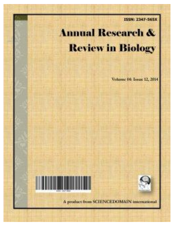

Annual Research & Review in Biology

30(1): 1-8, 2018; Article no.ARRB.45672
ISSN: 2347-565X, NLM ID: 101632869

Consumer Preferences, Carcass Characteristics and Sensory Evaluation of Meat of Four Guinea Fowl Genotypes in the Transitional Zone of Ashanti Region, Ghana

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Authors' contributions

This work was carried out in collaboration between all authors. Author EA designed the study, performed the statistical analysis, wrote the protocol, and wrote the first draft of the manuscript. Authors SYA and WKJK managed the analyses of the study. Author EDA managed the literature searches. All authors read and approved the final manuscript.

Article Information

DOI: 10.9734/ARRB/2018/45672
Editor(s):
(1) Dr. Xiao-Xin Yan, Professor, Department of Anatomy & Neurobiology, Central South University Xiangya School of Medicine (CSU-XYSM), Changsha, China.
(2) Dr. George Perry, Dean and Professor of Biology, University of Texas at San Antonio, USA.
Reviewers:
(1) Cristina El Mahdy, University of Agricultural Sciences and Veterinary Medicine Cluj-Napoca, România.
(2) Yi-Yu Zhang Key, Guizhou University, China.
Complete Peer review History: http://www.sciencedomain.org/review-history/27984

Original Research Article

Received 25 September 2018
Accepted 11 December 2018
Published 28 December 2018

ABSTRACT

This study was conducted to investigate the effects of Guinea fowl genotype on consumer preferences, carcass characteristics and sensory attributes of meat in Ghana. The study was divided into 3 phases, where phase one consisted of sales of a total of 82 Guinea fowls made up of Pearl, Lavender, Black and White and the administration of questionnaires to consumers, retailers, producers and processors in one Municipal (Asante Mampong) and one district (Ejura/sekere dumase district) in Ashanti Region. The second phase involved the slaughter of 16 male Guinea fowls consisting of 4 each of the genotypes for carcass and biochemical analysis. The third phase entailed determination of sensory attributes of cooked meat samples from the four genotypes. Phase two and three were carried out at the Poultry Unit of the Department of Animal Science. Data were analyzed using Microsoft Excel 2007 for consumer preferences and Genstat Release 11.1

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(Windows) for carcass and sensory analysis. The study revealed that Guinea fowl genotypes are preferred based on availability. The Pearl genotype was the most preferred. At 32 weeks of age, body weight was significantly ($p<0.05$) higher in Lavender, White and Black genotypes. Breast weight was significantly ($p<0.05$) highest in the White genotype. The Lavender recorded significantly ($p<0.05$) higher drumstick weight. On the other hand, the Black had significantly ($p<0.05$) higher thigh weight whiles Wing weight was significantly ($p<0.05$) higher in Pearl, Lavender and Black genotypes. Empty gizzard weight was significantly ($p<0.05$) highest in Pearl with the least in White. There were no differences in biochemical properties and sensory attributes of meat of genotypes except for raw meat samples where significant ($p<0.05$) difference was observed between genotypes. This study concludes that, all the genotypes could be preferred by consumers if made available and that the Pearl could perform much better if improved upon. Breeders should therefore improve upon the Pearl and also concentrate on the production of the White, Lavender and Black Guinea fowls for commercial production. Sustainability of these genotypes will also be achieved to prevent extinction as these are not as common as the Pearl. Further research to elucidate comparable advantage of any one of the genotypes is suggested to give major attention to the specific one.

Keywords: Product quality; primal cuts; commercial production; biochemical properties; sensory attributes.

1. INTRODUCTION

Guinea fowls have unique ability to free range and resist parasitic infestations than the domestic chicken [1]. Guinea fowls are noted for their hardiness and vigorous nature, excellent foraging and scavenging properties and relatively higher level of tolerance for hash climatic conditions [2].

