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Morphological Characteristics of Local Chicken Populations (*Gallus gallus domesticus*) in Farmed Basins of the Far North Region, Cameroon

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Abstract

In order to contribute to a better understanding of the biodiversity of local chicken populations, this study focused on the description of the essential qualitative parameters in the phenotypic characterization of local species. Conducted in 6 localities in the Far North Region of Cameroon (Doukoula, Yagoua, Guidiguis, Dziguilao, Maroua 3rd and Méri), a population of 240 local chickens, including 172 hens and 68 cocks were characterized in family farms. The choice of localities was made on the basis of their strong potential local chicken flocks in the region. To this end, each animal was the subject of a qualitative description based on the identification of the sex of the animal, the description of the colorations of the plumage and extremities, and the description of the types of format, plumage and crests. All observations were made with the naked eye and in daylight and then photographed. The main results show that the plumage colors are multiple and dominated by the White-Pied-Black (21.7%) and the Mille-fleur (20.8%); the wattles are dominated by the red (60%) and the pink (35.4%); the tarsi are dominated by the white (43.8%) and the black (32.08%); the white skin (92.5%) dominates over the pink skin (7.5%); the "Smooth-uniform" feather is dominant (97.08%), followed by the smooth-crested type (2.08%) and the fries type (0.82%); the medium size of the chickens is dominant (86.66%), followed by the dwarf size (9.58%) and the large size (3.75%). The results of this study demonstrate that there is a strong phenotypic diversity within the local chicken population. This diversity can serve as a basis for the development of selection, conservation and genetic potential improvement programs based on rational exploitation of the local chicken.

Keywords

Morphological Characteristics, Local Chicken, Far North Cameroon

1. Introduction

In Sub-Saharan Africa, poultry farming is of significant importance in rural areas and constitutes the primary source of animal protein for populations (Ayssiwede *et al.* [1]; Ngouonimba *et al.* [2]). Poultry is generally perceived as a safe saving and insurance against the risks of reduced food production and income (Fotsa *et al.* [3]). Also, poultry farming and local poultry products are at the center of many events in the social, cultural, economic and religious life of the populations (wedding ceremonies, traditional pharmacopoeia and maintaining social cohesion within traditional communities through donations and receiving visitors).

In Cameroon, intensive poultry farming is slow to spread in all agro-ecological zones of the country due to significant agro-ecological variations. In the Far North Region, village chicken farming represents the main source of animal protein of avian origin available and accessible for populations in different rural, peri-urban and urban environments [4] [5]. Village chicken also constitutes the main source of income for the poorest populations in this part of the country (Fotsa *et al.* [3]).

Despite the constraints linked to climatic hazards (severe drought), and health constraints linked to the resurgence of epidemics, the good adaptability of poultry to environmental conditions always favors a gradual reconstitution of livestock among breeders over the seasons. This breeding, rooted in the tradition of the populations, thus appears to be an important means of contributing to the resilience of the populations [5].

However, socio-economic changes, the liberalization of markets for industrial products of animal origin, urbanization, conflicts, natural disasters, the lack of health control and epidemic risks such as avian flu are all constraining factors that make old breeds very vulnerable. Although local chickens are still very closely linked to cultural values and geographical origins and are especially adapted to the local environment, many of them have suffered a significant decrease in the size of their populations and are therefore exposed to an erosion of their genetic diversity (Larivière *et al.* [6], Ayssiwede *et al.* [1]). Moreover, the strong pressure of crossbreeding with improved breeds coming from the southern part of the country or entering fraudulently from neighboring Nigeria constitutes a permanent threat to this population of chickens in the region. Therefore, the development and sustainable management of the local genetic potential of chickens first require the urgent production of new knowledge on these resources. This approach involves taking into account the anthropogenic knowledge of breeders while respecting the use of characterization tools recommended by FAO [7] and AU-IBAR [8]. Conducted with the aim of contributing to a better understanding of the biodiversity of local chickens, breeding basins with large flocks of local chickens have been identified in the Far North Region of Cameroon [4]. The results of this work can contribute to better conservation management and appropriate development of local poultry genetic resources in the region.

2. Study Area and Data Collection

2.1. Study Area

The study area was circumscribed in 6 districts representing the basins with high population potential of local chickens in the Far North Region of Cameroon (Figure 1).

