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Organoleptic and Bacterial Load of Poultry Jerky Produced From Guinea Fowl and Spent Chicken Layer Meat Marinated with Scent Leaf (*Ocimum gratissimum*) Extract

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Abstract

The study was conducted to determine the organoleptic and microbial properties of Poultry Jerky made from guinea fowl and spent chicken layer meat, marinated with Ocimum gratissimum (scent leaves) extract. The experiment was factorially combined (2 x 4) in a completely randomized design consisting of two poultry species (guinea fowl and spent layers), and four marinades: nothing added (Oc); Ocimum gratissimum and common salt (Os); Ocimum gratissimum and wet marinated (Ow), Ocimum gratissimum and dry marinated (Od). Results showed there was significant (P<0.05) effect of species on proximate composition of raw meat. Total viable bacteria (TVB) and coliform counts were higher in spent layer (7.4×10^2 and 2.9×10^2), respectively and lower in guinea fowl (5.6×10^2 and 0.8×10^2), respectively. Marinade had significant (P<0.05) effect on proximate composition of meat jerky from the two poultry species. In the jerky from both species, crude protein was lower in Ow, 21.42%, and higher for Od; 26.21% (guinea fowl) and 31.41% (spent layers). There was significant (P<0.05) positive correlation among the organoleptic properties. Marinade had no-significant (P>0.05) effect on doneness, tenderness, aroma, taste and acceptability for the jerky but there was significant (P<0.05) effect of marinade on colour where 6.20 was recorded in Oc, followed by Od and Ow (4.58 and 4.48, respectively), while Os had 3.84 but there was an overall acceptability of poultry jerky. Marinade had significant (P<0.05) effect on bacterial count of the jerky where, TVB count was higher in Oc (3.4×10^5) and lower in Os (0.7×10^5). Coliform count was also higher (3.5×10^3) in Oc and lower in Os (1.9×10^3) for guinea fowl and spent layer jerky's respectively. From the result of the study it has shown that Ocimum gratissimum extract can be used as a marinade in meat products.

Description of problem

Meat is one of the most nutritious foods that humans can consume, particularly in terms of supplying high-quality protein (essential amino acids), minerals (especially iron) and essential vitamins (1). (1) and (3), defined meat as all animal tissues suitable as food for human consumption. A daily intake of 100g of meat can supply up to 50% of the recommended daily allowance for Iron, Zinc, Selenium, Vitamins B_1, B_2, B_6, B_{12} and 100% of Vitamin A (4). This includes all processed or manufactured products prepared from animal tissues. Meat has been enriched with additives to protect, modify or improve its tenderness, juiciness or cohesiveness as well as preservation (5). Different methods of meat preservation have been employed these include: the use of salt cure and chemical preservatives (6). Marination is one of the methods employed to preserve meat.

Marination is been defined by Webster's dictionary as implying pickling or soaking meat in a marinade solution for hours. The production of marinades, include the addition of materials with anti microbial capabilities such as Garlic, Lemon or *Ocimum gratissimum (Og)* (7). In Nigeria *Ocimum gratissimum* goes by many local name, ***Daidoya*** in Hausa ***Efinrin*** in Yoruba, and *N**chuanwu*** **(8) or** "*Ahuji*" (9) in Igbo, it is cultivated for various purposes, the leaves of the plant contain essential oils (10) that display antimicrobial activity (11), it is used as a spice for cooking delicacies and as condiment in dishes because of its high pungent flavour of clove and unique aromatic taste (8).

Meat dishes are usually described by their source and method of preparation. While some meat products are marinated and barbecued, or simply boiled, roasted, or fried. It may be ground then formed into patties (hamburgers or croquettes), loaves, or sausages, or used in loose form (as in "sloppy Joe" or Bolognese sauce) or as dried meat like biltong and jerky .Jerky is a nutrient-dense meat that has been made lightweight by marinating with a wet or dry spice rub followed by drying, dehydrating or smoking with low heat (usually under 70 °C/160 °F) (12). Jerky may be produced using a combination of curing, smoking and drying procedures (13). Other meat products that are similar to jerky include; "Biltong" which is a dried meat common in South African cuisines. *Kilishi* is a form of dried meat cuisine, which originated in the Hausa land made from deboned cow, sheep or goat meat (14). "With today's varied options for preparing jerky, nearly any low-fat meat product can be made into jerky (15). Around the world, meat from domestic and wild animals is used to make jerky, meats from domestic animals include beef, pork, chevon and mutton or lamb and wild animals including, deer, kudu, springbok, kangaroo and bison (16).

