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ORIGINAL ARTICLE

PHENOTYPIC AND MORPHOMETRIC DIVERSITY OF LOCAL GUINEA FOWL IN THE DEPARTMENT OF KORHOGO IN NORTHERN CÔTE D'IVOIRE

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ABSTRACT

Background: Meleagriculture occupies the second place in the production of poultry heads in Côte d'Ivoire. **Objectives:** In order to contribute to the development of local guinea fowl, a phenotypic and morphometric characterization study on this local poultry was conducted in northern Côte d'Ivoire. **Methods**: This work was carried out through a one-way survey conducted in August and September 2017 in five localities (Katia, Tiekelezo, Zanakpokaha, Kassirimé and Lahata) in the Department of Korhogo. Phenotypic and morphometric data were collected on 70 local guinea fowls. They were subjected to basic and multivariate descriptive analyses. **Results**: The results revealed three varieties of guinea fowl defined by the drawings and coloration of their feathers. Panache guinea fowls (88.57%) were the largest followed by chamois guinea fowls (8.57%) and purple guinea fowls (2.86%). The height of the helmet (2.16 vs 1.85 cm) and the length of the barbels (2.65 vs 1.75 cm) allowed the male to be distinguished from the female. Seven of the quantitative variables (weight, helmet length, helmet height, barbels length, body length, chest perimeter, tarse tower) best characterized the morphology of these guinea fowls. Two guinea fowl groups, one with superior conformation and one with normal conformation, were determined using the seven quantitative variables. **Conclusions:** For any selection program, weight and chest perimeter are the best indicators.

Keywords: *local guinea fowls; morphobiometric characterization, Côte d'Ivoire.*

1. INTRODUCTION

Africa is immensely rich in animal biodiversity. It is home to almost a quarter of the world's biodiversity. This significant proportion of animal genetic resources (GRAn) is well adapted to their environment [1]. The Convention on Biological Diversity recommends preserving of biodiversity in the "environment" in which it developed [2]. Also, according to FAO statistics, 9 % of domestic poultry species have already disappeared, 20 % are at risk of extinction and 35% are not endangered. The status of the remaining 36% is unknown due to lack of information [3]. In addition, unselected and on farm local breeds have a low production potential compared to improved exotic breeds. This constraint constitutes an open door to uncontrolled cross local farmers. These anarchic crossbreeds are one of the sources of genetic erosion of certain local domestic breeds, resulting in their abandonment or disappearance. To address the issue of productivity and conservation of these local breeds, the Food and Agriculture Organization of the United Nations (FAO) recommends the identification and genetic characterization of domestic livestock [4]. These actions help to value promote local breeds that continue to disappearing due to their lack of knowledge of their real genetic potential, their abandonment and mismanagement. In Côte d'Ivoire, in order to address the lack of animal protein from which it has suffered from since the 1970s, the first line of research in recent decades has bee, to improve the productivity and competitiveness of animal sectors [5]. The fastest and most sustainable solution is the development of short-cycle and prolific species farming [5]. Poultry farming better responds to this aspiration for rapid production of animal protein. Family poultry (70%) compared to 30% produced by modern poultry dominates local production in this sector [6]. Meleagriculture occupies the second place with 14.35% in the production of poultry heads in Côte d'Ivoire [6]. The common guinea fowl is a major egg producer [7] and its meat is well appreciated by consumers [8,9]. It is also at the center of some socio-cultural ceremonies in Côte d'Ivoire [10]. Despite these many advantages, few studies have been carried out on this species in Côte d'Ivoire. Moreover, the morphological characteristics, the actual potential for production, reproduction and preservation are still unknown. In order to contribute to the development of local resources and the phenotypic characterization of the common guinea fowl in northern Côte d'Ivoire, this study was initiated. The aim is specifically to identify the different phenotypes of guinea fowl in this region and to estimate their morphometric parameters.

2. MATERIALS AND METHODS

2.1 Study site

The study was conducted over two months (August and September 2017) in five localities of the Department of Korhogo: Katia, Tiekelezo, Zanakpokaha, Kassirimé and Lahata (Figure 1). This area has a tropical Sudano-Guinean climate with two seasons characterized by a dry and a rainy period. The dry season extends from November to April and is marked by a warm and dry wind between December and January (the harmattan); while the rainy season stretches from May to October, with an estimated rainfall of 1300 mm to 1400 mm and evenly distributed. This region is essentially made up of savannah formations [11-12].

