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Original article

Morphobiometrical diversity of the indigenous chicken's population in the Sudano-sahelian zone of Cameroon

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ABSTRACT

Studies were undertaken at rural, peri-urban and urban areas of the Sudano-sahelian agro-ecological zone of Cameroon to describe the variations in physical characters and some important feather and skin mutations observed in different populations of native chickens of the sudano-sahelian zone of Cameroon. According to accessibility, availability of chickens and willingness of farmers to give informations , thirteen villages were investigated from January to September 2010 in the Far-north and North regions using a structured questionnaire. 558 chickens were randomly selected and each of them was completely described by direct observation, weighing and body measurements according to FAO (1981) recommendations. The main results show that feather colour of local poultry of the Sudano-sahelian agro-ecological zone of Cameroon is variable, but dominated by the wild type and white having frequencies of 18.64% and 15.41% respectively, whereas the other colours of feather vary from medium to very small frequencies, as grey colour of feather (1.61%). Four genetic types were represented in this agro-ecological zone, namely: normally feathered (87.63%), Naked-neck (4.30%), crested (4.84%) and Frizzle chickens (3.23%). Heterogeneity of colours was also observed at the level of shanks; where white was the dominant colour (38.53%) and green (4.12%) the lowest frequency. The comb showed just two varieties: single

(95.52%) and rose shape (4.12%). Sexual dimorphism was observed in all the traits with higher values recorded for males. The mean body weight of adult chicken, in the Sudano-sahelian agro-ecological zone of Cameroon is 1458±329g. Roosters are heavier (1588±332) than hens (1323±269g). All the body measurement considered are significantly higher in roosters. The high variability of characters offers possibilities for selection of rustic and more productive breeds in the Sudano-sahelian agro-ecological zone of Cameroon.

1. Introduction

Local chicken in Cameroon plays a considerable social and economical role,since it is held by 70% of rural farms each with an average of 10 to 13 chickens (Ngou Ngoupayou, 1990; Agbede et al., 1995; Tchoumboue et al 2000). It represent 70% of the national poultry flock but, is characterized by a low productivity (Fotsa et al., 2007). The production of local chicken population is approximately 50% of poultry products in the country (Pone, 1998; Teleu NGANDEU and Ngatchou, 2006), Its populations increased from 13 million in 1990 to over 35 million in 2001 (Ngou Ngoupayou, 1990; INS-Cameroun, 2001). According to Ngou Ngoupayou (1990) and the local poultry national population is held by small rural farms,. . Local chickens plays an important role in the socio-cultural life for wedding ceremonies, the rejection of the curse, traditional medicines and maintaining social cohesion within traditional communities through donations and receiving distinguished visitors (Gueye, 1998; Fotsa et al., 2007). The local chicken farms require very little investment and represent an economic activity for about 1.6 million rural families (Pone, 1998). Inspite the role devoted to the local chicken in Cameroon, it has not yet been systematically characterized phenotypically and genotypically. Perhaps, researches have being carry out in the western highland (Keambou et al., 2007) and in the forest zone (Fotsa et al., 2010).The lack of a whole caracterisation of the different genetic types and the constraints of their production make it difficult to envisage rational utilization of this genetic material in order to improve living conditions of rural population. In the northern part of the country, local chicken is part of the ….but there is very little information about its diversity.

There is, therefore a need to identify morphobiometrical characteristics of the local chicken for a better use of these genetic resource reservoirs. Thus the present study was carried out to contribute to a better knowledge of the Cameroon avian diversity. Precisely, it seeks to describe the phenotypic attributes of the native chicken population of the Sudano-sahelian zone in Cameroon.

2. Materials and methods

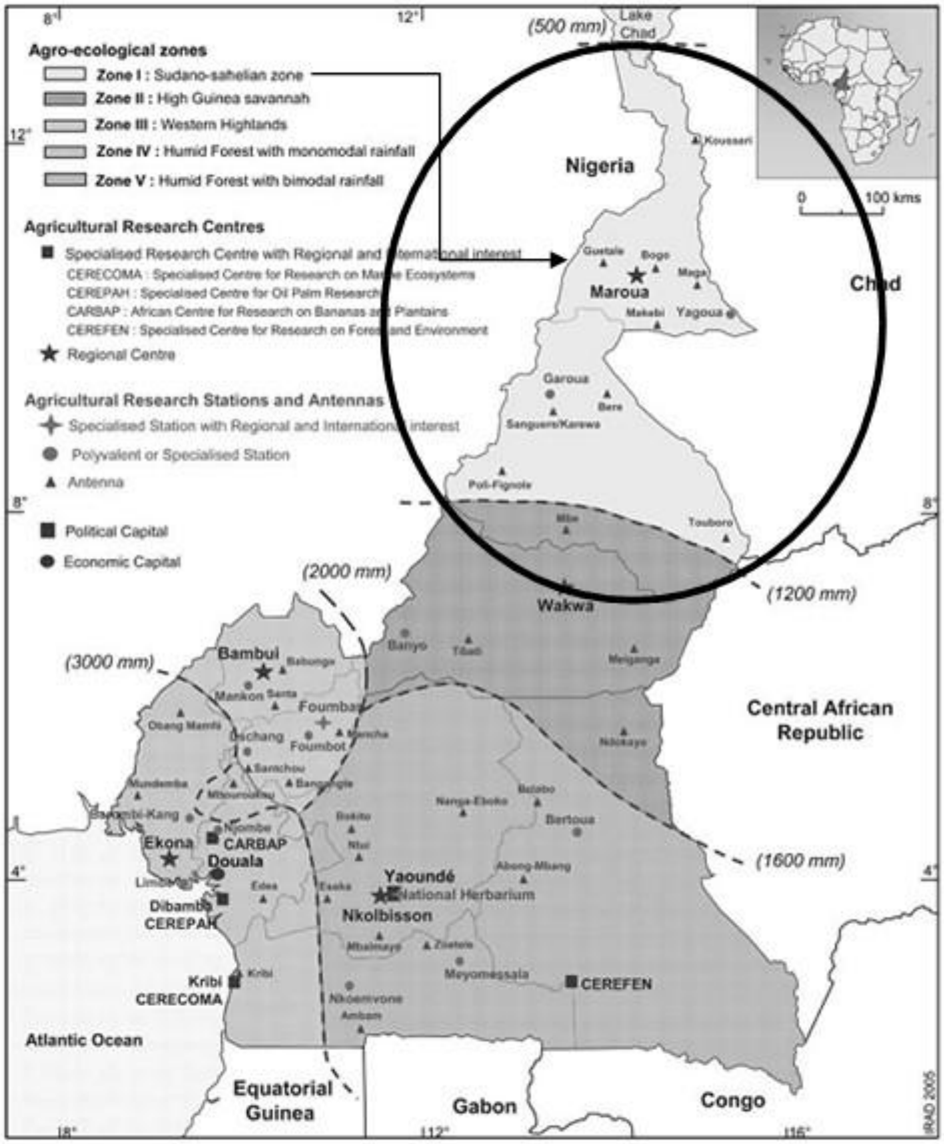
2.1. The characterisation of study area

The Sudano-sahelian zone of Cameroon covers far north and north regions (Fig. 1.).

2.1.1. Climate of the study area

The Sudano-sahelian zone of Cameroon is under the tropical climate of the Sudan type, it is located between 8.5°North and 14°East, covering 99.822 km^2, with a human population of 2.687.860. Population density varies from 13/Km^2 in the South part to 54/km^2 in the North part (Cameroon reports, 2001).

The Sudano-sahelian zone is hot and dry and the rainfall is relatively small (650 to 1200 mm per year) decreasing from south to north, the temperature vary between 24°C to 28°C dry and relatively cool from November to January, dry and hot from January to April, torrentially rainy from April to June and cool and sporadically wet from June to November. The year begins under the influence of the harmatan winds in the dry season. In this period, temperatures are at their highest (Gwanfogbe et al., 1983).



Source: DSDSR 2002

Fig. 1. Cameroon Agro-ecological map and the study area.

2.1.2. Plant and animal life

The Sudano-sahelian zone in Cameroon is a land of savanna. Most of the area is covered by thin grasses punctuated by thorny shrubs, Faidherbia, and Karita. The territory was once more heavily forested, but repeated burning and livestock trampling has left this original vegetation only in the valleys.

This zone of the country was once home to most of Africa's iconic species: antelope, chacals, cheetahs, crocodiles, elephants, giraffes, heron, hippopotamus, hyenas, jaguars, lions, monkeys, warthogs, and others (Hudgens et al., 1999).

