaughter till when consumed or utilized, many measures such as application of preservatives have been put in place in order to reduce rate of loss of meat quality. Many consumers today are concerned about the synthetic chemicals used as preservative in food, this sometime cause a detrimental effect on their well-being, resulting towards less production of processed food (Yang and Ray, 1994) [1]. Meat is high in nutrients, but very prone to spoilage and to prevent this from occurring value addition to meat is essential (Anna *et al*., 2005) [2]. This involves processing and preservation of meat so as to prolong its shelf-life and improve its acceptability. (Eyas Ahmed *et al*., 2006) [3]. Processing aids in producing varieties and convenient meat products in order to meet animal protein requirements, while preservation aided by processing extend the shelf-life of meat and meat products (Sharma and Kondaiah, 2005) [4] one of such product is *kilishi*. *Kilishi* being a tropical intermediate moisture meat product that is prepared essentially from beef slices, infused in slurry of defatted groundnut paste and spices and sundried (Ogunsola and Omojola, 2008) [5]. Leistner (1987) [6] asserted that *kilishi* is a rich nourishing snack, and source of supplementary animal protein.

In order to reduce the usage of synthetic chemicals as preservatives in food, research is geared towards dietary inclusion of natural substances such as spice and herbs into ruminant's diets to improve meat keeping quality. Spices possessed a diverse array of natural phytochemicals that are known for their complementary and interrelated actions, such as antioxidant effects (Kochhar, 2008) [7]. It has also been deduced that one of the underlying major mechanisms of action of spices is on cellular enzymatic pathways when consumed (Prasad *et al*., 2004) [8]. The aim of this study was to investigate the effect of dietary garlic powder as feed additive on quality, sensory properties and lipid stability of *kilishi*: a dried meat product of West African Dwarf ram.

Materials and methods

Experimental animal, management and treatments

A total of 40 yearlings West African Dwarf (WAD) rams were reared at the Ruminant unit of the Teaching and Research Farm of Ekiti State University, Ado-Ekiti. West African Dwarf rams were fed on five dietary treatments of which garlic powder was included at different levels of 0%, 2%, 4%, 6% and 8% respectively. The animals were randomly assigned to five dietary treatments and each treatment has four replicates of two rams per replicate, in completely randomized design (CRD). The feeding trial lasted for the period of 90 days. The WAD rams were fed with guinea grass (*Panicum maximum*) as basal diets and water provided *ad-libtum*.

Table 1: experimental feed composition (%)

Items	Composition
Ingredients	
Soybean meal	10.0
Maize	35.0
Rice bran	15.0
Brewer's dry grain	37.5
Bone meal	1.0
Salt	1.0
Vitamin/mineral	0.25
Premix	0.25
Total	100
Calculated protein (%)	16.07
Calculated Energy(kcal/kg)	2605.7

Slaughtering and mutton preparation At the completion of feeding 90 days feeding trials, three WAD rams of average weight ± 25kg were randomly selected from each treatment group. Rams were slaughtered, eviscerated and carcass dissected by standard procedure through reference point. Each carcass was halved into two and chilled at 4ºC for 24 hours. *Bicep femoris* muscles were dissected from the round portion of each carcass of WAD rams exposed to the treatment diets.

Preparation of kilishi Ingredients the spices and other ingredients used in preparation of *kilishi* were procured from a repute source. Constituents of ingredients were milled and mixed together in an appropriate proportion as shown on Table 2.

Preparation of kilishi Bicep femoris muscle of freshly slaughtered WAD ram fed experimental diets was used for the study. Muscle preparation was done by methods of Ogunsola and Omojola (2008) [5] with some modifications. The muscles were excised, and the meat was trimmed free of fat, nerves, blood vessels and excess connective tissues with a sharp knife. The chunk of meat was cut into smaller portions about the size of about 150-200g. Slicing was done along the fibre axis of each portion giving very thin slices of about 3.5mm thickness in a continuous sheet. Sliced thin sheets of meat was spread on flat surface and placed in the sun. The first stage of drying of sliced thin meat sheet lasted for two days. The meat slices were turned over every hour to allow for even drying and to prevent meat from getting stuck to the drying surface.