Guinea fowls are raised solely for their meat and eggs which serve as supplementary protein source to other animal species. The birds are very influential in food security of farm family, and provide employment for most rural communities [3]. These birds are exclusively used by Dagombas and Gonjas for their annual festivals, for sacrifices (the white breed especially) and for performing certain funeral rites. The Frafras, Dagabas and Bulsas also use the Guinea fowl to welcome their mother-in-laws [4].

The indigenous Guinea fowl is one of the promising species of poultry on which limited studies has been carried out on its production, consumer preferences and carcass characteristics [5-7].

Commercialization of Guinea fowl on the African continent is still in its infancy [8]. Raising Guinea fowls on free range under subsistent farmers is on the increase due to lack of good quality day-old keets for commercial production. Setting up commercial Guinea fowl enterprises in the country is therefore not encouraging because of its low productivity [9]. According to [10], large-scale commercial Guinea fowl production has not been possible due to lack of genetically improved source of good quality day old keets to be distributed to farmers by breeders. Several stakeholders are into promoting sustainable Guinea fowl production which demands lots of appropriate information on best practices for a profitable Guinea fowl production [9]. To effectively carry out commercial Guinea fowl production, there is need to investigate the genotypes most preferred by consumers.

This study, therefore seeks to determine the best Guinea fowl genotypes most preferred by consumers amongst Pearl, Lavender, White and Black for commercial production.

2. MATERIALS AND METHODS

2.1 Experimental Location

The study was conducted in two Municipalities in the Ashanti Region of Ghana (Mampong and Ejura) and at the Poultry Unit of the Animal Science department, University of Education, Winneba, Ashanti-Mampong campus, Ghana.

Ashanti Region is found in the middle part of Ghana. It is located between longitude 0º 15'W – 2 º15' W and latitudes 6ºN-7 º30'N of the equator [11]. The Region has a population of 4,780,380 representing the highest proportion (19.4%) of the total population of 24,658,825 in Ghana as at 26th September, 2010. The Region lies in the Southern half of the country and occupies 24,389 square kilometers (10.2%) of the total land of

Ghana. after Northern and Brong Ahafo Regions, in terms of land area; it is the third largest in the country [12].

Mampong-Ashanti is located at the North-Eastern part of the Ashanti Region. Geographically the area is within the transitional zone lying between the Guinea Savannah in the North and the Rain Forest in the south. Mampong Ashanti lies on latitude 07˚ 03' N and longitude 01˚ 24'W on an altitude of 289.7m above sea level [13]. It has a total area of 2,345 km^2 with a population of 39,732 people. The rainfall pattern is bimodal, with the major rainfall season occurring from March to July with 1000 mm of rainfall while the minor season occurs from September to November with 350 mm of rainfall [13]. The average daily temperature is between 25°C and 30°C and the average relative humidity of the area is 91.5%.

Ejura has a total area of 1,252 km^2 with a settlement population of 70,807 people. Ejura is in the far north of the region, near the Afram Rivers and connected by highways with the towns of Mampong, Yeji and Techiman [14].

2.2 Experimental Birds and Design

A total of one hundred and one (101) birds, made up of Pearl, Lavender, White and Black genotypes were randomly selected from a population of 500 from the Animal Science Farm. The birds were raised for 32 weeks, where they were fed on starter diet containing 22% crude protein and 2950 kcal/kg metabolizable energy. The grower diet contained 20% crude protein and 2800 kcal/kg metabolizable energy and the finisher diet contained 17.5% crude protein and 2780 kcal/kg metabolizable energy. Water was also provided *ad libitum.*

2.2.1 Consumer preferences for Guinea fowl genotypes

The simple random technique was used to select respondents for interview in the market and at homes. The face-to-face interview method was employed using structured questionnaire to obtain important responses from consumers. A total of one hundred respondents, made up of consumers, retailers, producers and processors were used. To determine consumer preferences, a total of 82 Guinea fowls made up of Pearl (34), Lavender (25), White (18) and Black (5) were sold depending on their availability during market days and at vantage places in both communities in December.

