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Full Length Research Paper

Discriminant Analysis of Sexual Dimorphism in Zoometrical Characters of Adult Local Chicken in the Tropical Forest Zone

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Measurement of some zoometrical traits and indices in male and female local chickens were undertaken as means of differentiation. Data on body weight (BW), breast circumference (BC), wing span (WS), Ornithological measurement (OM), total leg length (TLL), stockiness (STK), massiveness (MAS), long-leggedness (LLG) and condition (CI) were collected on 161 adult local chickens comprising of 86 cocks and 75 hens reared under village scavenging conditions in a cross-sectional survey. The hens showed significantly ($p<0.05$) higher OM and STK (72 versus 67%) while cocks were higher ($p<0.05$) in BW, WS, BC, TLK, MAS, LLG and CI. Low, moderate and high positive and negative coefficients of correlation (*r*) were recorded among the body parameters in both sexes. Highest *r* was observed between WS and TLL (r=-0.920; $p<0.01$) in hens and between TLL and BC (r=0.362; $p<0.01$) in cocks. In the indices highest *r* was recorded between BW and CI in hens and between BW and CI in cocks. The discriminating power of the variables was highest in TLL, chronologically followed by BW, WL and BL. The reduction in the number of measurements saves time and energy required to distinguish between the sexes.

Keywords: Cocks, cross-sectional survey, hens, indices, zoometrical traits

INTRODUCTION

Local chickens had not been accorded pronounced recognition in economic empowerment of Africans until lately. Local chickens possess distinctive characteristics as a gene pool for traits of importance to adaptation, hardiness and resistance to common diseases of exotic chickens (Byarugaba, 2007); leanness and relatively low price (Le Behan –Dual, 2004), lack of religious restriction against its consumption (Jaturasitha, 2004); tastier meat compared to their exotic counterparts (Kolawole, 2010) and sustainable production system. Consequently, there is now a great number of researches on them in Africa (Adebayo and Babafunso, 2001; Naido, 2003; Demeke, 2004; Ijaiya *et al*., 2010 and Grobbelaar, 2010).

However, the incessant decimation of these local germplasms as a result of spread of exotic chickens, through hawking, to every nook and cranny of the country requires frequent evaluation to determine the level of genetic variation as a result of interbreed between/among

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them. Sexual dimorphism must be established for accurate judgment of their characteristics and in cases where they have been established, there is the need for verification and validation.

Sexual dimorphism represents phenotypic differences between male and female of the same animal species in size, form and structure. Generally, birds show plumage dimorphism and characteristically, males are the more brightly coloured sex (McGraw *et al*., 2002). This has been ascribed to the asymmetrical reproductive contributions of the sexes (Owens and Hartley, 1998) and reproductive fitness such as body condition (Willow *et al*., 2009) or survival (Marion, 1994). Dimorphism may also influence differences in parental investment during times of food scarcity (Velando, 2002). Sexual dimorphism in form and behavior can lead to sex differences in space and resource use (Marti, 2008). Most sexual segregation research has been done on ungulates (Martin, 2008) but such research had been extended to bats (Kamran et al., (2007), and birds (Jacob *et al*., 2000).

In Nigeria, numerous attempts have been made to characterize the local chickens using univariate analysis of live weight and zoometrical measurements. However, there is paucity of published information on such using morphological indices and multivariate analysis; which are currently receiving increased attention in birds (Strelec *et al*., 2005; Zenatello and Kiss, 2005; Robertson *et al*., 2008). The aim of this study is to measure some zoometric traits and corporal indices in male and female local chickens as a mean of differentiation.

MATERIALS AND METHODS

Location and description of study area

The study was carried out in Ekiti State. There are 16 Local Government Areas (LGAs) in the state which is divided into 3 Districts: Ekiti South (District A), Ekiti Central (District B) and Ekiti North (District C). District A is made up of six LGAs: Ekiti East, Aiyekire, Ekiti South West, Ikere, Ise-Orun and Emure; District B is made up of five LGAs: Ado, Irepodun/Ifelodun, Ekiti West, Efon Alaaye and Ijero awhile District C is made up of five LGAs: Ikole, Oye, Ilejemeje, Moba and Ido-osi.

Biological specimens and sampling technique

The data were collected on one hundred and sixty one (161) randomly selected adult local chickens comprising of 86 cocks and 75 hens reared under village scavenging conditions between November 2011 and March 2012. The local government areas in each district were arranged alphabetically and thereafter numbered serially. All the local government areas that are even-numbered were selected as experimental sites. In all, a total of seven local government areas were selected for the study. The LGAs were Ekiti East, Emure and Ise-Orun in District A; Efon-Alaaye and Ijero in District B and Ikole and Moba in District C.

Parameters examined

The parameters examined on each adult indigenous chicken were body weight (BWT) and four zoometrical measurements (breast circumference, wing span, Ornithological measurement and total leg length). To ensure accuracy, each measurement was taken twice, early in the morning before the chickens were released for scavenging only on apparently healthy birds. From the parameters above, four zoometrical indices: massiveness, stockiness, long-leggedness and condition index were calculated.

Body weight and anatomical points of reference for each zoometrical measurement

1. The body weight (BWT) of the birds was taken using a weighing scale.
2. Breast circumference (BC) was measured as the circumference at the edge of the sternum under the wings
3. Wingspan (WS) (Pettingill, 1985): Distance between the ends of the longest primaries with wings stretched on the work table, maintain the joints of the wings as stretched as possible.
4. Ornithological/body length (BL) measurement (Scott, 1982): Measured from the tip of the beak to the end of the tail when the bird was laid down on its back.
5. Total leg length (TLL) was measured as the total of the lengths of femur, shank and metatarsal.