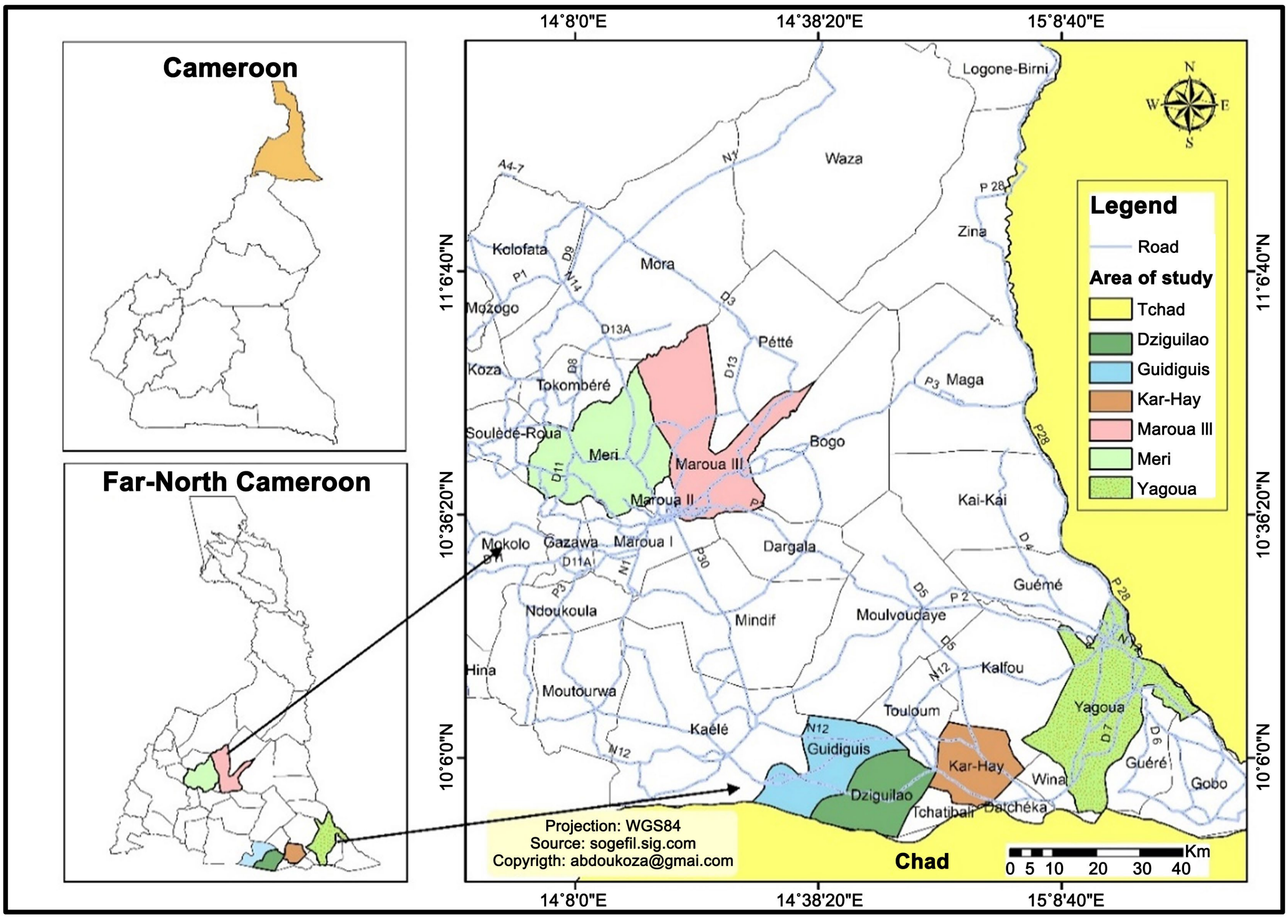


Figure 1. Location map of the study area.

The Far North Region extends between 10˚ and 13˚ North latitudes and 13˚ and 16˚ East longitudes. It covers an area of 34,263 km^2, or 7% of the national territory. In 2017, the population of the region was estimated at 4,186,844 inhabitants, or 18.01% of the total population of Cameroon, with an average density of 122 inhabitants/km^2 [9]. This Region is subject to a tropical climate in the broad sense, characterized by a single rainy season centered on a maximum in August. The average rainfall varies from 400 to 1100 mm per year [9]. The dry season is all the more rigorous and long (seven months and more) as one moves towards the North and away from the Mandara Mountains. The intense sunshine and high temperatures are often felt more as one approaches the shores of Lake Chad. Furthermore, the relative humidity in the region is quite low with an average of 35% in the plains.

2.2. Data Collection and Statistical Analysis

Sampling was carried out mainly in basins with large numbers of local chickens in the Far-North Region, Cameroon. The accessibility and consent of volunteer breeders to data collection also made it possible to cover the identified breeding basins. All the localities identified as basins with large numbers of local chickens were identified on the basis of the annual numbers of poultry by district reported by the statistics of the Ministry of Livestock, Fisheries and Animal Industries. Also, the flow of local poultry supplying the rural, peri-urban and urban markets of the region also guided the choice of the identified localities. A sample of 240 adult local hens aged 6 to 12 months, *i.e.* 172 hens and 68 roosters were identified and characterized exclusively in family farms that did not have exogenous breeds. In addition, the choice of animals to be characterized was also based on their apparent good health. A data collection sheet was designed and implemented according to the models recommended by FAO [7] and AU-IBAR [8]. The qualitative description of the parameters of phenotypic diversity was made according to the method described by Mohammi *et al.* [10] and Messabhia [11]. For this purpose, each adult chicken was the subject of a direct phenotypic description based mainly on qualitative data. After observations with the naked eye and in daylight, this description focused mainly on: the determination of the sex of the animal; the size of the animal; the colorations of the different parts (crest, eyes, earlobes, wattles, beak, eyelobe, skin, plumage and tarsi); the types of crest (single or double or pink); the types of plumage (smooth, curly or silky); the distribution of plumage or extent (bare neck, feathered legs, crested head and uniform plumage). The said visible characteristics were photographed for a better illustration of the phenotypic diversity (**Figures A1-A6**).

Descriptive statistics were used to describe the characteristics of the individuals studied. The contingency test was used to test the association or independence between the factors sex, localities and qualitative characters. These analyses were carried out using SPSS software version 21.0.

3. Results and Discussions

3.1. Plumage Coloration According to Localities

Table 1 presents the distribution of feathering colorations of local chicken populations according to sex and localities.

Table 1. Distribution of feathering color according to localities and sex.

Plumage Coloration	Doukoula		Dziguilao		Guidiguis		Maroua 3		Meri		Yagoua		Sex				Total		t.c.
													Female		Male				
	n	%	n	%	n	%	n	%	n	%	n	%	n	%	n	%	N	%	
White	3	8.1	0	0	9	18.7	2	5.9	0	0	3	7.5	13	7.5	4	5.8	**17**	**7.1**	*
Ermined	0	0	0	0	1	2.1	3	8.9	0	0	0	0	4	1.7	0	0	**4**	**1.7**	*
Partridge golden	0	0	2	5	1	4.2	3	8.9	8	19.5	0	0	15	6.2	0	0	**15**	**6.2**	
White-Pie-Black	9	24.3	11	27.5	5	10.4	5	14.7	8	19.5	14	5.9	40	16.6	12	5	**52**	**21.7**	
Multicolor	15	40.5	9	22.5	9	18.7	1	2.9	3	7.3	13	32.5	32	13.3	18	7.5	**50**	**20.8**	
Fawny	1	2.7	4	10	1	2.1	0	0	0	0	0	0	6	2.1	1	0.4	**6**	**2.5**	
Fawny-silver	1	2.7	0	0	0	0	0	0	0	0	0	0	0	0	1	0.4	**1**	**0.4**	
Fawny-golden	0	0	0	0	1	2.1	0	0	0	0	0	0	1	0.4	0	0	**1**	**0.4**	
Fawnyand black	0	0	0	0	2	4.2	0	0	0	0	0	0	2	0.8	0	0	**2**	**0.8**	
Black	0	0	1	2.5	1	2.1	2	5.9	0	0	2	5	6	2.5	0	0	**6**	**2.5**	
Black-silver	4	10.8	4	5	0	0	3	8.9	3	7.3	4	10	10	4.2	3	1.2	**13**	**5.4**	
Black-golden	0	0	4	5	7	14.6	6	17.6	12	29.3	1	2.5	21	8.7	9	3.8	**30**	**12.5**	
Black-red	0	0	2	5	3	6.2	1	2.9	4	9.7	0	0	4	1.7	6	2.5	**10**	**4.2**	
Red	0	0	0	0	5	10.4	0	0	0	0	0	0	4	1.7	1	0.4	**5**	**2.1**	
Black and red golden	4	10.8	1	2.5	0	0	0	0	0	0	3	7.5	1	0.4	7	2.9	**8**	**3.3**	
Red-white	0	0	1	2.5	1	2.1	0	0	0	0	0	0	0	0	2	0.8	**2**	**0.8**	
Red-golden	0	0	1	2.5	1	2.1	8	23.5	3	7.3	0	0	6	2.5	7	2.9	**13**	**5.4**	
Total	**37**	**100**	**40**	**100**	**48**	**100**	**34**	**100**	**41**	**100**	**40**	**100**	172		68		**240**	**100.0**	