2.2. Data collection

According to accessibility, availability of chickens and willingness of farmers to give informations , thirteen villages, 4 villages in the North and 9 villages in the Far-north regions were randomly selected for investigation from January to September 2010, data were collected in In each village, the data collected depended on the availability of chickens and willingness of farmers to provide information. Data were also collected, in markets of urban, peri-urban and rural areas where large number of birds where gathered for selling. Relevant data was obtained from 558 chickens in the thirteen villages.

Morphological traits were recorded based on visual appraisal. They comprised chicken feathering type, plumage colour, comb type and colour, earlobe presence and colour ...etc.

All morphological data were collected according to the standard avian descriptor proposed by FAO and UNEP (1986).

Biometrical or quantitative data where the bird's weight (measured with an electronic scale having a capacity of 3 kg and a sensitive of 1g), and body measurements (body length, head and neck length, tarsus length and circumference .... etc) obtained by means of ribbon meters (200cm capacity and 1mm readability) and a digital calliper with a 0.001 readability. All the measurements were taken by one person to avoid inter-individual variations.

2.3. Data analyses

Descriptive analysis statistics (frequencies; standard deviation) of morphological data (Feathering type, plumage colour, comb type and colour, earlobe presence and colour) were done using the SPSS 12.0 software

Body weights and body measurements were submitted to the two factors generalised linear model of the analysis of variance, for completely randomized descriptive significant levels were stated at 5% and 1% using the SPSS 12.0 software. The statistical model used was

$$Y_{ijk} = \mu + G_i + S_j + (GxS)_{ij} + e_{ijk}$$

Where: Y_{ijk} = Observation on the k^{th} individual in the i^{th} genetic type and j^{th} sex.

μ = Overall mean

G_i = Effect of i^{th} genetic type.

S_j = Effect of j^{th} sex.

$(GxS)_{ij}$ = interaction between genetic type and sex .

e_{ijk} = Standard error on the k^{th} individual in the i^{th} genetic type and j^{th} sex.

When significant differences were observed between effects, mean separation were done using the Duncan multiple range tests.

3. Results

3.1. Genetic types

Variations were observed in general feathering features in the Sudano-sahelian local chickens of Cameroon as shown in Table 1.

Table 1
Distribution of genetic types of local chicken in the Sudano-sahelian agro-ecological zone of Cameroon.

Genetic types	Sexes	N	%
Normal	♂	245	43.91
	♀	244	43.73
	♂♀	489	
Crested	♂	10	1.79
	♀	17	3.05
	♂♀	27	
Naked-neck	♂	17	3.05
	♀	7	2.25
	♂♀	24	
Frizzle	♂	14	2.51
	♀	4	0.72
	♂♀	18	

Total	♂	286	51.25
	♀	272	48.75
	♂♀	558	100.0

n = number of chickens, % = percentage, ♂= male, ♀=female, ♂♀= male and female.

Four main genetic types Normal featured, Naked-neck, crested and frizzle plumage chicken were identified in the local chicken population of the Sudano-sahelian agro-ecological zone of Cameroon. The normal featured genetic type was the dominant chicken, with 87.63% of the overall population, while the frizzle genetic type with a proportion of 3.23% was the least represented. Apart from the Normal genetic type, percentage representation of the other types encountered was < 5%. The differences between genetic types were highly significant (P<0.01).

Significant differences (P<0.01) were observed between the sexes for crested, Naked neck genetic types.

The four main genetic types of chickens encountered in the villages and in the markets of the Sudano-sahelian agro-ecological zone of Cameroon are presented in photographs 2, 3, 4 and 5.

Fig. 2. Normal feathered rooster. **Fig. 3.** Crested hen.

Fig. 4. Naked-neck rooster. **Fig. 5.** Frizzle plumage rooster.

3.2. Feather pattern and colour

The distribution of feather colours of the local chicken from the sudano-sahelian agro-ecological zone of Cameroon is presented in Table 2.

The plumage colour of indigenous chicken populations in the Sudano-sahelian agro-ecological zone of Cameroon has a wide range of variation. Fifteen colours were identified with a high percentage of wild type colour (18.64%), followed by white (15.41%) and brown (14.52%). while the grey and black colours are the least represented in the overall local chicken population.

However, no significant differences (P<0.01) in percentage of colours were found between wild type and white colour, also between white and brown, black and grey colours.

Some of the major plumage colours of chicken from Sudano-sahelian agro-ecological zone of Cameroon are shown in photographs 6 to13.

Table 2
Distribution of feather colours according to sex and genetic type in local chickens in the Sudano-sahelian zone of Cameroon.

Patterns	Sex	Normal		Naked neck		Crested		Frizzle		Total	
		n	%	n	%	n	%	n	%	n	%
White	♂	43	7.71	6	1.08	-	-	-	-	49	8.78
	♀	30	5.38	2	0.36	4	0.72	1	0.18	37	6.63
Black	♂	2	0.36	-	-	-	-	-	-	2	0.36
	♀	10	1.79	-	-	-	-	-	-	10	1.79
Brown	♂	22	3.94	1	0.18	-	-	5	0.90	28	5.02
	♀	47	8.42	1	0.18	4	0.72	1	0.18	53	9.50
Red	♂	12	2.15	1	0.18	-	-	-	-	13	2.33
	♀	3	0.54	-	-	-	-	-	-	3	0.54
Grey	♂	1	0.18	-	-	-	-	-	-	1	0.18
	♀	7	1.25	1	0.18	-	-	-	-	8	1.43
Cucko	♂	52	9.32	1	0.18	1	0.18	1	0.18	55	9.86
	♀	15	2.69	1	0.18	-	-	-	-	16	2.87
Millefleur	♂	08	01.43	-	-	2	0.36	-	-	10	1.79
	♀	25	04.48	-	-	-	-	-	-	25	4.48
Wild types	♂	4	0.72	-	-	1	0.18	1	0.18	06	01.08
	♀	88	15.77	2	0.36	6	1.08	2	0.36	98	17.56
Black and white	♂	20	3.58	3	0.54	3	0.54	2	0.36	28	5.02
	♀	-	-	-	-	-	-	-	-	-	-
Golden black	♂	12	2.15	1	0.18	-	-	-	-	13	2.33
	♀	-	-	-	-	-	-	-	-	-	-
Silver black	♂	11	1.97	-	-	2	0.36	-	-	13	2.33
	♀	-	-	-	-	-	-	-	-	-	-
Black and red	♂	29	5.19	2	0.36	-	-	-	-	31	5.56
	♀	1	0.18	-	-	1	0.18	-	-	2	0.36
White and brown	♂	10	0.36	1	0.18	-	-	-	-	11	1.97
	♀	3	0.54	-		-	-	-	-	3	0.54
Ermined	♂	-	-	-	-	-	-	-	-	-	-
	♀	15	2.69	-	-	2	0.36	-	-	17	3.05
Multi-color	♂	19	3.41	1	0.18	1	0.18	5	0.90	26	4.66
	♀		-	-	-	-	-	-	-	-	-
Total	♂	245	43.91	17	3.05	10	1.79	14	2.51	286	51.25
	♀	244	43.73	7	1.25	17	3.05	4	0.72	272	48.75
	♂♀	489	87.63	24	4.30	27	4.84	18	3.23	558	100

n = number of chickens, % = percentage, ♂= male, ♀=female, ♂♀= male and female.

Fig. 6. Millefleur plumage colour.

Fig. 7. Cucko plumage colour.

Fig. 8. Ermined plumage colour.

Fig. 9. Wild type plumage colour.

Fig. 10. Golden black plumage colour.

Fig. 11. Silver black plumage colour.

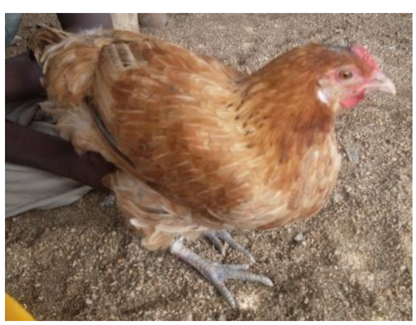


Fig. 12. Brown plumage colour.

Fig. 13. White plumage colour.

3.3. Shank colours and spur presence

Table 3 shows the distribution of shank colour according to sex and genetic type of the local chicken in the Sudano-sahelian agro-ecological zone of Cameroon.

Table 3
Distribution of shank colours according to sex and genetic type of the local chicken in the Sudano-sahelian agro-ecological zone of Cameroon.