2.2.2 Sensory evaluation of meat of four Guinea fowl genotypes

Meat samples for evaluation from various genotypes were evaluated in December at the Poultry Unit. Sensory attributes and terms were clearly defined and explained to participants. Ten (10) panelists made up of Guinea fowl consumers, consisting of 5 females and 5 males within the age range of 33 and 53 years from the University of Education, Winneba, Mampong-Ashanti campus were trained according to the guidelines for sensory evaluation of meat samples of the [15], using descriptive analysis technique [16]. Five attributes taken into consideration included: colour, aroma, juiciness, flavour and tenderness. Table: 1 gives the definitions and scale used for scoring in the evaluation.

The breast muscles with skin removed were taken from raw samples of Pearl, Lavender, White and Black Guinea fowls and were frozen overnight at a temperature of -20°C. The breast muscles were cooked for 30 minutes after a core temperature of 100°C using a gas stove. Meat samples were cooked in equal quantity of water (600 ml) and salt (3 g).

Meat samples were coded with a three-digit random code. Cooked samples were cut into 2 cmx2 cmx2 cm squares cubes whiles still warm and immediately wrapped in aluminium foil and then served in plates. Each sample was replicated three times, making a total of twelve samples. Panelists went round a served table and tasted meat samples and gave their scores in the score sheet provided. Voltic mineral water at room temperature was provided to panelists who cleaned their palates between samples. Colour was assessed on freshly cut crossed-sections of meat samples.

2.2.3 Carcass characteristics of four Guinea fowl genotypes

A sample size of Four (4) each of the various genotypes were randomly selected for slaughter to determine the proportion of body components for carcass studies. Separation of carcass into Breast, head, neck, drumstick, shank, thigh, wing and giblets (liver, heart, intestines, gizzard and crop) were done. Joint drumstick and thigh separation was done by a cut starting above the

Table 1. Definition of attributes used in the sensory analysis of meat of different Guinea fowl genotypes

Attribute	Verbal definition	Scale assigned
Aroma	The intensity of Guinea fowl aroma after taking a few short sniffs as the foil is removed	Very weak (1),Weak (2), Intermediate (3), Strong (4), very strong(5)
Flavour	The intensity of the Guinea fowl flavour (combination of taste and swallowing)	Very good (1),Good (2), Intermediate (3),Fair (4), Weak(5)
Juiciness	Impression formed after the first two to three chews between the molar teeth OR perception of water content in the sample after 3,4 chewings	Very juicy (1),Juicy (2), Intermediate (3), Dry (4), Very dry(5)
Tenderness	The impression of tenderness after two to three chews between the molar teeth OR Time and number of chewings required to masticate the sample ready for swallowing.	Very tender (1),Tender (2), Intermediate (3), Tough (4), Very tough(5)
Colour	Appearance of meat samples	Very pale (1),Pale (2), Intermediate (3), Dark (4), Very dark(5)

Source: [5]; [17]

thigh, stretching towards the acetabulum and ending behind the pubis (the pelvic-thigh cut). The drumstick-thigh separation was then performed by a cut vertical to the joint between the drumstick and thigh bones. The wings were separated from the carcass through shoulder cut going along the joint (articulatory) regions of shoulder blade and the raven bone. The breasts were separated by a cut vertical to the ventral joint rib region (rib cut). This part was used for sensory evaluation and laboratory analysis.

