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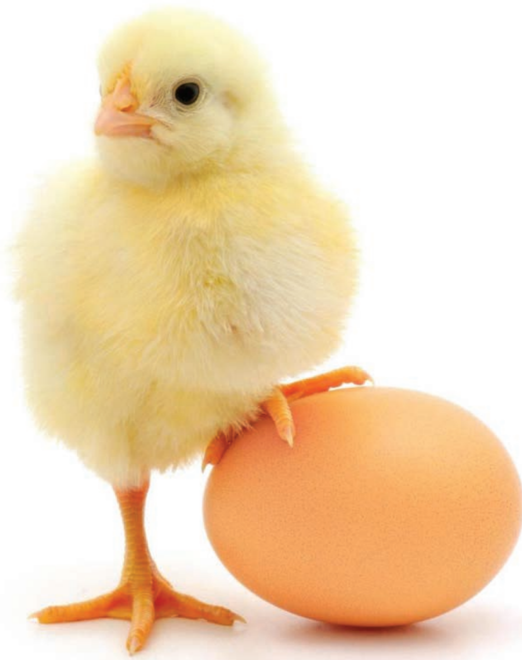

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Research Article
Morpho-Biometric Characterization of Indigenous Guinea fowl (*Numida meleagris*) Populations in Northern Togo

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Abstract
Objective: The present study aimed at carrying out the morpho-biometric characterization of indigenous guinea fowl populations. **Materials and Methods:** Data collection was conducted between March and July 2018 in two agroecological zones in northern Togo. The study was carried out on 738 adult guinea fowl. Each animal was described by direct observation. Body weight and measurements were recorded. **Results:** The results revealed twelve colours of the plumage with a dominance of Bonaparte (39.0%) and Pearl grey (27.1%) colours and a rarity of Cinnamon pied (0.7%), Isabelle (0.3%) and Coral blue (0.1%) colours. The plumage was mostly smooth (90.5%). The eyes were mostly brown (57.0%) but Albino guinea fowl predominantly had white colour (85.2%) for the eye. Regardless of the phenotype, the helmet was curved (73.2%) and mumps white-bluish colour (85.5%). In Atakora, the beak was brown (81.3%), the wattles were red-white (49.8%), the shanks were black-red (32.6%) and the toes were red (47.6%) while in the Dry Savannah the beak was red (52.9%), the wattles were red-bluish (38.4%), the shanks were black-orange (12.3%) and the toes were grey (35.2%). For the beak length, drumstick length, body length and body weight, the Dry Savannah guinea fowl showed significantly ($p<0.05$) higher values than those of Atakora guinea fowl. Moreover, guinea fowl with Pearl grey phenotype (1.36 ± 0.28 kg) were heavier ($p<0.05$) than the other phenotypes. **Conclusion:** Positive relationship could not be established between phenotype and biometric characteristics in this study. Further studies are required using molecular and zootechnical information to establish relationship between different phenotypes.

Key words: Guinea fowl, morpho-biometric characterization, diversity, poultry farming, Togo

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Competing Interest: The authors have declared that no competing interest exists.

Data Availability: All relevant data are within the paper and its supporting information files.

INTRODUCTION

Traditional poultry farming in sub-Saharan Africa and more specifically in Togo, contributes to the strengthening of family farming through its contribution to the creation of jobs, incomes and the achievement of food security objectives for rural households[1-3]. In recent decades, with the rapid urbanization of rural areas, intensive poultry farming is developing. The intensive poultry farming, whose main speculation is eggs and meat production, requires significant technical and financial resources beyond the reach of subsistent farmers[4]. However, despite its low levels of investment and productivity, traditional poultry farming continues to occupy an important place in the livelihoods of the people especially in rural areas where poultry are kept for multiple purposes such as consumption, religious and social practices, income generation through the sale of eggs and birds[5-7].

In Togo, family poultry is widespread especially in rural areas. It is practiced by more than 90% of households[8]. One of the major species of poultry mainly reared in the northern part of the country is the indigenous guinea fowl (*Numida meleagris*). It is a family rearing characterized by promiscuity between guinea fowl and animals of different species. The animals feed mainly around the farm. Most farmers do not care for their birds and their houses are built with precarious materials[8]. Guinea fowl production in Togo encounters many constraints such as health management, feed supply and housing (especially of keets) and causing high mortality of 80-100%[3,9,10]. Therefore, many studies are being conducted to improve indigenous guinea fowl producting conditions for a better productivity[3,11-14]. However, in order to appropriately apply all the management and valorization strategies being developed, prior knowledge of the resources available and their performance is required. To our knowledge there are no reports on the phenotypic and genetic characterization of the indigenous guinea fowl in Togo. This study therefore aimed to contribute to a better knowledge of this species in Togo for its better use in the improvement and development programs. Specifically, the morphological and biometric characteristics of indigenous guinea fowl in northern Togo were studied.

MATERIALS AND METHODS

Study areas: The study was conducted in northern Togo and specifically in two agroecological zones: the Dry Savannah and Atakora zones. Guinea fowl production is predominant in these two agroecological zones in Togo[15].

The north of Togo is located between 0° and 1° East longitude and 9° and 11° latitude North.

- **The dry savannah zone:** it is located in the extreme north of the country covering the Savannah region and Keran prefecture. It is a lowland area. Precipitation, mainly between May and October, ranges between 1000 and 1100 mm per year with an average of 82 days of rain. Temperature is between 22 and 35°C.
- **Atakora:** it is an area of mountains covering Kara region minus Keran prefecture. Annual rainfall varies from 1100-1400 mm with an average of 113 days of rain. The temperature ranges between 21 and 34°C.

Sampling and data collection: The study was conducted between March and July , 2018 in fourteen prefectures of the two agroecological zones (Fig. 1). Two villages per prefecture were selected in all prefectures except three prefectures where one and three villages were sampled. The selection criteria were demarcation by minimum distance between villages to obtain the least related animals possible, the presence of' family farms of sufficient size, the accessibility of the area and the availability of' breeders. In each village, three farmers each having at the time of the study, at least five adult guinea fowl, were interviewed. Each guinea fowl was subjected to a direct phenotypic description, measurements and photography. Qualitative data were: the colour and type of plumage, the shape of the helmet, the colour of the beak, the colour of eye, the colours of mumps and wattles, the colour of shank and toes. Quantitative measures recorded were: the beak length, the wattles length, the dewlap length, the shank length and diameter, the drumstick length, the body length, the wingspan, the chest circumference and the body weight. The quantitative data were collected using an electronic balance of 1 g precision, a vernier caliper of 0.01 mm precision and a tape measure. Qualitative characteristics were described by visual observation. All descriptions and measures were taken by the same investigator. Thus, 738 guinea fowl were sampled in 81 farms of 27 villages.

The different body measurements were performed according to the following definitions:

- **Length of the beak:** Distance between the tip of the upper mandible and the commissure of the two mandibles.
- **Length of wattles:** Distance between the insertion point of the wattle in the head and the lowest point.