In Nigeria poultry producers face the problem of glut especially during festive periods when the supply out-weighs the demand (broiler production), processing the poultry into jerky will serve as a medium of preserving the meat while still retaining the organoleptic, nutritional and aesthetic attributes, thereby helping the farmer retrieve cost of production.

The objectives of this work was to determine; the bacterial load, organoleptic properties and overall acceptability of poultry jerky produced from guinea fowl and spent layer meat that were treated with *Ocimum gratissimum* extract.

Materials and Method

Experimental design

The experiment was a 2 x 4 factorial arrangement in a complete randomized design, consisting of meat from two poultry birds, (Guinea fowl and Spent layers), four marinades; Oc served as control (*nothing added*); Os (*O. gratissimum and common salt*); Ow (*O. gratissimum* and wet marinated), Od (*O. gratissimum* and dry marinated).

Production of *Ocimum gratissimum* extract

Fresh *Ocimum gratissimum* leaves were harvested, in June, 2018, from a cultivated vegetable garden in Zaria. The leaves were rinsed with distilled water and finely blended to a paste, which was squeezed with a muslin cloth to extract the juice as described by (7) 2014a. Two hundred and forty (240) ml of the *O. gratissimum* juice was used to treat 1.72 Kg of meat as reported by (17) 2014b. This was used to marinate the poultry meat according to the marinade treatments.

Marinade Preparation

The dry and wet marinades were constituted to specific proportions according to recipes shown in the Tables 1a and 1b:

Table 1a: Ingredient composition of dry marinade

Ingredients	Quantity used
Table salt (NaCl)	2 ½ teaspoon (12.5 g)
Cracked pepper	¾ table spoon(11.1 g)
Brown Sugar	3 table spoons(44.4 g)
Garlic powder	3 table spoons(44.4 g)

Source: (12)

Table 1b: Ingredient composition of wet marinade

Ingredients	Quantity used
Soy sauce	1 cup (240 ml)
Lemon juice	1 ½ table spoon(22.2 g)
Worcestershire sauce	¼ cup (62.5 ml)
Garlic powder	1 teaspoon(5.69 g)
Red pepper	1 ½ table spoon(22.2 g)
Black pepper	1 tea spoon(5.69 g)

Source: (15)

Meat Preparation for the study

Eighteen Guinea fowls and 18 Isa Brown Spent layers, of about 89 weeks of age were sourced in the month of June, 2018, from Takashiba Farms in Babban Tunga town of Tafa Local Government Area of Niger State. The birds were transferred to a holding pen and slaughtered at the Animal Products Meat Laboratory of the Department of Animal Science, Ahmadu Bello University, Zaria. The birds were dressed and the skin and fat on the meat were removed and discarded as a means of reducing the fat content of the meat, since "lean meat is an ideal cut for making jerky", (18). Meat was then excised from the primal cuts; breast (served as the main meat used), wings, thighs and drum sticks (upper part without the tendons) and each (Guinea fowl and Spent layer) were separately packaged in plastic Ziploc bags then transferred to the refrigerator to cool, and to further inhibit microbial growth and activity and make the process of slicing the meat easier as reported by (19). The partially frozen meat was sliced into Jerky sizes (1/8 to ¼ inches thick) according to (13; 18) and the meat strips were divided and weighed into four different portions (1.72Kg each portions); Oc - Control, Os – *O.g.* + Salt, Od – *O.g.* + dry marinade, Ow– *O.g.* + wet marinade. The experimental samples were packaged and treated at the rate of 240ml marinade per 1.72 Kg of meat according to (17).

The four (1.72Kg each) marinated meat samples were placed in the refrigerator to further marinate over-night, as was suggested by (12) and (19). The marinated samples were removed from the fridge 20 hours later and allowed to heat to room temperature before being padded with kitchen absorbent sheets to remove extra moisture from the meat.

