

Research Article



Comparison of Carcass Characteristics and Meat Quality of Goliath Chickens to Local and Cobb 500 Chickens

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Abstract | Carcass composition and meat quality vary between species and within species vary by breed. The objective of the study was to compare the carcass and meat quality characteristics of Goliath chickens recently developed by farmers with those of local chickens and exotic chickens commonly found in Benin. Thus, data on carcass characteristics, and sensory meat quality were collected on 120 chickens divided into four groups: (1 and 2), each composed of 20 males and 20 females Goliath chickens, group 3 was composed of local chickens (10 males and 10 females) and group 4 was composed of 20 Cobb 500 broilers. These birds were reared in intensive system (IS) and free-range system (FS). Groups 1 and 4 were reared in confinement and slaughtered at 12 weeks of age and 8 weeks of age, respectively; groups 2 and 3 were reared in free-range and slaughtered at 20 weeks of age. The slaughter ages were chosen according to farmers' practices. For the confinement-raised birds, Cobb 500 had the highest averages of live weight, hot carcass weight, cold carcass weight, breast weight, wing weight, and thigh-to-drumstick weight, and the highest carcass yield and proportion of breast ($P < 0.001$). The Cobb 500 have whiter meat. Based on the sensory characteristics, the meat of Goliath was more tender than Cobb 500. The muscle of local chickens was more reddish and yellowish than that of the Goliath ($P < 0.001$). The meat of Goliath chicken was rated higher than that of the locals by panelists. Regardless of farming methods, the meat of Goliath chickens was accepted and appreciated by the panelists.

Keywords | Chicken, Breed, Farming method, Carcass, Meat, Benin

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INTRODUCTION

In 2018, global chicken meat production was estimated at 114,267 tons of meat, with a national production of 15 tons in Benin (FAO, 2020) for a population of 11,362,269 (INSAE, 2020). This production is largely provided by local chickens that are better appreciated by consumers but whose availability is below demand (Tougan, 2013, Youssao et al., 2013). To remedy this problem, stakeholders in the poultry industry have selected the Goliath chicken,

which has experienced great growth since 2006, the year of its revelation thanks to its vulgarization by the Ministry of Livestock, Agriculture and Fisheries. Although the growth of this chicken is appreciated by the breeders, little information is available on the characteristics of the carcass and the quality of the meat of this chicken. For a better appreciation of the quality of this meat, two studies were carried out on the characteristics of the carcass and the quality of the meat of these chickens. The first study took into account the age effect (Ahokpossi et al., 2023a) as a factor of

variation and the second evaluated the effect of the rearing method (Ahokpossi et al., 2023b) on carcass characteristics and meat quality. The results of these two studies showed that Goliath chickens, whether raised in confinement or the wild, have a lump of meat that is generally appreciated by farmers and consumers. Considering the genetic diversity of poultry raised in Benin, what will then be the assessment of the Goliath chicken in terms of meat quality among the poultry resources frequently raised in Benin. The objective of the study was to compare the carcass and meat quality characteristics of Goliath chickens recently developed by farmers with those of local chickens and exotic chickens frequently found in Benin.

MATERIALS AND METHODS

ETHICAL APPROVAL

The animals were raised and slaughtered in accordance with the requirement of the Ethic Committee in production and animal health following the reference No. 025/LBATV/LARBA/EPAC/UAC dated 04 October 2021 of Laboratory of Animal Biotechnology and Meat Technology of the University of Abomey-Calavi.

MATERIAL

The biological material used in this study consisted of 80 Goliath chickens (40 males and 40 females); 20 local chickens (10 males and 10 females) and 20 broilers (Cobb 500).