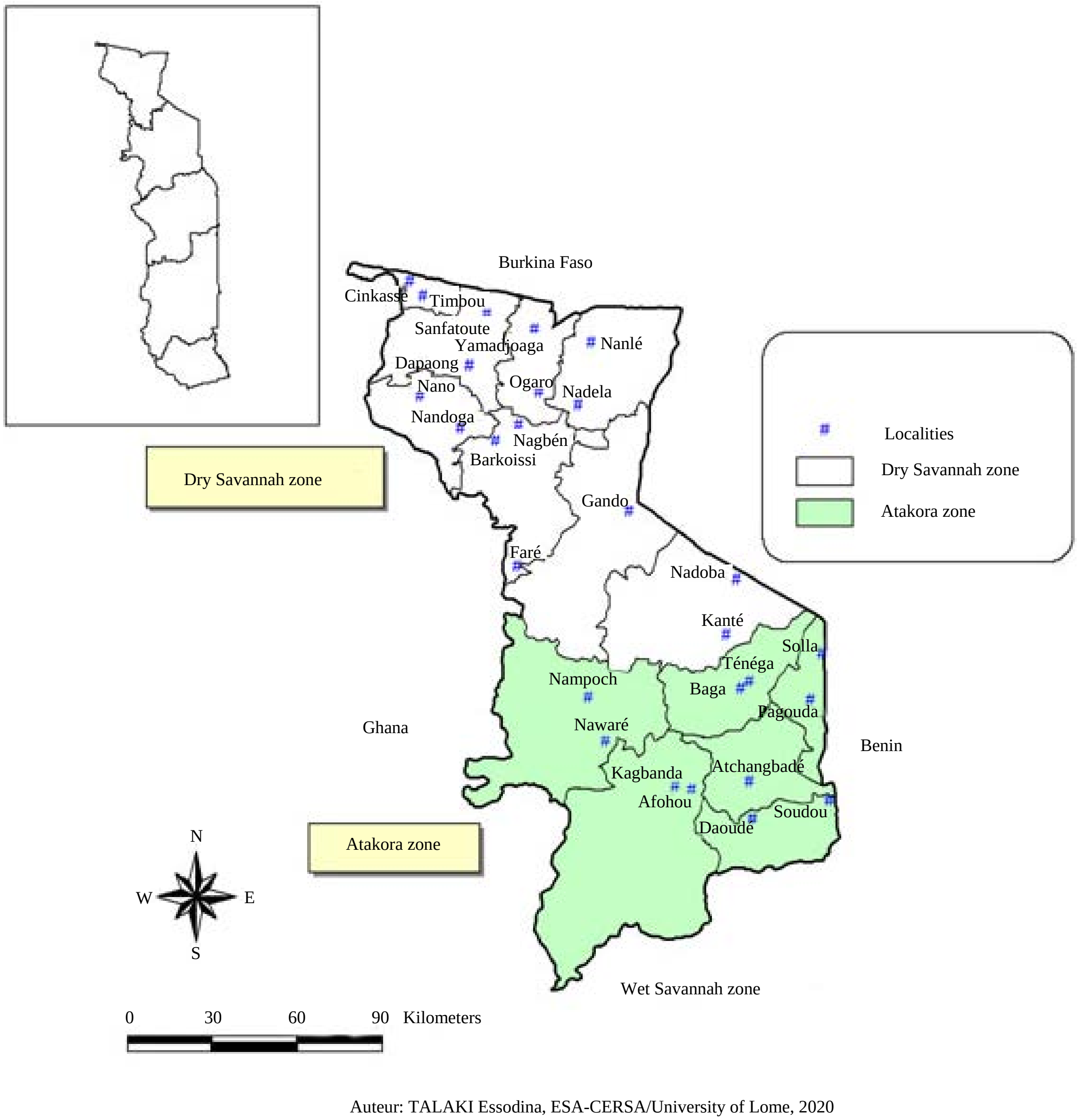

Fig. 1: Sampled sites location

- **Length of the dewlap:** Distance between the insertion chin and its terminal end.
- **Body length:** Distance between the tip of the upper mandible and the tail (without feathers), the body of the bird was gently stretched over its entire length.
- **Chest circumference:** Chest circumference outlet below the wings and at the projecting region of the sternum
- **Wingspan:** length between the ends of the right and the left wings after having gently stretched them at full length.
- **Drumstick length:** Distance between the knee (femoro-tibial joint) and the joint with the tarsus.
- **Shank length:** Length from the articulation with the drumstick to the spur of each shank.
- **Shank diameter:** Measured perpendicular to the anterior-posterior plane and in the middle portion of the shank.
- **Body weight:** Live weight of the guinea fowl.

Statistical analysis: Descriptive statistics were used to describe the colour of the plumage and other morphological features. Z test was used to compare the percentages between agroecological zones and between phenotypes. Mann-Whitney test and Kruskal-Wallis test were used to compare the quantitative variables respectively between agroecological zones and between phenotypes. Dunn-test (with Bonferroni correction) was used for pairwise comparisons whenever Kruskal-Wallis test showed significant differences. The differences were significant if the probability (p-value) was less than 5%. All statistical analyzes were performed using Statistical Package for Social Science (SPSS) Statistic 20 software.

RESULTS

Morphological characteristics

Plumage colours (phenotypes): A great diversity of plumage coloration was observed with a total of 12 colours (Fig. 2). The most frequently five colours observed were: Bonaparte (39.0%), Pearl grey (27.1%), Multicoloured (14.1%), Royal purple (7.2%) and Albino (3.7%) (Table 1). The agroecological zone influenced significantly ($p<0.05$) the plumage coloration. Bonaparte (50.6%) and Black pied (6.4%) proportions in Atakora were higher ($p<0.05$) than those of Dry savannah which were respectively 32.5 and 1,1%. On the other hand, Pearl grey (31.8%) and Lavender (3.0%) phenotypes were more encountered ($p<0.05$) in Dry Savannah than in Atakora (18.7 and 0.4%).

Type of plumage and shape of the helmet: The type of plumage was influenced ($p<0.05$) by the agroecological zone. Two types of plumages were observed with a predominance of the smooth type (90.5%) (Table 2). The proportion of

Table 1: Frequency of plumage colour by agroecological zone

	Agroecological zones					
	Atakora		Dry savannah		Total	
Plumages	No.	Percentage	No.	Percentage	No.	Percentage
Phenotypes						
Albino	6	2.2[a]	21	4.5[a]	27	3.7
Coral blue	1	0.4[a]	0	0.0	1	0.1
Bonaparte	135	50.6[a]	153	32.5[b]	288	39.0
Cinnamon pied	1	0.4[a]	4	0.8[a]	5	0.7
Chamois	3	1.1[a]	8	1.7[a]	11	1.5
Pearl grey	50	18.7[a]	150	31.8[b]	200	27.1
Isabelle	1	0.4[a]	1	0.2[a]	2	0.3
Lavender	1	0.4[a]	14	3.0[b]	15	2.0
Lavender pied	1	0.4[a]	9	1.9[a]	10	1.4
Black pied	17	6.4[a]	5	1.1[b]	22	3.0
Multicolored	29	10.9[a]	75	15.9[a]	104	14.1
Royal purple	22	8.2[a]	31	6.6[a]	53	7.2
Total	267	100.0	471	100.0	738	100.0