Meat samples were assayed for moisture%, ash%, protein%, fat%, carbohydrates%, pH, energy KJ and cholesterol% at the Biochemistry Laboratory of the Department of Kwame Nkrumah University of Science and Technology, Kumasi Birds were withdrawn from feed at 24 hours before slaughter. Each live bird was weighed with an electronic scale (kitchen scale) and given identification tags to differentiate them especially during scalding and removal of feathers. The birds were then stuck with a sharp knife to cut the jugular veins and were allowed to bleed for about 60 seconds, after which they were scalded in warm water ($70^{O}C$). Manual plucking of feathers was done and viscera organs were removed at the vent area through an incision. Guinea fowls were re-weighed after evisceration to obtain carcass weight. The live weight and carcass weight were determined before separation, to determine the dressing out percentage of birds, which is expressed as; $= \frac{\text{carcass weight}}{\text{live weight}} \text{ x } 100$

2.3 Data analysis

Responses from questionnaire and sale of Guinea fowls were collated and sorted out according to the answers given using Microsoft Excel 2007 for analysis, which was to generate descriptive statistics for the various parameters measured. The Generalized Linear Model procedure of GENSTAT Release 11.1(Windows) was also used to analyze the sensory evaluation and carcass characteristic data. Where significant ($P<0.05$) difference existed between means, the Least Significance Difference (LSD) method was used to separate the means.

The univariate model was used in the sensory analysis and is stated as:

$$Y^{k}ijm = \mu^{k} + \alpha^{k}_{i} + v^{k}_{j} + \delta ij + e^{k}ijm.$$

Where $Y^{k}ijm$ = score of assessor i on attribute k of the r^{th} replicate of the j^{th} product: μ^{k} =grand mean for the attribute k: α^{k}_{i} = differences in scoring level between assessors (assessor main effect): v^{k}_{j} = differences between the average scoring for the different product(main product effect): δij = differences between assessors in measuring differences between products (the assessor-product interaction): $e^{k}ijm$= residual variation due to replicates (error term)

3. RESULTS AND DISCUSSION

3.1 Consumer Preferences for Different Guinea Fowl Genotypes

Consumer preferences for Guinea fowl genotype are influenced by factors such as availability and plumage colour. One hundred percent of consumers preferred the Pearl because of its commonest. The Black genotype was the least preferred because it was considered to resemble a vulture.

3.2 Genotypic Effects on Carcass Characteristics

There were significant (p<0.05) differences in body weight at age 32 weeks among genotypes (Table 2). The Lavender, White and Black had significantly (p<0.05) higher body weight than the Pearls. Similarly, Lavender and Black had significantly (p<0.05) higher bled weight than the White and Pearl. However, the former had higher bled weight than the latter. With regards to defeatherd weight, the Lavender was significantly (p<0.05) higher than their counterparts, the White was equally higher (p<0.05) than Pearl but no differences was recorded between White and Black. This means that the Lavender had better performance than the rest of the genotypes.

The results in this study is in line with that of [18] who reported highest body weight gain in White followed by Lavender and then Pearl. According to [19], breed does not have any effect on the amount of blood that oozes from birds, which means report contradicts the results obtained in this study.

3.3 Effects of Genotypes on Some Primal Cuts

Guinea fowl genotype had significant (p<0.05) influence on breast weight, drumstick weight and thigh weight (Table 3). The White genotype had significantly (p<0.05) higher breast weight than the Black and Pearl. The Black equally recorded significantly (p<0.05) higher than the Pearl but no differences were recorded between Lavender, White and Black genotypes. In a similar trend, the White had significantly (p<0.05) higher head weight whiles Pearl had the least. Drumstick weight was significantly highest in Lavender than the White, Black and Pearl genotypes. The White and Black were significantly (p<0.05) higher than the Pearl but no differences were observed between the former and the latter. However, the Black genotype recorded significantly (p<0.05) higher thigh weight than the White, Lavender and Pearl but no differences were recorded between the former, middle and latter. Differences in weight may be attributed to genetic make-up of birds. The results in this study is similar to [20] who reported similar findings in primal cut weights between male Pearl Grey and Royal Purple Guinea fowls.