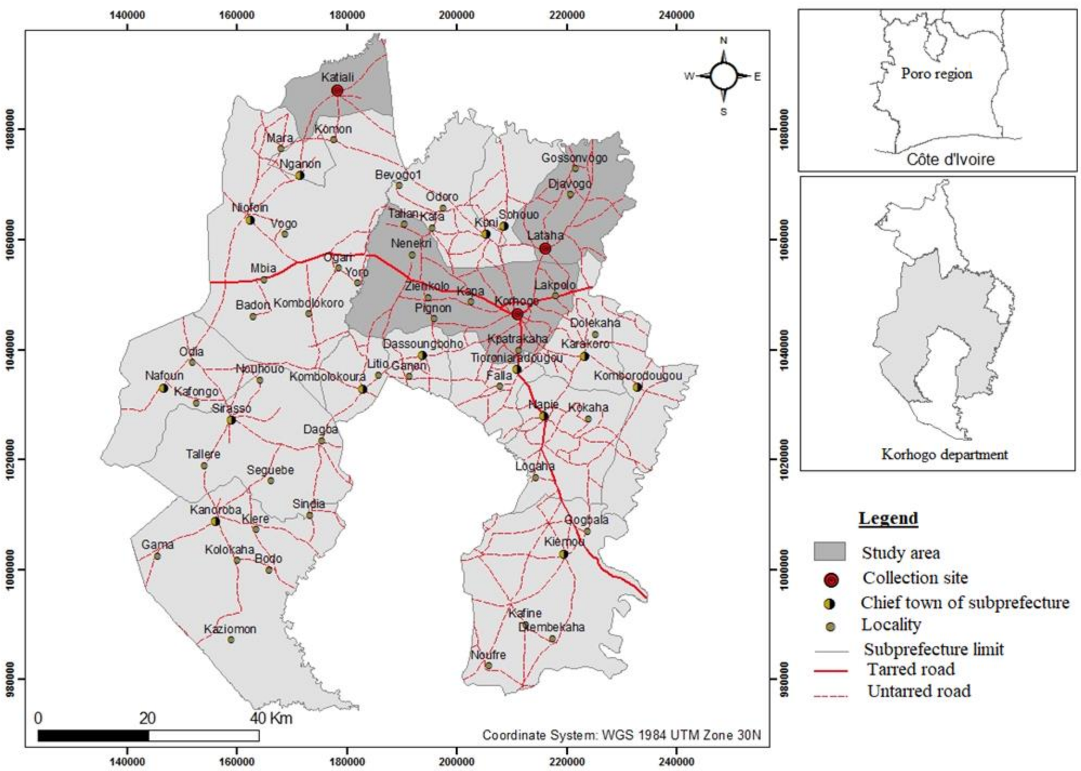

Figure 1: Prospecting and data collection sites in the Department of Korhogo in Northern Côte d'Ivoire.

2.2 Biological material

The biological material used in this study was the common guinea fowls encountered in the different localities of the study area.

2.3 Choice of local breeders and sampling of the guinea fowls

Characteristics, which have been of interest to the chosen local breeders were their willingness to respond to the questionnaire and their agreements for handling their guinea fowl. The size of the farmer's flock should be at least ten (10) adult guinea fowl heads. In each of the five locations visited, at least one farm was visited and the owner of the guinea fowls was interviewed. Adult guinea fowl of at least six (6) months of age from each owner were individually phenotypically descripted and morphometric character measurements were made using the descriptors defined by FAO [4,13].

2.4 Data collection

Data were collected on guinea fowls in the study area. Visible characteristics such appendage colors (helmet, barbels, face, beak, legs), skin and feather, drawings of feathers, were observed and noted. Measurements of eleven (11) quantitative variables were taken according to FAO recommendations and noted, including length and height of helmet, barbels length, beak length, body length, span of chest perimeter, pestle length, tarsal length, tarse tower. The individual live weight of each guinea fowl sampled obtained using an electronic balance with a 2000 g capacity and 1 g of precision. Other measurements were taken using a one-meter tape graduated in millimeters.

