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Original scientific article

MORPHOLOGICAL VARIATIONS IN QUALITATIVE AND QUANTITATIVE TRAITS OF FULANI ECOTYPE CHICKENS IN NIGERIA

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The study of Fulani ecotype (indigenous) chicken becomes necessary for proper understanding of its potentials for future breeding programmes in Nigeria. Sixty adult Fulani ecotype chickens comprising 22 males and 38 females were sourced from the Fulani kraal at Opeji in Odeda Local Government area of Ogun State and used to determine their qualitative and quantitative traits. Twenty (20) cocks out of the original 22 were selected randomly from the population for semen quality assessment. Results indicated that polydactyly was observed on 26.67% of the population. Brown and dark brown plumage colours were dominant and had an occurrence of 48.34% and 33.33%, respectively. Comb type was predominantly single (85%) while 46.67% of the population had Spur. Plumage colour influenced ($p<0.05$) comb length, comb width, earlobe width and tail length while shank colour had significant ($p<0.05$) effect on earlobe length, wattle length, wattle width, tail length. Plumage colour had significant ($p<0.05$-0.01) effect on sperm motility, semen pH, sperm concentration and semen volume but not ($p>0.05$) on livability and abnormality. Brown plumage had the highest

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($p<0.05$) sperm motility (88.50±0.89%) and pH (7.01±0.01) which was similar to brown black. Fulani cock with light brown plumage colour had the highest ($p<0.05$) sperm concentration ($1.90±0.11×10^9$/ml) while dark brown had the least value $1.54±0.11×10^9$/ml. Light brown chicken recorded higher ($p<0.05$) semen volume (0.21±0.01/ml) when compared with the dark brown chicken (0.14±0.01/ml). Medium to high positive correlations were observed among all linear body measurements. The study concluded that there existed high phenotypic diversity in Fulani chickens and could be exploited for improved breeding and conservation programmes in Nigeria. The body weight and other linear body measurements of the chickens are highly and positively correlated. However, lighter plumage Fulani ecotype cocks could be adopted in multiplication program where semen motility and concentration are paramount.

Key words: Plumage colour, Body weight. Semen, Fulani chicken

INTRODUCTION

The Nigerian local chicken otherwise called the native or village chicken is widely distributed in the rural areas of the country where they are kept by the natives principally as a source of protein and income (EGAHI *et al*., 2010). There are three chicken ecotypes in Nigeria namely the Fulani, the Eastern and the Yoruba ecotypes. Classification of the Nigerian indigenous chickens has been on the basis of location. There are various ecotypes of the local chickens in the different Agro ecological zones in Nigeria as reported by different authors. NWOSU (1979) identified three main strains in ecotype named Nssuka, Owerri and Awgu types at the Southeastern states of Nigeria. OLUYEMI *et al*. (1982) also reported variation in many traits of the indigenous chicken from the Southern region of Nigeria which they found to be different from those of other parts of the Country. OLORI (1992) noted two ecotypes characterized as Forest and Savannah or Yoruba and Fulani ecotypes.

The Fulani ecotype is native to the drier parts of the country found in the Savannahs (Guinea and Sahel Savannah), Montane regions and cattle Kraals of the North and the South-West part of Nigeria and weigh about 1.75-2.5 kg at maturity (AJAYI, 2010) and are usually managed under extensive system of animal husbandry.

The Fulani ecotype chicken is characterized to be hardy, diseases and adverse climate condition tolerance and has great potential for genetic improvement for both meat and egg production. The ecotype is unique and known for its outstanding qualities that make it to stand out among other breeds of chickens in the tropics. The chicken was reported by OLAWUNMI *et al.* (2008) to be bigger than the Yoruba ecotype chicken. In similar vein, ATTEH (1999) reported that Fulani ecotype chicken is better than other indigenous breeds of chicken in Nigeria in term of live weight thus are referred to as Fulani ecotype.

Despite these qualities inherent in this chicken, the origin could not be traced. OGUNDIPE (1990) and TIAMIYU (1999) in their work linked the origin of Fulani ecotype chicken as the product of the cockerel exchange programme where indigenous fowls and Rhode Island Red chickens were crossbred. The nomadic Fulani tribe that happens to be the custodian of this chicken ecotype is trans-humance in nature. They move about with their belongings including the chickens in search of greener pasture for their cattle. This migratory way of life of the Fulani tribe has helped to preserve the gene of this chicken from being diluted. The genetic potentials of

Fulani ecotype chicken still remain undefined forming a major barrier for the development and implementation of suitable genetic improvement strategies at a national level. This study therefore aimed at examining morphological variations in qualitative and quantitative traits including sperm quality characteristics of this chicken ecotype.

MATERIALS AND METHODS

The practices adopted in this study were carried out according to the guidelines as approved by the Animal Care and Use Committee of the Federal University of Agriculture, Abeokuta, Nigeria, Animal Ethics Committee (unaabACUCF003/1009)

Study area

The study was carried out at the Poultry Unit of the Institute of Food Security, Environmental Resources and Agricultural Research (IFSERAR), Federal University of Agriculture, Abeokuta, Ogun State, Nigeria. The site is located in Odeda Local Government area of Ogun State and lies in the derived savannah vegetation zone of south-western Nigeria on latitude 7˚ 13' 49.46" N, longitude 3˚ 26' 11.98" E and altitude 76m above the sea level. The climate is humid with a mean annual rainfall of 1037mm and mean temperature and humidity of 34˚C and 83%, respectively. The vegetation in the farm represents the interphase between the tropical rainforest and the derived savannah with relative humidity of 82% (GOOGLE EARTH, 2019).

Experimental birds and management

Sixty (60) adult Fulani birds of both sexes comprising 22 adult males and 38 adult females of age range between 29 and 32 weeks were sourced from Fulani Kraals in Opeji axis, Odeda Local Government of Ogun State. The birds were kept for three weeks under semi-intensive system on sex basis. The semi-intensive cage was made up of three movable cages which were opened into a run. The run (roaming area) was bounded and sealed with chicken net round the perimeter and roof, respectively. Space allocation per bird within the roaming area was $4m^2$. Thereafter, the birds were allotted to deep litter system within two weeks at a stocking density of $1.125m^2$/bird. They were fed isonitrogenous and isocaloric commercial grower diet containing crude protein (16%), and metabolisable energy (2450Kcal/J). Fresh feed and water were supplied *ad libitum* daily for 56days. The birds were treated generally within the roaming area. They were not separated into different experimental unit.