Study Area: The Goliath chickens used in this study were raised in southern Benin, more precisely in the Poultry Experimental Unit of the Laboratory of Animal Biotechnology and Meat Technology of the Polytechnic School of Abomey-Calavi of the University of Abomey-Calavi. This farm is located in the commune of Abomey-Calavi, Togba district in the Agori district, at 6°42'6" North longitude and 2°32'4" East latitude. The commune of Abomey-Calavi is bordered to the North by the commune of Zè, to the South by the Atlantic Ocean, to the East by the communes of So-Ava and Cotonou and to the West by the communes of Tori-Bossito and Ouidah. It has an area of 539 km² and a population of over 656,358 inhabitants in 2013 (INSAE, 2016). The climate is subequatorial with 2 rainy seasons and 2 dry seasons. The major rainy season begins in April and ends in July. Then comes the short dry season which lasts from August to mid-September. It is followed by the short rainy season from September to the beginning of November. The long dry season lasts from the beginning of December to March.

METHODS

Animal rearing: The Goliath chicks used in this study come from a core group of breeders acquired from Goliath chicken breeders in southern Benin. The local chicks

were obtained from a locally brooded female breeders and the Cobb 500 were acquired from VETO PLUS, an approved company which deals in the distribution of day-old chicks. Two rearing methods were employed: the intensive rearing system (IS) in which 20 males and 20 females Goliath chickens (group 1) were reared until 12 weeks of age and 20 Cobb 500 (group2) were reared until 8 weeks of age. The birds had free access to feed and water. These birds were vaccinated against Newcastle disease, Gumboro disease and were treated against internal and external parasites. The free-range system (FS) comprised two groups, 20 males and 20 females Goliath (group 3) and 20 locals (group 4). In this rearing method, the birds were left to scavenge for feed throughout the day. The birds in the free-range method were reared for 20 weeks. These ages were chosen according to the age at slaughter of each breed in Benin.

Carcass characteristics and meat quality: The slaughter procedure, determination of chicken carcass characteristics, measurement of pH measurement of chicken flesh color, determination of water holding capacity and evaluation of sensory characteristics of chicken meat were done according to the methodology described by Ahokpossi et al. (2023). The pH meter used for this purpose is a HANNA portable pH meter which was previously calibrated with two pH standards, at pH 4 and 7, according to the procedure described by the manufacturer (HANNA Instruments R, Italy). Similarly the Kornica Minolta CR 400 chromameter was used

STATISTICAL ANALYSES

Data were collected by rearing method (confinement and scavenging). For each rearing method, the breed type was used as a factor of variation. The mean and standard deviations of the variables studied were calculated and compared by the student's t-test.

RESULTS

CARCASS CHARACTERISTICS OF GOLIATH, LOCAL AND COBB 500 CHICKENS

The characteristics of the different types of chickens are presented in Table 1. In confinement, the Cobb 500 had a higher body weight than the Goliaths ($P < 0.001$). The same was true for other carcass parts and performance ($P < 0.001$). In free range, the Goliath chickens had significantly higher live weight and carcass weight compared to the locals ($P < 0.001$). But no difference was observed between the yield of the breasts ($P > 0,05$).

VARIATION IN pH OF MEAT FROM GOLIATH, LOCAL AND COBB 500 CHICKENS

In confinement, the average pH₁(6.37) and pH_u (5.95) of

Table 1: Carcass characteristics of Goliath, local and Cobb 500 chickens

Parameters	Goliath 12 w (mean ± SD)	Cob 500 (mean ± SD)	Significance test	Goliath 20w f-r (mean ± SD)	Local (mean ± SD)	Significance test
weight (g)	1359.9 ± 247.92b	2182.2 ± 136.34a	***	1581.3 ± 280.90a	752.8 ± 73.31b	***
Carcass h (g)	854.7 ± 190.68b	1661.9 ± 108.33a	***	1083.0 ± 224.19a	480.4 ± 78.48b	***
Carcass c (g)	843.8 ± 192.38b	1652.9 ± 105.54a	***	1067.0 ± 230.02a	476.4 ± 76.88b	***
Breast (g)	188 ± 38.52 b	518 ± 57.54a	***	247.4 ± 62.21a	111.1 ± 22.59b	***
Wings (g)	130.6 ± 33.30 b	185.9 ± 20.81a	***	171.7 ± 37.37a	60.9 ± 12.48b	***
Thigh-drumstick (g)	297.2 ± 73.91b	494.2 ± 39.00a	***	339.6 ± 76.16a	147.5 ± 29.59b	***
Carcass h (%)	62.52 ± 4.86b	76.15 ± 1.31a	***	68.25 ± 3.74	63.65801 ± 6.44	NS
Carcass c (%)	61.66 ± 4.29b	75.75 ± 1.61a	***	67.20 ± 4.59	63.13539 ± 6.28	NS
Breast (%)	22.10 ± 1.11b	31.12 ± 2.06a	***	22.74 ± 2.42	23.12454 ± 2.25	NS
Thigh-drumstick (%)	15.28 ± 1.85b	11.22 ± 1.45a	***	15.90 ± 1.77a	12.67 ± 1.70b	***