n: effective; **%:** Frequency; **N:** Total number by plumage coloration; **t.c.:** contingency test; ****:** significative ($p < 0.01$). The contingency test ($p < 0.01$) shows that localities influence feathering.

Observations (**Table 1**) made on the distribution of feathering colors illustrate 17 different colorations. The White-Pie-Black (21.7%) and the Multicolor (20.8%) colorations are dominant. On the other hand, the fawny-silver, fawny-gold, ermine and red-white colorations are less represented. This observed diversity shows that the plumage colorations of local hens are very varied (**Figure A1**). These results are similar to those described by Roukayath [12] and Haoua *et al.* [13]. They also corroborate those of Bessadok *et al.* [14] in Tunisia illustrating that local hens offer a variability of plumage whose chance of crossbreeding intermingles the different shades of plumage. Sarker *et al.* [15] further showed that color variations in native chickens are regulated by seven to nine genes, and the pubescent weight of birds from local populations is closely linked to their plumage color and type.

3.2. Comb Coloration According to Locality and Sex

Table 2 shows the distribution of comb color according to locality and sex of local chicken populations.

Table 2. Distribution of comb color according to locality and sex.

Localities	Pink Crest		Red Crest		Black Crest		Total
	n	%	n	%	N	%	N
Doukoula	25	67.57	11	29.73	1	2.70	**37**
Dziguilao	15	37.5	24	60	1	2.5	**40**
Guidiguis	9	18.75	35	72.92	4	8.33	**48**
Maroua 3	7	20.59	24	70.59	3	8.82	**34**
Meri	10	24.39	24	58.54	3	7.32	**41**
Yagoua	24	60	14	35	2	5	**40**
Total	**90**	**37.50**	**132**	**55.00**	**14**	**5.83**	**240**
Sex							
Female	87	50.58	71	41.28	14	8.14	**172**
Male	3	4.41	65	95.59	0	0	**68**
Total	**90**	**37.5**	**136**	**56.67**	**14**	**5.83**	**240**
t.c.				**			

n: effective; **%:** Frequency; **N:** Total number**; t.c.:** contingency test; ****:** significative ($p < 0.01$). The contingency test ($p < 0.01$) shows that localities and sex influence the crest coloration.

At the level of the crests (Table 2), the most representative colorations observed are red (56.67%) and pink (37.5%) compared to the black crest coloration (5.83%). Also, depending on the sex, the pink crest dominates in females (50.58%), while in males it is the red crest that dominates with 95.59% (Figure A2). These results are in contradiction to those obtained by Haoua *et al.* [13], noting a percentage of 43.17% of red crest in males. However, they corroborate those obtained by Messabhia [11], in Algeria, with 87.1% of red crest, 12.9% of pink crest in males in addition to other relatively weak colorations such as grey, black and white. Which also corroborates the work of Mahammi *et al.* [10] whose dominant color is red with percentages ranging from 55.1% to 90.4%.

3.3. Beak Coloration According to Locality and Sex

Table 3 shows the distribution of beak coloration according to locality and sex.

For the beak colors (Table 3), grey-white (30.83%), White (24.58%) and black (24.17%) dominate. On the other hand, the grey-yellow coloration (4.58%) is the least representative and is reflected in both females and males with respectively (5.81%) and (1.47%). However, depending on the sex, females are distinguished by white (29.65%), grey-white (26.16%) and black (25%) beaks. In males, grey-white (42.65%) and black (22.06%) beaks are the most frequent (Figure A3). These results are similar to those observed by Keambou *et al.* [16], listing the presence of different colorations including grey or horny with a percentage of 47.4% against 21.6% for black and 24.7% for yellow. The observations made by Mahammi *et al.* [10] also corroborate with our observations. On the other hand, Moula *et al.* [17]

and Bembide *et al.* [18] found that horny (gray) beak color is less frequent than yellow.

Table 3. Distribution of beak coloration according to locality and sex.

Localities	White		Yellow		Grey		Black		Grey-White		Grey-Yellow		Total
	n	%	n	%	n	%	n	%	n	%	n	%	N
Doukoula	7	18.92	2	5.41	1	2.70	9	24.32	18	48.65	0	0.00	**37**
Dziguilao	11	27.50	5	12.50	3	7.50	7	17.50	10	25.00	4	10.00	**40**
Guidiguis	9	18.75	8	16.67	2	4.17	9	18.75	13	27.08	7	14.58	**48**
Maroua 3	11	32.35	2	5.88	11	32.35	7	20.59	3	8.82	0	0.00	**34**
Meri	12	29.27	0	0.00	4	9.76	11	26.83	14	34.15	0	0.00	**41**
Yagoua	9	22.50	0	0.00	0	0.00	15	37.50	16	40.00	0	0.00	**40**
Total	**59**	**24.58**	**17**	**7.08**	**21**	**8.75**	**58**	**24.17**	**74**	**30.83**	**11**	**4.58**	**240**
Sex													
Female	51	29.65	10	5.81	13	7.56	43	25.00	45	26.16	10	5.81	**172**
Male	8	11.76	7	10.29	8	11.76	15	22.06	29	42.65	1	1.47	**68**
Total	**59**	**24.58**	**22**	**9.17**	**21**	**8.75**	**58**	**24.17**	**74**	**30.83**	**6**	**37.5**	**240**
t.c.								**					

n: Number; **%:** Frequency; **N:** Total number; **t.c.:** contingency test; ****:** significant (p < 0.01). The contingency test (p < 0.01) reveals that the beak coloration is influenced by the locality and the sex.