Patterns	Sex	Normal		Naked neck		Crested		Frizzle		Total	
		n	%	n	%	n	%	N	%	N	%
White	♂	107	19.18	8	1.43	4	0.72	4	0.72	123	22.04
	♀	79	14.16	4	0.72	7	1.25	2	0.36	92	16.48
Yellow	♂	55	9.86	5	0.90	2	0.36	5	0.90	67	12.01
	♀	40	7.17	1	0.18	2	0.36	-	-	43	7.71
Black	♂	24	4.30	2	0.36	-	-	-	-	26	4.66
	♀	37	6.63	1	0.18	2	0.36	1	0.18	41	7.35
Grey	♂	29	5.20	-	-	2	0.36	1	0.18	23	4.12
	♀	54	9.68	1	0.18	5	0.90	1	0.18	61	10.93
Green	♂	8	1.43	-	-	-	-	-	-	8	1.43
	♀	14	2.51	-	-	1	0.18	-	-	15	2.69
Brown	♂	4	0.72	-	-	3	0.54	-	-	8	1.43
	♀	11	1.97	-	-	-	-	-	-	11	1.97
Multi-colours	♂	18	3.23	2	0.36	2	0.36	-	-	22	3.94
	♀	9	1.61	-	-	-	-	-	-	9	1.61
Total	♂	245	43.91	17	3.05	10	1.79	14	2.51	286	51.25
	♀	244	43.73	7	1.25	17	3.47	4	0.72	272	48.75
	♂♀	489	87.63	24	4.30	27	4.84	18	3.23	558	100.0

n = number of chickens, % = percentage, ♂= male, ♀=female, ♂♀= male and fema.

Shank revealed various colours, with white (38.53%) as most dominant, followed respectively by yellow (19.71%), grey (16.67%) and black (12.01%). Although all the seven colours are represented in normal and crested genetic type, green and brown colours pattern are absent in Naked-neck and Frizzle chickens.

We observed that shank colour varies (P<0.01) with sex, independently from the genetic type. The brown colour frequency is approximately identical in males and females, white and yellow colours are most predominant in males, white, black and grey colours of the shank have highest frequencies in females.

The frequency of spur presence according to sex and genetic type of the local chicken in the Sudano-sahelian agro-ecological zone of Cameroon is presented in table 4.

In general, the presence of spur in the Sudano-sahelian chicken populations varied with genetic type (P<0.01). It is present only in 39.43% of the Sudano-sahelian local chicken population, 34.95% represented in rooster. Irrespective of the genetic type, the spur is mainly present (P<0.01) in male birds, frequencies of this appendix in females vary from 0 to 3.76%.

3.4. Comb types and colours

The comb features identified in the Sudano-sahelian indigenous chicken are presented in the table 5.

Table 4
Frequency of spur presence according to sex and genetic type of the local chicken in the Sudano-sahelian zone of Cameroon.

Characteristics	Sex	Normal		Naked neck		Crested		Frizzle		Total	
		n	%	n	%	n	%	n	%	n	%
Presence	♂	168	30.11	14	2.51	6	1.08	7	1.25	195	34.95
	♀	21	3.76	3	0.54	-	-	1	0.18	25	4.48
Absence	♂	77	13.80	3	0.54	4	0.72	7	1.25	91	16.31
	♀	223	39.96	4	0.72	17	3.05	3	0.54	247	44.27
Total	♂	245	43.91	17	3.05	10	1.79	14	2.51	286	51.25
	♀	244	43.73	7	1.25	17	3.05	4	0.72	272	48.75
	♂♀	489	87.63	24	4.30	27	4.84	18	3.23	558	100.0

n = number of chickens, % = percentage, ♂= male, ♀=female, ♂♀= male and female.

Table 5 : Distribution of comb types according to sex and genetic type of the local chicken in Sudano-sahelian agro-ecological zone of Cameroon.

Characteristics	Sex	Normal		Naked neck		Crested		Frizzle		Total	
		n	%	n	%	n	%	N	%	N	%
Single	♂	233	41.76	16	2.87	10	1.79	13	2.33	272	48.75
	♀	236	42.29	6	1.08	15	2.69	4	0.72	261	46.77
Rose	♂	12	2.15	1	0.18	-	-	1	0.18	14	2.51
	♀	8	1.43	1	0.18	-	-	-	-	9	1.61
Absent	♂	-	-	-	-	-	-	-	-	-	-
	♀	-	-	-	-	2	0.36	-	-	2	0.36
Total	♂	245	43.91	17	3.05	10	1.79	14	2.15	286	51.25
	♀	244	43.73	7	1.25	17	3.05	4	0.72	272	48.75
	♂♀	489	87.63	24	4.30	27	4.84	18	3.23	558	100.0

n = number of chicken, % = percentage, ♂= male, ♀=female, ♂♀= male and female.

There are two types of comb: single (95.52%) and rose (4.12%), the difference between the two types was highly significant (P<0.01). The comb is absent in 0.36% of chicken and found only in crested females. Irrespective of the comb feature, combs seem to be equitably distributed between males and females.

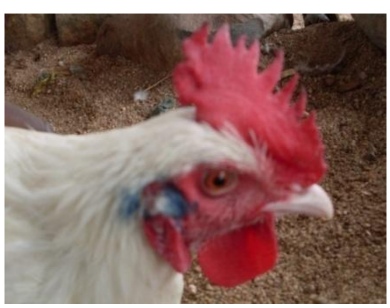


Fig. 14. Single comb of chickens.

Fig. 15. Rose comb of chickens.

Furthermore, these few qualities of comb have a variety of colours (Table 6).

Table 6
Distribution of comb colours according to sex and genetic type of the local chicken in Sudano-sahelian agro-ecological zone of Cameroon.

Characteristics	Sex	Normal		Naked neck		Crested		Frizzle		Total	
		n	%	n	%	n	%	n	%	n	%
Red	♂	240	43.17	17	3.06	9	1.62	14	2.52	280	50.36
	♀	113	20.32	3	0.54	10	1.80	1	0.18	127	22.84
Pink	♂	2	0.36	-	-	-	-	-	-	2	0.36
	♀	77	13.85	4	0.72	4	0.72	-	-	85	15.29
Black	♂	-	-	-	-	-	-	-	-	-	-
	♀	24	4.32	-	-	1	0.18	2	-	27	4.86
Red and black	♂	1	0.18	-	-	1	0.18	-	-	2	0.36
	♀	6	1.08	-	-	-	-	-	-	6	1.08
Yellow	♂	-	-	-	-	-	-	-	-	-	-
	♀	3	0.54	-	-	-	-	-	-	3	0.54
Grey	♂	2	0.36	-	-	-	-	-	-	2	0.36
	♀	16	2.88	-	-	-	-	1	0.18	17	3.06
White	♂	-	-	-	-	-	-	-	-	-	-
	♀	3	0.54	-	-	-	-	-	-	3	0.54
Brown	♂	-	-	-	-	-	-	-	-	-	-
	♀	2	0.36	-	-	-	-	-	-	2	0.36
Total	♂	245	44.06	17	3.06	10	1.80	14	2.52	286	51.44
	♀	244	43.89	7	1.26	15	2.70	4	0.72	270	48.56
	♂♀	489	87.95	24	4.32	25	4.50	18	3.23	556	100.0

n = number of chickens, % = percentage, ♂= male, ♀=female, ♂♀= male and female.

Eight colours were identified in the overall local chicken population of the Sudano-sahelian zone of Cameroon. Red (73.20%) and pink (15.65%) coloration are the most frequent, the difference between these colours highly significant (P<0.01). Irrespective of sex and genetic type. Considering the genetic type, only the Normal chicken presented all the colorations.

3.5. Earlobe presence and colours

The distribution of earlobe presence according to sex and genetic type of the local chicken in the Sudano-sahelian agro-ecological zone of Cameroon is presented in table 7.

Table 7
Distribution of ear lobe presence according to sex and genetic type of the local chicken in Sudano-sahelian agro-ecological zone of Cameroon.

Patterns	Sex	Normal		Naked neck		Crested		Frizzle		Total	
		n	%	n	%	N	%	N	%	N	%
Presence	♂	245	43.91	17	3.05	10	1.79	14	2.51	286	51.25
	♀	237	42.47	6	1.08	15	2.69	4	0.72	262	49.95
Absence	♂	-	-	-	-	-	-	-	-	-	-
	♀	7	1.25	1	0.18	2	0.36	-	-	10	1.79
Total	♂	245	43.91	17	3.05	10	1.79	14	2.51	286	51.25
	♀	244	43.72	7	1.25	17	3.05	4	0.72	272	48.75
	♂♀	489	87.63	24	4.30	27	4.84	18	3.23	558	100.0

n = number of chickens, % = percentage, ♂= male, ♀=female, ♂♀= male and female.