12 W: 12 weeks; 20 W: 20 weeks; Carcass h: Carcass hot; Carcass C: Carcass cold; f-r: free-range; ***: P < 0.001; NS: P > 0.05; Means in the same row followed by different letters differ significantly at the 5% level

Table 2: pH of Goliath, local and Cobb 500 meat.

Parameters	Organs	Goliath 12w (mean ± SD)	Cob 500 (mean ± SD)	Significance test	Goliath 20 w (mean ± SD)	Local (mean ± SD)	Significance test
pH1h	Breast	6.37 ± 0.11a	5.46 ± 0.11b	***	5.43 ± 0.17	5.41 ± 0.31	NS
	Thigh-drumstick	6.49 ± 0.08a	5.74 ± 0.15b	***	5.44 ± 0.10	5.41 ± 0.19	NS
pHu	Breast	5.95 ± 0.07a	5.3 ± 0.18b	***	5.16 ± 0.09b	5.07 ± 0.12a	***
	Thigh-drumstick	6.23 ± 0.12a	5.62 ± 0.18b	***	5.22 ± 0.21	5.24 ± 0.34	NS

12 W: 12 weeks; 20 W: 20 weeks; ***: P < 0.001; NS: P > 0.05; Means in the same row followed by different letters differ significantly at the 5% level

Table 3: Water holding capacity of Goliath, local and Cobb 500 chicken meat.

Variables	Organs	Goliath 12 W (mean ± SD)	Cob 500 (mean ± SD)	Significance test	Goliath f-r (mean ± SD)	Local (mean ± SD)	Significance test
Drip loss (%)	Breast	3.48±4.45	1.68±1.51	NS	1.48 ± 0.84	2.02 ± 0.84	NS
	Thigh-drumstick	4.11±2.00a	1.67±1.27b	**	2.470±0.75	1.74±0.75	NS
Cooking (%)	Breast	18.41±12.51b	34.43±4.71a	**	30.83 ± 0.94	29.99 ± 0.94	NS
	Thigh-drumstick	26.17±5.07	27.95±8.85	NS	27.71±1.13	27.63±1.13	NS
WHC (%)	Breast	21.89±5.97b	36.12±12.32a	**	32.31 ± 1.33	32.01 ± 1.33	NS
	Thigh-drumstick	30.29±5.82	29.23±8.15	NS	30.18±1.19	29.37±1.19	NS

12 W: 12 weeks; 20 W: 20 weeks; **: P < 0.01; ***: P < 0.001; NS: P > 0.05; Intra-class means in the same row followed by different letters differ significantly at the 5% threshold

Table 4: Meat color parameters of local Goliath and Cobb 500 chickens

Variables	Organs	Goliath12 W (mean ± SD)	Cob 500 (mean ± SD)	Significance test	Goliath 20 W (mean ± SD)	Local (mean ± SD)	Significance test
Breast	L*	53.08±3.02	52.44±4.01	NS	55.18±2.71	57.50±4.17	NS
	a*	5.25±1.49a	3.71±1.62b	*	5.22±1.55	5.84±2.22	NS
	b*	5.38±1.05a	2.01±1.34b	***	4.85±2.79b	10.84±1.82a	***
	c	7.64±1.44a	4.36±1.80b	***	7.40±2.94b	12.43±2.28a	***
	h	0.78±0.12a	0.50±0.25b	**	0.69±0.23b	1.08±0.14a	***
Thigh-drumstick	L*	47.94±2.58	48.13±3.23	NS	46.17±3.79	44.49±5.78	NS
	a*	15.29±2.75	13.88±2.35	NS	16.78±2.12	18.66±2.79	NS

b*	10.18±1.98	8.52±1.51	NS	10.11±2.30	10.18±4.72	NS
c	18.43±3.22a	16.30±2.72b	***	7.40 ± 3.38b	12.43 ± 2.27a	***
h	0.58±0.06	0.55±0.03	NS	0.5362 ± 0,10a	0.48 ± 0,15b	***