3.4. Coloration of Barbels and Eyelobe

Table 4 shows the distribution of barbel and eyelobe color according to locality and sex.

Table 4. Distribution of barbel and eyelobe color according to locality and sex.

Localities	Barbel Coloration								Eyelobe Coloration						
	Black		Pink		Red		Red Black		Blk Yellow		Black-Orange		Black-Gray		Total
	n	%	n	%	n	%	n	%	n	%	n	%	n	%	N
Doukoula	1	2.70	24	64.86	11	29.73	1	2.703	3	8.11	34	91.89	0	0	**37**
Dziguilao	0	0	13	32.5	25	62.5	2	5	5	12.5	34	85	2	5	**40**
Guidiguis	0	0	9	18.75	38	79.17	1	2.08	8	16.67	38	79.17	2	4.167	**48**
Maroua 3	0	0	7	20.59	25	73.53	2	5.88	0	0	34	100	0	0	**34**
Meri	0	0	10	24.39	31	75.61	0	0	0	0	41	100	0	0	**41**
Yagoua	2	5	22	55	14	35	2	5	2	5	38	95	0	0	**40**
Sex															
Female	3	1.74	82	47.67	79	45.93	8	4.65	13	7.56	156	90.7	3	1.74	**172**
Male	0	0.00	3	4.41	65	95.60	0	0.00	5	7.35	62	91.18	1	1.47	**68**
Total	**3**	**1.25**	**85**	**35.42**	**144**	**60**	**8**	**3.33**	**18**	**7.5**	**118**	**49.17**	**4**	**1.67**	**240**
t.c.				**							**				

n: Number; **%:** Frequency; **N:** Total number; **t.c.:** contingency test; ****:** significant (p < 0.01). The contingency test (p < 0.01) shows that the coloration of the barbel and that of the eyelobe are both influenced by the locality and the sex.

At the level of the barbels (**Table 4**), the results indicate a domination of red (60%) and pink (35.4%) compared to the weakest coloration black (1.25%). Depending on the sex, it emerges from this result that the red (47.67%) and pink barbels (45.93%) have similar proportions in females unlike the males almost dominated by Red (95.6%). These results corroborate the results of Mahammi *et al.* [10], Mahammi [19] and Messabhia [11], according to which red wattles dominate with (88%) followed by pink wattles (10.5%) and rarely black wattles (1.5%).

The results on the colorations of the eyelobe (**Table 4**) show that the black-orange coloration is dominant (91.25%) on all the subjects of the different basins. Furthermore, depending on the sex, the black-orange coloration of the eyelobe dominates at 90.7% in females and 91.6% in males respectively. On the other hand, the least frequent coloration is the black-gray (1.67%) generally observed in animals with totally black plumage, beak and tarsi. Also, these observations of the eyes are genetically little studied. According to Fotsa *et al.* [3], the dominant red-orange color of the eyes of our hens corresponds to wild-type hens. These colorations would result from interactions between alleles at the locus E "extension", B "barring", ID "inhibitor of dermal melanin" and BR "brown-eye", the colorations at the level of the eye lobe, corroborate those of Mahammi [19] who also observed the dominance of the red-orange color of the eyes (71.56%) over the yellow color (20%) and the less represented brown-black colorations (8.38%).

3.5. Mumps Coloration According to Locality and Sex

Table 5 shows the distribution of mumps color.

Table 5. Distribution of mumps color according to locality and sex.

Localities	**Mumps Coloration**										
	Pink		**White**		**Red**		**Blak**		**Red-Whit**		**Total**
	n	%	n	%	n	%	n	%	n	%	N
Doukoula	8	21.62	23	62.16	5	13.51	0	0	1	2.7	**37**
Dziguilao	13	32.5	18	45	6	15	0	0	3	7.5	**40**
Guidiguis	16	33.33	12	25	14	29.17	3	6.25	3	6.25	**48**
Maroua 3	15	44.12	4	11.76	13	38.24	0	0	2	5.88	**34**
Meri	22	53.66	9	21.95	10	24.39	0	0	0	0	**41**
Yagoua	9	22.5	20	50	11	27.5	0	0	0	0	**40**
t.c.					**						
Sex											
Female	67	38.95	71	41.28	23	13.37	2	1.16	9	5.23	**172**
Male	16	23.53	15	22.06	36	52.94	1	1.47	0	0	**68**
Total	**83**	**34.6**	**86**	**35.83**	**59**	**24.6**	**3**	**1.30**	**9**	**3.75**	**240**
t.c.					**						

n: Number; **%:** Frequency; **t.c.:** contingency test; ****:** significant (p < 0.01); ***:** not significant p > 0.01.

As for the coloration of the mumps (**Table 5**), we observe the dominance of White (35.83%), followed by pink (34.6%) and red (24.6%). The least representative colorations are black (1.30%) and red-white (3.75%). Depending on the sex, we note the very dominant White colorations (41.28%) in females, against (22.06%) in males. On the other hand, red mumps (52.94%) predominate in males against (13.24%) in females (**Figure A6**). These observations corroborate on the one hand with the results of Messabhia [11], who highlights three colors: white, orange and red. However, he observes that the red color is dominant with percentages of 96.7%, 70% and 76.7% for the populations of three localities studied in Ivory Coast. On the other hand, orange-colored mumps are totally absent in our study. According to Cabarles *et al.* [20], the variations observed in the color of mumps result from the adaptation of different populations to their various ecosystems.

3.6. Skin and Tarsi Coloration According to Locality and Sex

Table 6 shows the distribution of skin and tarsi color according to locality and sex.

Table 6. Distribution of skin and tarsi color according to locality and sex.