Data collection

Using a 5kg – weighing instrument, a ruler and a measuring tape, live weight and body parameters were obtained. Data were collected on body weight (BDW), shank length (SL), thigh length (TL), body length (BL), wing length (WL), skull width (SKW), comb length (CML), comb width (CMW), ocular length (OCL), ocular width (OCW), beak width (BKW), earlobe length (ELL), earlobe width (ELW), wattle length (WTL), wattle width (WTW), back length (BCL), tail length (TLL), folding wing length (FW), central toe length (CTL), beak length (BKL), skull length (SKL) and neck length (NL).

The quantitative and qualitative parameters were divided into four categories depending on body regions: head, neck, body, extremities, and the general body characteristics. All linear body measurements were taken to the nearest 0.1cm. Shank colour, polydactyl, plumage colour, comb colour, comb type, beak colour, earlobe colour, presence of spur and ptilopody were collected by visual observation by multiple observers and photographs. All measurements were taken in the morning before the birds were fed. Linear measurement of the body parameters and weight were determined as described by ILORI *et al*. (2017).

Semen collection

The cocks were allowed two weeks of adaptation with the new environment (deep litter system) and were trained to respond to the abdominal massage technique for semen collection. Twenty cocks comprising four cocks per plumage colour (black, dark brown, brown, white and black/white) were used (Figures 1a-d). The massage technique described by LAKE (1962) was used to collect semen from the cocks. Single ejaculate of semen was collected from each cock twice a week between 7:00 and 9:00 a.m. by abdominal massage method. Four replicates of semen samples were collected across the days per exercise. Semen collection and evaluation were performed at room temperature. Semen was collected for four weeks.

Figure 1a. Black plumage cock

Figure 1b. Dark brown plumage cock

Figure 1c. Light brown plumage cock

Figure 1d. White/black plumage cock

Semen evaluation

Semen evaluation was carried out on sperm motility, live sperm, sperm abnormality, sperm concentration, pH of the semen and semen volume. Semen evaluation was carried out in the Animal Physiology Laboratory, Federal University of Agriculture, Abeokuta.

Sperm motility

Sperm motility was determined as described by BEARDEN and FUQUAY (1997). The semen samples were assessed for sperm motility using Celestron PentaView microscope (LCD-44348 by RoHS, China) at 400 x magnifications. A semen mount was made using 5µl semen and the semen was placed directly on a microscope slide and covered with cover slip. For each sample, ten microscopic fields were examined to observe progressive sperm motility and the mean of the ten successive evaluations was recorded as the final motility score.

Live sperm

Sperm livability was evaluated as described by BEARDEN and FUQUAY (1997) with the use of eosin-nigrosin stain. A thin smear of mixture of semen and eosin-nigrosin solution were drawn across the slide and dried. Semen samples were examined under a digital microscope (Celestron Penta®) LCD view at 400x magnification for live spermatozoa. Spermatozoa that appeared white were recorded as live spermatozoa and those that pick up the stain were recorded as dead spermatozoa.

Sperm abnormality

Sperm abnormality was evaluated as described by BEARDEN and FUQUAY (1997) with the use of eosin-nigrosin stain. A thin smear of mixture of semen and eosin-nigrosin solution was drawn across the slide and dried. Abnormality of sperm cells located in the head, mid-piece and tail was observed under Celestron PentaView LCD microscope (400 x magnifications**).**

Sperm concentration

Sperm concentration was determined with the use of a semen photometer (SDM 1 RAM, 12300/0106 Germany).

Semen pH

Semen pH was determined with the use of a litmus paper and confirmed with a pH meter H1 98128 mode.

Semen volume

Semen volume from each cock was measured with the use of a collection tube graduated in ml.

Statistical analyses

Quantitative data obtained on linear body measurements were analyzed using General Linear Model of SAS (2002) for the effect of plumage colour. Significant means were separated using Duncan Multiple Range Test (DMRT) of the same package. Semen qualities were analyzed using the same package. Descriptive statistics (frequency and percentages) was used to analyse qualitative traits such as plumage colour, polydactyly, comb type, earlobe colour, presence of spur, beak colour, shank colour, and comb colour. The pictures for the qualitative traits are as shown below:

Model 1

$Y_{ijk} = \mu + P_i + S_j + (PS)_{ij} + \sum_{ijk}$
Where:
Y_{ijk} = observed value of dependent variable
μ = population mean
P_i = Effect of plumage colour of Large Fulani ecotype chicken on linear body measurements (i=5)
S_j = Effect of shank colour of Large Fulani ecotype chicken on linear body measurements (j=4)
$(PS)_{ij}$ = Effect of the interaction between plumage colour and shank colour
$\sum_{ijk}$ = Residual error

Model 2

Semen quality characteristics model;
$Y_{ij} = \mu + P_i + \sum_{ij}$
Y_{ij} = Observed value of dependent variable (livability, abnormality, motility, pH, concentration and volume)
μ = Population mean
P_i = Effect of plumage colour on semen quality characteristics (i=5)
$\sum_{ij}$ = Residual error

Figure 2. Polydactyly in Large Fulani Ecotype Chicken

Comb types in Large Fulani Ecotype Chicken

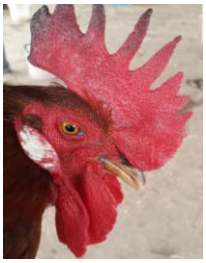

Figure 3a. Normal comb type

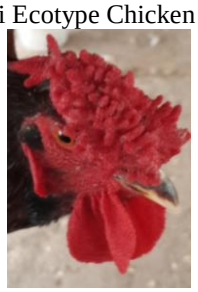

Figure 3b. Rose comb type

Earlobe color in Large Fulani Ecotype Chicken

Figure 4a. White earlobe

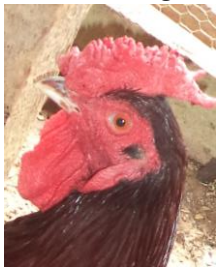

Figure 4b. Red earlobe

Figure 4c. Variegated earlobe

Shank colour in Large Fulani Ecotype Chicken

Figure 5a. Black

Figure 5b. White

Figure 5c. Yellow

RESULTS

Body characteristics of Fulani ecotype chickens

The qualitative traits observed in Fulani ecotype chickens used for the study are presented in Table 1. Over half (63.33%) of the chickens population were females while 36.67% were males. Polydactyly was observed in 26.67% of the population while 73.33% were having normal leg toes. Number of individuals in each plumage colour varied within the population. Brown colour had highest sampled individuals (48.34 %) while white/black colour was the least (1.67%).