12 W: 12 weeks; 20 W: 20 weeks; *: P < 0.05; **: P < 0.01; ***: P < 0.001; NS: P > 0.05; Intra-class means of the same line followed by different letters differ significantly at the 5% threshold; L*: Brightness; a*: Red index; b*: Yellow index; c: Chromaticity; h: Hue

Table 5: Variations in sensory parameters of Goliath, local and Cobb 500 chicken meat.

Variables	Organs	Goliath 12 w (mean ± SD)	Cob 500 (mean ± SD)	Significance test	Goliath 20 S f-r (mean ± SD)	Local (mean ± SD)	Significance test
Tenderness	Breast	3.38 ±0.59	3.13±0.63	NS	3.97 ±0.39	3.84 ±0.48	NS
	Thigh-drumstick	3.48±0.60a	2.92±0.69b	**	4.05±0.40	3.85±0.47	NS
Juiciness	Breast	3.12 ±0.40	3.09±0.70	NS	3.68±0.27	3.57±0.52	NS
	Thigh-drumstick	3.17±0.56	3.16±0.58	NS	3.75 ±0.28	3.65±0.57	NS
Flavor	Breast	3.09±0.58	2.94±0.88	NS	3.55±0.31a	2.94±0.81b	**
	Thigh-drumstick	3.08±0.77	2.92±0.95	NS	3.72±0.36a	3.14±0.84b	**
Overall score	Breast	7.00±0.93	6.28±1.61	NS	7.78±0.61	7.26±1.26	NS
	Thigh-drumstick	6.60±1.40	6.44±1.82	NS	8.02 ±0.71a	7.38±1.19b	*

12 W: 12 weeks; 20 W: 20 weeks; *: P < 0.05; **: P < 0.01; NS: P > 0.05; Intra-class means in the same row followed by different letters differ significantly at the 5% threshold

the breast of Goliath chickens were higher than those of Cobb 500 chickens pH1(5.46) and pHu (5.3), and the same was true for the pH1 and pHu of the thigh and drumstick muscle (Table 2). Concerning the free-range birds, only the pHu of the breast of Goliath chickens was significantly (P < 0.001) higher than that of the locals (Table 2).

WATER HOLDING CAPACITY OF GOLIATH CHICKENS COMPARED TO LOCAL AND COB 500 CHICKENS

The results of the evaluation of the water-holding capacity of the Goliath chicken meat compared to that of local chickens and the Cobb 500 are presented in Table 3.

In confinement, the muscle juice loss of the thigh and drumstick assembly of Goliath chickens at draining was significantly higher than that of Cobb 500 (4.11 vs 1.67, respectively) (P<0.001). Contrary to this result, a significantly higher juice loss was observed in the breast muscle of Cobb 500 chickens during cooking than in Goliath chickens (34.43 vs 18.41, respectively). Additionally, the breast muscle of the Goliaths lost less water than that of the Cobb 500. For the chickens raised in free range, no difference was observed between juice loss during draining and cooking.

MEAT COLOR EVALUATION OF GOLIATH, LOCAL AND COB 500 CHICKENS

The color of the breast muscle of the chickens was different according to the breed type (Table 4). In confinement, the values of red index (5.25); yellow index (5.38); chromaticity (7.64) and hue (0.78) of the Goliaths' breast muscle were higher than those of the Cobb 500 (3.71; 2.01; 4.36

and 0.50). In contrast, only chromaticity (18.43 vs. 16.30) of the thigh and drumstick muscle showed a significant difference (p<0.001) with the highest value in the Goliaths. Regarding the chickens reared on the loose, the breast muscles of the local chickens were more yellow with higher chromaticity and hue than those of the Goliaths (Table 4). The same was true for the chromaticity values of the thigh and drumstick muscles (p<0.001).