Localities	Skin Color						Tarsi Color										
	Pink		Whit		Black		Whit		Ash		Yellow		Black		Yellow-Grenish		Total
	n	%	n	%	n	%	n	%	n	%	n	%	n	%	n	%	N
Doukoula	5	13.51	30	81.08	2	5.40	20	54.1	5	13.51	5	13.51	7	18.92	0	0	**37**
Dziguilao	7	17.5	30	75.00	3	7.50	21	52.5	8	20	6	15.00	5	12.5	0	0	**40**
Guidiguis	8	16.66	38	79.16	2	4.16	22	45.8	3	6.25	13	27.08	9	18.75	1	2.08	**48**
Maroua 3	1	2.94	30	88.23	3	8.82	16	47.1	2	5.882	0	0.00	16	47.06	0	0	**34**
Meri	5	12.2	31	75.60	5	12.19	10	24.4	5	12.2	0	0.00	26	63.41	0	0	**41**
Yagoua	5	12.50	29	72.50	6	15.00	16	40	10	25	0	0.00	14	35	0	0	**40**
Total	**31**	**12.91**	**188**	**78.33**	**21**	**8.75**	**105**	**43.8**	**33**	**13.75**	**24**	**10.00**	**77**	**32.08**	**1**	**0.42**	**240**
Sex																	
Female	20	11.62	143	83.13	13	7.55	72	41.9	18	10.47	14	8.14	68	39.53	0	0	**172**
Male	11	16.17	45	66.17	8	11.76	33	48.5	15	22.06	10	14.71	9	13.24	1	1.47	**68**
Total	**31**	**12.91**	**188**	**78.33**	**21**	**8.75**	**105**	**43.8**	**33**	**13.75**	**24**	**10.00**	**76**	**31.67**	**1.00**	**0.42**	**240**
t.c.				*											**		

n: Number; **%:** Frequency; **t.c.:** contingency test; ****:** significant ($p < 0.01$); ***:** not significant $p > 0.01$. The contingency test ($p < 0.01$) reveals that the coloration of the tarsi is influenced by the locality and the sex, unlike the coloration of the skin ($p > 0.01$) which is not linked to the locality or the sex.

Concerning the coloration of the skin (**Table 6**), it is dominated by white with 78.33%, followed by the pink coloration (12.91%) and black-ash (8.75%). We also note in females 83.13% of white skin against 66.17% in males. These results coincide with those of Sarker *et al.* [15] and Moula *et al.* [21], who observed white and pink skins with a good dominance of white skin. Also, pink skin was observed at high frequency in the study conducted by Duguma [22]. Subjects with yellow skins were not observed in the local chicken population unlike the work of Mahammi *et al.* [10] conducted in Western Algeria. On the other hand, the work of Dao *et al.* [23] indicates 76% of white skin and 23.9% of yellow skin observed in chickens.

Furthermore, observations on the colorations of the tarsi (**Figure A5**) indicate percentages respectively of: (43.8%) white and (31.67%) black. The ash (13.75%) and yellow (10.0%) colorations are weakly observed. On the other hand, the yellow-greenish coloration (0.4%) is a rarity in the local chicken population. Depending on the sex, the white coloration in females is of the order of 41.9% against 48.5% in males; the ash coloration comes with 10.47% in females and 22.06% in males; and black appears at a frequency of 39.53% in females and 13.24% in males. The results obtained by Moreda *et al.* [24] and Sarker *et al.* [15] corroborate these observations which mention the tarsi of white, yellow, black, and green color but, the dominant color is the white followed by the yellow. However, Getu *et al.* [25] also noted the tarsi of white, yellow, black, green and gray color. The dominant colors are yellow and white.

3.7. Format Type by Location and Gender

Table 7 shows the distribution of format type by locality and gender.

Table 7. Distribution of format type by locality and sex.

Localities	Large		Medium		Small		Total
	n	%	n	%	N	%	N
Doukoula	2	5.40	30	81.10	5	13.5	**37**
Dziguilao	1	2.50	34	85.00	5	13.00	**40**
Guidiguis	4	8.33	42	87.50	2	4.16	**48**
Maroua 3	0	0.00	30	88.00	4	12.00	**34**
Meri	2	4.88	39	95.10	0	0.00	**41**
Yagoua	0	0.00	33	82.50	7	17.50	**40**
Total	**9**	**3.75**	**208**	**86.66**	**23**	**9.58**	**240**
Sex							
Female	0	0.00	153	89.00	19	11.10	**172**
Male	9	13.23	55	80.88	4	5.88	**68**
Total	**9**	**11.22**	**208**	**69.88**	**23**	**16.98**	**240**
t.c.				**.			

n: Number; **%:** Frequency; **t.c:** contingency test; **:** significant ($p < 0.01$). The contingency test ($p < 0.01$) indicates an influence of the locality and sex on the type of format of local chicken populations.

In terms of chicken format (**Table 7**), it emerges from all the localities that: medium-sized chickens are dominant in the local chicken population with a frequency of 86.66% against 3.75% for large format and 9.58% for dwarf or small format. Sexual dimorphism shows that on all the females observed, the frequency of large format chickens is zero. Furthermore, compared between the localities, Guidiguis is distinguished by a higher frequency of large format subjects (8.33%). Also, in the localities of Meri, Doukoula and Dziguilao, large chickens are respectively 4.88%, 2.41% and 2.5%. The localities of Maroua 3 and Yagoua stand out on the other hand by the absence (0.0%) of large chickens. Medium-sized subjects are more represented in the localities of Maroua 3 (88%), Guidiguis (87.5%) and Meri (95.1%). It is also noted that the locality of Yagoua has a high frequency of small-sized subjects (17.5%). The good representativeness of local medium-sized hens would be due to the selective choices of breeders who keep very few dwarf hens whose market value is low on the local market. These observations are similar to those noted by Dao *et al.* [22] who indicate that birds from the Dry Savannah have a larger size and weight than those from other areas. The size and weight of birds decrease along a north-south gradient. This work corroborates those of Fotsa *et al.* [26] following experiments carried out on local ecotypes from the North-West, West, Center and South Cameroon in comparison with commercial strains of the label type. However, the presence of Dwarfism phenotypes appears to be much higher (11.10% in females) and (5.88% in males) compared to observations made in southern Cameroon (2.13% in females) and (2.04% in males). Indeed, many breeders believe that the Dwarf genetic type (small chicken) stands out for its quality as a good mother hen in a straying system that is extremely exposed to predators and extreme weather.