Chicken populations of the Sudan-sahelian zone of Cameroon showed significantly (P<0.01), high percentage of earlobe presence (98.21%). The absence of this feature is only in 1.79% of the overall population, and only observed in female chickens. Twelve earlobe colours were observed in the Sudano-sahelian local chicken as indicated in Table 8.

Table 8
Distribution of ear lobe colours according to sex and genetic type of the local chicken in Sudano-sahelian agro-ecological zone of Cameroon.

Patterns	Sex	Normal		Naked neck		Crested		Frizzle		Total	
		n	%	n	%	N	%	N	%	N	%
Red and white	♂	100	18.25	3	0.55	3	0.55	3	0.55	109	20.0
	♀	85	15.51	5	0.91	3	0.55	-	-	93	16.97
Red	♂	128	23.36	11	2.01	6	1.09	6	1.09	151	27.55
	♀	11	2.01	-	-	1	0.18	-	-	12	2.19
White	♂	10	1.83	1	0.18	1	0.18	-	-	12	2.19
	♀	92	16.79	1	0.18	5	0.91	2	0.37	100	18.25
Grey	♂	1	0.18	-	-	-	-	2	0.37	3	0.55
	♀	13	2.37	-	-	2	0.37	-	-	15	2.74
Pink	♂	-	-	-	-		-	-	-		
	♀	11	2.01	-	-	3	0.55	-	-	14	2.55
Red and yellow	♂	6	1.09	-	-	-	-	2	0.37	10	1.83
	♀	3	0.55	-	-	-	-	-	-	3	0.55
Yellow	♂	-	-	-	-	-	-	1	0.18	1	0.18
	♀	8	1.46	-	-	1	0.18	-	-	9	1.64
Red pigmented	♂	-	-	-	-	-	-				
	♀	9	1.64	-	-	-	-	1	0.18	10	1.83
White pigmented	♂	-	-	-	-	-	-	-	-	-	-
	♀	2	0.37	-	-	-	-	1	0.18	3	0.55
Pink and black	♂	-	-	-	-	-	-	-	-	-	-
	♀	1	0.18	-	-	-	-	-	-	1	0.18
Pink and white	♂	-	-	-	-	-	-	-	-	-	-
	♀	1	0.18	-	-	-	-	-	-	1	0.18
Orange	♂	-	-	-	-	-	-	-	-	-	-
	♀	1	0.18	-	-	-	-	-	-	1	0.18
Total	♂	245	44.71	17	3.10	10	1.83	14	2.56	286	52.19
	♀	237	43.25	6	1.10	15	2.74	4	0.73	262	47.81
	♂♀	482	87.96	23	4.20	25	4.56	18	3.29	548	100.0

n = number of chickens, % = percentage, ♂= male, ♀=female, ♂♀= male and female.

The white and red colour was the most represented with a proportion of 36.86%, followed by the red (29.74%), the two colours were mostly present in males than females and the colours pink & black, pink & white and orange were observed with a very low proportions (0.54%).

3.6. Beak colours

Beak showed eight different colours (Table 9).

Table 9
Distribution of beak colours according to sex and genetic type of the local chicken in Sudano-sahelian agro-ecological zone of Cameroon.

Characteristics	Sex	Normal		Naked neck		Crested		Frizzle		Total	
		n	%	n	%	N	%	n	%	n	%
Brown	♂	81	14.52	5	0.90	3	0.54	8	1.43	97	17.38
	♀	88	15.77	4	0.72	9	1.61	1	0.18	102	18.28
Black	♂	54	9.68	2	0.36	2	0.36	5	0.90	63	11.29
	♀	72	12.90	-	-	3	0.54	3	0.54	78	13.98
White	♂	35	6.27	3	0.54	-	-	-	-	38	6.81
	♀	53	9.50	3	0.54	3	0.54	-	-	59	10.57
Yellow	♂	25	4.48	1	0.18	-	-	1	0.18	27	4.84
	♀	19	3.41	-	-	2	0.36	-	-	21	3.76
Black and white	♂	27	4.48	1	0.18	3	0.54	-	-	31	5.56
	♀	4	0.72	-	-	-	-	-	-	4	0.72
Black and yellow	♂	19	3.41	3	0.54	2	0.36	-	-	24	4.30
	♀	3	0.54	-	-	-	-	-	-	3	0.54
Black and brown	♂	4	0.72	2	0.36	-	-	-	-	6	1.08
	♀	-	-	-	-	-	-	-	-	-	-
Grey	♂	-	-	-	-	-	-	-	-	-	-
	♀	5	0.90	-	-	-	-	-	-	5	0.90
Total	♂	245	43.91	17	3.05	10	1.79	14	2.51	286	51.25
	♀	244	43.73	7	2.25	17	3.05	4	0.72	272	48.75
	♂♀	289	87.63	24	4.30	27	4.84	18	3.23	558	100.0

n = number of chickens, % = percentage, ♂= male, ♀=female, ♂♀= male and female.

The brown colour is dominant (35.66%) among the four genetic types. With 30.29% for Normal, 1.61% for Naked neck, 1.61% for Frizzle and 2.15% for Crested type. The other most representative colour of the beak in the overall population is black (25.27%), white (17.38%) and yellow (8.60%).

3.7. Eye colours

The distribution of eye colours according to sex and genetic type of the local chicken of the Sudano-sahelian area of Cameroon is shows in Table 10.

Differences in colour distribution were highly significant (P<0.01)..Four main eye colours were identified. Orange colour is the most prevalent (70.25%), followed by yellow (19.53%) and brown (9.68%), while the red colour of the eye is present in 0.54% lonely in Normal chickens of the overall population.

3.8. Live body weights and body measurements of the indigenous chickens in Sudano-sahelian zone of Cameroon

The means and standard deviation of live body weight and measurements according to sex and genetic type of the local chicken population is shown in table 12.

Table 10
Distribution of eye colours according to sex and genetic type of the local chicken in Sudano-sahelian agro-ecological zone of Cameroon.

Patterns	Sex	Normal		Naked neck		Crested		Frizzle		Total	
		n	%	n	%	N	%	N	%	N	%
Orange	♂	203	36.38	15	2.69	5	0.90	10	1.79	233	41.76
	♀	141	25.27	5	0.90	12	2.15	1	0.18	159	28.50
Yellow	♂	30	5.38	2	0.36	3	0.54	3	0.54	38	6.81
	♀	66	11.83	1	.18	3	0.54	1	0.18	71	12.72
Brown	♂	11	1.97	-	-	2	0.36	1	0.18	14	2.51
	♀	35	6.27	1	0.18	2	0.36	2	0.36	40	7.17
Red	♂	1	0.18	-	-	-	-	-	-	1	0.18
	♀	2	0.36	-	-	-	-	-	-	2	0.36
Total	♂	245	43.91	17	3.05	10	1.79	14	2.51	286	51.25
	♀	244	43.73	7	1.25	17	3.47	4	0.72	272	48.75
	♂♀	489	87.63	24	2.30	27	4.84	18	3.23	558	100.0

n = number of chickens, % = percentage, ♂= male, ♀=female, ♂♀= male and female.

Table 12
Body weight and body measurements (mean± standard deviation) according to sex and genetic type of the local chicken population in Sudano-sahelian agro-ecological zone of Cameroon