SENSORY PARAMETERS OF GOLIATH, LOCAL AND COB 500 CHICKENS

In confinement, the tenderness of the muscles of the thigh and the drumstick of the Goliath chickens was higher than that of the Cobb 500 chickens (P<0.01). Apart from this parameter, no significant difference was observed between Goliath and Cobb 500 chickens (P> 0,05) (Table 5). In contrast, a contrary trend was observed between the Goliath and local chicken cuts. The Goliath chickens had a higher tenderness and juiciness and were better appreciated than the local chickens (P<0.01) (Table 5).

DISCUSSION

Carcass quality is the proportion of lean meat or flesh to fatty tissue, bone and viscera (Lebret and Picard., 2015). Under confinement, Cobb 500 broilers had higher live weights, carcass component weights and yield than the Goliath chickens. This higher weight gain observed in the Cobb is justified by the fact that the Cobb 500 are fast-growing broilers that are selected for growth while the Goliaths are a cross between fast-growing broilers and locals that are slow-growing chickens with low weight

at maturity. The choice of the different ages at slaughter is chosen in view of the breeding practices in Benin. Indeed, at 8 weeks of age, Cobb 500 had an average weight of 2182.2 g compared to 776.37 g for Goliaths (a weight at which these animals are not consumed) (Ballogoun et al., 2020; Ahokpossi et al., 2023b). After 8 weeks, raising Cobb 500s is no longer profitable for farmers because the birds will have more abdominal fat deposits, which results in poor meat quality and also causes mortality in these birds. In the free range, Goliath chickens had higher live weight and carcass weight and weights of the different components of the carcass than those of the local chickens, which is explained by the fact that the Goliath is an improved breed of the local chicken in terms of growth performance (AgroBenin, 2017).

Genetic type has an effect on the rate and magnitude of postmortem pH drop (Lebret et al., 2015). In confinement, the variability in pH values observed between Goliath (12 weeks of age) and Cobb500 (8 weeks of age) is due to the muscle mass of the Cobb 500 which is larger and therefore a high amount of glucose which by metabolism gives lactic acid hence the acidity of the muscle on the other hand in Goliath, the muscle mass is not very important with little glucose which is metabolized and thus limits the fall in post mortem pH and therefore an increase in pHu. The low pH values of Cobb 500 compared to Goliath may also be due to the age difference between chickens at slaughter. Tougan et al. (2013) had similar results in local chickens where older birds had the highest pH values. Houéssionon et al. (2020) showed in Barbary ducks that pH changes progressively with age at slaughter. These results are confirmed by the work of Berri et al. (2001) and Le Bihan-Duval et al. (2001) who obtained significant differences in the post-mortem biochemical evolution between different chicken genotypes at equal ages.

Goliath chickens have a better water-holding capacity than exotic chickens in confinement. The juice loss from the thigh and drumstick muscles of Goliath chickens was significantly higher than that of Cobb 500 chickens. On the other hand, when cooked, the breast muscle of the Cobb 500 lost significantly more juice than that of the Goliath chickens slaughtered at 12 weeks of age. This difference can be explained by the high free water content of the Cobb 500 meat, as the accelerated growth observed in exotic chickens is related to the higher water content of their muscle meat compared to slow-growing broilers. Our results are similar to those observed by Debut et al. (2003) and Aksoy et al. (2021) who reported a higher juice loss on draining in slow-growing broilers than in fast-growing broilers and also a higher juice loss on cooking in fast-growing chickens than in slow-growing chickens. In contrast, in confinement, no difference was observed between Goliath

chickens and local chickens raised under the same conditions and slaughtered at the same ages. These observations are contrary to the results of the work of Jaturasitha et al. (2008) who observed the genotype effect on water-holding capacity when studying the carcass and meat of local Thai male chickens compared to improved laying breeds of chickens and their crossbreeds.