Variation was also noticed in the comb type of the chickens observed with 85.00% of the population having single comb type and the least being rose comb type (1.67%). Differences were observed in the percentage occurrence of earlobe colour with red (51.67%) being the highest followed by white (30.00%) while white/red earlobe (18.33%) was the least. Spur was present on 46.67% of the population, 3.33% had none while 50% exhibited spur at rudimentary stage. The result also revealed that brown (85%) was the major beak colour observed among Fulani ecotype chicken while yellow, black/brown and black had 6.67%, 3.33% and 5%, respectively. The predominant shank colour was yellow (58.34%) followed by grey (28.33%); 10% of the population had white shank colour while only 3.33% of the population exhibited black shank colour. No occurrence of Ptilopody or feathered shank in the chickens sampled for this study. The comb colour was predominantly red for all the chickens observed.

Table 1. Qualitative traits of Fulani ecotype chickens

Trait	Variant	Frequency	Percentage (%) distribution
Sex	Male	22	36.67
	Female	38	63.33
	Sub-total	60	100.00
Polydactyly	Absent	44	73.33
	Present	16	26.67
	Sub-total	100	100.00
Plumage colour	Dark brown	20	33.33
	Brown	29	48.34
	White	7	11.67
	Black	3	5.00
	White/Black	1	1.67
	Sub-total	60	100.00
Comb type	Single	51	85.00
	Rose	1	1.67
	Spiked rose	6	10.00
	Pea comb	2	3.33
	Sub-total	60	100.00
Earlobe colour	White	18	30.00
	Red	31	51.67
	White/Red (Pink)	11	18.33
	Sub-total	60	100.00
Spur	Absent	2	3.33
	Present	28	46.67
	Rudimentary stage	30	50.00
	Sub-total	60	100.00
Beak colour	Brown	51	85
	Yellow	4	6.67
	Black/Brown	2	3.33
	Black	3	5.00
	Sub-total	60	100.00
colour	Yellow	35	58.34
	Grey	17	28.33
	White	6	10.00
	Black	2	3.33
	Sub-total	60	100.00
Ptilopody	Present	0	0.00
	Absent	60	100.00
	Sub-total	60	100.00
Comb colour	Red	60	100.00

Effect of plumage colour on linear body measurement of Large Fulani ecotype chickens

The results in Table 2 showed the least square means of the effect of plumage colour on body linear measurements. Comb Length, Comb Width, Earlobe Width and Tail Length were significantly ($p < 0.05$) affected by plumage colour. The mean value for comb length was highest (4.75 ± 1.86cm) for light brown and lowest (2.97 ± 0.79 cm) for white.

Table 2. Means (±Se) showing effects of plumage colour on body measurements of Fulani ecotype chickens

	Plumage colour						
Parameters	Dark brown	Brown	White	Deep brown Black	Light brown Black	Light Brown	Black
BDW	1.46 ± 0.17	1.30 ± 0.11	1.08 ± 0.16	1.39 ± 0.21	1.34± 0.42	1.58 ± 0.34	1.47 ± 0.26
SL	7.19 ± 0.47	6.77 ± 0.35	6.36 ± 0.28	6.95 ± 0.47	7.48 ± 1.01	7.65 ± 0.60	6.83 ± 0.59
TL	12.41 ± 0.59	11.46 ± 0.66	11.61 ± 0.42	12.44 ± 0.73	12.13 ± 0.43	12.58 ± 0.60	11.93± 1.38
BL	50.20 ±2.23	48.60 ± 1.62	47.83 ± 2.10	51.16 ± 3.04	49.73 ± 6.02	49.00 ± 7.40	49.50 ± 4.01
WL	29.46 ± 1.22	29.24 ± 0.90	30.84 ± 0.88	30.84 ± 1.28	30.50 ± 2.46	31.60 ± 1.45	30.37 ± 1.61
SKL	7.66 ± 0.21	7.30 ± 0.20	6.93 ± 0.25	7.06 ± 0.29	7.48 ± 0.38	7.70 ± 0.21	6.80 ± 0.65
SKW	4.59 ± 0.14	4.50 ± 0.09	4.30 ± 0.08	4.57 ± 0.14	4.90 ± 0.34	4.90 ± 0.30	4.33 ± 0.23
CML	4.52 ± 1.08^{ba}	3.90 ± 0.60^{ba}	2.97 ± 0.79^{b}	4.63 ± 0.86^{ba}	4.68 ± 2.08^{ba}	4.75 ± 1.86^{ba}	3.77 ± 1.82^{ba}
CMW	1.84 ± 0.69^{b}	1.87 ± 0.54^{b}	0.93 ± 0.41^{b}	2.01 ± 0.46^{b}	2.45 ± 1.52^{ba}	2.48 ± 1.04^{ba}	1.13 ± 0.70^{b}
OCL	1.22 ± 0.03	1.21 ± 0.03	1.14 ± 0.04	1.19 ± 0.05	1.25 ± 0.09	1.15 ± 0.13	1.20 ± 0.10
OCW	1.07 ± 0.02	1.03 ± 0.02	1.00 ± 0.04	0.99 ± 0.04	1.00 ± 0.04	1.08 ± 0.10	1.07 ± 0.03
BKL	1.58 ± 0.08	1.55 ± 0.08	1.56 ± 0.08	1.66 ± 0.05	1.65 ± 0.17	1.48 ± 0.14	1.50 ± 0.15
BKW	1.19 ± 0.05	1.12 ± 0.04	1.10 ± 0.02	1.11 ± 0.05	1.05 ± 0.09	1.15 ± 0.10	1.23 ± 0.08
ELL	1.73 ± 0.28	1.78 ± 0.20	1.37 ± 0.25	1.97 ± 0.34	1.65 ± 0.64	1.73 ± 0.33	1.77 ± 0.47
ELW	1.59 ± 0.24^{ba}	1.47 ± 0.12^{ba}	1.14 ± 0.23^{b}	1.58 ± 0.20^{ba}	1.40 ± 0.42^{ba}	1.53 ± 0.30^{ba}	1.47 ± 0.37^{ba}
WTL	2.62 ±.0.85	2.13 ± 0.38	1.53 ±0.54	2.96 ±0.70	2.15 ± 1.35	2.30 ± 0.94	3.03 ± 1.75
WTW	2.64 ± 0.49	2.32 ± 0.27	2.03 ± 0.33	2.80 ± 0.41	2.53 ± 1.09	2.43 ± 0.62	2.53 ± 0.89
NL	14.64 ± 2.05	12.62 ± 0.35	11.73 ± 0.60	13.26 ± 0.69	13.33 ± 1.01	12.88± 1.28	12.33 ± 1.01
BCL	19.27 ± 0.92	17.78 ± 0.76	16.50 ± 0.72	18.25 ± 0.28	18.53 ± 2.91	20.13 ± 2.55	18.77 ± 2.96
TLL	14.96 ± 1.46^{ba}	14.70 ± 0.71^{ba}	14.24 ± 0.96^{b}	17.82 ± 2.18^{ba}	15.63 ± 3.14^{ba}	15.40 ± 2.13^{ba}	15.00 ± 2.27^{ba}
FW	19.66 ± 0.80	19.82 ± 0.42	19.64 ± 0.68	20.63 ± 0.81	20.18 ±1.21	21.00 ± 0.91	19.57 ± 1.00
CT	4.63 ± 0.19	4.56± 0.10	4.27 ± 0.15	4.54 ± 0.20	4.78 ± 0.31	4.65 ± 0.33	4.40± 0.26