2.5 Data analysis

The qualitative (phenotypic) data collected were submitted to basic descriptive analyses, such as estimated proportions at each qualitative trait. Quantitative variables (morphometrics) were also subjected to basic descriptive analyses such as means and standard deviations, followed by the Fisher's test for comparison of means by sex. These linear variables have also been analyzed by the least squares method, using sex as a variation factor to test its effect on the quantitative variables.

The relationship between body weight and body linear measurements was determined using Pearson's product moment correlation (r). Linear regression of body linear parameters on body weight was also performed using the following simple linear regression equations [14].

Simple regression equation:

$$Y=aX + b \quad \textbf{(1)}$$

Y = dependent variable (Body weight), $\bar{Y}$=mean of dependent variable
X = independent variable, $\bar{X}$=mean of independent variable
a = regression coefficient (a=Cov (X,Y)/V(X))
b = the intercept (b=$\bar{Y}$-a$\bar{X}$)

To determine the morphometric discriminating characters of the guinea fowl, the quantitative descriptors were successively subjected to Principal Component Analysis (PCA) and Ascending Hierarchical Classification (AHC). All these analyses were performed using STATISTICA version 7.1; SPSS version 16 and XLSAT version 2016.

3. RESULTS

3.1 Phenotypic description of local guinea fowl

A total of 70 guinea fowls, including 37 males and 33 females, were characterized (Table I). Three feather phenotypes were observed in varying proportions. Panache is the most representative with 88.57%, followed by chamois with 8.57% and violet (Figure 2). In appendices, the majority (89%) of the barbels are white-red, the rest (10%) are red, and the helmet is generally brown (73%) or red-brown (11%). Birds with black orange legs and black skin are 67% and 70% respectively, compared to 26% with orange legs and 30% with white skin. The black face is observed in 50 % of birds and in 39 % of birds with a black white face. These different proportions of colors do not depend on the sex of the bird.

Table 1: Number of local guinea fowls collected at the various sampling sites

Site	Male	Female	Total	Proportion
Katia	6	12	18	26 %
Tiekelezo	16	4	20	27 %
Zanakpokaha	6	6	12	17 %
Kassirimé	3	7	10	14 %
Lahata	6	4	10	14 %
Total	37	33	70	100 %

Guinea fowl with panache feathers (Figure 2) generally have a brown helmet (74.2%), their barbels are white-red (87.1%) with a black face (53.2%). Their beaks are frequently brown (71.0%) with black skin (75.8%) and black-orange legs (66.1%). As for the chamois-colored guinea fowls (Figure 3), they often have the brown helmets (83.3%) and their barbels are entirely white-red (100%). Their beaks are sometimes brown-red (50.0%) with white skin (83.3%) and black-orange legs (66.7%). On the other hand, the purple feather guinea fowls (Figure 4) are distinguished by a black-brown or any black helmet (50.0%) with their 100% brow beaks, black skin (100%) and 100% black-orange legs.

3.2 Morphometric characteristics of the local guinea fowl

Average helmet height, barbels length and chest perimeter were significantly different at the 5% level between males and females (Table II). Thus, males had longer helmets (2.16 cm vs 1.85 cm) and longer barbels (2.65 cm vs 1.75 cm) than females (Table II). On the other hand, females had on average larger thoracic perimeters than males (30.21 cm vs 28.41 cm). The average weight of local adult guinea fowl in the study area was 1.24 ± 0.22 kg. The difference in weight between males and females was not significant according to the Fisher test at 5% (Table II). Of the remaining seven characters, none showed significant differences between males and females (Table II).

Figure 2 : Panache feather guinea fowl.

Figure 3 : Chamois guinea fowl.

Figure 4 : Violet guinea fowl.

Table 2: Mean, standard deviation and Fisher's test of the 11 morphometric characters studied.

