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Use of breast length as a quantitative trait in characterisation of indigenous chickens in Semi-arid Nigeria

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Abstract

Indigenous chickens are the major source of organic meat and eggs. A study was carried out to determine their quantitative traits from six states (Kano, Katsina, Jigawa, Sokoto, Zamfara and Kebbi) in semi-arid region, Nigeria. Quantitative traits were measured on 240 adult indigenous chickens and were sampled from 20 households in the study area. The results showed that sexual dimorphism exists between the hens and the cocks. The males had higher values in most of the traits measured. Location had significant ($p<0.05$) effect on wing length, drumstick length, body length, back width and chest depth. The results also revealed positive and significant association between bodyweight and other quantitative traits for both hen and cocks. Stepwise multiple regression f bodyweight on morphometric traits showed that combination of breast length, back width, thigh length, body length, neck length and head circumference accounted for 72% of variation in cocks while five traits (breast length, thigh length, chest depth, body length and beak length) accounted for 67% of the variation in hens. Cocks have more sexual dimorphism. The association between bodyweight and most morphometric traits was positive and significant for both hen and cocks. It is however, recommended that breast length, a quantitative trait can be used as determinant of body size improvement for selection and breeding programmes of indigenous chickens.

Keywords: morphometric traits, sexual dimorphism, correlation and regression

*Posthumous

Utilisation de la longueur de la poitrine comme trait quantitatif dans la caractérisation des poulets indigènes au Nigeria semi-aride

Résumé

Les poulets indigènes sont la principale source de viande et d'œufs biologiques. Une étude a été menée pour déterminer leurs caractéristiques quantitatives dans six États (Kano, Katsina, Jigawa, Sokoto, Zamfara et Kebbi) dans la région semi-aride du Nigéria. Les caractères quantitatifs ont été mesurés sur 240 poulets indigènes adultes et ont été échantillonnés dans 20 ménages de la zone d'étude. Les résultats ont montré qu'il existe un dimorphisme sexuel entre les poules et les coqs. Les mâles avaient des valeurs plus élevées dans la plupart des caractères mesurés. L'emplacement a eu un effet significatif ($p<0,05$) sur la longueur des ailes, la longueur du pilon, la longueur du corps, la largeur du dos et la profondeur de la poitrine. Les résultats ont également révélé une association positive et significative entre le poids corporel et d'autres caractères quantitatifs pour les poules et les coqs. La régression multiple par étapes du poids corporel sur les traits morphométriques a montré que la combinaison de la longueur de la poitrine, de la largeur du dos, de la longueur des cuisses, de la longueur du corps, de la longueur du cou et du périmètre crânien

représentait 72 % de la variation chez les coqs tandis que cinq traits (longueur de la poitrine, longueur de la cuisse, profondeur de la poitrine, longueur du corps et longueur du bec) représentaient 67 % de la variation chez les poules. Les coqs ont plus de dimorphisme sexuel. L'association entre le poids corporel et la plupart des traits morphométriques était positive et significative à la fois pour les poules et les coqs. Il est cependant recommandé que la longueur de la poitrine, un caractère quantitatif, puisse être utilisé comme déterminant de l'amélioration de la taille corporelle pour les programmes de sélection et d'élevage de poulets indigènes.

Mots-clés : traits morphométriques, dimorphisme sexuel, corrélation et régression*Posthume

Introduction

Indigenous chickens play important socioeconomic roles in developing countries (Alders, 2004; Salam, 2005). They are kept for provision of animal protein (meat and eggs), generation of incomes, religious and cultural festival by rural community dwellers (Alders *et al*., 2009). Nearly all rural and peri-urban families in developing countries keep a small flock of free-range chickens (Jens *et al*., 2004). Many indigenous breeds that have unique characteristics such as disease resistance and adaptation to their environment are being replaced by industrial breeds (FAO, 2012). Around 22% of the world's livestock breeds are classified as being at risk of extinction, due to loss of genetic diversity and decrease in population sizes by crossbreeding with commercial exotic breeds (FAO, 2012). These specialized exotic breeds in many livestock species now suffer from the consequences of inbreeding, and as a result, many productive breeds are becoming more dependent on intensive management (Wollny, 2003). The objective of the study is to characterize indigenous chickens in semi-arid zone using morphometric traits.