3.8. Feathering Type According to Locality and Sex

Table 8 illustrates the distribution of feathering type according to locality and sex.

Table 8. Distribution of feathering type according to locality and sex.

Localities	Curly		Smooth		Smooth-Crested		Total
	n	%	N	%	N	%	N
Doukoula	0	0	37	100	0	0	**37**
Dziguilao	0	0	39	97.5	1	2.5	**40**
Guidiguis	2	4.17	48	100	0	0	**48**
Maroua 3	0	0	32	94.12	0	0	**34**
Meri	0	0	37	90.24	4	9.76	**41**
Yagoua	0	0	40	100	0	0	**40**
Sex							
Female	2	1.16	165	95.93	5	2.91	**172**
Male	0	0	68	100	0	0	**68**
Total	**2**	**0.83**	**233**	**97.08**	**5**	**2.08**	**240**
t.c.				*			

n: Number; **%:** Frequency; **N:** Total number; **t.c.:** contingency test; *: not significant $p > 0.01$. The contingency test ($p > 0.01$) indicates that there is no link between the type of feathering of the local chicken population, sex and locality.

In **Table 8**, the observed population feathering also indicates that: the "Smooth-uniform" type predominates with 97.8% of which: 95.93% in females and 100% in males; the "Smooth-crested" and "Curly-uniform" types exist very little with 2.08% and 0.83% each respectively. In addition, the "Smooth-crested" (2.91%) and "Curly-uniform" (1.16%) types are weakly represented in females. However, in males, these types of feathering were not observed. These results are similar to those of Haoua *et al.* [13] where, it is observed in local hens a dominance of the Smooth-uniform feathering type (87.18%) and a low proportion of the crested (4.48%) and curly (2.38%) types. On the other hand, the naked-neck feathering type (4.13%) appears. Also, Duguma [22] refers to the naked neck type which allows better resistance to heat and a low protein requirement for feather production.

3.9. Ridge Type by Locality and Sex

Table 9 shows the distribution of ridge type by locality and sex.

Table 9. Distribution of ridge type by locality and sex.

Localities	Rosy Comb		Single Comb		Total
	n	%	N	%	N
Doukoula	3	8.11	34	91.89	**37**
Dziguilao	2	5	38	95	**40**
Guidiguis	1	2.08	47	97.92	**48**
Maroua 3	2	5.88	32	94.12	**34**
Meri	4	9.76	37	90.24	**41**
Yagoua	7	17.5	33	82.5	**40**
Total	**19**	**7.92**	**221**	**92.08**	**240**
Sex					
Female	16	9.30	156	90.70	**172**
Male	3	4.41	65	95.59	**68**
Total	**19**	**7.92**	**221**	**92.08**	**240**
t.c.			*		

n: Number; **%:** Frequency; **t.c.:** contingency test; ***:** not significant ($p > 0.01$). The contingency test ($p > 0.01$) shows that sex and locality do not influence the type of comb of local chicken populations.

As for the types of combs (**Table 9**), the "Single comb" type (92%) largely dominates compared to the "Rosy comb" type (9.30%). Although it is poorly represented in the localities; the rosy comb type in females is better represented (9.30%) compared to its frequency in males (4.41%). On the other hand, the single comb type is slightly higher in males (95.59%) than in females (90.70%). These results corroborate those obtained by Aklilu *et al.* [27]; Moreda *et al.* [24] illustrating the dominance of the simple comb type. Also, Moula *et al.* [21] observed three types of comb in the Kabyle hen in Algeria: the single comb type; the double comb type and the triple comb type, with a predominance of the single comb type (93%). Similarly, the observations of Moula *et al.* [17] on local hens in Algeria, Vietnam and the Democratic Republic of the Congo showed three types of comb, of which the single type predominates with 85% and the pea and double types are rarer.

4. Conclusion and Perspectives

At the end of this study, which was carried out in the main breeding basins of local chickens in the Far North Region of Cameroon, it appears that the genetic material in family farms is distinguished by a significant phenotypic variation attributable to visible genes. Despite the high exposure to the difficult environments in which they evolve, the rich genetic diversity seems to evolve in an anarchic manner. The description of qualitative characteristics illustrates a strong variability of colorations. The White-Pie-Black and thousand flower plumages, the red wattles and crests, the white defects and skin are all dominant. The "Smooth-uniform" feathering and the medium format type are also dominant. These observations give this population of local chickens an important socio-economic, cultural and ritual place. Furthermore, this diversity appears highly conducive to the reconstitution of livestock in family farms impacted by recurring epidemiological incidences. Thus, the biodiversity observed within the local chicken population suggests possibilities for preservation and genetic improvement through recommended selection and/or crossbreeding methods. Biometric, zootechnical and molecular characterization studies would be necessary to better observe genetic types and performances in controlled environments and better assess diversity at the genome level of local chickens.

Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

References

[1] Ayssiwede, S.B., Dieng, A., Houinato, M.R.B., Chrysostome, C.A.A.M., Issay, Hornick, J.L. and Missohou, A. (2011) Elevage des poulets traditionnels ou indigènes au Sénégal et en Afrique Subsaharienne: Etat des lieux et contraintes. *Annales de Médecine Vétérinaire*, **157**, 103-119.

[2] Ngouonimba, H.J.S., Itoua, O., Paul, M. and Parisse, A. (2019) Aperçu de quelques paramètres qualitatives dans la caractérisation morpho-biométrique des poules locales (*Gallus gallus*) ou 'Batéké' dans les périphéries Nord et Sud de Brazzaville en République du Congo. *Journal of Animal & Plant Sciences*, **42**, 7175-7197. https://doi.org/10.35759/janmplsci.v42-2.1

[3] Fotsa, J.C., Rognon, X., Tixier-Boichard, M., Coquerelle, G., Poné Kamdem, D., Ngou Ngoupayou, J.D., *et al.* (2010) Caractérisation phénotypique des populations de poules locales (*Gallus gallus*) de la zone forestière dense humide à pluviométrie bimodale du Cameroun. *Animal Genetic Resources/Ressources Génétiques Animales/Recursos Genéticos Animales*, **46**, 49-59. https://doi.org/10.1017/s207863361000069x

[4] MINEPIA (2021) Annuaire statistiques du sous-secteur l'élevage, des pêches et des industries animales. 67.