Characters	Mean and SD (Male)	Mean and SD (Female)	F Value
Weight (kg)	1.25 ± 0.24	1.24 ± 0.21	0.855
Haut_ca	1.28 ± 0.41	1.13 ± 0.47	0.146
Long_ca	2.16 ± 0.37	1.85 ± 0.34	0.001**
Long_ba	2.65 ± 0.64	1.75 ± 0.45	0.001**
Long_be	2.39 ± 0.29	2.40 ± 0.3	0.973
Long-co	23.82 ± 7.61	27.58 ± 9.28	0.075
Eng	39.32 ± 3.29	38.98 ± 3.19	0.663
Per_th	28.41 ± 3.54	30.21 ± 3.38	0.033*
Long_pi	11.95 ± 0.71	11.67 ± 0.61	0.085
Long_ta	5.78 ± 0.42	5.86 ± 1.10	0.396
Tou_ta	3.85 ± 0.20	3.75 ± 0.22	0.067

__Long_ca__: Helmet length, __Haut_ca__: Helmet height, __Long_ba__: Barbels length, __Long_be__: Beak length, __Long_co__: Body length, __Eng:__ Wingspan. __Per_th__: Thoracic perimeter, __Long_pi__: Pestle length, __Long_ta__: Tarse length, __Tou_ta__: Tarse tower, Linear measurements in cm, F-values with asterisks confirm a significant difference between the means of the same quantitative variable. __SD__= standard deviation.

The majority of the correlations between morphometric characters obtained were slow. However, thoracic perimeter was the best correlated with the other morphometric variables. This trait was strongly correlated with the live weight (+0.68) and body length (+0.59) of the bird (Table 3).

Table 3: Correlation matrix between the 11 morphometric variables in the local guinea fowl

	Weight	Ht_ca	Lg_ca	Lg_ba	Lg_be	Lg_co	Eng	Per_th	Lg_pi	Lg_ta	Tou_ta
Weight	1										
Hat_ca	0.24*	1									
Long_ca	0.30*	0.39**	1								
Long_ba	-0.15	-0.04	0.42**	1							
Long_be	0.17	0.33**	0.21	0.06	1						
Long_co	0.08	0.59**	-0.11	-0.49**	0.26*	1					
Eng	0.10	-0.11	0.15	0.32**	0.03	-0.42**	1				
Per_th	0.68**	0.39**	0.12	-0.46**	0.29*	0.56**	-0.09	1			
Long_pi	0.23	-0.05	0.02	0.08	0.03	-0.15	-0.01	0.21	1		
Long_ta	0.14	0.17	-0.02	0.12	0.17	0.02	0.08	0.16	0.22	1	
Tou_ta	0.39**	0.61**	0.29*	0.04	0.25*	0.45**	0.02	0.42**	0.01	0.20	1

*Weight (kg), __Lg_ca__: Helmet length. __Ht_ca__: Helmet height, __Lg_ba__: Barbels length. __Lg_be__: Beak length, Lg_co: Body length, __Eng__: Wingspan. __Per_th__: Thoracic perimeter. __Lg_pi__: Pestle length, __Lg_ta__: Tarse length, __Tou_ta__: Tarse tower, Linear measurements in cm; __*__: correlation is significant at 0.05 level; __**:__ correlation is significant at the 0.01 level.*

With a significant correlation of live weight to the thoracic perimeter, the equation of a simple linear prediction line was obtained.

$$\text{Weight (g)} = 42.21 Per\_Th + 8.06 \quad \textbf{(1)}$$

3.3 Contribution of morphometric variables in the description of guinea fowl

The principal component analysis (PCA) performed with the 11 quantitative variables showed that seven of the 11 variables best contributed to the formation of the first two axes, with cumulative variances of 67.3% (Table 4). Axis 1 is defined only on the positive side by weight, helmet width, body length, thoracic girth and tarse tower. This axis characterizes high weight guinea fowls with a large body and chest perimeter (Figure 5 A). Axis 2 defines guinea fowl with long helmets and long barbels. The projection of individuals by sex in the same plane allowed the best description of guinea fowls. Thus, the majority of males were characterized by a long barbels with a long helmet (Figure 5 B). Females, on the other hand, had only short barbels with short helmets. Regardless of sex, individuals were clustered in the center of axis 1 defined by weight. Weight was not a discriminating variable for the sex of the guinea fowl.

Table 4: Own values and percentage of variation expressed by the first two axes from 7 characters analyzed in 70 local guinea fowls.