^{abc}Means within the same rows with different superscripts differ ($P< 0.05$), SE= standard error

BDW=Body weight SL=Shank length TL=Thigh length WL=Wing length OCL=Ocular length
ELL=Earlobe length WTL=Wattle length WTW=Wattle width SKW=Skull width BKW=Beak width
CML=Comb length CMW=Comb width BL=Body length BKL=Beak length
ELW=Earlobe width TLL=Tail length SKL=Skull length NL=Neck length FW=Folding wing length CTL=Central toe length OCW=Ocular width BCL=Back length

All measurements are in cm except for body weight (kg/b)

Comb width was highest (2.48 ± 1.04 and 2.45 ± 1.52 cm) for light brown and light brown black, respectively and least (0.93± 0.41) for white plumage colour. The highest Earlobe width (1.59 ± 0.24 cm) was recorded for dark brown and lowest (1.14 ± 0.23cm) for white plumage colour. Tail length was highest (17.82 ± 2.18cm) in deep brown black and lowest (14.24 ± 0.96 cm) in white plumage colour.

Effect of shank colour on linear body measurement of Large Fulani ecotype chickens

The least square means of the effect of shank colour on linear body measurement is presented in Table 3. From the result, shank colour significantly ($p<0.05$) affected Earlobe Length, Wattle Length, Wattle Width and Tail Length amongst other parameters evaluated.

Table 3. Means (±se) showing effects of shank colour on linear body measurements of Fulani ecotype chicken

	Shank colour				
Parameters	Yellow	Grey	White	Scaly grey	Black
BDW	1.22 ± 0.10	1.42 ± 0.07	1.53 ± 0.24	2.23 ± 0.63	1.58 ± 0.08
SL	6.72 ± 0.29	7.19 ± 0.22	7.43 ± 0.46	7.25 ± 0.25	6.55 ± 0.45
TL	11.77 ± 0.42	11.94 ± 0.70	12.25 ± 0.46	14.70 ± 0.30	10.80 ± 0.20
BL	47.72 ± 1.46	51.03 ± 1.24	48.68 ± 4.99	59.55 ± 0.45	55.00 ±1.00
WL	29.08 ± 0.71	30.96 ± 0.64	32.00 ± 1.17	34.35 ± 1.65	29.80 ± 1.70
SKL	7.35 ± 0.16	7.15 ± 0.16	7.35 ± 0.34	7.40 ± 0.10	6.90 ± 0.80
SKW	4.56 ± 0.07	4.37 ± 0.08	4.73 ± 0.28	5.10 ±0.40	4.60 ± 0.50
CML	3.94 ± 0.51	3.91 ± 0.59	4.27 ± 1.40	7.10 ± 1.80	5.60 ± 3.30
CMW	1.74 ± 0.37	1.40 ± 0.32	2.15 ± 0.80	5.15 ± 3.05	2.90 ± 2.20
OCL	1.20 ± 0.03	1.19 ± 0.03	1.20 ± 0.09	1.25 ± 0.15	1.15 ± 0.05
OCW	1.03 ± 0.10	1.01 ± 0.02	1.05 ± 0.07	1.05 ± 0.05	1.10 ± 0.00
BKL	1.62 ± 0.05	1.57 ± 0.06	1.43 ±0.08	1.60 ± 0.10	1.45 ± 1.15
BKW	1.13 ± 0.03	1.12 ± 0.04	1.10 ± 0.07	1.30 ± 0.20	1.15 ± 0.05
ELL	1.56 ± 0.16^{b}	1.91 ± 0.16^{b}	1.72 ± 0.26^{b}	3.75 ± 0.25^{a}	2.25 ± 0.95^{b}
ELW	1.37 ± 0.12	1.61 ± 0.11	1.47 ± 0.23	2.05 ± 0.05	1.65 ± 0.45
WTL	2.04 ± 0.36^{b}	2.37 ± 0.36^{b}	2.08 ± 0.74^{b}	6.50 ± 1.00^{a}	3.95 ± 2.25^{ba}
WTWZ	2.32 ± 0.24^{b}	2.53 ± 0.23^{ba}	2.28 ± 0.51^{b}	4.95 ± 0.35^{a}	2.60 ± 0.80^{ba}
NL	13.01 ± 0.63	12.89 ± 0.40	12.88 ± 0.93	13.75 ± 0.25	13.25 ± 0.75
BCL	17.73 ± 0.69	18.13 ± 0.58	19.87 ± 1.99	22.40 ± 2.10	17.85 ± 0.65
TLL	14.67 ± 0.77^{b}	16.11 ± 0.85^{b}	14.15 ± 1.49^{b}	25.40 ± 7.60^{a}	17.95 ± 2.05^{b}
FW	19.56 ± 0.40	20.38 ± 0.41	20.88 ± 0.70	22.05 ± 0.05	20.15 ± 1.85
CTL	4.56 ± 0.10	4.53 ± 0.13	4.38 ± 0.14	4.50 ± 0.10	4.80 ± 0.30