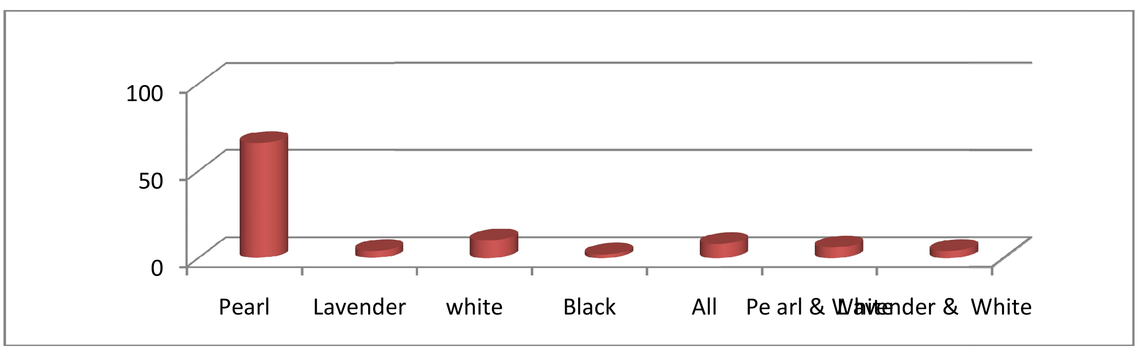

Fig. 1. Consumer preferences for different Guinea fowl genotypes

Table 2. Effects of genotypes on carcass characteristic

Parameter	Pearl	Lavender	White	Black	SEM	P-value
Live body weight (g)	1396^b	1496^a	1469^a	1484^a	23.45	0.01
Bled weight (g)	1188^c	1274^a	1208^b	1256^a	16.63	0.03
Defeathered weight (g)	1087^c	1160^a	1125^b	1140^{ab}	11.69	0.02
Dressed weight (g)	992	1064	1027	1042	25.94	0.11
Dressing %	71.50	72.80	70.50	70.80	1.780	0.59

^{abc} Means bearing different superscripts in the same row are different at p<0.05.
SEM= standard error of means

Table 3. Effects of genotypes on some primal cuts

Parameter	Pearl	Lavender	White	Black	SEM	P-value
Breast weight(g)	248^{c}	270^{ab}	276^{a}	266^{b}	4.12	0.01
Head weight(g)	34.80^{d}	38.80^{b}	39.80^{a}	35.50^{c}	0.2769	0.01
Neck weight(g)	53.50	57.50	63.00	64.00	4.14	0.10
Drumstick weight(g)	47.80^{c}	55.80^{a}	52.50^{b}	52.80^{b}	1.375	0.03
Shank weight(g)	12.25	12.25	13.75	13.00	0.718	0.19
Thigh weight(g)	67.00^{b}	66.80^{b}	69.00^{b}	73.00^{a}	1.781	0.03
Wing weight(g)	64.00^{a}	65.20^{a}	57.20^{b}	65.50^{a}	1.034	0.01

^{abcd} Means bearing different superscripts in the same row are different at p<0.05.
SEM= standard error of means

Table 4. Effects of genotypes on giblet parameters

Parameter	Pearl	Lavender	White	Black	SEM	P-value
Liver weight(g)	16.50	15.80	18.80	16.00	0.731	0.59
Heart weight(g)	6.75	7.50	9.75	8.25	1.701	0.09
Intestine weight(g)	37.80^{b}	37.50^{b}	35.80^{c}	41.80^{a}	1.108	0.04
Empty gizzard weight(g)	28.00^{a}	24.20^{c}	20.20^{d}	26.20^{b}	0.949	0.01
Crop weight(g)	10.00	7.75	9.25	8.25	0.64	0.17

^{abc} Means bearing different superscripts in the same row are different at p<0.05.
SEM= standard error of means

3.4 Effects of Genotype on Giblets Parameters

Total intestine weight was significantly (p<0.05) higher in Black than their counterparts Pearl, Lavender and White (Table 3). The White was significantly (p<0.05) higher than the Pearl and Lavender but no differences were observed between the former and the latter. However, Empty gizzard weight was significantly (p<0.05) highest in Pearl, followed by Black, Lavender and White. Variations in carcass weights may be due to factors such as: management conditions, study locations, dietary treatments and age at slaughter of birds [21]; [22].