Principal components	Axis 1	Axis 2
Own variance	2.965	1.748
% Total Variance	42.360	24.970
% Cumulative Variance	42.360	67.329
Weight	0.628**	0.184
Per_th	0.835**	-0.206
Hat_ca	0.758**	0.257
Long_co	0.732**	-0.410
Tou_ta	0.741**	0.304
Long_ba	-0.362	0.824**
Long_ca	0.289	0.817**

*__**:__ Significant values (value ≥ 0.5); Per_th: Thoracic perimeter, __Haut_ca__ : Helmet height, Long_co : Body length, __Tour_ta__: Tarse tower, __Long_ba__: Barbels length, __Long_ca__: Helmet length.*

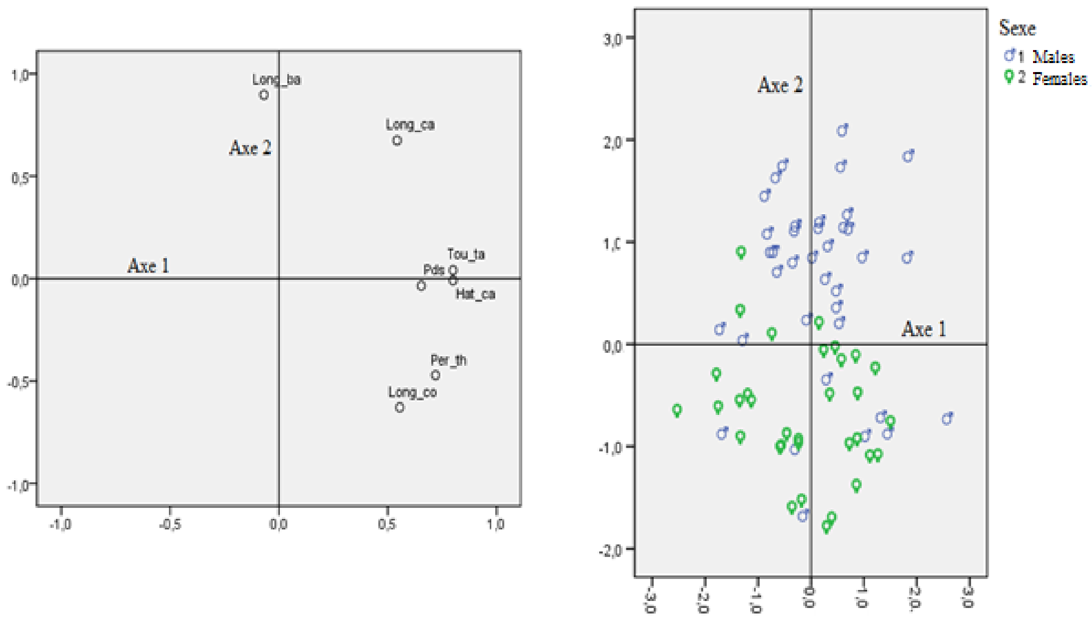

Figure 5: Projection of morphometric variables (A) and individuals by sex (B) in the first factorial plane defined by axes 1 and 2. ***Pds***: *Weight,* ***Long_ca***: *Helmet length,* ***Haut_ca***: *Helmet height,* ***Long_ba***: *Barbels length, Long_be: Beak length,* ***Long_co***: *Body length,* ***Per_th***: *Thoracic perimeter,* ***Tour_ta***: *Tarse tower.*

Two groups of guinea fowls were obtained by the hierarchical ascending classification (Figure 6) from seven preponderant variables (Weight, Helmet length, Helmet height, Barbels length, Body length, Chest perimeter and Taste tower) obtained at the CPA.