^{abc}Means within the same rows with different superscripts differ ($P< 0.05$), SE= standard error

BDW=Body weight SL=Shank length TL=Thigh length WL=Wing length OCL=Ocular length ELL=Earlobe length WTL=Wattle length WTW=Wattle width SKW=Skull width BKW=Beak width CML=Comb length CMW=Comb width BL=Body length BKL=Beak length ELW=Earlobe width TLL=Tail length SKL=Skull length NL=Neck length FW=Folding wing length CTL=Central toe length OCW=Ocular width BCL=Back length All measurements are in cm except for body weight (kg/b).

Chicken with scaly grey shank colour had higher Earlobe Length (3.75±0.25 cm) compared to that with yellow shank (1.56±0.16 cm). Wattle Length was more pronounced on Fulani chicken with shank colour scaly grey with highest value of 6.50 ±1.00cm and lowest (2.04±0.36 cm) for shank colour yellow. The highest Wattle Width (2.60±0.80cm) was recorded for chicken with black shank color while white shank color chicken had the least Wattle Width (2.28±0.51 cm). The highest value for Tail Length was recorded for chicken with shank color scaly grey (25.40±7.60 cm) while shank color white had the least value (14.15±1.49 cm).

Effect of plumage color on semen quality characteristics

Results in Table 4 showed that plumage color had significant effect on sperm motility ($p<0.01$), semen pH ($p<0.01$), sperm concentration ($p<0.05$) and semen volume ($p<0.01$) but not significant ($p>0.05$) on livability and abnormality. Least square means of sperm motility as affected by plumage color revealed that brown chickens had the highest sperm motility followed by dark brown, light brown and brown black with corresponding mean values of 88.50±0.89%, 88.25±1.54%, 86.75 ±1.54% and 80.75±1.54%, respectively. On sperm pH, brown black and brown had the highest values of 7.01±0.01 and 7.01±0.00, respectively, while light brown and dark brown had mean values of 6.98±0.01 and 6.97±0.01, respectively. The Fulani chickens with light brown plumage color had the highest sperm concentration followed by brown, brown black and dark brown with the mean values of 1.90±0.11 $x10^9$/ml, 1.83±0.10 $x10^9$/ml, 1.59±0.11 $x10^9$/ml and 1.54±0.11 $x10^9$/ml, respectively. Semen volume was seen to be highest 0.21±0.01/ml for each of Fulani chickens with plumage color light brown and brown black while brown had 0.20±0.01/ml and dark brown had the least value of 0.14±0.01/ml. There was no significant ($p>0.05$) difference between livability and the plumage color. The livability for all the plumage colors ranged from 84.69 ±1.34% for light brown to 86.88±1.34% for dark brown. Sperm abnormality was not affected by plumage color ($p>0.05$). However, it ranged from 1.59±0.21% for brown black to 2.25±0.21% for dark brown.

Table 4. Means (±se) effects of plumage color on semen qualities of Fulani ecotype chicken

Color	Livability (%)	Abnormality (%)	Motility (%)	pH	Concentration ($x10^6$)	Volume (ml)
Dark Brown	86.88±1.34	2.25±0.21	88.25±1.54^a	6.97±0.01^b	1536.00±109.18^c	0.14±0.01^b
Light Brown	84.69±1.34	1.94±0.21	86.75±1.54^a	6.98±0.01^b	1902.88±109.18^a	0.21±0.01^a
Brown	86.56±1.34	1.59±0.21	80.75±1.54^b	7.01±0.01^a	1593.38±109.18^{bc}	0.21±0.01^a
Black Brown	86.15±0.78	1.94±0.12	88.50±0.89^a	7.01±0.00^a	1832.46±63.03^{ba}	0.20±0.01^a

Correlation coefficients for semen quality characteristics

The Pearson correlation coefficients between semen quality characteristics are presented in Table 5. The correlation coefficients were generally very low to medium with positive and negative values ranging from (0.01 to 0.37) and (-0.02 to -0.15), respectively.

Significant and positive correlation existed between semen volume and sperm concentration (r=0.37) and between semen volume and semen pH (r=0.14). Also, low but significant correlation was recorded between semen volume and sperm motility (r=0.24) and between sperm concentration and semen pH (r=0.13). The correlation coefficient between concentration and motility (r= -0.03), and pH and abnormality (r= -0.02) were negative and not significant (p>0.05). Semen pH and motility were also negatively correlated and not significant (r= -0.07; p>0.05)). The correlation coefficient between volume and livability and abnormality with livability were low and not significant (r= 0.01 in both cases; p>0.05).