Materials and methods

Study area

The study was conducted in some selected states in semi-arid region of Nigeria. The selected states cover between latitude $4^{0}144'$ – $10^{0}15'$ and longitude $10^{0}537'$-$13^{0}837'$ with varying averages of rainfall from 690mm to 950mm. The annual temperature varies from 24.1 – 26.3°C in the study area.

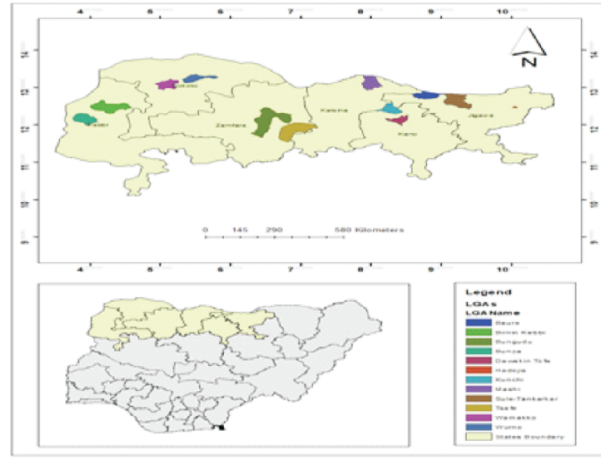

Figure 1: Map of Nigeria showing the study area

Table 1: Climatic attributes of study locations

S/N	State	Longitude (ºN)	Latitude (ºE)	Average Annual Rainfall (mm)	Average Annual Temperature (ºC)
1	Jigawa	11.00 – 13.00	8.00– 10.15	690	24.1
2	Kano	10.537 – 12.614	7.651 – 9.29	950	26.4
3	Katsina	11.104 – 13.346	6.878 – 8.949	875	26
4	Kebbi	12.30 – 12.40	4.20 – 4.30	800	26
5	Sokoto	11.50 – 13.837	4.144 – 6.763	700	25
6	Zamfara	12.10 – 12.167	6.15 – 6.25	888	26.3

Source: Adefisan and Abatan (2015)

Flock management

The birds were managed in semi-intensive system of production where they roam freely during the day and return home in the evening for dietary supplementation and shelter against predators and harsh weather conditions.

Data collection procedure

Bodyweight was measured using 10 kg capacity weighing scale calibrated in kilogrammes while linear measurements were taken using flexible measuring tape calibrated in centimetres (cm). The anatomical reference points were measured in accordance with the standard zoometrical procedures (Gueye *et al*., 1998). The linear traits measured were; Body length (cm) was measured as the distance between the first cervical vertebrae and the pygostyle, Body height (cm) was measured as the distance from legs on the ground up to the back of the body. Body width (cm) was measured as the distance between the right and the left flank of the body. Wing length (cm) was measured as the distance from the caput humeri to the third carpal digit.Neck length (cm) was measured as the distance between occipital condyle and cephalic borders of the coracoids. Head length (cm) was measured as the distance between the end of the beak and the end of the occipital condyl. Head width (cm) was measured as distance from the right orbital prominence to the left orbital prominence.Shank length (cm) was measured as the distance from the shank joint to the extremity of the digituspedis.Foot length (cm) – was measured as length between the genu and the regiotarsalis.Thigh circumference (cm) was measured as the circumference of the drumstick at the coxaregion.Comb height (cm) was measured as the distance between the point of attachment of the comb to the head and its highest point.Comb length (cm) was measured as the horizontal distance between the beginnings to the end of the comb.