[5] INS (2019) Annuaire statistiques 2028 de la Région de l'Extrême-Nord. 276.

[6] Larivière, J.M. and Leroy, P. (2008) Conservation et valorisation de la diversité des ressources génétiques du poulet en Europe: Initiatives et perspectives. *Annales de Médecine Vétérinaire*, **152**, 203-220.

[7] FAO (2013) Caractérisation phénotypique des ressources génétiques animales. Directives FAO sur la Production et la Santé Animales No. 11, 151.

[8] AU-IBAR (2014) Assessment of Animal Genetic Resources Characterization, Inventory and Monitoring Tools to Guide Revision and Harmonization Processes. Report of the Workshop of the Genetics Project, 52.

[9] INS (2019) Annuaire statistique du Cameroun. 261.

[10] Mahammi, F.Z., Gaouar, S.B.S., Tabet-Aoul, N., Tixier-Boichard, M. and Saïdi-Mehtar, N. (2014) Morpho-Biometric Characteristics and Breeding Systems of Local Chickens in the Oranie Region (West Algeria). *Cahiers Agricultures*, **23**, 382-392. https://doi.org/10.1684/agr.2014.0722

[11] Messabhia, A. (2016) Caractérisation phénotypique et profil biochimique de quel-ques souches locales de poules en Algérie. Ph.D. Thesis, Université Frères Mentouri-Constantine 1.

[12] Roukayath, C.T. (2008) Caractérisation phénotypique et gestion de la population de poulets locaux dans les communes de Dassa et de Toffo au Bénin. Master's Thesis, Université d'Abomey-Calavi.

[13] Haoua, M.T., Poutougnigni, M.Y., Keambou, T.C. and Manjeli, Y. (2015) Morphobiometrical Diversity of the Indigenous Chicken's Population in the Sudano-Sahelian Zone of Cameroon. *Scientific Journal of Animal Science*, **4**, 133-154.

[14] Bessadok, A., Imen, K. and El Gazzah, M. (2003) Etat des ressources génétiques de la population locale du poulet en Tunisie. *Tropicultura*, **21**, 167-172.

[15] Sarker, N.R., Hoque, A., Faruque, S., Islam, N. and Bhuiyan, F.H. (2014) An *ex Situ* Study on Body Characteristics and Effect of Plumage Color on Body Weight of Indigenous Chicken (*Gallus domesticus*) in Bangladesh. *Acta Scientiarum*. *Animal Sciences*, **36**, 79-84. https://doi.org/10.4025/actascianimsci.v36i1.20118

[16] Keambou, T.C., Manjeli, Y., Tchoumboue, J., Teguia, A. and Iroume, R.N. (2007) Caractérisation morpho-biométrique des ressources génétiques de poules locales des hautes terres de l'ouest Cameroun. *Livestock Research for Rural Development*, **19**, Article No. 107. http://www.lrrd.org/lrrd19/8/keam19107.htm

[17] Moula, N., Luc, D.D., Dang, P.K., Farnir, F., Ton, V.D., Binh, D.V., Leroy, P. and Antoine-Moussiaux, N. (2011) The Ri Chicken Breed and Livelihoods in North Vietnam: Characterisation and Prospects. *Journal of Agriculture and Rural Development in the Tropics and Subtropics*, **112**, 57-69.

[18] Bembide, C., Hako Touko, B.A., Manjeli, Y. and Keambou Tiambo, C. (2013) Caractérisation morphobiométrique de la poule locale en Centrafrique. *Animal Genetic Resources/Ressources Génétiques Animales/Recursos Genéticos Animales*, **53**, 33-44. https://doi.org/10.1017/s2078633612000525

[19] Mahammi, F.Z. (2015) Caractérisation phénotypique et moléculaire des populations de poules locales (*Gallus gallus domesticus*) de l'Ouest Algérien. Master's Thesis, Université des Sciences et de la Technologie d'Oran.

[20] Cabarles, J.C., Lambio, A.L., Vega, S.A., Capitan, S.S. and Mendioro, M.S. (2012) Distinct Morphological Features of Traditional Chickens (*Gallus gallus domesticus* L.) in Western Visayas, Philippines. *Animal Genetic Resources/Ressources Génétiques Animales/Recursos Genéticos Animales*, **51**, 73-87.

https://doi.org/10.1017/s2078633612000410

[21] Moula, N., Moussiaux, A.N., Farnir, F., Detilleux, J. and Leroy, P. (2009) Réhabilitation socioéconomique d'une poule locale en voie d'extinction: La poule Kabyle (*Thayazit lekvayel*). *Annales de médecine vétérinaire*, **153**, 178-186.

[22] Duguma, R. (2006) Phenotypic Characterization of Some Indigenous Chicken Ecotypes of Ethiopia. *Livestock Research for Rural Development*, **18**, Article No. 131. http://www.lrrd.org/lrrd18/9/dugu18131.htm

[23] Dao, B., Kossoga, A., Lombo, Y., Ekoué, S., Talaki, E., Dayo, G.K. and Bonfoh, B. (2015) Caractérisation phénotypique des populations locales de Poulets (*Gallus gallus domesticus*) au Togo. *Bulletin of animal health and production in Africa*, **63**, 15-33.

[24] Moreda, E., Singh, H., Sisaye, T. and Johansson, A.M. (2014) Phenotypic Characterization of Indigenous Chicken Population in South West and South Part of Ethiopia. *British Journal of Poultry Sciences*, **3**, 15-19.

[25] Getu, A. and Tadese, A. (2014) A Phenotypic and Genetic Characterized Indigenous Chicken Ecotypes in Ethiopia. *International Journal of Applied Science and Engineering*, **2**, 22-27.

[26] Fotsa, J.C., Bordas, A., Rognon, X., Tixier-Boichard, M., Poné, K.D. and Manjeli, Y. (2007) Caractérisation des élevages des poules locales et comparaison en station de leurs performances à celles d'une souche commerciale de type label au Cameroun. *Septièmes Journées de la Recherche Avicoles*, Tours, 28-29 March 2007, 414-417.