Values with different superscripts are significantly different ($p<0.05$). Proportions equal to 0 or 100% were not included in the test

Table 2: Frequency of plumage type and helmet shape by phenotype and agroecological zone

	Type of plumage				Shape of helmet					
	Smooth		Silky		Erect		Curved		Total	
Characters	No.	Percentage	No.	Percentage	No.	Percentage	No.	Percentage	No.	Percentage
Phenotypes										
Albino	0	0.0	27	100.0	5	18.5	22	81.5	27	100.0
Coral blue	1	100.0	0	0.0	0	0.0	1	100.0	1	100.0
Bonaparte	288	100.0	0	0.0	89	30.9	199	69.1	288	100.0
Cinnamon pied	5	100.0	0	0.0	0	0.0	5	100.0	5	100.0
Chamois	0	0.0	11	100.0	1	9.1	10	90.9	11	100.0
Pearl grey	200	100.0	0	0.0	64	32.0	136	68.0	200	100.0
Isabelle	2	100.0	0	0.0	1	50.0	1	50.0	2	100.0
Lavender	14	93.3	1	6.7	1	6.7	14	93.3	15	100.0
Lavender pied	7	70.0	3	30.0	4	40.0	6	60.0	10	100.0
Black pied	22	100.0	0	0.0	3	13.6	19	86.4	22	100.0
Multicolored	76	73.1	28	26.9	19	18.3	85	81.7	104	100.0
Royal purple	53	100.0	0	0.0	11	20.8	42	79.2	53	100.0
Zones										
Atakora	254	95.1[a]	13	4.9[a]	72	27.0	195	73.0	267	100.0
Dry Savannah	414	87.9[b]	57	12.1[b]	126	26.8	345	73.2	471	100.0
Total	668	90.6	70	9.3	198	26.8	540	73.2	738	100.0

Values with different superscripts are significantly different ($p<0.05$). Proportions equal to 0 or 100% were not included in the test

Fig. 2(a-l): Plumage colours: (a) Albino or White without pearls, (b) Chamois or White with pearls, (c) Pearl grey, (d) Bonaparte, (e) Royal purple, (f) Black pied, (g) Coral blue, (h) Lavender, (I) Lavender pied, (j) Isabelle, (k) Cinnamon pied, (l) Multicolored

smooth plumage was higher (p<0,05) in Atakora (95.1%) than in Dry Savannah (87.9%) and inversely for the silky plumage with 12.1% in Dry Savannah and 4.9% in Atakora.

The shape of the helmet was neither associated with the agroecological zone nor with the phenotype (p>0.05). Two forms of helmet (curved and erect) were identified with a predominance of the curved form (73.2%) (Table 2).

Coloration of the beak: Only the agroecological zone had a significant effect (p<0.05) on the colour of the beak. Two colorations were identified: the brown colour and the red colour (Table 3). Brown colour was higher (p<0.05) in Atakora (81.3%) than Dry Savannah (47.1%) while red colour was more represented in Dry Savannah (52.9%) than Atakora (18,7%).

Coloration of eyes: Six colorations of the eye were observed with a dominance of brown colour (57.0%) (Table 4). The agroecological zone and the phenotype significantly influenced (p<0.05) the coloration of eyes. The grey-white colour was majority in Atakora (7.1%) while it only represented 0.4% in the Dry Savannah. Guinea fowl with a white coloration of the plumage (Albino and Chamois) had mostly white eyes. The proportion of this white coloration of the eyes was on the one hand higher in the Albino (85.2%) than in the Chamois

Table 3: Frequency of beak coloration by phenotype and by agroecological zone

	Coloration of the beak					
	Brown		Red		Total	
Characters	No.	Percentage	No.	Percentage	No.	Percentage
Phenotypes						
Albino	10	37.0	17	63.0	27	100.0
Coral blue	1	100.0	0	0.0	1	100.0
Bonaparte	196	68.1	92	31.9	288	100.0
Cinnamon pied	2	40.0	3	60.0	5	100.0
Chamois	3	27.3	8	72.7	11	100.0
Pearl grey	115	57.5	85	42.5	200	100.0
Isabelle	1	50.0	1	50.0	2	100.0
Lavender	5	33.3	10	66.7	15	100.0
Lavender pied	5	50.0	5	50.0	10	100.0
Black pied	15	68.2	7	31.8	22	100.0
Multicolored	53	51.0	51	49.0	104	100.0
Royal purple	33	62.3	20	37.7	53	100.0
Zones						
Atakora	217	81.3^{a}	50	18.7^{a}	267	100.0
Dry Savannah	222	47.1^{b}	249	52.9^{b}	471	100.0
Total	439	59.5	299	40.5	738	100.0

Values with different superscripts are significantly different ($p<0.05$). Proportions equal to 0 or 100% were not included in the test

Table 4: Frequency of eyes coloration by phenotype and by agroecological zone

	Coloration of eyes													
	White-brown		White-grey		White		Brown		Grey		Black		Total	
Characters	No.	Percentage	No.	Percentage	No.	Percentage	No.	Percentage	No.	Percentage	No.	Percentage	No.	Percentage
Phenotypes														
Albino	1	3.7^{a}	0	0.0	23	85.2^{a}	2	7.4^{a}	1	3.7^{ac}	0	0.0	27	100.0
Coral blue	0	0.0	0	0.0	1	100.0	0	0.0	0	0.0	0	0.0	1	100.0
Bonaparte	1	0.3^{b}	15	5.2^{a}	16	5.6^{bdh}	160	55.6^{bc}	53	18.4^{ac}	43	14.9^{a}	288	100.0
Cinnamon pied	0	0.0	0	0.0	1	20.0^{acfh}	3	60.0^{abe}	0	0.0	1	20.0^{a}	5	100.0
Chamois	0	0.0	0	0.0	2	18.2^{bcef}	8	72.7^{bce}	1	9.1^{abc}	0	0.0	11	100.0
Pearl grey	0	0.0	0	0.0	2	1.0^{d}	127	63.5^{be}	44	22.0^{a}	27	13.5^{a}	200	100.0
Isabelle	0	0.0	0	0.0	0	0.0	2	100.0	0	0.0	0	0.0	2	100.0
Lavender	0	0.0	0	0.0	1	6.7^{bdef}	3	20.0^{acd}	10	66.7^{b}	1	6.7^{a}	15	100.0
Lavender pied	0	0.0	1	10.0^{a}	4	40.0^{aef}	0	0.0	4	40.0^{ab}	1	10.0^{a}	10	100.0
Black pied	0	0.0	3	13.6^{a}	6	27.3^{f}	10	45.4^{ab}	2	9.1^{ac}	1	4.5^{a}	22	100.0
Multicolored	0	0.0	2	1.9^{a}	23	22.1^{fg}	61	58.6^{bd}	6	5.8^{c}	12	11.5^{a}	104	100.0
Royal purple	0	0.0	0	0.0	0	0.0	45	84.9^{e}	6	11.3^{ac}	2	3.8^{a}	53	100.0
Zones														
Atakora	1	0.4^{a}	19	7.1^{a}	22	8.2^{a}	148	55.4^{a}	43	16.1^{a}	34	12.7^{a}	267	100.0
Dry Savannah	1	0.2^{a}	2	0.4^{b}	57	12.1^{a}	273	58.0^{a}	84	17.8^{a}	54	11.5^{a}	471	100.0
Total	2	0.3	21	2.8	79	10.7	421	57.0	127	17.2	88	11.9	738	100.0

Values with different superscripts are significantly different ($p<0.05$). Proportions equal to 0 or 100% were not included in the test

(18.2%) and on the other hand this coloration was less present in Pearl grey (1.0%) than in Albinos and Chamois guinea fowl.