Table 5. Pearson correlation coefficients of semen qualities of Fulani ecotype chicken

	Livability	Abnormality	Motility	pH	Concentration	Volume
Livability	1.00					
Abnormality	0.01^{ns}	1.00				
Motility	0.03^{ns}	0.10^{ns}	1.00			
pH	0.04^{ns}	-0.02^{ns}	-0.07^{ns}	1.00		
Concentration	0.04^{ns}	-0.15*	-0.03^{ns}	0.13*	1.00	
Volume	0.01^{ns}	-0.08^{ns}	0.24***	0.14*	0.37***	1.00

* = (P<0.05), *** = (P<0.001)

Correlation coefficients between body weight and other linear body measurements

Table 6 shows the results of the correlation between body weight and other linear body measurements. The correlation obtained among body weight and all other linear body parameters were highly significant (p<0.001) and positive. Back length, body length and earlobe recorded highest correlation coefficient of 0.87, 0.85 and 0.8, respectively. This degree of correlation coefficient was closely followed by earlobe width (0.79), wattle width (0.78) and tail length (0.76) while wing length had the least value of 0.44.

DISCUSSION

White plumage Fulani ecotype chickens had consistently lowest values for most of the linear body measurements. In another study by DECAMPOS *et al*. (2013), coat colour gene significantly influenced tail length in West African Dwarf Sheep with black coat having highest values. These opinions could be responsible for the low body weight and the corresponding comb length, comb width and tail length measurements of the white plumage Fulani ecotype chickens obtained in our study. This opinion is also consistent with the findings of ABBASS *et al*., (2017); DODAMANI *et al*., (2021) who reported low body weight in white plumage indigenous chickens while higher weight was reported in the black plumage birds. However, this observation is contrary to the finding of SARKER *et al*. (2014) who reported superior linear body measurement with white hilly chickens in Bangladesh. The variation could be as a result of varying environment and genetic compositions as the birds sampled differed along these lines (EGENA *et al*., 2012). Plumage colour has been identified as significant genetic component while development along commercial interest has also follow the plumage line (OLUKOSI *et al*., 2019) and could therefore be explore according to locations and regions.

Table 6. Pearson correlation coefficients between body weight and other linear body measurements of Fulani ecotype chicken

	BDW	SL	TL	BL	WL	SKL	SKW	CML	CMW	OCL	OCW	BKL	BKW	ELL	ELW	WTL	WTW	NL	BCL	TLL	FW	CTL
BDW	1																					
SL	0.78***	1																				
TL	0.59***	0.76***	1																			
BL	0.85***	0.78***	0.70***	1																		
WL	0.44***	0.22ns	0.33**	0.49***	1																	
SKL	0.62***	0.67***	0.62***	0.62***	0.29*	1																
SKW	0.63***	0.57***	0.44***	0.54***	0.37**	0.70***	1															
CML	0.68***	0.73***	0.62***	0.73***	0.23ns	0.59***	0.55***	1														
CMW	0.61***	0.69***	0.54***	0.67***	0.12ns	0.53***	0.53***	0.93***	1													
OCL	0.65***	0.61***	0.55***	0.62***	0.32**	0.75***	0.70***	0.42***	0.35**	1												
OCW	0.57***	0.60***	0.52***	0.61***	0.23ns	0.66***	0.54***	0.53***	0.52***	0.67***	1											
BKL	0.50***	0.62***	0.64***	0.53***	0.11ns	0.56***	0.45***	0.39**	0.37**	0.56***	0.35**	1										
BKW	0.66***	0.49***	0.44***	0.53***	0.24ns	0.56***	0.54***	0.35**	0.28*	0.69***	0.49***	0.50***	1									
ELL	0.80***	0.70***	0.57***	0.79***	0.34**	0.53***	0.55***	0.86***	0.79***	0.46***	0.47***	0.35**	0.41***	1								
ELW	0.79***	0.80***	0.63***	0.81***	0.38**	0.61***	0.49***	0.88***	0.77***	0.50***	0.56***	0.42***	0.40**	0.91***	1							
WTL	0.75***	0.67***	0.60***	0.72***	0.33***	0.53***	0.56***	0.93***	0.83***	0.43***	0.49***	0.38ns	0.42***	0.92***	0.87***	1						
WTW	0.78***	0.70***	0.61***	0.73***	0.28**	0.55***	0.55***	0.92***	0.85***	0.44***	0.49***	0.44***	0.47***	0.88***	0.85***	0.96x***	1					
NL	0.47***	0.39***	0.45***	0.48***	0.19ns	0.33**	0.24ns	0.35**	0.31*	0.45***	0.27*	0.41***	0.26*	0.33**	0.40**	0.31***	0.32**	1				
BCL	0.87***	0.87***	0.73***	0.82***	0.33**	0.72***	0.69***	0.67***	0.61***	0.71***	0.61***	0.57***	0.68***	0.72***	0.74***	0.67***	0.71***	0.50***	1			
TLL	0.76***	0.60***	0.65***	0.82***	0.57***	0.53***	0.55***	0.68***	0.57***	0.52***	0.38**	0.50***	0.46***	0.78***	0.73***	0.76***	0.74***	0.41***	0.67***	1		
FW	0.75***	0.76***	0.68***	0.81***	0.49***	0.58***	0.51***	0.74***	0.69***	0.53***	0.55***	0.50***	0.34**	0.75***	0.80***	0.72***	0.72***	0.48***	0.73***	0.79***	1	
CTL	0.59***	0.57***	0.41***	0.62***	0.42***	0.67***	0.51***	0.51***	0.46***	0.55***	0.51***	0.54***	0.50***	0.47***	0.59***	0.47***	0.48***	0.37**	0.53***	0.48***	0.55***	1

* = $p<0.05$, ** = $p<0.01$, *** = $p<0.001$, ns = $p>0.05$

BDW=Body weight SL=Shank length TL=Thigh length WL=Wing length OCL=Ocular length ELL=Earlobe length WTL=Wattle length WTW=Wattle width SKW=Skull width BKW=Beak widthCML=Comb length

CMW=Comb width BL=Body length BKL=Beak length ELW=Earlobe width TLL=Tail length SKL=Skull length NL=Neck length FW=Folding wing length CTL=Central toe length OCW=Ocular width BCL=Back length

All measurements are in cm except for body weight (kg/b).