Jerky production

The marinated meat strips were then arranged on the dehydrator trays, making sure they did not touch each other (12; 15) to allow for proper drying. The drying process lasted for a period of about 5 - 7 hours, at about 70^{o}C. When done it was allowed to cool before packaging, "a dry and well done jerky will be crispy, crack when bent but will not break (12; 15; 19)

Organoleptic assessment: Sensory evaluation was conducted on the jerky produced at the Animal Products Meat Laboratory of the Department of Animal Science Ahmadu Bello University Zaria. It (sensory evaluation) was preceded by the training of the panelists that participated in the evaluation. 30 trained and semi–trained taste panelists were used for the sensory analysis. The entire panelists were issued, tooth picks, and serviette to accompany the coded Jerky sample, each sample was coded (known, only to the researcher) to avoid bias, samples were evaluated independently cracker biscuits were also provided to serve as a palate cleanser. A detergent and sachet water was made available during all sessions. The coded samples were assessed for doneness, aroma, taste, texture, color and overall acceptability with questionnaires based on a seven - point Hedonic scale, the maximum score of 7 for like extremely and a lowest score of 1 was assigned to dislike extremely as according to (20).

Evaluation of proximate composition of raw/fresh meat and poultry jerk: Proximate analysis of raw/fresh meat and poultry jerk produced to determine: dry

matter, crude protein, crude fiber, ether extract, ash and nitrogen free extract contents were carried out at the Bio – chemical Laboratory, of National Veterinary Research Institute, Vom according to (21) methods. The total bacterial plate counts, identification and characterization involved fresh meat surfaces spread over Potato Dextrose Agar (PDA) (Cat. 1160) and cured meats were spread over Dichloran-Glycerol (DG18) Agar as described by (22). Possible individual microorganism species were isolated from the agars by sub-culturing onto a non-selective agar. The possible presence and classification of microorganism were determined using; Potato Dextrose Agar (PDA) (Cat. 1022) using, (21) methods at the Laboratory of the Department of Microbiology, Ahmadu Bello University, Zaria.

Statistical Analysis: All data generated was subjected to the analysis of variance (ANOVA), using the General Linear Model (GLM) procedure of (23). The significant means were separated using Dunnet test. Relationship of variables was analyzed with Correlation coefficient**.**

Experimental Model

$Y_{ijk} = a + P_i + M_j + (P \times M)_{ij} + e_{ijk}$

Y_{ijk} = Response parameters of the Jerky

a = population mean

P_i = effect of the poultry meat (Guinea Fowl and Spent Chicken Layer)

M_j= effect of the *marination (*Control, Salt, Dry, Wet)

$(P_i \times M_j)_{ij}$= Effect of interaction between poultry meat and marinade

e_{ijk}= error term

Results and Discussion

Proximate composition of fresh untreated meat from two poultry species

The results of the proximate composition of fresh (non-marinated) meat from two poultry species are presented in Table 2. The moisture content and ether extract obtained in this study for spent layers were above that of (24) who reported 71.05 % and 1.62 % for moisture content and ether extract, respectively while the crude protein and ash recorded were below the values of (24) with crude protein of 21.39 % and 1.29 % ash. Proximate composition of guinea fowl were lower than the range of values reported by (25) whose range of values were moisture content (74.01 – 74.55 %), ether extract (2.26 – 2.99 %) and ash (0.95 – 1.08 %), crude protein content (20.47 – 22.70 %) was within the range of value given by (25), for part of breast, drumstick and thigh. The significant ($P<0.05$) effect of poultry species on the proximate composition could possibly be due to species difference, different environmental condition, feeding. Guinea fowl meat could therefore be nutritionally favourable because of this low fat content and high protein content, which supports the findings of (25) and (26). The high nitrogen free extract (energy) obtained in spent layer could be attributed to the high fat content. According to (27), the chemical composition of poultry meat was affected by breed, sex, feeding regime, meat yield, composition, and cut of meat as well as carcass processing.

Table 2: Proximate composition of fresh untreated meat from two poultry species

Parameters	*Poultry Species*		SEM
	Guinea Fowl	Spent Layer	
Moisture content	73.03[b]	75.48[a]	0.00
Crude protein	21.03[a]	20.11[b]	0.02
Ether extract	1.78[b]	2.39[a]	0.05
Crude fibre	0.22[a]	0.10[b]	0.01
Ash	2.16[a]	0.97[b]	0.01
Nitrogen free extact	74.82[b]	76.44[a]	0.04

[ab] means within rows having different superscripts differed significantly (P<0.05), SEM = Standard error of mean

Bacterial count of fresh untreated meat from two poultry species

The result of bacterial count of fresh non marinated meat from two poultry species is presented in Table 3.The bacterial counts obtained in this study were below the Nigeria Agency for Drug Administration and Control (NAFDAC) recommendations, of between 5.0 x 10^5 Total Viable Bacteria (TVB) and 1.0 x 10^6cfu/g (coliform), for public health. Coliforms are indicator organisms signifying contamination of the product (28). However on the whole the TVB count and coliform count were higher in spent layer and lower in guinea fowl. This could be attributed to the hardy nature of guinea fowl which give them some resistance against microorganisms.