Parameters	Sex	Genetic type				Mean
		Normal	Naked neck	Crested	Frizzle	
Body weight (g)	♂	1600± 340	1533±335	1465±326	1516±168	1588±332
	♀	1319±267	1511±357	1330±279	1225±178	1323±269
	♂♀	1460±336 ^{A}	1528±333 ^{A}	1380±299^{A}	1451±207 ^{A}	1458±329
Body length (cm)	♂	44.06±3.07	43.27±4.56	42.65±3.13	43.93±1.82	43.96±3.12
	♀	40.66±2.57	41.86±3.47	39.69±2.59	39.63±3.49	40.59±2.61
	♂♀	42.35±3.30 ^{B}	42.85±4.25 ^{B}	40.79±3.10^{A}	42.97±2.84^{B}	42.32±3.34
Wing length (cm)	♂	20.01±1.38	20.62±1.79	19.80±1.27	20.32±1.41	20.05±1.41
	♀	17±70±1.16	17.07±1.77	17.56±1.39	17.75±0.87	17.67±1.19
	♂♀	18.86±1.72 ^{A}	19.58±2.40 ^{B}	18.39±1.72 ^{A}	19±75±1.69 ^{B}	18.89±1.77
Neck length (cm)	♂	13.52±1.59	13.51±1.78	12.65±2.19	13.71±1.25	13.49±1.61
	♀	12.52±1.24	12.21±0.95	12.06±1.55	12.25±1.44	12.48±1.26
	♂♀	13.02±1.51 ^{AB}	13.13±1.68 ^{B}	12.28±1.79 ^{A}	13.39±1.40 ^{B}	13.00±1.54
Thorax circum ference (cm)	♂	31.45±3.61	32.32±3.78	30.15±3.17	31.68±3.68	31.47±3.59
	♀	30.20±3.56	29.24±2.29	29.77±3.01	29.50±2.35	30.14±3.48
	♂♀	30.82±3.63 ^{A}	31.43±3.65 ^{A}	29.91±3.02 ^{A}	31.19±3.49^{A}	30.82±3.60
Tarsus length (cm)	♂	11.03±1.04	10.65±1.14	10.70±1.36	10.75±1.03	10.98±1.06
	♀	09.19±0.85	10.21±1.66	09.12±0.84	9.00±0.41	09.21±0.88
	♂♀	10.11±1.32^{AB}	10.52±1.30 ^{B}	9.70±1.30 ^{B}	10.36±1.19 ^{A}	10.12±1.32
Tarsus circum ference (cm)	♂	1.44±0.17	1.41±0.21	1.36±0.15	1.43±0.15	1.43±0.17
	♀	1.26±0.18	1.31±0.12	1.21±0.12	1.27±0.16	1.26±0.14
	♂♀	1.35±0.18 ^{A}	1.38±0.19 ^{B}	1.26±0.15 ^{A}	1.39±0.16 ^{B}	1.35±0.18
Head length (cm)	♂	7.79±0.53	7.97±0.57	7.65±0.63	7.82±0.46	7.80±0.53
	♀	7.13±0.45	7.00±0.29	7.12±0.49	7.75±0.29	7.14±0.45
	♂♀	7.47±0.59 ^{AB}	7.69±0.67 ^{BC}	7.32±0.59 ^{A}	7.81±0.43 ^{C}	7.48±0.59

$^{A\ B\ C}$ in the same row for each parameter with the same superscripts are not significantly different (P> 0.05); ♂= male, ♀=female, ♂♀= male and female.

The live body weight was significantly different in males and females by (P< 0.001); on the contrary body weight between the different genetic types were none significantly different. However, Naked-neck chickens have the highest absolute body weight, followed respectively by Normal, Frizzle and Crested genetic type. Furthermore, there was no significant difference in thorax circumferences between the different genetic types, while various significant differences were observed among the genetic type for other body measurements.

Mean body weight of the local chicken (Table 13), independently of genetic type, in the Sudano-sahelian agro-ecological zone of Cameroon was 1458±329g. Body measurements such as thorax circumference did not vary significantly with the genetic type, genetic types, even through the absolute values of these parameters were higher in Naked-neck genetic type.

Irrespective of the genetic type, the weight and all body measurements here considered are significantly higher in males than in females.

3.9. Body appendixes measurements of the indigenous chickens in the Sudano-sahelian zone of Cameroon

The means and standard deviation of body appendices measurements according to sex and genetic type of the local chicken population are shown in table 13.

Table 13
Body appendices measurements according to sex and genetic type of the local chicken in Sudano-sahelian agro-ecological zone of Cameroon.

Parameters	Sex	Genetic types				Mean
		Normal	Naked neck	Crested	Frizzle	
Comb length (cm)	♂	7.85±1.98	7.05±2.47	6.11±2.27	5.723±2.56	7.64±2.12
	♀	3.99±1.30	5.24±1.95	3.25±1.17	3.087±0.68	3.96±1.33
	♂♀	5.92±2.56 ^{BC}	6.52±2.44 ^{C}	4.31±2.13 ^{A}	5.137±2.53 ^{AB}	5.84±2.56
Comb height (cm)	♂	4.11±1.30	3.891±1.35	3.45±1.01	3.20±1.56	4.03±1.324
	♀	1.62±1.07	2.249±0.96	1.60±1.40	1.02±0.43	1.63±1.09
	♂♀	2.87±1.73 ^{AB}	3.413±1.44 ^{B}	2.28±1.54 ^{A}	2.71±1.66 ^{A}	2.86±1.71
Wattle length (cm)	♂	4.41±1.23	4.34±1.58	3.65±0.82	3.42±1.48	4.33±1.27
	♀	1.30±0.91	1.75±0.74	1.28±0.94	0.97±0.73	1.30±0.91
	♂♀	2.86±1.90 ^{B}	3.59±1.83 ^{C}	2.16±1.46 ^{A}	2.88±1.69 ^{AB}	2.86±1.88
Beak length (cm)	♂	4.41±1.23	4.342±1.58	3.650±0.82	3.418±1.48	4.333±1.268
	♀	1.30±0.91	1.745±0.74	1.284±0.94	0.973±0.74	1.304±0.906
	♂♀	2.86±1.90 ^{A}	3.585±1.827 ^{A}	2.160±1.46 ^{A}	2.875±1.689 ^{A}	2.856±1.876
Spur length (cm)	♂	0.59±0.60	0.63±0.54	0.30±0.41	0.45±0.55	0.571±0.585
	♀	0.09±0.40	0.43±0.74	0	0.22±0.45	0.091±0.398
	♂♀	0.34±0.56 ^{AB}	0.58±0.59 ^{B}	0.11±0.28 ^{A}	0.40±0.53 ^{B}	0.337±0.557
Finger length (cm)	♂	7.76±0.62	7.72±0.62	7.62±0.70	7.78±0.33	7.75±0.61
	♀	6.86±0.50	6.57±0.45	6.82±0.59	6.88±0.48	6.85±0.50
	♂♀	7.31±0.72 ^{AB}	7.38±0.78 ^{AB}	7.12±0.73 ^{A}	7.58±0.52 ^{B}	7.32±0.72

$^{A\ B\ C}$ in the same row for each parameter with the same superscripts are not significantly different (P> 0.05); ♂= male, ♀=female, ♂♀= male and female.

Only beak length showed no significant differences (P<0.01) between the four genetic types. The highest values of appendixes measurements were found in naked-neck, except the finger was longest in frizzle chicken.

3.10. Analysis of variance (ANOVA) of live body weight and biometric traits according to sexes and genetic types and their interaction in the Sudano-sahelian local chicken

Table 14 presents the analysis of variation of live body weights and body measurements of the local chicken of the Sudano-sahelian area of Cameroon.

Table 14
ANOVA of live body weight and body measurements of the Sudano-sahelian local chicken population of Cameroon.

Source of variation	Degrees of freedom	F- values							
		Body weight	Body length	Wing length	Neck length	Thorax c.	Tarsus length	Tarsus c.	Head length
Genetic type	3	0.12	19.82	0.25	1.35	1.25	2.35	0.03	0.91**
Sex	1	8.0***	50.08*	66.8***	8.4*	68.49*	8.59**	0.18**	1.01*
GxS	3	0.17	17.03	2.85	1.54	12.73	4.23**	0.01	0.69*
Error	551	0.09	8.23	1.71	2.11	12.57	0.94	0.03	0.24
CV		0.013	0.12	0.06	0.06	0.15	0.04	0.007	0.02

Source of variation	Degrees of freedom	F- values					
		Comb length	Comb height	Wattle length	Beak length	Spur length	Finger length
Genetic type	3	12.96**	5.02*	4.90**	0.18	0.51	0.67
Sex	1	80.29***	40.11***	66.99***	0.50*	1.03*	4.00***
GxS	3	3.67	0.42	0.57	0.28*	0.14	0.61
Error	551	3.12	1.47	1.22	0.09	0.25	0.31
CV		0.07	0.06	0.05	0.01	0.02	0.02

*P<0.05, ** P<0.01, *** P<0.001, G: Genetic type, S: Sex, Thorax c: thorax circumference; tarsus c: tarsus circumference.

Genetic type significantly (P<0.01) affect only the head length, comb and wattle length and comb height (P<0.05), while other measurements were highly influenced by sex (P<0.001), and the interaction (genetic type x sex) only affect the tarsus (P<0.01), head and beak length (P<0.05). Genetic type X sex (interaction) was significantly (P<0.01) in tarsus and (P<0.05) in head and beak length.

3.11. Correlations between parameters

3.11.1. Correlations between the body weights and body measurements according to sexes

The presentation of the correlations according to sexes revealed important differences between males and females of local chickens in Sudano-sahelian zone of Cameroon (Table15).

The majority of body measurements were highly intercorrelation in male chickens, the highest significant (P<0.001) correlation coefficient was found between the wattle length and the comb height. Negative non significant (P>0.05) correlation coefficients were found between beak length and spur length, comb length and height and wattle length. Male body weight was significantly correlated with all body measurements excepted neck length. Comb and spur length had the highest significant (P<0.001) correlation coefficient with male body weight. In females, many non significant (P>0.05) negative or positive correlation coefficients were found.