High variations in quantitative and qualitative traits exist in the Fulani ecotype chicken used in this study. The study of qualitative traits in the ecotype chickens shows that single comb and rose comb are the most common comb types among the chickens. The current result revealed high proportion of chickens with single comb type among the Fulani ecotype chickens; thereby suggesting the prevalence of recessive gene (r) for comb type in the population. This isin line with the findings of BELL (2002); APUNO *et al*. (2011); TABBAA and HASSANIN (2018) where rose and single comb types were reported as the most commonly found in chickens. Rose combs are as a result of a dominant autosomal gene abbreviated as R, while the recessive allele r causes the expression of single comb. Though single comb type has recessive allele, it is populous in chickens as indicated by the frequency. Earlier findings by BELL (2002); APUNO *et al*. (2011); TABBAA and HASSANIN (2018) gave credence to the result obtained in this study.

Yellow colour was the predominant shank colour in the Fulani ecotype chickens as observed in this study. This result is at variance with the earlier work by EGAHI *et al*. (2010) which stated that 42.2% of Nigerian indigenous chickens had black shank colour. This difference observed might be due to the fact that EGAHI *et al*. (2010) considered other indigenous chickens or ecotypes in addition to the Fulani ecotype. Different chicken types express different qualitative traits including the shank colour and this could be responsible for the results obtained in this current study.

The present observation where majority of the population are potentially endowed with spur is consistent with the submission of EGENA *et al*. (2010). Presence of spur in chickens is a pointer that the birds will be heavier than those not having the appendage. It is likewise a pointer to the fact that Fulani Ecotype chickens has potential to grow bigger. The finding of EGENA *et al*. (2012) who reported higher body weight, length and girth in indigenous chickens with higher spur length also gave credence to the result obtained in our study.

The phenotypic frequency observed in this study is lesser than the spur incidence reported by MANCHA *et al*. (2006) in Jos Plateau, Nigeria but higher than the values reported by OGUNTUNJI and AYORINDE (2009) and EGENA *et al*. (2011) in a population of indigenous chickens in Oyo East, South West Nigeria. This suggests a preponderance variation in the performance of indigenous chickens' distributions across locations as reported by EGENA *et al*. (2012). The Authors reported variations in the performance of indigenous chickens in different administrative zones of Niger State, Nigeria. This opinion holds true as there could be variation in performance of the birds even with same genetic composition but different environment. According to BOYCE *et al*. (2020) phenotypic expression is a product of gene and environment. Environment which includes management and nutrition may be responsible for the emergence of spur in this case though the birds might be of the same genetic quality. The result in this study is therefore consistent with this opinion. Again, MANCHA *et al*. (2006) and EGENA *et al*. (2011) worked in the middle belt region of Nigeria. The belt has higher population of the Fulanis compared with the southern belt with relatively lesser population (OGUNTUNJI and AYORINDE, 2009). This reason could be responsible for the results obtained by these researchers. Meanwhile, our current study reported an improvement over that of OGUNTUNJI and AYORINDE (2009). This could be related to climate change and other challenges that have resulted into mass movement of many groups, including the Fulanis from the northern parts of Nigeria to the south and the resultant movement of the chicken type. According to OGUNDIPE (1989) and OLORI (1992) the

isolated family group life-style of the Fulani keepers probably conserve the genetic quality of the chicken as well as their livestock.

The birds used in this study were sourced from Fulani Kraals within the study area. The Fulani tribe keeps essentially the ecotype chicken which is obviously bigger compared with the southern or Yoruba ecotype which are predominantly characterised with primordial spur and small body size. Study by OMOTAYO *et al*. (2013) indicated the Fulani group in the Southwest Nigeria for example, concentrates in a remote part away from urban and conspicuous modern facilities and amenities. This isolated life style makes it easy for the group to preserve their heritages and properties thus preserving genetic quality of the ecotype.

The frequency and variation in the earlobe of the chickens is this study is consistent with the earlier result reported by DANA *et al*. (2010). According to these authors, 40% of the indigenous chickens in Ethiopia have white earlobes while a large proportion of the chickens are with red earlobe. This finding is consisted with the result obtained in this study as more Fulani ecotype chickens are observed to have the red earlobe type. However, it is in contrast with the findings of EGAHI *et al*. (2010) who reported a high proportion (about 73%) of indigenous chickens with white earlobe in Nigeria. The disparity between our study and EGAHI *et al*. (2010) could be as a result of the sampled interest, while our study focused on Fulani chicken in particularly, EGAHI *et al*. (2010) was focused on indigenous chickens in general without a prejudice to their genetic composition. Fulani ecotype chicken could be assumed to have the potential to produce egg shell colour other than white. The combinations of brown, white and variegated earlobes indicating the genetic traits of either white, brown and intermediate colour between white and egg shelled eggs is a pointer to the ability of the ecotype to lay brown shelled eggs in the future breeding brown where brown shell may or would be of priority. White earlobe is a trait of white shell eggs as its common in indigenous chickens of the Southern ecotype (EGAHI *et al*., 2010). Fulani chicken could be further investigated for the genes responsible for variegated earlobe for future acceptability of the eggs beyond traditional use which is always the case in Southwest Nigeria and therefore be selected for brown shelled eggs.

The average beak and comb lengths for Fulani ecotype chicken in this research were lesser than the values reported by OLAWUNMI *et al*. (2008). The difference could be due to the age and size of the birds as no mention was made about these two growth factors. Body sizes have been reported to be influenced by age and other management practices (TIMOTHY *et al*., 2011; BELLO *et al*., 2019). Average body length and weight recorded in this study is longer and heavier, respectively than the Yoruba counterpart. This is in tandem with the reports of ATTEH (1999) and OLAWUNMI *et al*. (2008) that the Fulani ecotype chicken is bigger than other Nigerian indigenous chickens.