Data analysis

Effect of location and sex on morphometric traits in indigenous chickens were determined by subjecting the data to Analysis of variance (ANOVA) using JMP 14.0. The GLM multivariate procedure was used throughout the analysis in the model.

$Y_{ijk} = \mu + L_i + S_j + LS_{ij} + E_{ijk}$

Where,

Y_{ijk} = variable

μ = population mean

L_i = effect of the i^{th} location (1, 2, 3, 4, 5, 6)

S_j = effect of j^{th} sex (1= male and 2= female)

LS_{ij} = interaction effect of location and sex

E_{ijk} = random residual effect.

Variables that showed significant differences were separated at 5% level of probability using Tukey – HSD.

Pairwise correlation between bodyweight and linear body measurements of indigenous chicken cocks and hens were estimated. Prediction of bodyweight from linear body measurements was carried out using stepwise multiple regression analysis

in the model;
$Yj = \beta 0 + \beta 1X1 + \ldots\ldots\ldots\ldots \beta 14x14 + eij$
Where:
Yj = Bodyweight (dependent variable)
B0=intercept
X1, ……, X14 = Linear body measurements
eij = residual error

Results and discussion

Descriptive statistics of morphometric traits of indigenous cocks and hens is presented on Table 2. With the exception of shank circumference for cock and hen (3.66 cm and 3.71cm) and height of birds (22.05 cm and 22.13cm), linear traits were higher for the cocks. The mean bodyweight for cocks from this study is similar to the report of Alabi *et al*.(2012) for naked neck (2.18kg) and Venda (2.06kg) cocks in South Africa. On the contrary, values for the hens were higher for naked neck (1.61kg), Venda (1.68kg) and Potchefstroom koekoe;8k (1.70kg) than the values obtained in the present study. The low bodyweight of hens from the present study might be because most of the hens were incubating their eggs during the period.

Effect of location and sex on morphometric traits of indigenous chickens in semi-arid Nigeria is presented in Table 3. The result showed that location effect was highly significant ($p<0.01$) on wing length (Wgl), beak length (Bkl), drumstick length (Dkl), body length (Byl), back width (Bkw) and chest depth (Ctd). Similarly, sex effect was highly significant ($p<0.01$) on bodyweight (BW), breast length (BST), body length (BL) and back width (BW). Interaction effect between location and sex (Fig. 1) revealed that wing length and height of birds were significant ($p<0.005$). The cocks in this study were superior to the hens in most of the traits measured. Findings from this study agreed with work reported by Alabi *et al*. (2012) in South Africa.

Table 4 presents coefficients of correlation among morphometric traits of indigenous cocks. Positive and negative correlation were recorded. Breast length expressed a highly significant ($p<0.01$) association ($r=0.70$) with body weight while wing length had positive association ($p<0.01$) with shank length ($r= 0.51$), the shank length showed a positive association ($p<0.05$) with height of birds (Hgt) $r= 0.61$, neck length (Nkl) $r=0.51$, and back width (Bkw) $r=0.46$. Other associations ($p<0.05$) noted with back width were drumstick length (Dkl), neck length (Nkl) and height (Hgt).Table 5 shows coefficients of correlation among morphometric traits of indigenous hens. Positive and negative correlation were also observed. Breast length had highly significant ($p<0.01$) association ($r=0.72$) with body weight while wing length had significant association ($p<0.01$) with shank length ($r=0.50$ and body length ($r=0.49$). Similarly, shank length had significant association ($p<0.01$) with drumstick length ($r=0.49$). Other associations ($p<0.05$) noted for neck length, height and back width were with chest depth, back width, height and neck length.The positive and high relationship between bodyweight and breast length revealed that breast length can be used as a predictor of bodyweight which was similar to the findings of Fayeye*et al*. (2014) from their study with Isa brown and Ilorin Ecotype chickens. Adebambo*et al*. (1996) also reported breast breadth as a good indicator of meatiness in most poultry species. Moderate and positive relationship between body weight and shank length obtained in this study was similar to the findings of Haunshi*et al*. (2012). According to Yakubu*et al*. (2009) strong and positive association between bodyweight and morphometric traits as an indication of pleiotropy and provides basis for possible genetic manipulation and improvement of Nigerian local chickens. It is obvious therefore breast length is a good indicator for estimating bodyweight for both hens and cocks.