Table 3: Bacterial load of fresh untreated meat from two poultry species

Parameters	*Poultry Species*		SEM
	Guinea Fowl	Spent Layer	
Viable Bacteria Count	5.6 x10^{2b}	7.4 x10^{2a}	0.5 x10^2
Coliform Count	0.8 x10^{2b}	2.9 x10^{2a}	0.4 x10^2

[ab] means within rows having different superscripts differed significantly (P<0.05), SEM = Standard error of mean;

Interaction effect of marination and two poultry species on proximate composition of Jerky

The result of the main effect of marinade on proximate composition of meat jerky from two poultry species is presented on table 4. The results showed that marinade had significant (P<0.05) effect on proximate composition of meat jerky from two poultry species. In guinea fowl and spent layer, higher crude protein obtained in Od was attributed to the higher moisture content loss (25), in comparison with other treatments, resulting in a more concentrated product (29). Higher ether extract obtained in Oc may be as a result of not adding any treatment. Crude fibre was higher in Ow that could be as a result of the plant extract used and components of the wet marinade which were fibrous in nature (25). While higher ash content recorded in Os is attributed to the addition of salt which consist of sodium and chlorine.

Table 4: Interaction effect of marination and two poultry species on proximate composition of Jerky

	Marinade Types									
	Guinea Fowl					*Spent Layer*				
Parameters (%)	Oc	Os	Ow	Od	SEM	Oc	Os	Ow	Od	SEM
Moisture content	63.64^{b}	63.53^{b}	66.50^{a}	62.56^{c}	0.07	66.16^{b}	54.89^{c}	66.91^{a}	42.86^{d}	0.07
Crude protein	24.02^{b}	22.19^{c}	21.42^{d}	26.21^{a}	0.06	24.63^{b}	24.25^{c}	21.42^{d}	31.41^{a}	0.06
Ether extract	8.51^{a}	4.06^{d}	6.13^{b}	5.10^{c}	0.04	4.73^{a}	1.89^{d}	2.62^{b}	2.36^{c}	0.04
Crude fibre	0.01^{c}	0.89^{b}	1.10^{a}	0.02^{c}	0.02	0.00^{c}	0.11^{b}	0.38^{a}	0.00^{c}	0.02
Ash	0.58^{d}	4.64^{a}	1.58^{b}	1.18^{c}	0.02	0.97^{c}	5.01^{a}	1.11^{b}	0.93^{c}	0.02
NFE	66.89^{d}	68.22^{b}	69.78^{a}	67.49^{c}	0.06	72.04^{b}	45.06^{d}	71.65^{c}	75.16^{a}	0.06

^{abcd} means within rows having different superscripts differed significantly (P<0.05), SEM = Standard error of mean, NFE = Nitrogen free extract, Oc = Control Nothing added, Os = *Ocimumgratissimum* + salt, Ow = *Ocimumgratissimum* + wet marinade, Od = *Ocimumgratissimum* + dry spice

Effect of marination and meat from two poultry species on organoleptic properties and doneness of Jerky

The result from Table 5 shows the main effect of marination on organoleptic properties of meat jerky from two poultry species. The results show no-significant (P>0.05) effect of marination on doneness, tenderness, aroma, taste and acceptability for both guinea fowl and spent layer this could be related to the fact that all products were accepted because the panelists could not differentiate the products. However there was significant (P<0.05) effect of marination on colour which could be attributed to the green colour from *O. gratissimum* extract and other ingredients added. In both guinea fowl and spent layers Oc had a higher score against Od and Ow, which were liked slightly and Os that was neither liked nor disliked, "colour is the major determinant of consumer acceptability of meat products at the retailer counter, therefore one of the most important considerations in meat product merchandising is that of maintaining optimum colour of appearance" (30).