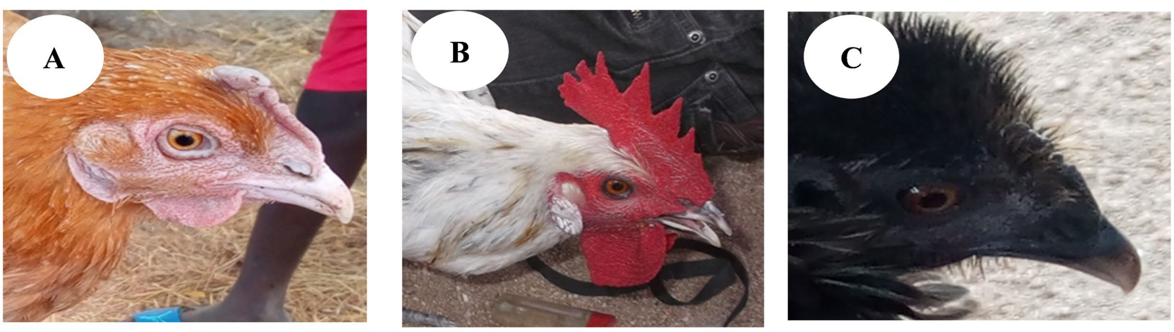
[27] Aklilu, E., Kebede, K., Dessie, T. and Banerjee, A.K. (2013) Phenotypic Characterization of Indigenous Chicken Population in Ethiopia. *International Journal of Interdisciplinary and Multidisciplinary Studies*, **1**, 24-32.

Appendix: Phenotype Observed in Local Chicken Populations from Different Breeding Areas in the Far North Region of Cameroon

Legend: Types of feathering coloring

Image A: White; **Image B:** Black golden; **Image C:** White pie black; **Image D:** Multicolore; **Image E:** Fowny plumage; **Image F:**Red plumage; **Image G:** White golden; **Image H:**Ermined **Image I:** Partridge golden; **Image J:** Black; **Image K**: Black and Red golden; **Image L:** Red golden

Figure A1. Types of feathering coloring from local chicken breeding.



Légend: Type of comb coloring

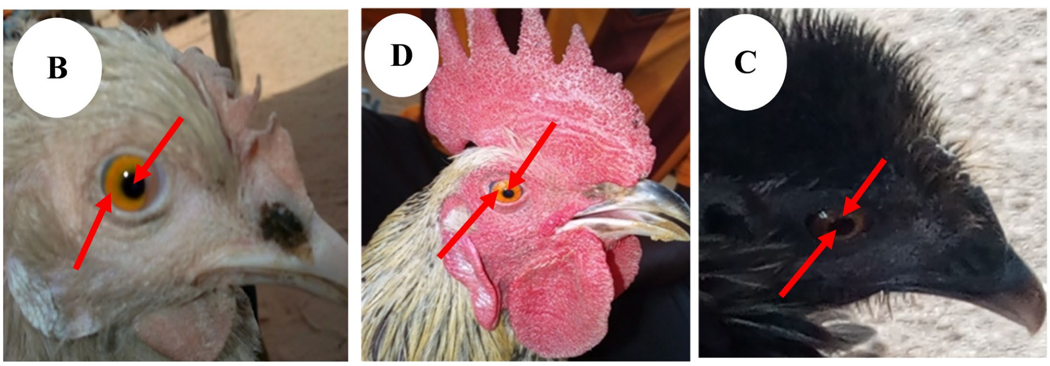
Image A: Pink; **Image B:** Red; **Image C:** Black

Figure A2. Type of comb coloring from local chicken breeding.

<u>Légend:</u> Type of beak coloring

Image A: Grey; **Image B:** Yellow;**Image C:** Black; **Image D:** White; **Image E:** Grey and White; **Image F:** Yellow and White; **Image G:** Black and White; **Image H:** Black and Yellow

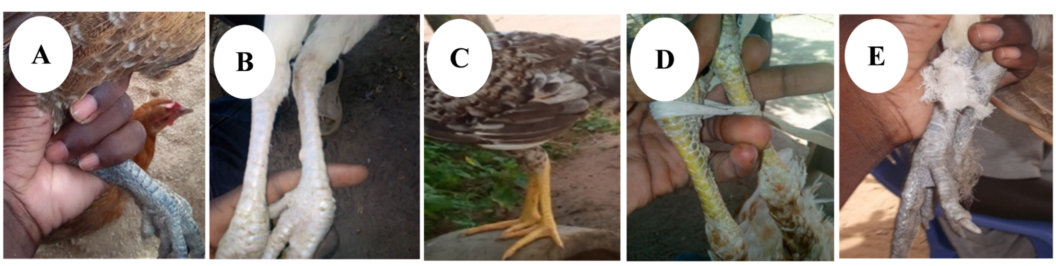
Figure A3. Type of beak coloring from local chicken breeding.



<u>Légend:</u> Type of eyelobe coloring

Image A: Black and yellow; **Image B:** Black and Orange**; Image C:** Black and gray

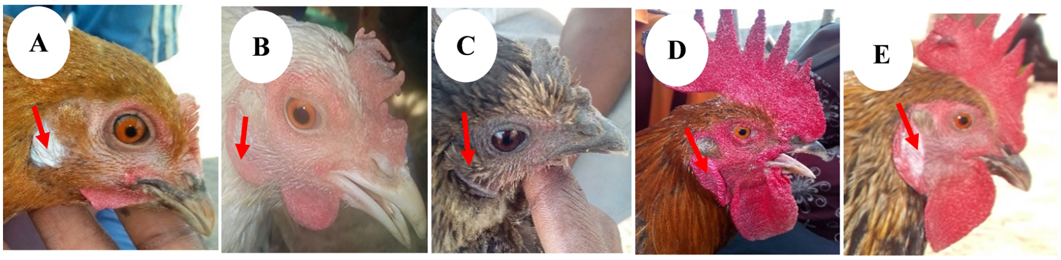
Figure A4. Type of eyelobe coloring from local chicken breeding.



<u>Légend:</u> Type of tarsi coloring

Image A: Black; **Image B:** white; **Image C:** Yellow; **Image D:** Yellow greenish; **Image E:** Ash

Figure A5. Type of tarsi coloring from local chicken breeding.



Légend: Type of mumps coloring

Image A: White; **Image B:** Pink; **Image C:** Black; **Image D:** Red; **Image E:** Red and white.

Figure A6. Type of mumps coloring from local chicken breeding.