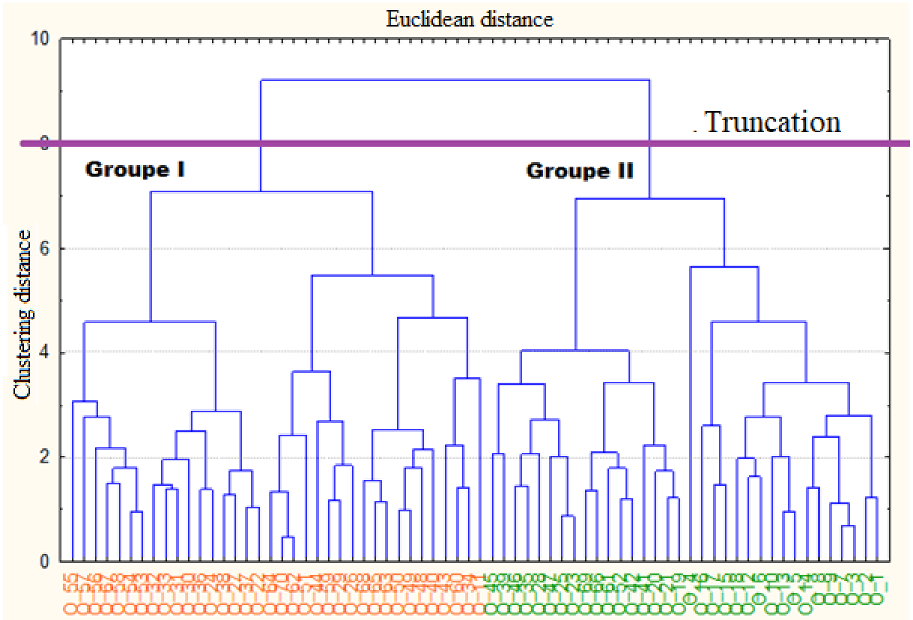

Figure 6: Two groups of guinea fowls defined by the CAH.

3.4 Description of the two groups of guinea fowl

Group I consists of 36 guinea fowls, including 1 guinea fowl of Katia, 13 of Tiekelezo, 6 of Zanakpokaha, 9 of Kassirimé and 7 of Lahata. The guinea fowls in this group had the lowest means for the characters studied, except for the length of the barbels (2.25 ± 0.72 cm) (Table 5). Group II consists of 34 guinea fowls, 17 for Katia, 7 for Tiekelezo, 6 for Zanakpokaha, 1 for Kassirimé and 3 for Lahata. The guinea fowls in this group were characterized by a large helmet (1.50 ± 0.35 cm), a longer body (30.84 ± 9.51 cm) and a larger chest perimeter (30.74 ± 2.92 cm) (Table 5).

Table 5: Principal characteristic of two groups.

Variables	Group I	Group II	P
Number	36	34	
weight (kg)	1.20±0.26	1.29±0.17	0.07
Haut_ca (cm)	0.93±0.34	1.50±0.35	0.00***
Long_ca (cm)	1.93±0.37	2.10±0.39	0.06
Long_ba (cm)	2.25±0.72	2.19±0.72	0.73
Long_co (cm)	20.64±3.97	30.84±9.51	0.00***
Per_th (cm)	27.86±3.58	30.735±2.92	0.00***
Tou_ta (cm)	3.67±0.17	3.95±0.16	0.00***

***Long_ca**: Helmet length. **Haut_ca**: Helmet height, **Long_ba**: Barbels length. **Long_be**: Beak length, **Long_co**: Body length, **Eng**: Wingspan, Per_th: Thoracic perimeter, **Long_pi**: Pestle length, Long_ta: Tarse length, **Tour_ta**: Tarse tower. P values with asterisks are significant P ≤ 0.05.*

4. DISCUSSION

In the local guinea fowl population of northern Côte d'Ivoire, three different varieties were identified by their plumage color: panache, chamois and violet. The most common was the panache guinea fowl with 88.57%. All three varieties of guinea fowl were pearl-type, as the wild pearl gray type described by Le Coz-Douin [15]. The different feather coloration observed are under the influence of four (4) visible effect genes [16, 17]. The chamois (c) gene responsible for the chamois (white) color in guinea fowl, it is an autosomal recessive gene. The lilac gene (l) responsible for the lilac color (dilution of grey), an autosomal recessive gene. The Isabelle gene (is) responsible for the color beige, it is recessive and sex-linked. The pearl gene (p) is responsible for the pearl or non-pearl pattern of the feather, it is dominant and autosomal [16]. The combination of these four genes is responsible for the different colors observed in the common guinea fowl. In fact, according to Dams, there are four varieties of pearl feather and four verities not pearled in the guinea fowl [16]. In this study, the observation of only three varieties of guinea fowl may be explained by the fact that this work was carried out only in the northern area of Côte d'Ivoire. The skin color was mostly black (70%) with a few white skin individuals (30%). This is in line with the color distribution observed by Ayorinde (2004) in Nigeria, which reported that the skin of the white guinea fowl is light yellow to white depending on the amount of xanthophylls while the skin of the other varieties is either gray or black due to high melanin [18]. All white guinea fowl and a little panache guinea fowls in this study have white skin indicating a low production of xanthophyll in the skin. In contrast, purple guinea fowl with black skin would indicate high production of melanin in their skin.