Coloration of mumps: Four colorations of mumps were identified (Table 5). The phenotype and the agroecological zone significantly influenced ($p<0.05$) the coloration of mumps. The bluish-white and bluish colorations were more represented in Atakora (89.5 and 2.6%) than in Dry Savannah (83.2 and 0.21%) whereas the white coloration was more observed in Dry Savannah (8.9%) compared to Atakora (0.7%). The bluish-white colour was higher in Pearl grey (94.5%), Royal Purple (94.3%) and Bonaparte (92.7%) phenotypes compared to Albino (11.1%) and Chamois (9.1%) phenotypes. However, the pink-white colour was more observed in the Albino (88.9%) and Chamois (54.5%) phenotypes than in Multicolored (11.5%) and Bonaparte (1.4%) phenotypes.

Fig. 3(a-h): Wattles colours: (a) White, (b) Bluish-white, (c) Bluish-red, (d) Red-white, (e) Red, (f) Pink-white, (g) Bluish-pink and (h) Pink

Table 5: Frequency of mumps coloration by phenotype and by agroecological

	Coloration of mumps									
	Bluish-white		White-pink		White		Bluish		Total	
Characters	No.	Percentage	No.	Percentage	No.	Percentage	No.	Percentage	No.	Percentage
Phenotypes										
Albino	3	11.1^{a}	24	88.9^{a}	0	0.0	0	0.0	27	100.0
Coral blue	1	100.0	0	0.0	0	0.0	0	0.0	1	100.0
Bonaparte	267	92.7^{b}	4	1.4^{b}	13	4.5^{a}	4	1.4^{a}	288	100.0
Cinnamon pied	3	60.0^{abef}	1	20.0^{cef}	1	20.0^{ab}	0	0.0	5	100.0
Chamois	1	$9.1^{a.d}$	6	54.5^{ac}	4	36.4^{b}	0	0.0	11	100.0
Pearl grey	189	94.5^{b}	0	0.0	7	3.5^{a}	4	2.0^{a}	200	100.0
Isabelle	2	100.0	0	0.0	0	0.0	0	0.0	2	100.0
Lavender	12	80.0^{bcef}	0	0.0	3	20.0^{ab}	0	0.0	15	100.0
Lavender pied	6	60.0^{acefg}	3	30.0^{ce}	1	10.0^{ab}	0	0.0	10	100.0
Black pied	14	63.6^{def}	5	22.7^{cde}	3	13.6^{ab}	0	0.0	22	100.0
Multicolored	83	79.8^{fg}	12	11.5^{e}	9	$8.6^{a.b}$	0	0.0	104	100.0
Royal purple	50	94.3^{bg}	0	0.0	3	$5.7^{a.b}$	0	0.0	53	100.0
Zones										
Atakora	239	89.5^{a}	19	7.1^{a}	2	0.7^{a}	7	2.6^{a}	267	100.0
Dry Savannah	392	83.2^{b}	36	7.6^{a}	42	8.9^{b}	1	0.2^{b}	471	100.0
Total	631	85.5	55	7.4	44	6.0	8	1.1	738	100.0

Values with different superscripts are significantly different ($p<0.05$). Proportions equal to 0 or 100% were not included in the test

Coloration of wattles: Eight colorations of the wattles were identified (Fig. 3 and Table 6). The dominant colours were red-white (37.4%), bluish-red (35.1%) and red (19.1%). The effect of the agroecological zone and the phenotype was significant ($p<0.05$) on the coloration of the wattles. The red-white colour was dominant in Atakora (49.8%) while the bluish-red (38.4%) and red (23.4%) colours were dominant in Dry Savannah. The red-white colour was mainly observed in Black pied (68.2%), Albino (59.3%), Royal purple (54.7%), Multicolored (50.0%) while the bluish-red colour was predominantly found in Pearl grey phenotypes (61.5%).

Coloration of shanks: Ten colorations were identified in the shanks (Fig. 4 and Table 7) with a predominance of black-red (25.1%), red (20.5%) and black (17.9%) colours. The agroecological zone and the phenotype had a significant

Table 6: Frequency of wattles coloration by phenotype and by agroecological zone

	Coloration of wattles																	
	Bluish-white		White		Pink		Pink-white		Bluish-pink		Red		Red-white		Bluish-red		Total	
Characters	No.	%age	No.	%age	No.	%age	No.	%age	No.	%age	No.	%age	No.	%age	No.	%age	No.	%age
Phenotypes																		
Albino	0	0.0	0	0.0	0	0.0	1	3.7^{ab}	0	0.0	10	37.0^{a}	16	59.3^{a}	0	0.0	27	100.0
Coral blue	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	1	100.0	0	0.0	1	100.0
Bonaparte	0	0.0	0	0.0	4	1.4^{a}	11	3.8^{ab}	5	1.7^{a}	57	19.8^{a}	118	41.0^{a}	93	32.3^{ac}	288	100.0
Cinnamon pied	0	0.0	0	0.0	0	0.0	0	0.0	1	20.0^{b}	1	20.0^{a}	3	60.0^{ab}	0	0.0	5	100.0
Chamois	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	6	54.5^{a}	5	45.5^{b}	0	0.0	11	100.0
Pearl grey	3	1.5^{a}	0	0.0	2	1.0^{a}	3	1.5^{a}	7	3.5^{ab}	32	16.0^{a}	30	15.0^{b}	123	61.5^{b}	200	100.0
Isabelle	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	2	100.0	2	100.0
Lavender	1	6.7^{a}	0	0.0	0	0.0	1	6.7^{ab}	0	0.0	3	20.0^{a}	3	20.0^{ab}	7	46.7^{ab}	15	100.0
Lavender pied	0	0.0	0	0.0	0	0.0	1	10.0^{ab}	0	0.0	3	30.0^{a}	4	40.0^{ab}	2	20.0^{abc}	10	100.0
Black pied	0	0.0	0	0.0	1	4.5^{a}	2	9.1^{ab}	0	0.0	3	13.6^{a}	15	68.2^{a}	1	4.5^{c}	22	100.0
Multicolored	0	0.0	3	2.9^{a}	1	1.0^{a}	6	5.8^{ab}	1	1.0^{a}	17	16.3^{a}	52	50.0^{a}	24	23.1^{ac}	104	100.0
Royal purple	0	0.0	1	1.9^{a}	1	1.9^{a}	6	11.3^{b}	0	0.0	9	17.0^{a}	29	54.7^{a}	7	13.2^{ac}	53	100.0
Zones																		
Atakora	0	0.0	2	0.7^{a}	6	2.2^{a}	14	5.2^{a}	3	1.1^{a}	31	11.6^{a}	133	49.8^{a}	78	29.2^{a}	267	100.0
Dry Savannah	4	0.8	2	0.4^{a}	3	0.6^{a}	17	3.6^{a}	11	2.3^{a}	110	23.4^{b}	143	30.4^{b}	181	38.4^{b}	471	100.0
Total	4	0,5	4	0,5	9	1.2	31	4.2	14	1.9	141	19.1	276	37.4	259	35.1	738	100.0