Preparation of kilishi slurry Preparation of *kilishi* slurry was done by the methods of Ogunsola and Omojola (2008) [5]. The ground nut seed was roasted for 5 min at 80 - 90°C and cooled. The testa removed, cleaned and milled into a paste. The milled paste was kneaded in a round bowl to express the oil. The paste obtained after oil extraction was used in *kilishi* preparation. The weight of derived paste was taken, placed in a bowl; other ingredients were added including salt to taste (Table 2). The mixture was further mixed with 32.95% (w/w) of water to make slightly thick slurry.

Kilishi preparation Preparation of *kilishi* was done by the methods of Ogunsola and Omojola (2008) [5] with some modification. The pieces of dried sliced meat were soaked in the slurry for 1 hr. 15minutes after which they were carefully removed, spread out one by one on flat baskets to facilitate draining and drying process. After drying for 6 hours, the infused meat slices were slightly grilled for 5 minutes to heat treat the products, thereafter cooled by spreading on a flat surface. *Kilishi* samples were packaged in thick brown paper prior to subsequent analysis.

Determination of chemical composition of Kilishi

Chemical Composition of *kilishi* sample was determined by the procedures of AOAC, (2005) [9]. Crude protein of *kilishi* samples was obtained using Kjeldahl methods. Ether extract was determined by soxhlet extraction method using petroleum ether. Moisture content was determined by drying 5g of *kilishi* sample (5g) in an oven at temperature between 100-105°C to a constant weight. Ash content of *Kilishi* was determined by igniting the *kilishi* samples in a Muffle furnace at 550-600°C for 24 hours until ashes were produced.

Determination of Lipid Oxidation of Kilishi Lipid oxidative stability of *kilishi* samples was assessed by the determination of secondary products of lipid oxidation as 2-thiobarbituric acid reactive substances (TBARS) at 7-day, 14-day and 21-day post-production, using cohesion bioscience assay kit.

Measurement of shear force of Kilishi

Kilishi sample was sheared by the procedures described by Honikel (1998) [10], at three locations with Warner-Bratzler V-notch blade shearing instrument.

Table 2: Composition of *Kilishi* ingredients (g100 g^{-1})

Ingredients	Other names	Composition
Ginger	*Zingiber officinale*	4.50
Black pepper	*Piper guineense*	3.00
Red pepper	*Capsicum frustescens*	2.50
Sweet pepper	*Capsicum annum*	2.0
Alligator pepper	*Afromomum meleginata*	2.80
Onion	*Allium cepa*	10.00
African nutmeg	*Monodora myristica*	0.50
Curry	*Fagara zanthoxyloides*	1.00
Salt	Sodium chloride	0.50
Magi seasoning	Monosodium glutamate	6.50
Sugar	Sugar	3.75
Groundnut paste	*Arachis hypogea*	35.00
Water		32.95
	Total	100.0

Modified methods of Ogunsola and Omojola (2008) [5].

Sensory Evaluation of Kilishi This was conducted according to the procedures of AMSA (1995) [11] as described by Apata *et al*. (2013) [12]. A 10-member semi-trained taste panel was used to conduct the sensorial characteristics of the samples. The panelists were provided with unsalted biscuits and water for use in between *kilishi* samples from test diets. *Kilishi* samples were coded and independently evaluated for using a 9-point hedonic scale on which 1=dislike extremely and 9=like extremely for, aroma, flavour, tenderness, juiciness, texture and overall-acceptability.

Experimental design and statistical analysis

The experimental design of the study was Completely Randomized Design (CRD). Data obtained from this study were analyzed with SAS, (2002) [13], while the means were separated using Duncan multiple Range test of the same software.