Table 2: Descriptive statistics of morphometric traits of indigenous cocks and hens

Trait	Cocks			Hens		
	Mean ± S.E	CV	Range	Mean ± S.E	CV	Range
Bw(Kg)	2.111 ± 72.7	33.5	1.9667 – 2.252	1.281± 40.64	36	1.20078 – 1.36163
Bst(cm)	23.1± 0.5	22	22.02 – 24.09	19.18±0.40	24	18.38 – 19.98
Bkl(cm)	3.37 ± 0.05	15	3.27 – 3.46	3.25±0.04	44	3.18 – 3.33
Wgl(cm)	13.11±0.4	29	12.34 – 13. 88	11.37±0.29	28	10.80 – 11.94
Skl(cm)	7.22±0.1	15	7.01 – 7.45	7.36±0.12	19	7.11 – 7.60
Skc(cm)	3.66±0.06	15	3.55 – 3.78	3.71±0.05	16	3.60 – 3.81
Thl(cm)	10.83±0.21	19	10.40 – 11.25	10.30±0.18	20	9.94 – 10.66
Dkl(cm)	7.54±0.25	32	7.05 – 8.03	8.19±0.22	30	7.75 – 8.62
Nkl(cm)	9.12±0.20	21	8.72 – 9.52	9.46±0.20	24	9.06 – 9.86
Hgt(cm)	22.05±0.27	12	21.52 – 22.58	22.13±0.25	12	21.64 – 22.61
Hdc(cm)	10.62±0.16	15.1	5.0 – 14.0	10.21±0.14	15.2	6.0 – 16.0
Byl(cm)	22.29±0.37	16	21.56 – 23.03	19.16±0.32	19	18.53 – 19.78
Bkw(cm)	6.87±0.20	29	6.47 – 7.27	8.16±0.27	37	7.63 – 8.69
Ctd(cm)	7.14±0.23	31.1	5.0 – 14.0	8.11±0.26	35.7	4.2 – 17.0

WGT= Bodyweight,BSt= breast length,Thl= Thigh length, CTD= chest depth, BYL=Body length, BKL= Beak length, NKL= Neck length, BKW= Back width, HDC= Head width, SKL= Shank length, SKC= Shank circumference, WGL= Wing length, DKL= Drumstick length, CV= Coefficient of Variability, S.E= Standard error

Table 3: Effect of location and sex on morphometric traitsof Nigerian indigenous chickens