Table 5: Effect of marination and meat from two poultry species on organoleptic properties and doneness of Jerky

	Marinade Types									
	Guinea Fowl					*Spent Layer*				
Parameters	Oc	Os	Ow	Od	SEM	Oc	Os	Ow	Od	SEM
Doneness	5.68	5.59	5.28	5.29	0.38	5.46	5.05	5.26	5.36	0.38
Tenderness	5.57	5.32	5.18	5.04	0.39	5.32	4.99	5.21	5.22	0.39
Aroma	4.72	4.94	5.01	4.85	0.40	4.98	4.60	4.94	5.06	0.40
Taste	4.48	5.34	5.10	5.03	0.39	4.81	4.66	5.05	5.41	0.39
Colour	6.20^{a}	4.48^{b}	4.58^{b}	3.84^{b}	0.39	6.06^{a}	4.22^{b}	4.66^{b}	4.67^{b}	0.39*
Acceptability	5.43	5.41	5.10	4.92	0.40	5.44	4.66	5.15	5.27	0.40

^{ab} means within rows having different superscripts differed significantly (P<0.05), SEM = Standard error of mean, Oc = Control Nothing added, Os = *Ocimumgratissimum* + salt, Ow = *Ocimumgratissimum* + wet marinade, Od = *Ocimumgratissimum* + dry spice

Main effect of marinade on bacterial count of meat Jerky from two poultry species

Table 6 shows the result of main effect of the marinade on the microbial load of the two poultry species. The result of the TVB obtained in this study is within the acceptable range (10^4 to < 10^6) while coliform count is within the acceptable range (10^2 to < 10^4). The meat product obtained in this study was fit and safe for consumption. Higher TVB and coliform counts obtained in Oc could be attributed to non-addition of *O. gratissimum* extract as a marinade since the inclusion or the addition of materials with anti-microbial capabilities such as *O. gratissimum* and salt etc (7), aid in reducing the overall microbial count. In this study Os had the lowest microbial content in both spent layer and guinea fowl. "Essential oils of *O. Gratissimum* are probably responsible for its reported antimicrobial activity against path*oge*nic strains of Gram positive (*S. aureus, Bacillus spp*.) and Gram negative bacteria (*E. coli, P. aeruginosae, S. typhi, K. pneumoniae, P. mirabilis*) and a path*oge*nic fungus *C. albicans*, it was found to be active against all the bacterial strains **(31)** .

Table 6: Main effect of marinade on bacterial count of meat Jerky from two poultry species

Parameters	Guinea Fowl		Spent Layer	
	Viable Bacteria Count (10^5)	Coliform Count (10^3)	Viable Bacteria Count (10^5)	Coliform Count (10^3)
Oc	3.4^a	3.5^a	3.5^a	3.6^a
Os	0.7^d	1.9^c	1.4^c	1.0^c
Ow	3.1^b	3.3^b	2.0^b	2.7^b
Od	2.7^c	3.2^b	1.9^b	2.6^b
SEM	0.07	0.07	0.07	0.07

^{abcd} means within columns having different superscripts differed significantly (P<0.05), SEM = Standard error of mean, Oc = Control Nothing added, Os = *Ocimum gratissimum* + salt, Ow = *Ocimum gratissimum* + wet marinade, Od = *Ocimum gratissimum* + dry spice

Correlation of organoleptic properties of meat Jerky

The result of correlation of organoleptic properties is presented in Table 7. The results show significantly (P<0.05) high correlation in this study. The correlation value for doneness against aroma, taste, colour and acceptability were 0.50, 0.55, 0.37 and 0.59, respectively. The values for aroma were 0.67, 0.43 and 0.64 against taste, colour and acceptability, respectively. The values obtained for taste were 0.38 and 0.74 when it was correlated with colour and acceptability while the value for colour was 0.52. It shows that as doneness increases other variables (aroma, taste, colour and acceptability) increases. This indicates that as one variable improves, the others improve too (32).

Conclusion

The following conclusions were made from the results of the study.

i. *The* antimicrobial capability of *O. gratissimum* extract was responsible for poultry jerky which had the Total viable bacteria and Coliform count

Table 7: Correlation of organoleptic properties of meat jerky

	Doneness	Aroma	Taste	Colour	Acceptability
Doneness	1				
Aroma	0.50*	1			
Taste	0.55*	0.67*	1		
Colour	0.37*	0.43*	0.38*	1	
Acceptability	0.59*	0.64*	0.74*	0.52*	1

*Correlation is significant (P<0.05)

within an acceptable range thus increasing the shelf life of meat products.

ii. The use of *O. gratissimum* extract showed no-significant effect on organoleptic properties (doneness, tenderness, aroma, taste and acceptability) of the poultry jerky but significantly affected the colour.

Recommendations

Based on the findings of this research work the following recommendations were made:

i. Ocimum. *gratissimum* can be used to preserve meat.

ii. The production of jerky from meat will serve as a means of adding value, providing an added market and also as an alternative to meat glut during festive seasons

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