Values with different superscripts are significantly different ($p<0.05$). Proportions equal to 0% or 100% were not included in the test

Table 7: Frequency of shanks coloration by phenotype and by agroecological zone

	Coloration of shanks																					
	White		Grey-orange		Grey-red		Grey		Black-white		Black-grey		Black- orange		Black-red		Black		Red		Total	
Characters	No.	%age	No.	%age	No.	%age	No.	%age	No.	%age	No.	%age	No.	%age	No.	%age	No.	%age	No.	%age	No.	%age
Phenotypes																						
Albino	3	11.1^{ab}	0	0.0	0	0.0	2	7.4^{acd}	0	0.0	0	0.0	4	14.8^{a}	0	0.0	0	0.0	18	66.7^{a}	27	100.0
Coral blue	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	1	100.0	0	0.0	0	0.0	0	0.0	0	0.0	1	100.0
Bonaparte	14	4.9^{a}	2	0.7^{a}	0	0.0	21	7.3^{acd}	12	4.2^{ab}	29	10.1^{ab}	16	5.5^{a}	93	32.3^{ac}	39	13.5^{a}	62	21.5^{be}	288	100.0
Cinnamon pied	2	40.0^{bc}	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	1	20.0^{abc}	0	0.0	2	40.0^{abf}	5	100.0
Chamois	2	18.2^{ab}	0	0.0	0	0.0	1	9.1^{acd}	0	0.0	0	0.0	1	9.1^{a}	0	0.0	0	0.0	7	63.6^{ab}	11	100.0
Pearl grey	0	0.0	3	1.5^{ab}	1	0.5^{a}	9	4.5^{ab}	3	1.5^{a}	31	15.5^{a}	18	9.0^{a}	52	26.0^{abc}	79	39.5^{b}	4	2.0^{c}	200	100.0
Isabelle	0	0.0	0	0.0	0	0.0	2	100.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	2	100.0
Lavender	0	0.0	0	0.0	0	0.0	4	26.7^{c}	1	6.7^{ab}	2	13.3^{ab}	1	6.7^{a}	1	6.7^{abc}	5	33.3^{ab}	1	6.7^{bcd}	15	100.0
Lavender pied	2	20.0^{ab}	1	10.0^{b}	2	20.0^{b}	0	0.0	0	0.0	0	0.0	0	0.0	1	10.0^{abc}	0	0.0	4	40.0^{ab}	10	100.0
Black pied	2	9.1^{ab}	0	0.0	0	0.0	0	0.0	3	13.6^{b}	0	0.0	2	9.1^{a}	1	4.5^{ab}	1	4.5^{ac}	13	59.1^{ad}	22	100.0
Multicolored	15	14.4^{b}	2	1.9^{ab}	1	1.0^{a}	12	11.5^{acd}	5	4.8^{ab}	3	2.9^{b}	12	11.5^{a}	14	13.5^{b}	2	1.9^{c}	38	36.5^{ab}	104	100.0
Royal purple	6	11.3^{ab}	0	0.0	0	0.0	1	1.9^{bd}	3	5.7^{ab}	6	11.3^{ab}	7	13.2^{a}	22	41.5^{c}	6	11.3^{ac}	2	3.8^{ef}	53	100.0
Zones																						
Atakora	26	9.7^{a}	0	0.0	1	0.4^{a}	15	5.6^{a}	21	7.9^{a}	24	9.0^{a}	3	1.1^{a}	87	32.6^{a}	31	11.6^{a}	59	22.1^{a}	267	100.0
Dry Savannah	20	4.2^{b}	8	1.7^{a}	3	0.6^{a}	37	7.9^{a}	6	1.3^{b}	48	10.2^{a}	58	12.3^{b}	98	20.8^{b}	101	21.4^{b}	92	19.5^{a}	471	100.0
Total	46	6.2	8	1.1	4	0.5	52	7.0	27	3.7	72	9.8	61	8.3	185	25.1	132	17.9	151	20.5	738	100.0

Values with different superscripts are significantly different ($p<0.05$). Proportions equal to 0% or 100% were not included in the test

Fig. 4(a-j): Shanks colours: (a) Black, (b) Black-white, (c) Black-grey, (d) Black-red, (e) Black-orange, (f) Grey, (g) Grey-red, (h) Grey-orange, (I) Red, (j) White

influence ($p<0.05$) on the shank coloration. The most frequently colours observed in the Atakora were: black-red (32.6%), white (9.7%) and black-white (7.9%) whereas black (21.4%) and black-orange (12.3%) were more observed in Dry Savannah. The proportion of white shanks in Cinnamon pied (40.0%) and Multicolored (14.4%) phenotypes was higher than that of Bonaparte (4.9%) phenotype. Black shanks were most observed in Pearl grey (39.5%) while red shanks were higher in Albino (66.7%) and Chamois (63.6%) phenotypes.

Coloration of toes: Nine colorations of toes were identified (Table 8) with a predominance of red (35.4%), grey (28.7%) and black (12.1%) colours. The agroecological zone and the phenotype significantly influenced($p<0.05$) the coloration of the toes. The most colours observed in Atakora were: red (47.6%), white (13.5%) and black-white (3.7%) whereas the most colours observed in Dry Savannah were: grey (35.2%), black (14.0%) and black-orange (6.8%). The proportion of black toes was higher in Isabelle (50.0%), Pearl grey (31.0%)