	Wgt(g)	Bst(cm)	Wgl(cm)	Bkl(cm)	Skl(cm)	Skc(cm)	Thl(cm)	DkL(cm)	Nkl(cm)	Hgt(cm)	Hdc(cm)	Byl(cm	Bkw(cm	Ctd(cm)
LOC														
Kan	1702	20.66	12.46^{ab}	3.395^{ab}	7.716	3.770	10.92	10.31^{a}	9.28	23.50	14.19	21.92^{ab}	8.52^{a}	9.18^{a}
Kat	1553	20.81	10.70^{b}	3.208^{ab}	7.243	3.589	10.24	7.84^{bcd}	9.28	21.57	10.35	18.96^{c}	7.69^{ab}	7.78^{ab}
Jig	1680	20.08	12.24^{ab}	3.251^{ab}	7.292	3.814	10.97	8.52^{b}	9.50	22.46	10.54	20.24^{abc}	8.49^{a}	8.16^{ab}
Sok	1400	20.76	11.09^{b}	3.162^{b}	7.451	3.722	10.52	7.66^{bcd}	9.72	21.92	10.20	20.12^{abc}	7.79^{ab}	7.84^{ab}
Zfr	1777	22.49	14.03^{a}	3.346^{ab}	7.200	3.559	9.73	6.85^{cd}	9.35	21.65	10.38	22.22^{a}	6.66^{b}	6.79^{b}
Kbi	1705	20.24	12.17^{ab}	3.454^{a}	6.905	3.676	10.76	6.29^{d}	8.57	21.49	9.84	19.54^{b}	6.50^{b}	6.43^{b}
P-value	0.076	0.319	<.001	0.037	0.144	0.362	0.074	<.001	0.174	0.070	0.214	<.001	<.001	0.025
SED (±)	135.7	1.116	0.780	0.1032	0.2959	0.1350	0.469	0.481	0.497	0.603	1.916	0.812	0.591	1.025
Sex														
Male	2111	23.06	12.87	3.352	7.251	3.677	10.93	7.62	9.17	22.08	10.58	22.20	6.95	7.87
Female	1281	19.18	11.57	3.266	7.339	3.697	10.22	8.13	9.43	22.11	11.17	19.22	8.10	8.10
P-value	<.001	<.001	0.006	0.170	0.623	0.804	0.014	0.087	0.395	0.929	0.611	<.001	0.001	0.729
SED	82.3	0.677	0.473	0.0626	0.1795	0.0819	0.284	0.292	0.302	0.366	1.162	0.493	0.358	0.654
Loc														
***Sex**														
P-value	NS	NS	*	NS	NS	NS	NS	NS	NS	*	NS	NS	NS	NS

Footnote: WGT= Bodyweight,BSt= breast length,Thl= Thigh length, CTD= chest depth, BYL=Body length, BKL= Beak length, NKL= Neck length, BKW= Back width, HDC= Head width, SKL= Shank length, SKC= Shank circumference, WGL= Wing length, DKL= Drumstick length, HGT= Height, LOC= Location, Kan= Kano, Kat = Katsina, Jig= Jigawa, Sok= Sokoto, Zfr= Zamfara, Kbi= Kebbi