The meat color of chickens changes often and depends on the metabolic and contractile characteristics of the muscle (EL Rammouz., 2005). The fresh pectoral muscle has a pale pink color and the thigh muscle shows a slightly dark red color (EL Rammouz., 2005). In claustration, the brevis muscle of Cobb 500 was paler (a^*) than that of Goliath. Yellowing (b^*), chromaticity (c) and hue (h) were also lower. This color difference can be explained by breed type, as Cobb 500 chickens are produced for their meat, which is white, and also by the difference in age at slaughter. This is because as the age of the bird increases, the pigments responsible for the meat become more stable, according to Berri et al. (2007); Baéza et al. (2012) who found that increasing the production age of chickens is accompanied by a darker colour and reduced water loss during storage. In free-range, Goliaths had less yellow breast muscle, chromaticity and hue than local chickens. This observed variability is justified by the fact that local chickens utilize forages better than Goliaths. These forages are responsible for the pigmentation of the meat. According to the work of EL Rammouz. (2005) the colour of the meat depends on the concentration of hemin which also depends on biological factors in the animal.

In confinement, the breast muscles of Goliath and Cobb 500 chickens did not differ significantly in terms of sensory parameters, but the thigh and drumstick muscles of Goliath chickens were more tender than those of Cobb 500 chickens. However, no differences were observed for juiciness and flavour factors. Our results confirm those of Rajkumar et al. (2016) who reported non-significant variations between different chicken breeds with respect to sensory qualities.

On the contrary, our results are not consistent with those of Aksoy et al. (2021) who found that fast-growing broilers have better tenderness than slow-growing ones. This variation in our observations could be explained by the fact that Goliaths are slaughtered before maturity while Cobb are slaughtered at maturity. In free-range, the breast muscle and the thigh and drumstick had a more marked flavour than those of the locals. In addition to this difference in this parameter, the thigh and drumstick muscle of Goliaths is overall more preferred than that of the locals. This flavour in Goliaths is an effect of age. Locals are mature at 28 weeks according to Youssao et al. (2012) age at which

these birds develop their flavour. Flavour is related to age according to the work of Gordon and Charles (2002) and Fanatico et al. (2006). With regard to tenderness and juiciness, no differences were observed, which is related to the results of Latter (2000) who found no significant differences when examining the impact of genotype on sensory parameters of five different crosses of slow, medium and fast-growing breeds.

CONCLUSION

This study, conducted on three types of chickens reared in confinement and in free-range conditions, concluded that at slaughter age according to the rearing system, Cobb 500 chickens have higher slaughter weight and carcass characteristics than Goliath chickens reared in confinement. In contrast, the Goliath chickens had higher carcass weights than the local chickens in the free-range system. In confinement, Goliath chickens had a higher pH and less water lost than Cobb 500 water. While the Cobb 500 chickens had paler meat than the Goliaths. In free range, the pH of the muscle in the thigh and drumstick of the Goliaths was higher than that of the locals. Goliath chickens raised in free range were more accepted by the consumers with a higher slaughter weight than the local chickens. Further studies should consider reporting on the hygienic conditions under which slaughter and processing of the meat is made. Additionally, the effect of sex on the carcass traits and acceptability of Goliath chicken meat can be explored.

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CONFLICT OF INTEREST

The authors declare that they have no competing interests.

NOVELTY STATEMENT

The Goliath chicken is a new chicken (a slow-growing broiler) that has been developed by breeders in Benin. This study will enable breeders and consumers to find out where its characteristics and meat quality stand in relation to local and Cobb 500 chickens, whose characteristics and meat quality are well known.

AUTHOR CONTRIBUTIONS

A.G. A. Christie AHOKPOSSI designed and performed the study, interpreted the results and wrote the first version of manuscript. F. A. Chakirath SALIFOU, analysed data

contributed and participated to the correction of the manuscript. Issaka YOUSAO ABDU KARIM and Yaovi AMEYAPOH participated in the design, results interpretation and revision of the manuscript. All the authors read and approved the final manuscript.

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