Table 8: Frequency of toes coloration by phenotype and by agroecological zone

	Coloration of toes																			
	White		Grey-red		Grey		Black-white		Black-grey		Black-orange		Black-red		Black		Red		Total	
Characters	No.	%age	No.	%age	No.	%age	No.	%age	No.	%age	No.	%age	No.	%age	No.	%age	No.	%age	No.	%age
Phenotypes																				
Albino	2	7.4^{a}	0	0.0	4	14.8^{ab}	0	0.0	0	0.0	4	14.8^{a}	0	0.0	0	0.0	17	63.0^{a}	27	100.0
Coral blue	0	0.0	0	0.0	1	100.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	1	100.0
Bonaparte	19	6.6^{a}	1	0.3^{a}	88	30.6^{ab}	6	2.1^{a}	5	1.7^{a}	8	2.8^{b}	17	5.9^{a}	11	3.8^{a}	133	46.2^{a}	288	100.0
Cinnamon pied	1	20.0^{a}	0	0.0	2	40.0^{ab}	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	2	40.0^{ab}	5	100.0
Chamois	2	18.2^{a}	0	0.0	3	27.3^{ab}	0	0.0	0	0.0	1	9.1^{ab}	0	0.0	0	0.0	5	45.5^{ab}	11	100.0
Pearl grey	0	0.0	0	0.0	60	30.0^{ab}	3	1.5^{a}	12	6.0^{ab}	9	4.5^{ab}	22	11.0^{a}	62	31.0^{b}	32	16.0^{b}	200	100.0
Isabelle	0	0.0	0	0.0	1	50.0^{ab}	0	0.0	0	0.0	0	0.0	0	0.0	1	50.0^{b}	0	0.0	2	100.0
Lavender	0	0.0	0	0.0	9	60.0	0	0.0	0	0.0	2	13.3^{ab}	0	0.0	2	13.3^{ab}	2	13.3^{ab}	15	100.0
Lavender pied	2	20.0^{a}	1	10.0^{b}	3	30.0^{ab}	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	4	40.0^{ab}	10	100.0
Black pied	5	22.7^{a}	0	0.0	1	4.5^{b}	1	4.5^{a}	0	0.0	1	4.5^{ab}	1	4.5^{a}	0	0.0	13	59.1^{a}	22	100.0
Multicolored	16	15.4^{a}	0	0.0	34	32.7^{ab}	2	1.9^{a}	3	2.9^{ab}	1	1.0^{b}	0	0.0	3	2.9^{a}	45	43.3^{a}	104	100.0
Royal purple	7	13.2^{a}	0	0.0	6	11.3^{bc}	2	3.8^{a}	5	9.4^{a}	7	13.2^{a}	8	15.1^{a}	10	18.9^{b}	8	15.1^{bc}	53	100.0
Zones																				
Atakora	36	13.5^{a}	1	0.4^{a}	46	17.2^{a}	10	3.7^{a}	8	3.0^{a}	1	0.4^{a}	15	5.6^{a}	23	8.6^{a}	127	47.6^{a}	267	100.0
Dry Savannah	18	3.8^{b}	1	0.2^{a}	166	35.2^{b}	4	0.8^{a}	17	3.6^{a}	32	6.8^{a}	33	7.0^{a}	66	14.0^{b}	134	28.5^{b}	471	100.0
Total	54	7.3	2	0.3	212	28.7	14	1.9	25	3.4	33	4.5	48	6.5	89	12.1	261	35.4	738	100.0

Values with different superscripts are significantly different ($p<0.05$). Proportions equal 0% or 100% were not included in the test

and Royal purple (18.9%) phenotypes compared to Bonaparte (3.8%) and Multicolored (2.9%) phenotypes. The red colours of the toes was higher in Albino (63.0%), Black pied (59.1%), Bonaparte (46.2%) and Multicolored (43.3%) phenotypes than those of Pearl grey (16.0%) and Royal purple (15.1%) phenotypes.

Biometric characteristics: Biometric characteristics are listed in Table 9.

Beak length, wattles length and dewlap length: The beak length and the wattles length were only influenced ($p<0.05$) by the agroecological zone whereas the dewlap length was both influenced ($p<0.05$) by the phenotype and by the agroecological zone. Dry Savannah guinea fowl (2.53 ± 0.21 cm) had longer ($p<0.05$) beaks than those of Atakora guinea fowl (2.48 ± 0.18 cm). On the other hand, for the wattles and the dewlap, Atakora guinea fowl (1.57 ± 0.49 cm and 2.37 ± 0.55 cm) showed the highest values ($p<0.05$). The dewlap of Bonaparte (2.33 ± 0.72 cm), Pearl grey (2.27 ± 0.62 cm) and Lavender pied (2.37 ± 0.50 cm) phenotypes was significantly longer ($p<0.05$) than that of Chamoise (2.01 ± 0.43 cm), Multicolored (2.07 ± 0.53 cm) and Cinnamon pied (1.88 ± 0.74 cm) phenotypes.

Shank length and diameter: Phenotype had significant influence ($p<0.05$) on both shank length and diameter. On the other hand, only the diameter of the shank was affected by the agroecological zone ($p<0.05$). Atakora guinea fowl (1.44 ± 0.13 cm) had larger shanks ($p<0.05$) than those of Dry Savannah guinea fowl (1.33 ± 0.18 cm).Guinea fowl with albino (7.30 ± 0.50 cm) phenotype had significantly ($p<0.05$) longershanks than those of Bonaparte (7.00 ± 0.50 cm), Pearl grey (7.00 ± 0.50 cm), Lavender pied (6.50 ± 0.62 cm) and Cinnamon pied (7.00 ± 0.50 cm) phenotypes. For the diameter of the shank, Bonaparte (1.39 ± 0.18 cm), Pearl grey (1.38 ± 0.19 cm), Lavender pied (1.43 ± 0.15 cm), Black pied (1.42 ± 0.12 cm) and Royal purple (1.42 ± 0.14 cm) phenotypes showed higher values compared to Chamoise (1.27 ± 0.18 cm), Lavender (1.31 ± 0.11 cm) and Multicolored (1.32 ± 0.22 cm) phenotypes.

Drumstick length, body length, wingspan and chest circumference: Phenotype had no influence ($p<0.05$) on the drumstick length and body length. These two parameters were only influenced ($p<0.05$) by the agroecological zone. Dry Savannah guinea fowl had higher ($p<0.05$) drumstick and

Table 9: Median and interquartile range : beak length (Lbe), wattles length (Lba), dewlap length (LF), shank length (LT), shank diameter (DT), drumstick length (LP), wingspan (E), body length (LC), chest circumference (CP), live weight (P) by phenotypes[1)] and by agroecological zones