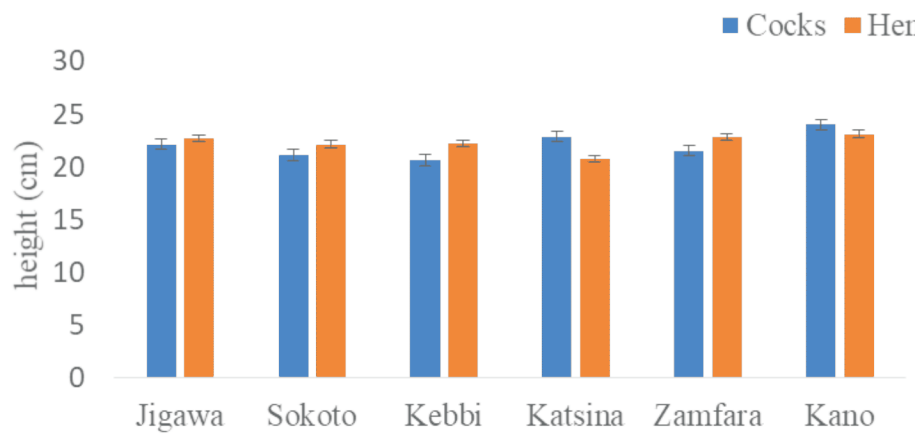

Fig 2: Influence of location and sex on height

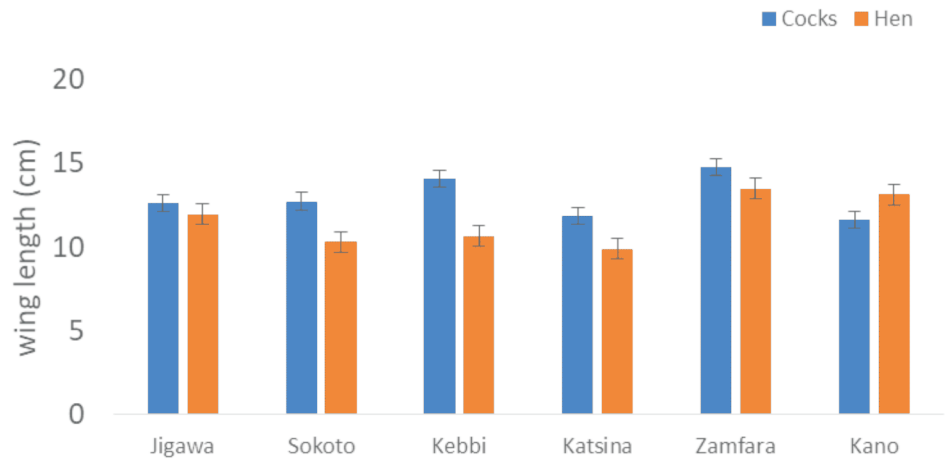

Fig 3: Influence of location and sex on wing length

Table 4: Correlations between morphometric traits of indigenous chicken cocks

	Wgt(g)	Bst	Bkl	Wgl	Skl	Skc	Thl	DkL	Nkl	Hgt	Hdc	Byl	Bkw	Ctd
Wgt(g)	1.0000	0.7005**	0.3679**	0.0324**	-0.1901	0.1597	0.3910*	-0.3422**	-0.3932	-0.2854*	0.0733	0.4132*	-0.6697**	-0.1128**
Bst		1.0000	0.4213*	0.0224	-0.1463	0.2120	0.3773	-0.3393**	-0.3055	-0.1845*	0.0104	0.2957*	-0.6115**	-0.0861**
Bkl			1.0000	0.0494	-0.1468**	0.3207**	-0.1047	-0.1016*	-0.3540	0.0110	-0.0098	0.2104	-0.3383	0.0438
Wgl				1.0000	0.5108**	-0.1125	0.1740**	-0.1593	0.3745	0.1642*	0.5136	0.2972**	0.0416	0.0243
Skl					1.0000	-0.1131**	0.2276**	0.3094**	0.6054	0.5066**	0.4777*	0.2796**	0.4559**	0.2375**
Skc						1.0000	0.0933*	-0.0234	-0.1197	0.1025*	0.0557*	0.0159	-0.0911*	-0.0350*
Thl							1.0000	-0.2421*	0.0331	-0.1215*	0.1991	0.0546**	-0.2717	0.0136
DkL								1.0000	0.2360	0.6201**	0.1587	-0.0134	0.6304**	0.1726**
Nkl									1.0000	0.3111**	0.4153*	0.1772**	0.4967**	0.1230**
Hgt										1.0000	0.3346	0.2455**	0.5556**	0.1639**
Hdc											1.0000	0.2076	0.2079*	0.0625*
Byl												1.0000	-0.0995*	0.0064*
Bkw													1.0000	0.2739**
Ctd														1.0000

Footnote: WGT= Bodyweight,BSt= breast length,Thl= Thigh length, CTD= chest depth, BYL=Body length, BKL= Beak length, NKL= Neck length, BKW= Back width, HDC= Head width, SKL= Shank length, SKC= Shank circumference, WGL= Wing length, DKL= Drumstick length, HGT= Height