Results and discussion

Table 3 showed the results of the proximate composition of *kilishi* samples produced from West African Dwarf (WAD) rams fed garlic powder additives. The results showed that moisture content ranged from 5.85 to 7.21% in WAD rams fed dietary treatments. The moisture contents values obtained were similar to the range of 5.50% to 7.60% reported by Eke *et al*. (2012) [14] in *dambu-nama* and lower than value of 10.00 % (beef *kilishi*) and 9.92 % (pork *kilishi*) reported by Ogunsola and Omojola (2008) [5] but values were within the range 8.2 % to 11.1 % reported by Egbunike and Okubanjo (1999) [15] in oven dried and sun dried *kilishi*. The moisture content also fell within the values reported by Chukwu and Imodiboh (2009) [16] for *kilishi* and comparable to those observed for *banda* (traditional hard-smoked meat products) by Oladejo and Adebayo-Tayo (2011) [17]. Moisture contents observed in the study were at variance with value of 23.23% reported by Fakolade and Omojola (2008) [18] in commercially produced *kilishi*. The moisture content of *kilishi* was influenced by handling of life animal prior slaughtering, the method used during its processing; period of drying been prolonged and several methods of cooking adopted with little or no impact of dietary treatments. Low moisture content obtained in the study supports the assertion of Chukwu and Imodiboh (2009) [16] that *kilishi* is sufficiently dried to minimize the impact of microbial growth and this is responsible for high keeping quality of the product. The study further revealed that low moisture contents of the product ascertained that kilishi is a typical dried meat product of high keeping quality. This contravened the assertion of Ogunsola and Omojola (2008) [5] who described meat product that have less than 20% of moisture as intermediate moisture meat and Egbunike and Okubanjo (1999) [15] who stated that intermediate moisture meats (IMM) were low in moisture, shelf-stable under tropical climates without refrigeration.

The mean crude protein of *kilishi* differ significantly (p<0.05) between WAD rams fed dietary garlic powder as an additives and control. *Kilishi* crude protein ranged from 61. 82 to 65.12% as obtained in the study were slightly above the value 61.95% reported by Chukwu and Imodiboh (2009) [16] but was higher than the range 19.44 and 23.55% reported by Jonathan *et al. (*2016) [18]; range of 33.88 to 60.33 % reported by Ogunsola and Omojola (2008) [5] for *kilishi* and Igene *et al.* (1990)[19] who reported a value of 50.02% crude protein for traditional *kilishi*. Also, comparable to those observed for *banda* (traditional hard-smoked meat products) by Oladejo and Adebayo-Tayo (2011) [17]. Protein content results demonstrate the value and potential of *kilishi* as a high protein food product (Chukwu and Imodiboh**,** 2009) [16]. High crude protein values of kilishi obtained from dietary treatments in the study conformed to the report of Egbunike and Okubanjo (1999)[15] that dried contained three to four times the raw protein equivalent, which makes them to be less bulky. Ogunsola and Omojola (2008) [5] opined that processing meat into *kilishi* product improves the protein of the product thus increase its nutrient composition tremendously. Also, additional ingredients of plant source used during processing of *kilishi* must have contributed immensely to the high crude protein content (Omojola *et al*., 2003) [20]

The ash content of *kilishi* was higher in treatment 5 than treatments 1, 2, 3 and 4 respectively. The ash content was similar to the value of 9.6% reported by Igene *et al.* (1990) [19] for the finished meat products. The ash content of control fed WAD rams was closer to the findings of Ogunsola and Omojola (2008) [5] but lower than the garlic powder treated diets. The ash content obtained in the study for *kilishi* were higher than the value of 5.71% obtained by Chukwu and Imodiboh (2009) [16]; 6.72% by Jones *et al.* (2001) [21] in traditionally prepared *kilishi* and values of 6.75-9.5% reported by Jonathan *et al. (*2016) [18] for *kilishi*. The high ash contents obtained in the study may be a reflection of the phytochemicals present in garlic powder, condiments and spices used in *kilishi* production (Chukwu and Imodiboh 2009) [16]. According to Ogunsola and Omojola (2008) [5] that high ash content is indicative of the individual mineral levels of the spices to give a cumulative mineral level. This makes *kilishi* an important source of a desirable nutrient as far as minerals are concerned. *Kilishi* fat content ranged from 11.69±2.26 and 13.79±2.44%, were lower than those observed by Ogunsola and Omojola (2008) [5] in *kilishi* made from beef and pork respectively. Jonathan *et al*. (2016) [18] reported lower fat content than the values obtained in the study for *kilishi*. It was observed in the study that products derived from rams fed garlic powder diets had lower fat content than control diet, this may be due to the fact that the fat content in meat and meat products have been influenced by site of fat deposition within the carcass in relation to the diets (Wood *et al*., 2008) [22]. Also, garlic bioactive components probably reduced excess fat deposition at the cellular level in WAD rams during feeding. This study revealed that high crude protein and moderate fat observed in the *kilishi* samples of treated carcasses qualifies recommendation of garlic powder as an additive in ruminant' s diets which can help boost source of animal protein without detrimental effect on consumer's well-being.