Characteristics	Lbe (Cm)	Lba (Cm)	LF (Cm)	LT (Cm)	DT (Cm)	LP (Cm)	E (Cm)	LC (Cm)	CP (Cm)	P (Kg)
Mean and standard deviation	2.52±0.16	1.57±0.35	2.27±0.52	7.07±0.47	1.38±0.14	11.74±0.75	43.15±2.05	43.42±2.27	30.69±2.15	1.30±0.20
Phenotypes										
Kruskal-Wallis	NS	NS	*	*	*	NS	*	NS	*	*
Albino	2.50±0.23	1.60±0.51	2.14±0.61^{ab}	7.30±0.50^{a}	1.39±0.24^{ab}	11.60±1.00	43.00±3.00^{b}	44.00±3.00	31.00±2.00^{ab}	1.26±0.26^{ab}
Bonaparte	2.49±0.20	1.51±0.48	2.33±0.72^{a}	7.00±0.50^{b}	1.39±0.18^{a}	12.00±1.00	43.00±2.50^{a}	44.00±3.00	30.50±2.50^{b}	1.29±0.26^{b}
Cinnamon pied	2.52±0.19	1.46±0.46	1.88±0.74^{b}	7.00±0.50^{b}	1.37±0.24^{ab}	11.50±1.25	43.00±3.50^{ab}	44.50±4.75	32.00±2.50^{ab}	1.31±0.40^{ab}
Chamois	2.55±0.17	1.33±0.33	2.01±0.43^{b}	7.00±0.50^{ab}	1.27±0.18^{b}	11.50±1.00	42.00±3.00^{b}	44.00±5.00	30.00±3.50^{b}	1.26±0.24^{b}
Pearl grey	2.54±0.22	1.48±0.40	2.27±0.62^{a}	7.00±0.50^{b}	1.38±0.19^{a}	11.50±0.50	44.00±2.37^{a}	44.00±3.00	31.00±2.00^{ab}	1.36±0.28^{a}
Lavender	2.53±0.22	1.68±0.46	2.33±0.90^{ab}	7.00±0.50^{ab}	1.31±0.11^{b}	12.00±0.70	42.00±3.00^{b}	43.00±2.00	31.00±1.50^{ab}	1.28±0.20^{ab}
Lavender pied	2.49±0.22	1.51±0.40	2.37±0.50^{a}	6.50±0.62^{b}	1.43±0.15^{a}	12.00±0.62	43.00±2.25^{b}	43.50±2.87	30.50±5.00^{ab}	1.32±0.36^{ab}
Black pied	2.50±0.18	1.54±0.38	2.04±0.52^{ab}	7.00±0.50^{ab}	1.42±0.12^{a}	12.00±0.62	43.25±1.12^{a}	44.00±1.50	30.75±3.00^{ab}	1.25±0.20^{ab}
Multicolored	2.53±0.25	1.45±0.43	2.07±0.53^{b}	7.00±0.50^{ab}	1.32±0.22^{b}	11.50±1.00	43.00±3.00^{b}	44.00±2.50	31.00±2.00^{ab}	1.31±0.27^{ab}
Royal purple	2.51±0.21	1.49±0.32	2.11±0.55^{ab}	7.00±0.50^{ab}	1.42±0.14^{a}	12.00±1.00	44.00±2.00^{a}	44.50±3.00	31.00±2.30^{a}	1.34±0.27^{ab}
Agroecological zones										
Mann-Withney	*	*	*	NS	*	*	NS	*	NS	*
Atakora	2.48±0.18^{b}	1.57±0.49^{a}	2.37±0.55^{a}	7.00±0.50	1.44±0.13^{a}	11.50±1.00^{b}	43.50±2.50	43.00±2.50^{b}	30.50±3.00	1.23±0.22^{b}
Dry Savannah	2.53±0.21^{a}	1.45±0.40^{b}	2.11±0.64^{b}	7.00±0.50	1.33±0.18^{b}	12.00±1.12^{a}	43.00±2.12	44.00±2.50^{a}	31.00±2.00	1.35±0.26^{a}

Medians with different letters are significantly different ($p<0.05$) *$p<0.05$ NS: Not significant. [1]Coral blue (n = 1) and Isabelle (n = 2) were excluded due to small number of observations

body length values than those of Atakora (12.00±1.12 cm and 44.00±2.50 cm against 11.50±1.00 cm and 43.00±2.50 cm respectively).

Agroecological zone did not have effect on wingspan and chest circumference. But the chest circumference was influenced by the phenotype ($p<0.05$). Bonaparte (43.00±2.50 cm), Pearl grey (44.00±2.37 cm), Black pied (43.25±1.12 cm) and Royal purple phenotypes (44.00±2,00 cm) had a greater ($p<0.05$) wingspan than Albino (43.00±3.00 cm), Chamois (42.000±3.00 cm), Lavender (42.00±3.00 cm), Lavender pied (43.00±2.25 cm) and Multicolored (43.00±3.00 cm) phenotypes. Royal purple (31.00±2.30 cm) guinea fowl had larger ($p<0.05$) chest circumference than those of Bonaparte (30.50±2.50 cm) and Chamois (30.00±3.50 cm) guinea fowl.

Live weight: Live weight was influenced ($p<0.05$) by agroecological zone and phenotype. Dry Savannah guinea fowl (1.35±0.26 kg) were heavier ($p<0.05$) than Atakora guinea fowl (1.23±0.22 kg). Pearl grey phenotypes (1.36±0.28 kg) had higher weights ($p<0.05$) than Bonaparte (1.29±0.26 kg) and Chamois (1.26±0.24 kg) phenotypes.

Correlation between live weight and body measurements: Table 10 presents the correlation between live weight and the different measurements of the indigenous guinea fowl. A highly significant ($p<0.01$) and strong ($r = 0.517$) correlation appeared between the live weight and the body length and also between the live weight and the chest circumference ($r = 0.613$). On the other hand, the wattles length and the shank diameter were not significantly correlated with the weight.

DISCUSSION

Morphological characters: Indigenous guinea fowl plumage colour in the two agroecological zones in northern Togo is very varied. Twelve colours of plumage were identified with a dominance of Bonaparte and Pearl grey colours and a rarity of Cinnamon pied, Isabelle and Coral Blue colours. This plumage colour diversity of guinea fowl is not peculiar to Togo. Indeed, Brown *et al.*[16] in Ghana as well as Houndonougbo *et al.*[17] in Benin Republic reported 7 colours of plumage while Meutchieye *et al.*[18] identified 8 in Cameroon and Agbolosu *et al.*[19] observed 9 in Ghana. A high frequency of Pearl grey and Bonaparte phenotypes and scarcity of Coral blue phenotype were also observed in Ghana[16,19] with respective percentages of 43.7, 31.3 and 1.0%[19]. On the other

Table 10: Correlations between the weight and body measurements of indigenous guinea fowl in northern Togo

	P	Lbe	Lba	LF	LT	DT	LP	E	LC	CP
Weight (P)	1									
Beak length (Lbe)	0.271**	1								
Wattles length (Lba)	-0.071	-0.172**	1							
Dewlap length (LF)	-0.117**	-0.076*	0.413**	1						
Shank length (LT)	0.149**	0.128**	0.270**	0.163**	1					
Shank diameter (DT)	-0.003	-0.108**	0.391**	0.369**	0.513**	1				
Drumstick length (LP)	0.278**	0.026	0.157**	0.098**	0.234**	0.126**	1			
Wingspan (E)	0.390**	0.107**	0.118**	0.087*	0.110**	0.232**	0.424**	1		
Body length (LC)	0.517**	0.159**	0.120**	0.001	0.168**	0.123**	0.398**	0.462**	1	
Chest circumference (CP)	0.613**	0.118**	0.045	-0.018	0.100**	0.073**	0.214**	0.363**	0.222**	1

*p<0.05 **p<0.01

side, Meutchieye *et al.*[18] reported a dominance of White (26%) and Royal purple (22%) and a rarity of Lite lavender (0.49%) in Cameroon. Despite a high frequency of occurrence of the wild type colour (Pearl grey) in the indigenous guinea fowl population in northern Togo, visible effects of mutations were identified in this study. This reflects the effect of domestication and absence of fixation of these mutations showing that the population is not standardized on the phenotype[5,20]. The variability of plumage colours is caused by the presence of genes with major effects and interactions between several of them[5,21]. Multiple random crossings between animals of different plumage colours give other combinations in low proportions[22]. The relatively high frequency of Royal purple and white guinea fowl (Albino and Chamois) may also be related to the customs of the indigenous people who exploit much of these phenotypes in worship rites and therefore influenced their selection.