3.11.2. Correlations between body measurements according to genetic type

Correlation coefficients of body weight and body measurements in the four genetic types (Normal, Naked-neck, Crested and Frizzle) of local chickens of Sudano-sahelian zone of Cameroon are presented in tables 16 a, b, c and d.

Tables 16: Correlation matrices of the body weights and body measurements of local chicken population of the Sudano-sahelian zone of Cameroon according to normal (a), naked-neck (b), crested (c) and frizzle (d) genetic types.

Table 15
Correlations matrices of the body weight and the body measurements of local chicken population of Sudano-sahelian zone of Cameroon according to sexes.

Females							Males							
	Sl	**Cbl**	**Cbh**	**Bkl**	**Bw**	**Hl**	**Wtl**	**Nl**	**Wl**	**Txc**	**Bl**	**Tsl**	**Tsc**	**Fl**
Sl		.613**	.625**	-.070	.503**	.164*	.594**	.352**	.176*	.283**	.351**	.166*	.373**	.277**
Cbl	.047		.763**	-.111	.538**	.311**	.714**	.389**	.159*	.235**	.397**	.359**	.352**	.296**
Cbh	.122	.451**		-.107	.449**	.273**	.808**	.339**	.173*	.218**	.284**	.188*	.333**	.232**
Bkl	.049	-.161	-.181		.214**	.293**	-.132*	.091	.310**	.032	.177*	.200**	.125*	.288**
Bw	.074*	.361**	.192*	.090		.395**	.503**	.538**	.500**	.472**	.684**	.550**	.685**	.616**
Hl	.049	-.121	-.091	.370**	.139*		.220**	.274**	.328**	.141*	.447**	.466**	.332**	.462**
Wtl	.032	.526**	.645**	-.261	.166*	-.101		.461**	.262**	.304**	.331**	.251**	.382**	.274**
Nl	0	-.040	-.145	.188*	.080	.102*	-.106		.430**	.407**	.538**	.419**	.420**	.480**
Wl	-.107	-.004	-.128	.230**	.144*	.238**	-.022	.392**		.349**	.553**	.474**	.367**	.533**
Txc	.008	.229**	.129*	.065	.369**	.011	.101*	.153*	.276**		.298**	.210**	.400**	.338**
Bl	-.025	.155*	-.030	.125*	.428**	.235**	-.031	.308**	.382**	.201**		.631**	.543**	.565**
Tsl	.018	.211**	-.122	.152*	.384**	.148*	-.102	.196*	.307**	.101*	.549**		.436**	.590**
Tsc	.068	-.116*	-.038	.176*	.348**	.193*	-.003	.178*	.271**	.284**	.360**	.171*		.524**
Fl	-.042	-.168*	-.073	.431**	.239**	.397**	-.176	.302**	.475**	.228**	.334**	.290**	.251**	

*P<0.05, ** P<0.01; Bw: body weight; Bl: body length; Hl: head length; Nl: neck length ; Wl: wing length ; Txc: thorax circumference; Tsl: tarsus length; Tsc: tarsus circumference; Bkl: beak length; Cbl: comb length; Cbh: comb height; Wtl : wattle length ; Fl: finger length ; Sl: spur length.

Tables 16
a- Normal features.

	Sl	**Cbl**	**Cbh**	**Bkl**	**Bw**	**Hl**	**Wtl**	**Nl**	**Wl**	**Txc**	**Bl**	**Tsl**	**Tsc**	**Fl**
Sl	1													
Cbl	.605**	1												
Cbh	.599**	.845**	1											
Bkl	.051	.032	.006	1										
Bw	.487**	.596**	.517**	.202**	1									
Hl	.349**	.522**	.491**	.341**	.457**	1								
Wtl	.570**	.868**	.889**	0	.545**	.508**	1							
Nl	.345**	.414**	.339**	.167**	.463**	.343**	.409**	1						
Wl	.341**	.573**	.523**	.265**	.543**	.545**	.614**	.497**	1					
Txc	.238**	.289**	.255**	.053	.489**	.167**	.262**	.326**	.352**	1				
Bl	.407**	.553**	.483**	.188**	.660**	.543**	.529**	.546**	.663**	.316**	1			
Tsl	.376**	.653**	.528**	.227**	.595**	.604**	.618**	.474**	.704**	.267**	.715**	1		
Tsc	.435**	.525**	.472**	.194**	.669**	.471**	.516**	.434**	.538**	.388**	.607**	.547**	1	
Fl	.400**	.555**	.518**	.335**	.602**	.631**	.561**	.493**	.699**	.342**	.643**	.717**	.587**	1

Highly significant (P<0.01) association existed among body weight and body measurements of normal feathering chickens. With respect to body weight, the highest significant correlation coefficient was found with the tarsus circumference. In the normal feathering genetic type, no correlation was found between wattle and beak length.

Tables 16

b- Naked neck.

	Sl	Cbl	Cbh	Bkl	Bw	Hl	Wtl	Nl	Wl	Txc	Bl	Tsl	Tsc	Fl
Sl	1													
Cbl	.197	1												
Cbh	.323	.660*	1											
Bkl	.153	.084	.218	1										
Bw	.044	.688*	.325	.191	1									
Hl	.090	.472*	.480*	.598*	.450*	1								
Wtl	.342	.501*	.832*	.414*	.323	.559*	1							
Nl	.259	.403*	.457*	.368*	.555*	.712*	.580	1						
Wl	.343	.277	.431*	.524*	.249	.697*	.709	.702*	1					
Txc	.336	.558*	.572*	.307	.463*	.414*	.691	.605*	.500	1				
Bl	.047	.532*	.087	.244	.836*	.429*	.147	.435*	.365	.248	1			
Tsl	.002	.407*	.069	.264	.667*	.258	.059	.094	.129	.011	.783	1		
Tsc	-.038	.295	.116	.169	.318	.266	.272	.334	.374	.488*	.261	.28	1	
Fl	.168	.266	.444*	.608*	.301	.794*	.603	.785*	.873	.544*	.338	.10	.392	1

In the naked-neck local chicken population, low but significant correlation coefficients were found compared to the normal feathering genetic type. However, some correlation were strong, as is the case with the relation between wattle length and comb height (0.836**), are finger length and wing length (0.873**). No significant correlation was observed between spur length and the other body measurements.

Tables 16

c- Crested head.

	Sl	Cbl	Cbh	Bkl	Bw	Hl	Wtl	Nl	Wl	Txc	Bl	Tsl	Tsc	Fl
Sl	1													
Cbl	.668*	1												
Cbh	.531*	.518*	1											
Bkl	.182	.128	.105	1										
Bw	.545*	.431*	.464*	.342*	1									
Hl	.399*	.375*	.243	.311	.392*	1								
Wtl	.648*	.789*	.640*	.079	.333*	.476*	1							
Nl	.368*	.127	.064	.102	.040	.105	.202	1						
Wl	.370*	.454*	.271	.529*	.286	.650*	.565	.387	1					
Txc	.061	.141	-.119	.113	-.233	-.206	.041	.220*	.100	1				
Bl	.509*	.568*	.147	.448*	.475*	.670*	.465	.354	.759*	.089	1			
Tsl	.605*	.667*	.322	.360*	.510*	.679*	.568	.310*	.700*	-	.758*	1		
Tsc	.537*	.541*	.307	.482*	.445*	.623*	.592	.497*	.834*	.038	.867*	.776*	1	
Fl	.432*	.370*	.259	.618*	.545*	.588*	.401	.401*	.780*	.013	.771*	.736*	.794*	1

The observation of crested head correlation revealed negative correlations between thorax circumference and body weight, head length and comb high. The correlation between body weight and tarsus circumference was positive (0.867**) and highly significant ($P<0.01$).

Tables 16

d- Frizzle plumage.