Table 4 showed the results of the sensory evaluation and shear force value of *kilishi* samples. The results revealed that there were no significant (p>0.05) difference between sensory properties of *kilishi* samples but values varied numerically. *Kilishi* aroma ranged from 5.20 (treatment 2) to 6.40 (treatment 5). *Kilishi* flavour was higher (p<0.05) in treatment 5, followed by treatments 1 and 4 while the least flavour was scored in treatments 2 and 3. The most tendered *kilishi* sample was found in treatment 5 while treatment 1 had the least score. The study showed that juiciness was rated higher in treatments 1 and 4 than treatments 2, 3 and 5. *Kilishi* texture ranged from 2.80 (treatments 1and 3) to 3.40 in treatment 5 fed WAD rams. The results indicated that *kilishi* samples prepared from treatments 3 and 4 with similar rating were mostly accepted, followed by treatment 2 while treatment 5 *kilishi* samples was least accepted. Flavour of *kilishi* was higher than those reported by Ogunsola and Omojola (2008) [5]. Feeding garlic supplemented diets and several spices used in *kilishi* production also added to the flavour of the product (Ogunsola and Omojola, 2008) [5]. The sensory properties of *kilishi* obtained in the study were similar to those observed by Fakolade (2011) [23] in dried *kundi.* The sensory manifestation of the structure of meat and the manner in which the structure reacts to the force applied during biting and the specific senses involved in eating determines the meat tenderness (Moloney, 1999)[24]. This agrees with the findings of Bruwer *et al.* (1987) [25] that the more tender the meat the fewer residues remain in the mouth after chewing. Juiciness of meat depends on the raw meat quality and on the cooking procedure (Aaslyng *et al*., 2003) [26] and is directly related to the intramuscular lipid and moisture content of the meat (Cross *et al*., 1986) [27]. The coarseness of *kilishi* texture indicates that *kilishi* is dried meat product containing low moisture; this corresponds with the low value obtained for moisture content of *kilishi* in the study. Over-all acceptability of *kilishi* was ranked to be moderately liked for all samples as ranked by the panelists.

Shear force value of *kilishi* samples ranged from 4.47 kg/cm^2 (treatments 4 and 5) to 4.89 kg/cm^2 (treatment 1), these values were closer to reports of Dhanda *et al*. (1999) [28] and Bickerstaffe (1996) [29] for tendered mutton. Shear force values obtained in the study falls within an intermediately tendered meat product; this makes the *kilishi* a nourishing ready-to-eat meat product. This study showed that feeding garlic powder as additive had influenced mutton tenderness as shown by the reduction in shear force values.

Figure 1 showed the results of Thiobarbituric acid reactive substance (TBARS) values of *kilishi* samples at different storage days. *Kilishi* TBARs values were significantly ($p<0.05$) different between treatment diets as storage days advanced. However, it was observed that on 21-day post-production TBARS values significantly ($p<0.05$) reduced in *kilishi* of treatment5 (8% garlic) followed by treatments 4, 3 and 1 respectively. The TBARS value behaviour of *kilishi* samples followed the trend reported by Seol *et al*. (2013); Bolumar *et al*. (2011) [30, 31]. TBARS values obtained in the study contravened the reported of Vatansever *et al*. (2000) [32] in dried meat. The reducing effect of garlic powder on MDA levels of *kilishi* at interval of days agrees with Valesco and Williams (2011) [33] and assertion of Wood *et al*. (2003) [34] that antioxidants have been used to delay lipid oxidation, and extends shelf life of meat products.