3.5 Genotypic Effects on Biochemical Properties of Carcass

No significant (p>0.05) differences were recorded between genotypes for biochemical parameters measured (Table 4).

Results from this study did not agree with the findings of [23] who recorded significant differences on meat composition between Guinea fowl genotypes. It is believed that genetic progress, although beneficial, have put more stress on the growing bird resulting in histological and biochemical modifications of the muscle tissue that are presumed to have affected some of the meat quality traits [22].

Table 5. Mean Biochemical values of different Guinea fowl genotypes

Genotype/ Parameter	Pearl	Lavender	White	Black	SEM	P-value
Moisture %	72.46	72.15	72.39	72.63	0.26	0.644^{NS}
Protein %	22.72	22.88	22.45	22.29	0.25	0.561^{NS}
Fat %	0.82	0.79	0.98	0.86	0.17	0.861^{NS}
Ash %	1.00	1.10	1.11	1.09	0.10	0.846^{NS}
Carbohydrate %	3.00	3.08	3.07	3.13	0.09	0.817^{NS}
pH	4.33	4.30	4.36	4.31	0.09	0.961^{NS}
Energy KJ	456.80	457.30	463.00	460.00	8.24	0.944^{NS}
Cholesterol %	2.18	2.28	2.26	2.32	0.10	0.781^{NS}

^{NS}: Non-significant difference, SEM= standard error of means

Table 6. Sensory attributes means of different Guinea fowl genotypes

Genotype/ Attribute	Pearl	Lavender	White	Black	SEM	P-value
Colour	2.00^{c}	2.70^{b}	3.70^{a}	2.20^{c}	0.15	<.001*
Aroma	2.80	3.00	3.40	3.20	0.22	0.284^{NS}
Juiciness	2.90	3.00	2.70	2.80	0.24	0.823^{NS}
Flavour	2.70	2.30	2.40	2.10	0.23	0.323^{NS}
Tenderness	2.30	3.00	2.40	2.90	0.26	0.158^{NS}

^{abc} Means bearing different superscripts in the same row are different at p<0.05.
SEM= standard error of means

3.6 Genotypic Effects on Sensory Characteristics of Meat

Table 5 shows the mean values for the sensory attributes of four Guinea fowl genotypes. Descriptive sensory evaluation was analyzed using the randomized block design, where panelists were considered as blocks.

3.7 Sensory Attributes

Genotype had significantly ($p<0.05$) affected raw meat colour of birds (Table 5). The White (between intermediate and dark) differed significantly from Lavender, Pearl and Black. The Lavender (between pale and intermediate) also differed significantly from Pearl and Black but no differences was recorded between the former and the latter. According to [24], meat colour is an important indicator of quality of fresh or cooked meat. The appearance of meat influences its acceptance by consumers. Variation in poultry meat colour may be affected by factors such as bird age, sex, strain, diet, intramuscular fat, meat moisture content, pre-slaughter conditions and processing variables. The present study suggests that meat colour variation could occur as a result of strain effect since genetically the White Guinea fowl has a darker meat colour than Pearl, Lavender and Black.

4. CONCLUSION

Results from various genotypes under study indicated that the Pearl was most preferred because of its commonest. However, the Lavender performed better in terms of body weight gain, heavy primal cuts and giblet weights. The study therefore, recommends that Breeding technologies be adopted to improve upon the Pearl. Breeders should also concentrate on the production of the White, Lavender and Black genotypes for commercial production to prevent extinction. Further research to elucidate comparable advantage of any one of the genotypes is suggested to give major attention to the specific one.

ETHICAL APPROVAL

All authors hereby declare that "Principles of laboratory animal care" (NIH publication No. 85-23, revised 1985) were followed, as well as specific national laws where applicable. All experiments have been examined and approved by the appropriate ethics committee"

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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Peer-review history:
The peer review history for this paper can be accessed here:
http://www.sciencedomain.org/review-history/27984