The shape of the helmet was mainly curved and rarely erect. This result corroborates the findings of Agbolosu *et al.*[19] who reported three forms of helmet on Ghana guinea fowl: single (42.70%), curved (34.00%) and erect (23.30%). The plumage was essentially smooth and rarely silky. The appearance of silky plumage may be an adaptative character for better thermal tolerance. According to Duguma[23], indigenous chicks have the most important traits such as "h" (silky) that are genetically conserved for their special utility in tropical environment. In our study, the proportion of the silky type was significantly higher in the Dry Savannah (area with low rainfall) than in Atakora (area with high rainfall).

Variation in the eye colour of indigenous guinea fowl has been reported by previous studies. In Ghana, Agbolosu *et al.*[19] as well as Brown *et al.*[16] noted respectively four (white, brown, pink and black) and three (black, brown and grey) eye colours with dominance of black (71 and 55%) and brown (27 and 40%) colours. Meutchieye *et al.*[18] reported four colours (white, brown, yellow and black) in Cameroon with brown (38%), black (32%) and white (27%) colours dominance. The diversity of eye colour could be attributed to genes of an animal influencing blood supply and melanin levels, environmental effect in terms of availability of carotenoids and the interaction of the blood supply, melanin and carotenoids[24].

Colour diversity obtained for wattles and shanks in the present study is in agreement with the findings observed on guinea fowl in Cameroon[18], Ghana[16,19] and Kenya[25]. As the colour plays a role in the absorption and reflection of solar radiation, the wattles colour also plays a role in the thermoregulation[19,24]. Dark colours (black and grey) frequently encountered in the shanks of the guinea fowl could be a protection against heat by melanin.

Biometric characteristics: The variation in the traits of guinea fowl under the different agroecological zones and/or between phenotypes in this study could have resulted from the specific effect of genes or environment, or the interaction effect between genotype and environment. The values obtained for wattle length and dewlap length were lower than those reported by Dongmo Djiotsa *et al.*[26] in Cameroon which were respectively 3.18±0.22 cm and 4.29±0.30 cm. However, the beak length, drumstick length and shank diameter were similar to those obtained by Dongmo Djiotsa *et al.*[26]. For shank length, our results were similar to those obtained in Nigeria[27] and Cameroon[26] while the values obtained in the present study in Togo were lower than those (9 cm) reported in Kenya[25] and Ghana[16]. As the drumstick and shank constitute the poultry body support and reflect the animal size[28], guinea fowl in Dry Savannah agroecological zone were taller than those in Atakora agroecological zone. This difference between the two agroecological zones is related to the drumstick length and shank diameter. Paradoxically, no significant difference was observed between the two agroecological zones for the shank length. The values obtained for the wingspan were similar to those reported in Ghana[16] but were clearly superior to that obtained on guinea fowl of Cameroon by Dongmo Djiotsa *et al.*[26] which was 36.56 cm. For body length, our values were similar to those recorded in Kenya[25], Ghana[16] and Cameroon[26] but they were largely higher than that obtained (22.42 cm) in the Nigeria guinea fowl[27] which seem more chunky and compact. Indeed, the chest circumference of Nigerian guinea fowl which was reported as 35.37 cm[27] is greater than that of the Togo guinea fowl (this study), Ghana[16] and Cameroon[26]. The chest circumference seems to be related to the phenotype because the Royal purple phenotype had a larger chest circumference than the Bonaparte and Chamois phenotypes. Similarly, Bonaparte, Pearl grey, Black pied and Royal purple phenotypes had a larger wingspan than Albino, Chamois, Lavender, Lavender pied and Multicolored phenotypes. These results are contrary to those of Brown *et al*.[16] in Ghana who reported that in male guinea fowl, Pearl grey phenotype had a longer body, larger wingspan and larger chest circumference than Bonaparte phenotype. For the body weights, the superiority of Dry Savannah guinea fowl over those of Atakora could be explained by the livestock management including the use of feed supplements. The values obtained for live weight were similar to those reported in Ghana[16] and in Cameroon[26]. However, they were higher than those reported in Benin[9] and lower than those reported in Nigeria[27] and in Kenya[25]. Brown *et al*.[16] also reported that in male guinea fowl, Pearl grey and White phenotypes had higher weights than Bonaparte phenotype. These observations differ from our results which revealed that Pearl grey phenotype had higher weights than Bonaparte and Chamoise (white guinea fowl) phenotypes. Duodu *et al*.[29] also reported a higher body weight in the Pearl grey phenotype compared to the Lavender, White and Black guinea fowl.

The differences observed in the values of the studied parameters by the authors could be explained by some factors such as: the animal age, its physiological state, the genetic variability, the management practices (feeding, daily management), the measurement techniques or the combined effect of all these factors. Regional studies on guinea fowl are needed to assess the degree of diversity of populations or varieties that are raised in West and Central Africa. Furthermore, the sex of guinea fowl was not considered in this study but sex may account for differences in body weight as previously reported by Dongmo Djiotsa *et al*.[26].

CONCLUSION AND RECOMMENDATIONS

Indigenous guinea fowl in the two agroecological zones in northern Togo showed a great morpho-biometric variability. This diversity could be explained by the absence of directional selection and environmental conditions of the birds. Body measurements and live weights varied between agroecological zones and/or between phenotype. Dry Savannah guinea fowl were taller and heavier than that of Atakora. The Pearl grey phenotype had higher live weights than other phenotypes and would be the most indicated for improving growth performance. However, further studies are needed to establish any positive relationship between phenotype and the desired biometric characteristics. Before any improvement action of these guinea fowl populations, it is necessary to conduct the following studies: (1) A molecular characterization to better assess the diversity at the whole genome level, (2) A study of the zootechnical performances of main phenotypes in controlled environment to quantify the real productive potential of each phenotype, (3) An economic analysis of guinea fowl farming in Togo.

The combination of all phenotypic, molecular, zootechnical and economic information will help to develop a strategy for the sustainable management of guinea fowl in Togo. This information will also help to guide breeders' choices and develop efficient strains adapted to local breeding conditions.

SIGNIFICANCE STATEMENT

There is a scarcity of information on characterization of indigenous guinea fowl populations in Togo. The present study showed a great variation in the coloration of the plumage, eyes, mumps, wattles, shanks and toes. In addition, it revealed that the guinea fowl of the Pearl grey phenotype was heavier than Bonaparte and Chamois phenotypes. These results constituted a basic information which could help researchers to develop efficient guinea fowl varieties adapted to tropical production conditions.

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