Table 3: Proximate composition of *Kilishi* produced from mutton of WAD rams fed garlic powder as additive (%)

Items	Treatment 1 0% garlic	Treatment 2 2% garlic	Treatment 3 4% garlic	Treatment 4 6%	Treatment 5 8% garlic
Crude protein	61.82±0.04^b	62.78±0.41^b	64.66±0.72^a	65.12±0.87^a	65.91±0.53^a
Ether extract	13.36±1.95^a	11.69±1.26^b	13.07±1.70^a	13.19±1.59^a	12.79±1.44^a
Ash	8.74±1.30^c	10.12±1.22^a	9.67±1.35^b	9.03±1.03^b	10.43±1.69^a
Moisture	5.85±1.92^b	7.21±1.09^a	5.61±1.96^b	6.18±1.43^b	6.93±1.85^b

Mean± standard deviation; a, b, c – means in the same row with different superscripts are statistically significant ($p<0.05$)

Table 4: Sensory evaluations and shear force value *Kilishi* produced from mutton of WAD rams fed garlic powder supplemented diets

Items	Treatment 1	Treatment 2	Treatment 3	Treatment 4	Treatment 5
	0% garlic	2% garlic	4% garlic	6% garlic	8% garlic
Aroma	5.40±0.34	5.20±0.48	5.40±0.89	6.20±0.48	6.40±0.67
Flavour	6.60±0.52	6.40±0.30	6.20±0.79	6.60±.34	6.80±0.05
Tenderness	2.80±0.84	3.60±0.52	3.00±0.41	3.60±0.55	3.60±0.14
Juiciness	7.20±0.64	6.20±0.84	6.60±0.89	7.20±0.30	6.60±0.14
Texture	2.80±0.48	3.00±0.58	2.80±0.30	3.20±0.48	3.00±0.01
Overall acceptability	7.00±0.23	7.60±0.55	7.80±0.45	7.80±0.45	7.10±0.64
Shearforce(kg/cm^2)	4.89±0.22	4.54±0.08	4.54±0.19	4.47±0.23	4.47±0.22

Mean± standard deviation, a, b, c – means in the same row with different superscripts are statistically significant ($P<0.05$)

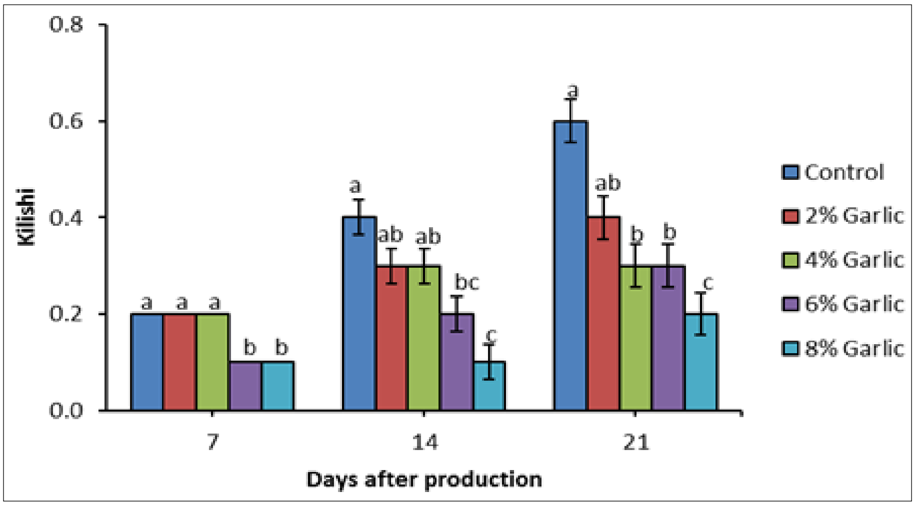

Fig 1: TBARS (mg MDA/Kg meat) of *Kilishi* derived from mutton of WAD ram fed experimental diets at different storage days; treatment 2 (2% garlic), treatment 3 (4% garlic), treatment 4 (6% garlic), treatment 5 (8% garlic); a, b, c – means in the same row with different superscripts are statistically significant ($P<0.05$)

4. Conclusion

The study revealed that feeding garlic powder as additive up to 8% inclusion level in WAD ram's diets enhanced *kilishi* of better sensorial properties, chemical characteristics by increasing crude protein contents as well as lowering effect on ether extracts (fat). Thiobarbituric acid reactive substance (TBARS) values of *kilishi* samples were lowered in treatment 5 than control as storage days advanced, this indicates that garlic powder can be used as natural dietary source of antioxidants to delay lipid oxidation in meat products.

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