The volume of semen collected in the current study was within the acceptable range for artificial insemination (HAFEZ, 1978**).** This suggests that the semen from the Fulani cocks can adequate for artificial insemination for the modern and future breeding programmes of the ecotype. The mean sperm concentration obtained in this study was higher than value reported by NWAGU *et al.* (1996) for indigenous chickens in Nigeria but lower than value reported by KESKIN and KGAYE (1995) in Denizli cocks in Turkey. The differences in the values of sperm concentration may be due to differences in age of birds, genetic make-up, environment and nutrition. The sperm concentration obtained in this study indicates that the sperm of Fulani cocks

contain sufficient cells that will be required for efficient fertility. The sperm motility obtained in this study also within the range of 67 -79% reported for normal cock semen (LAKE, 1966; AJAYI, 2011). This shows that fertility of Fulani chicken cocks is expected to be high and suitable for future multiplication of the ecotype. The Semen pH in the study was seen to be consistent with that of ETCHES (1998) and AJAYI *et al*. (2011) who reported 7.01 pH for normal indigenous chickens. This was however less than 7.40 value reported by ORUNMUYI *et al*. (2013), and the 8.3 reported by ISIDAHOMEN (2016) for indigenous cocks. Differences in values of semen quality of the cocks reported in literatures have been attributed to effects of strain, body weight, age and season. According to ABD EL GHANY *et al*. (2011) strain differences only affected semen volume, concentration and motility. However, UDEH *et al*. (2011) reported difference in volume while MAKHAFOLA *et al*. (2012) reported that strain of cocks significantly influence semen volume, pH and sperm concentration. These variations could therefore be attributed to strains, age and season or environment as the studies were carried out independently without prejudice. The opinions of ETCHES (1998), AJAYI *et al*. (2011), ABD EL GHANY *et al*. (2011), UDEH *et al*. (2011), MAKHAFOLA *et al*. (2012), ORUNMUYI *et al*. (2013) and ISIDAHOMEN (2016) therefore gave credence to the result obtained in our study.

The light brown and brown black plumaged Fulani chickens had the highest semen volume but lower than the values obtained by PETERS *et al. (*2008) for other strain of chickens. It is important to note that PETERS *et al. (*2008) made use of the combinations of improved local and exotic strains in their study and these were obtained from a deliberate research effort. This could actually be responsible for the result obtained compared to our study that focuses only on Fulani ecotype which was assumed to be from natural source (Fulani Kraal). Again, management is a factor here. This finding suggests that Fulani Chicken could produce high quality semen with good reproductive (fertility) potential and subsequent hatchability of eggs with good feeding. Consequently, the Fulani ecotype chicken could be assumed to have the potential for integration in modern poultry production in Nigeria. Similarly, ADEYEMO *et al*. (2007), AMEEN *et al*., (2014) reported that poultry breeds with heavier body weight have proportional larger testes and produce more sperm cell during spermatogenesis. This opinion suggests that Fulani cock could be explored for higher body type.

High correlation obtained among body weight and all other linear body parameters were consisted with earlier findings of IGE (2013) in Crossbred Fulani Ecotype chicken of Derived Savannah Zone of Nigeria which suggested that future breeding programmes for meaningful improvements in this ecotype of chicken can be achieved through selection of positive, high and significantly correlated traits. Selection for improvement of one trait will lead to selection in the correlated trait.

CONCLUSION

The study revealed that the Fulani ecotype chickens have high phenotypic diversity which could be exploited for improved breeding and conservation purposes. Body weight and other linear body measurements of the chickens are highly and positively correlated. However, lighter plumage Fulani ecotype cocks could be adopted in multiplication program where semen motility and concentration are paramount.

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MORFOLOŠKE VARIJACIJE KVALITATIVNIH I KVANTITATIVNIH OSOBINA KOKOŠKI EKOTIPA FULANI U NIGERIJI

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Izvod

Proučavanje Fulani ekotipa (autohtone) pileta postaje neophodno za pravilno razumevanje njegovih potencijala za buduće programe oplemenjivanja u Nigeriji. Šezdeset odraslih pilića ekotipa Fulani, koji se sastoje od 22 mužjaka i 38 ženki, dobijeni su iz Fulani kraal-a u Opeji u oblasti lokalne uprave Odeda u državi Ogun i korišćeni su za određivanje njihovih kvalitativnih i kvantitativnih osobina. Dvadeset (20) petlova od prvobitnih 22 odabrano je nasumično iz populacije za procenu kvaliteta sperme. Rezultati su pokazali da je polidaktilija primećena kod 26,67% populacije. Smeđe i tamnosmeđe boje perja bile su dominantne i imale su pojavu od 48,34%, odnosno 33,33%. Krestasti tip je pretežno bio bez ostruge (85%), dok je 46,67% populacije imalo ostrugu. Boja perja je uticala ($p<0,05$) na dužinu kreste, širinu kreste, širinu ušne školjke i dužinu repa, dok je boja potkolenice imala značajan uticaj ($p<0,05$) na dužinu ušne resice, dužinu kreste, širinu kreste, dužinu repa. Boja perja imala je značajan ($p<0,05$-$0,01$) uticaj na pokretljivost spermatozoida, pH sperme, koncentraciju sperme i zapreminu sperme, ali ne i ($p>0,05$) na sposobnost života i abnormalnost. Smeđe perje je imalo najveću ($p<0,05$) pokretljivost spermatozoida (88,50±0,89%) i pH (7,01±0,01) što je bilo slično braon crnom. Petao Fulani sa svetlosmeđom bojom perja imao je najveću ($p<0,05$) koncentraciju sperme (1,90±0,11×109/ml), dok je tamnosmeđi imao najmanju vrednost 1,54±0,11×109/ml. Svetlobraon pile je zabeležilo veću ($p<0,05$) zapreminu sperme (0,21±0,01/ml) u poređenju sa tamnosmeđim piletom (0,14±0,01/ml). Uočene su srednje do visoke pozitivne korelacije među svim linearnim merenjima tela. Studija je zaključila da postoji velika fenotipska raznolikost kod pilića Fulani i da bi se mogla iskoristiti za poboljšane programe oplemenjivanja i očuvanja u Nigeriji. Telesna težina i druge linearne telesne mere pilića su u visokoj i pozitivnoj korelaciji. Međutim, svetlije perje Fulani ekotip petlova bi se moglo usvojiti u programu razmnožavanja gde su pokretljivost i koncentracija sperme najvažniji.

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