	Sl	Cbl	Cbh	Bkl	Bw	Hl	Wtl	Nl	Wl	Txc	Bl	Tsl	Ts	Fl
Sl	1													
Cbl	.606*	1												
Cbh	.681*	.919*	1											
Bkl	-.515	-.401	-.348	1										
Bw	.272	.506*	.554*	.157	1									
Hl	-.096	.056	.029	.146	.062	1								
Wtl	.670*	.839*	.976*	-.283	.572**	.083	1							
Nl	.248	.393	.521	.201	.600**	.036	.612	1						
Wl	.089	.320	.414*	.381	.684**	.051	.502	.746*	1					
Txc	-.031	-.076	.159	.316	.142	.275	.240	.354	.350	1				
Bl	.134	.393	.438*	.349	.815**	.397	.481	.532*	.751	.371	1			
Tsl	.172	.563*	.571*	.079	.828**	.060	.601	.655*	.847	.082	.723*	1		
Tsc	.247	.099	.325	-.052	.279	.239	.411	.149	.211	.558*	.429*	.021	1	
Fl	.264	.456*	.581*	.201	.770**	.218	.681	.784*	.851	.218	.773*	.801*	.3	1

*P<0.05, ** P<0.01; Bw: body weight ; Bl : body length ; Hl : head length ; Nl : neck length ; Wl : wing length ; Txc : thorax circumference ; Tsl: tarsus length ; Tsc : tarsus circumference ; Bkl: beak length ; Cbl : comb length ; Cbh: comb height ; Wtl : wattle length ; Fl: finger length ; Sl: spur length .

With respect to head length, all body measurements in Frizzle genetic type were not significantly correlated, while the correlation between wattle length and comb was high (0.976**) compared to all parameters and highly significantly (P<0.01).

4. Discussion

Scientific investigation on indigenous chickens of Sudano-sahelian agro-ecological zone of Cameroon revealed a great diversity in genetic types, which were made up of high frequency of Normal feathered chickens, followed by crested and Naked-neck, while Frizzle genetic type represented the lowest frequency in the population. The diversity observed in the Sudano-sahelian region of Cameroon is in accordance with what has been mentioned in other regions of Cameroon (Fotsa and Pone, 2001; Keambou et al., 2007; Fotsa et al., 2010) as well as in various countries in Africa (Missohou et al., 1998; Akouango et al., 2004). The variation in morphological patterns indicates the existence of genetic variability a consequence of major genes and their interactions (Périquet, 1997). However, the present study revealed a higher frequency of naked neck and frizzles chicken and an absence of feathered tarsus compared to the results of Fotsa and Pone (2001), Keambou et al. (2007) and Fotsa et al. (2010). These differences may be due to adaptation of the different ecotypes to their respective environmental conditions. The Sudano sahelian agro-ecological area is hotter and drier than the other part of Cameroon, and the high frequency of genes determining naked neck and frizzle plumage could be an adaptation for a better thermo tolerance (Al-Rawi et Al-Athari, 2002). Absence of shank feathering and existence of frizzle plumage is a result of adaptation of indigenous chicken stock. These findings are consistent with those of McAinsh et al. (2004) who stated that the variation in genetic types is exactly what characterises local chickens. These authors further stated that this is probably an expression of high variability at genotype level. In this regard, it could be argued that within the Sudano-sahelian indigenous chicken populations might be presence of strains and /or breeds different from that of the western highlands of Cameroon.

The genetic type variability of Sudano-sahelian chickens is also perceived through their plumage colours and other patterns. According to Nesheim et al. (1979) and Ensminger (1992) plumage colour and pattern, shank colours and shank feathering, naked neck and comb type are inherited by single pairs of genes. Considerable number of chickens showed heterogeneity and had diverse plumage colour. Wild type colours appeared in high frequencies in the Sudano-sahelian chicken populations. Many genes govern the coloration of local chicken, I genes (IS, ID, i+), S genes and B (BSd, b+) genes are playing the coloration roles of plumage and varying with many factors. White and brown colours have high frequencies in the Sudano-sahelian local chicken while black colour showed the lowest frequency in this population. Keambou et al. (2007) also found similar results in the western highlands of Cameroon. High percentage of white plumage colour in the population and low percentage of black colour may be resulting from adaptation to a hot climate. This is in agreement with previous studies in Senegal (Missohou et al., 1998), in Ethiopia (Duguma, 2006), in Sudan (Nada, 2009) and other authors in different countries in Africa and worldwide.

Indigenous chicken shanks in the Sudano-sahelian population showed multiple colours. White is the major colour of shank. Keambou et al. (2007) in the western highlands and Fotsa et al. (2010) in the rainy forest zone of Cameroon supported these results when they reported that the major shanks colour of local chickens was white, while black colour represents low percentage. The presence of many genes of shank colours (Id, idC, ida, idM, id+) in the genotype of chicken provide for selection of the best colour to adapt to the physical conditions of the area (Fotsa et al., 2010). Black colour is always the most adaptable to harsh conditions (heat and others) as it involves high quantity of melanin to protect the body. The black colour predominant in sahelian local chicken shanks can be argued to protect against the heat by its melanin.

With respect to comb types, the current study of Sudano-sahelian zone showed low variation of comb types (single and rose). The same result was reported by Duguma (2006), and Keambou et al. (2007) in the western highland of Cameroon and Fotsa et al. (2010) in the forest zone of Cameroon. Badubi et al. (2006), Halima et al. (2007) and Nada (2009) reported high varieties of combs, but the single pattern always showed the high frequency in these populations. The comb pattern in chicken population is influenced by different genes; R and P. The single comb is a wild type of comb appearing locally in most local areas worldwide (Badubi et al., 2006; Halima et al., 2007; Duguma, 2006; Keambou et al., 2007; Nada, 2009; Fotsa et al., 2010). These few types of comb in the Sudano-sahelian zone showed variation in colours. The high frequency of red colour in the local chicken combs indicates that the gene which expresses this phenotype is a dominant gene, even though no reference is available on the genes responsible for comb colours. A similar result was reported by Keambou et al. (2007) in Cameroon, Duguma (2006) in Ethiopia and in Bangladesh (FAO, 2005).

The earlobe colours of the Sudano-sahelian chicken population also showed heterogeneity, with red and white colours being dominant. Similar results were reported by Duguma (2006), Keambou et al. (2007) and Nada (2009). The white earlobe colour which appeared especially in adult mature animals has a close relationship with the sexual maturity hormones of the chickens (Youssao et al., 2010). With other body part, beak and eye colours equally showed heterogeneity, as confirmed by Keambou et al. (2007), Fotsa et al. (2010), Youssao et al. (2010), whereas, Duguma (2006) reported just black colour of eye in Ethiopian local chicken population.

The high variation of patterns in Sudano-sahelian agro-ecological zone of Cameroon may be a result of high level and specificity of adaptation, natural selection, mutation and crosses of animals which has considerable number of genes, allowing for possible modifications and consequently resistance to the conditions and environment under which they live.

The variations of colours in local chicken is controlled by various genes, some of which are related to the whole body; as I genes and the others specific to one part of the body as W+, O , Ml , Mh ... etc . This high specialisation of function allows local chicken to be more adaptable and comfortable to their local area and harsh conditions.

The high variations in quantitative traits reported in this study, is in agreement with the research results reported by Badubi et al. (2006), Dugma (2006), Keambou et al. (2007) and Yakubu et al. (2009).

Sex-associated differences were observed in all the traits measured, with highly values recorded for male birds. This is consistent with the finding of Ngou Ngoupayou (1990), Hancock et al. (1994), Azón and Francesh (1998), Guèye et al. (1998), Mallia (1998), Missohou et al. (1998), Msoffe et al. (2001), Deeb and Cahaner (2001), Godonou (2002) and Dossou (2005),. In a related study, Baeza et al. (2001) attributed the differences between male and female ducks to sexual dimorphism. Interactions between body weight and some body appendices were significant. Yakubu et al. (2009) and Fayeye et al. (2006) in Nigeria confirmed these results. Furthermore, Parta et al. (2002) reported that Naked-neck have heavier body weight compared to Normal features. Similarly, Gala (2000) reported higher in body weight and shank length of Naked-neck and Frizzle plumage compared to Normal chickens. These results were quiet different from those in Sudano-sahelian zone of Cameroon where Normal feathered chickens showed the heavier body weight and Frizzle the lowest body weight. The estimates of correlations in the present study are comparable to those reported by earlier works (Gueye et al., 1998; Yang et al., 2006; Keambou et al., 2007; Yakubu et al., 2009). The strong relationship existing between body weight and body measurements may be useful as selection criterion, since positive correlation of traits suggest that the traits are under the same gene action (Pleiotropy). According to Nesheim et al. (1979) the size and colour of the comb and wattles are associated with gonad development and secretion of sex hormones. Large combs and wattles, and long legs are important morphological traits that allow better heat dissipation in the tropical hot environment. The comb and wattles have a large role in sensible heat losses. This specialised structure makes up about 40% of the major heat losses, by radiation, convection and conduction of heat produced from body surface at environmental temperature below 80°F (Nesheim et al., 1979). Horst (1988) and Nesheim et al., (1979) reported that the gene coding for these traits, which are not major genes but the result of multiple genes and their interactions, could be considered for incorporation into the development of high performance local birds for the tropical hot environment.