As Ayorinde (2004) reported in Nigeria, the helmet is slightly longer (3.7 vs 3.2 cm) and larger (2.2 vs 2.0 cm) in males than in females [18]. The values obtained in this study are in agreement with the Ayorinde (2004) results but in smaller proportions at the helmet length (1.281 vs 1.126 cm) and similar in terms of helmet height (2.16 vs 1.851 cm) [18]. This difference between the two countries could be due to a different age in the different samples, since the length and width of the helmet in guinea fowl are a function of sex and age. This difference could certainly be explained by the measuring instrument used, which could differ from one study to another. The study also revealed that the length of the barbels seems to be a distinguishing feature between males and females. Indeed, there was a significant difference between the length of the barbels of males and females (2.645 cm vs 1.745 cm). The thoracic perimeter was significantly different between females and males with respective values of 30.212 cm and 28.405 cm. These differences indicate a sex effect on quantitative parameters between males and females. These quantitative variables (barbels length, helmet length and height) could be used to identify the male or female guinea fowl in village settings for self-employed farmers. The sex effect on morphometric variables has been reported in various studies on local guinea fowl [19, 20]. The results of this study are different from those found by Brown *et al.,* (2017) in Ghana who observed lower values for chest perimeter (26.50 vs 26.32) [21]. Guinea fowl in the Korhogo region have a better conformation than those in Ghana. The morphometry of local guinea fowl is characterized by a slight difference in weight between males and females, with males appearing to weigh slightly more than females (1247 vs 1237 g). These results are in agreement with those of Abdul-Rahman *et al.,* (2015), who found that the male weighed more than the female (591 vs 558 g) in the local guinea fowl *Numida meleagris* in Ghana [22]. In Burkina Faso, however, Sonfo *et al.,* (2008) observed respective mean adult weights of 857 g and 962 g, below the results of this study [23]. Also, the weight of local guinea fowl in northern Côte d'Ivoire was high compared to the weight of local guinea fowl in Ghana and Burkina. These results show that there is no real dimorphism between male and female local guinea fowl. Nevertheless, the average adult weight of local guinea fowls in northern Côte d'Ivoire could be an ideal natural population for a selection program to improve guinea fowl meat production. However, the best correlation observed (0.68) between weight and chest perimeter could be used to determine the live weight of guinea fowl using a tape meter. A similar study conducted in the local hen Loukou (2013) showed a better correlation between thoracic perimeter and live weight [23]. Dzungwe *et al., (*2018) also obtained a better correlation between weight and chest perimeter of the French broiler Guinea fowl in the humid tropics of Nigeria relative to other linear characters [14]. This suggests a better prediction between weight and chest perimeter in guinea fowls. Original body dimensions were better predictors of body weight than the orthogonal traits derived from factor analysis [24].

Structuring the 70 guinea fowls sampled allowed them to be separated into two groups on the basis of the seven quantitative variables defined by the CPA as those best expressing the phenotypic variability of local guinea fowl in northern Côte d'Ivoire. The guinea fowls in group I have the lowest means for the traits studied. This could be explained by the way in which they are fed, which may differ from one area to another, the breeding behavior and the different age of the difference in age of the birds. Group II contains guinea fowls with a long body, a larger chest perimeter and high tarse tower; appears to have a better conformation than of group I. This better conformation could be explained by the fact that the guinea fowl have a longer body length, a larger chest perimeter and a higher tarse tower. This better conformation could be explained by the place of origin of the guinea fowls, the age of the birds and by the management style adopted by the local breeders. The birds having better conformation could be selected to improve the conformation of local guinea fowl.

5. CONCLUSION

This study identified some phenotypic and morphometric characteristics of the local guinea fowl in northern Côte d'Ivoire. Three varieties of local guinea fowl have been identified (Panache, Chamois, Violet) all pearled. These local guinea fowls exhibit less phenotypic diversity. Sex had a small influence on the measurable traits in both males and females. Only the height of the helmet and the length of the barbels can be used to differentiate the male from the female. Moreover, positive correlations between weight and body measurements are good indicators for the conduct of selection programs to improve the conformation of local guinea fowl to increase production in this species.

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