Table 5: Correlations between morphometric traits of indigenous chicken hens

	Wgt(g)	Bst	Bkl	Wgl	Skl	Skc	Thl	DkL	Nkl	Hgt	Hdc	Byl	Bkw	Ctd
Wgt(g)	1.0000	0.7185**	0.3546**	0.2792*	-0.1085	0.0620	0.2922**	-0.4681**	-0.3092**	-0.2457*	-0.0859	0.3009**	-0.5186**	-0.5403**
Bst		1.0000	0.2389*	0.1227	-0.0457	0.0362	0.1177	-0.5269**	-0.2984**	-0.2435*	-0.135	0.2317**	-0.5704**	-0.5556**
Bkl			1.0000	-0.0062	-0.0552	0.3376**	0.0464	-0.2473*	-0.2055*	0.0617	0.1364	0.0960	-0.1593	-0.1736
Wgl				1.0000	0.5002**	0.1458	0.4066**	0.1049	0.2166*	0.2147*	0.1248	0.4931**	0.0720	0.1247
Skl					1.0000	0.3788	0.3143**	0.4881**	0.5859**	0.5338**	0.2491**	0.4024**	0.5630**	0.5197**
Skc						1.0000	0.2146*	0.0260	0.0046	0.2786**	0.2139	0.1404	0.2811	0.1745
Thl							1.0000	0.1948*	0.2230*	0.2440**	0.0475	0.3349**	0.1648	0.1168
DkL								1.0000	0.6313**	0.5937**	0.1654	0.1492	0.7277**	0.7705**
Nkl									1.0000	0.6027**	0.2162*	0.4261**	0.6644**	0.6944**
Hgt										1.0000	0.1487	0.3536**	0.6258**	0.6474**
Hdc											1.0000	0.1627	0.1833*	0.1759
Byl												1.0000	0.1889*	0.2429
Bkw													1.0000	0.8908*
Ctd														1.0000

Footnote: WGT= Bodyweight,BSt= breast length,Thl= Thigh length, CTD= chest depth, BYL=Body length, BKL= Beak length, NKL= Neck length, BKW= Back width, HDC= Head width, SKL= Shank length, SKC= Shank circumference, WGL= Wing length, DKL= Drumstick length, HGT= Height

Table 6: Stepwise multiple regression of bodyweight on morphometric traits of indigenous chickens

Sex	Equation	B0	B1	B2	B3	B4	B5	R^2	C(p)	AIC	RMSE	BIC
M												
	BST	-139.97						0.49	66.56	1457.31	507.14	1464
	BST + BKW	64.77	-138.63					0.58	39.78	1440.34	460.99	1450.11
	BST + BKW + BYL	51.01	-150.92	51.57				0.65	22.46	1427.12	427.32	1439.21
	BST + BKW + BYL + NKL	48.68	-122.92	60.05	-61.89			0.67	18.10	1423.71	417.03	1438.08
	BST + BKW + BYL + NKL + THL	38.32	-109.93	64.72	-80.09	66.06		0.70	10.78	1417.05	399.96	1433.64
	BST + BKW + BYL + NKL + THL + HDC	35.87	-119.63	60.98	-99.08	56.13	69.47	0.72	7	1413.39	389.63	1432.15
F												
	BST	-105.43						0.52	53.86	1829.62	319.84	1837.95
	BST + THL	69.80	46.71					0.56	39.88	1819.72	306.28	1830.77
	BST + THL + CTD	53.95	57.92	-41.71				0.61	23.99	1806.91	289.91	1820.64
	BST + THL + CTD + BYL	43.41	46.89	-57.99	28.64			0.64	13.34	1797.36	277.92	1813.72
	BST + THL + CTD + BYL + BKL	40.74	46.41	-55.32	26.94	173.82		0.67	6	1790.16	268.89	1809.13

Footnote: BSt= breast length,Thl= Thigh length, CTD= chest depth, BYL, Body length, BKL= Beak length, NKL= Neck length, BKW= Back wid`

Table 6 shows six morphometric traits (breast length, back width, body length, neck length, thigh length and head circumference) accounted for 72% of variation for the cocks out of which 49% is associated with breast length, a good index for body weight prediction in cocks. For the hens, five morphometric traits (breast length, thigh length, chest depth, body length and beak length) accounted for 67% of the variation out of which 52% was contributed by breast length in hens. The breast length further proved to be a good indicator for estimating bodyweight for both hens and cocks.

Conclusion and recommendation

In conclusion, findings from this research proved that breast length is a parameter that could estimate bodyweight of indigenous cocks and hens of the semi-arid zone of Nigeria and thus hereby recommended for use as determinant of body size n selection and breeding programmes.

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