The positive correlations between body weight and body measurements were high in both males and females. Gueye et al. (1998) observed a strong correlation ($P<0.001$) between body weight of mature Senegalese indigenous chickens and other body measurements. It could be concluded from this statement that body measurements might be used to predict the body weight of mature indigenous chickens especially in males.

5. Conclusion

Based on results of the current study in Sudano-sahelian agro-ecological zone of Cameroon, indigenous chicken populations have a wide heterogeneity of morphobiometrical characteristics. Qualitative traits (genetic types, plumage colour, comb and earlobe colour ...etc) for the mature chickens (males and females) showed great diversities.

Based on results of the current study in Sudano-sahelian agro-ecological zone of Cameroon, indigenous chicken populations have a wide heterogeneity of morphobiometrical characteristics. Qualitative traits (genetic types, plumage colour, comb and earlobe colour ...etc) and quantitative traits (body weight and body measurements) for the mature chickens (males and females) showed great diversities.

There is, therefore a need to design and implement a national research program to collect, conserve and improve the indigenous chickens in order to enhance the traditional poultry production in the rural areas of the country. The following recommendations might be necessary in achieving this goal:

Genetic characterisation of indigenous chicken including genetic parameters estimates of production traits together with the molecular characterisation is essential for setting a strategy for improving the local poultry production.

Poultry research station should be established for local chicken ecotypes, and should be provided with skilled staffs (researchers and technicians) and adequate budget, with the primary goal to promote research on the effects of the traits and underlying genes on economic factors that should be undertaken for future rural (tropical) oriented breeding plans.

Conserving and promoting the genetic resource of local breeds of chicken with particular emphasis on the threatened genotypes such as dwarf, naked-neck and frizzle is essential for future exploitation. This assessed phenotypic and genetic information should be employed to preserve genetic variability.

Future studies should also emphases the gene flow and phylogenic characterisation of the indigenous chicken populations.

Improving the management condition for the indigenous chicken including provision of adequate and balanced feed and regular vaccination against the predominant infectious diseases will substantially increase the production performance and reduce the mortality of local birds.

Growth rate of indigenous chickens are generally low compared to that of commercial flocks, a consequence of genetic nutritional and parasitic problems; hence the need to evaluate the genetic performance of indigenous chicken in tropical countries.

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References

Agbédé, G.B., Teguia, A., Manjeli, Y., 1995. Enquête sur l 'élevage traditionnel de volailles au Cameroun. Tropicultura, 13. 1: 22-24. Anim. Genet. Resour. 2010, 46, 61–65. Food and Agriculture Organization of the United Nations, 2010.

Akouango, F., Bandtaba, P., Christophe, N., 2010. Croissance pondérale et productivité de la poule locale Gallus domesticus en élevage fermier au Congo.

Al-Rawi, A.A., El-Athari, A.K., 2002. Charactristics of indiger chickens in Iraq. Anim. Genet. Resour. Inform. 32, 87.

Badubi, S.S., Rakereng, M., Marumo, M., 2006 . Morphological characteristics and feed resource available for indigenous chicken in Botswana. Livest. Res. Rrural. Dev. 18(1).

Cameroon report, 2001. Country reports on human rights practices. U.S. Department of state, 23 February 2001.

Duguma, R., 2006 . The phenotypic characterisation of some indigenous chicken ecotypes of Ethiopia. Livest. Res. Rural. Dev. 18(9).

Ensimenger. E.M., 1992. Poultry science: animal agriculture series. 3rd edition, Interstate Publisher, Inc. Denville, Illinois, 65-93.

FAO, 1981. Descripteurs des espèces avicoles. Dans : banque de données des ressources génétiques animales. Rome, Italie. 13-15.

FAO, UNEP, 1986. Animal genetic resources data banks-descriptor list for poultry. Rome: Food and Agriculture Organization of the United Nations.

FAO, 1984. Animal genetic resource conservation by management: data banks and training .FAO animal production and health, No.44/1, Rome, Italy.

FAO, 2005. Animal genetic resource information. Food and Agriculture Organisation of United Nation (FAO), 76-81.

FAO, 2007. The state of the world's Animal Genetic Resources for Food and Agriculture, edited by B. Rischkowsky & D. pilling, FAO, Rome.

FAO, 2012. Phenotypic characterization of animal genetic resources. FAO Animal production and Health Guidelines No. 11. Rome (available at http://www.fao.org/docrep/015/i2686e00.pdf).

Fosta, J.C., Rognon, X., Tixier-Bochard, M., Coquerelle, G., Poné, D., Ngou, Ngoupayou D., Manjeli, Y., Bordas, A., 2010. Caractérisation phénotypique de poules locales (Gallus gallus) de la zone forestière dense humide à pluviométrie bimodale du Cameroun. Animal Genetic Resource, Food and Agricultural Organisation of United Nation .pp 49-59.

Fotsa, J.C., Poné, D.K., Manjeli, Y., Mafeni, Mase, J., 2007. A study of on-farm breeding systems and a phenotypic description of local fowls (Gallus gallus) in the forest zone of Cameroon .Cameroon. J. Agr. Sci. 32-38.

Fotsa, J.C., Poné, K.D., 2001. Etude de quelques caractéristiques morphologique des poulets locaux du Nord-ouest Cameroun. Bulletin RIDAF Volume 11N°2, Juillet – Décembre 2001, 13-20.

Gueye, E.F., 1998. Village egg and fowl meat production in Africa. World. Poult. Sci. 54, 73-86.

Gwanfogbe, Mathew, Meligui, Ambrose, 1983. Geography of Cameroon. Hong Kong: Macmillan Education Ltd.

Halima, Hassen, F.W.C., Neser, E., VanMarle-Koster, de Kock, A., 2007. Phenotypic variation of native chicken populations in Northwest Ethiopia. Trop. Anim. Health. Prod. J. In press.

Hudgens, Jim, Trillo, Richard, 1999. The rough guide to West Africa. London: Rough Guides Ltd.

INS-Cameroun, 2001. Institut national des statistiques:Note annuelle sur le secteur primaire. Agriculture, élevage, pêche , 30. Cameroun.

Keambou, T.C., Manjeli, Y., Tchomboué, J., Teguia, A., Iroume, R.N., 2007. Morphobimetrical charcterisation of local chicken genetic resources from western high lands of Cameroon .Faculté d'agronomé et science agricole , Université de Dschang. Livest. Res. Rural. Dev. Dschang , Cameroon .

Mc Ainsh, C.V., Kusina, J., Madsen, J., Nyoni, O., 2004. Traditional chicken production in Zimbabwe. World. Poult. Sci. J. 60, 233-246.

Missohou, A., Sow, R.S., Ngwe-Assoumou, C., 1998. Morphological and biometrical characteristics of Senegal indigenous chicken .AnGR Information. 24, 63-69.

Nada, M.N., 2009. Phenotypic characterization of native chicken of Sudan. M.Sc. Thesis. University of Gezira, Sudan.

Nesheim, C.M., Austic, E.R., Card, E.L., 1979. Poultry production. Lea and Febiger . Philadelphia. 12th edition. 58-92.

Ngou Ngoupayou, J.D., 1990. Country report on smallholder rural poultry production in Cameroon. In CTA seminar proceedings, Volume 2. Smallholder rural poultry production. Thessalonica, Greece, 39-47. Oct.

Poné, D.K., 1998. Poultry management and marketing of its products, 12. A joint CPDM Sessions Conference. 13–14 August. Bamenda Congress Hall, Cameroon.
SPSS (Statistical package for social sciences), 2002. SPSS User's guide version 12.0. SPSS Institute Inc., Cary NC.
Teleu Ngandeu, E., Ngatchou, A., 2006. Première évaluation du secteur avicole au Cameroun: Structure et importance du secteur avicole commercial et familiale pour une meilleure compréhension de l'enjeu de l'influenza aviaire. Projet OSR/GLO/MUL, Emergency assistance for the control and prevention of avian in fluenza, 48. FAO.
Weigend, S., Romanov, M.N., Rath, D., 2004. Methodology to identify evaluate and conserve poultry genetic resources. Paper presented at the XXII World Poultry Congress, 1-10, 8-13 August, Istanbul, Turkey.
Youssao, P.C., Tobada, P.C., Koutinhouin, B.G., Dahouda, M., Idrissou, N.D., Bonou, G.A., Tougan, U.P., Ahounou, S., Yapi-Guaoré, V., Kayang, B., Rognon, X., Tixier-Boichard, M., 2010. Phenotypic characterisation and molecular polymorphism of Gallus gallus of Savannah and Forest ecotypes of Benin. Afr. J. Biotechnol. 9(3), 369-381, 18 January.

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