Zoometrical indices estimation

$$\text{Massiveness (MAS)} = \frac{\text{Live weight } x100}{\text{Body length}}$$

$$\text{Stockiness (STK)} = \frac{\text{Breast circumfeence } x100}{\text{Body length}}$$

$$\text{Long leggedness (LLN)} = \frac{\text{Total leg length } x100}{\text{Body length}}$$

$$\text{Condition index (CND)} = \frac{\text{Live weight } x100}{\text{Wing span}}$$

Statistical Analysis

All the data were subjected to ANOVA to determine the effect of sex using the General Linear Model of SPSS Version 19 (1989). The same statistical package was used to separate the means of both sexes using the two-tailed,

Plate 1: Male indigenous chicken

Plate 2: Female indigenous chicken

Table 1. Descriptive statistics of the body weight (kg), linear body measurements (cm) and morphological indices (%) of adult indigenous hens and cocks

	Cocks			Hens		
Traits	Mean	Standard Deviation	Coefficient variation	Mean	Standard Deviation	Coefficient variation
Body weight	1.25^{a}	0.13	0.11	0.98^{b}	0.09	0.09
Body length	16.43^{b}	0.26	0.02	17.47^{a}	0.16	0.01
Wing span	11.45^{a}	0.17	0.02	11.30^{b}	0.12	0.01
Breast circumference	11.87^{a}	0.58	0.05	10.96^{b}	0.62	0.06
Total leg length	14.13^{a}	0.10	0.01	11.12^{b}	0.28	0.02
Stockiness	0.67^{b}	0.04	0.05	0.72^{a}	0.04	0.06
Condition index	0.11^{a}	0.01	0.13	0.09^{b}	0.01	0.08
Massiveness	0.14^{a}	0.01	0.13	0.08^{b}	0.69	4.99
Long leggedness male	0.86^{a}	0.01	0.02	0.68^{b}	0.01	0.02

means with different superscripts along the same row are significantly (p<0.05) different

two-sample t-test and to compute the Pearson's coefficients of correlation among the various body parameters. Canonical discriminant analysis on body weight and zoometrical measurements of the adult chickens were examined using the same SPSS package. The standardized discriminant function was used to monitor for the most discriminating variables between the sexes. Wilks` lambda (U statistic) was used to test the significance of the discriminant function and the Bartlett`s V transformation of lambda (chi-square statistic) was later used to compute the significance of lambda

RESULTS AND DISCUSSION

The means, standard deviations and coefficients of variation of the body parameters of indigenous hens and cocks are presented in Table I. The hens showed significantly (p<0.05) higher body length and stockiness while cocks were higher in body weight, wing span, breast circumference, total leg length, massiveness, long-leggedness and condition index. This is consistent with Yakubu and Salako (2009) who observed that sex influenced body weight and body linear measurements in local chickens of Nigeria to the favour of cocks. This sexual dimorphism could be attributed to the usual between-sex differential hormonal action (Baeza et al., 2001) resulting in differential growth rates or/and the selection intensity for high quality males for mating which led to fixation of larger body size and other heritable characters in male birds (Mccracken *et al.,* 2000).

Conformation, type and meatiness of birds could be assessed using massiveness, stockiness, long-leggedness and condition index (Yakubu, 2011). These indices state the ratio of measurements that characterizes the proportionality of bird's body (Oblakova, 2007). Meatiness trait was better illustrated in cocks using massiveness (14 versus 8%; p<0.05 for cocks and hens respectively) while

Table 2. Correlation matrices of body weight and morphometric traits of hens and cocks

Traits	BDW	BTC	WGS	BDL	TLL	MAS	STK	LLN	CND
BDW	-	-.437**	.320**	.567**	-.093	-.038	-.527**	-.548**	.865**
BTC	279**	-	.216	-.158	-.405**	-.114	.980**	-.388**	-.408**
WGS	-.248*	-.188	-	-.440**	-.920**	-.185	.299**	-.817**	-.112
BDL	.306**	.036	.311**	-	.604**	.081	-.350**	-.004	.790**
TLL	.148	-.362**	-.119	-.054	-	.199	-.506**	.795**	.254*
MAS	.303**	.020	-.117	.016	.062	-	-.152	.188	.025
STK	-.337**	.962**	-.275*	-.230*	-.333**	.042	-	-.368**	-.549**
LLN	.070	-.344**	-.234*	-.492**	.859**	.081	-.203	-	-.285*
CND	.989**	-.216*	-.353**	.337**	.175	.302**	-.284**	.071	-

***p<0.01, *p<0.05; Upper matrix: hens. Lower matrix: cocks.*

BWT: body weight; BTC: breast circumference; WNS: wing length; BDL: body length; TLL: total leg length; MAS: massiveness index; STK: stockiness index; LLN: long-leggedness index; CND: condition index.

Table 3. Standardized canonical discriminant function coefficients of the body parameters of adult indigenous chickens

Total leg length	0.972
Body weight	0.499
Wing length	-0.450

Eigenvalue: 2.345; variance explained (%):100%; Wilks' Lambda: 0.284; Bartlett's Test ($\chi 2$: 259.888; $p<0.01$).

in hens, it was better explained by stockiness (72 versus 67%; p<0.05 for hens and cocks respectively).

Condition index was higher in cocks (11%) than hens (9%). Long-leggedness was higher in cocks (86%) compared to hens (68%). The hens showed a narrower body, which is suitable for egg production while the cocks showed a broader appearance characteristic of meatiness. Low coefficients of variation were however recorded for both sexes indicating sensitivity of the traits to the genotype rather than the environment.

Phenotypic correlations among body weight, morphological traits and indices are presented in Table 2. Low, moderate and high positive and negative correlation coefficients were recorded among the various body parameters in both sexes. In hens, the coefficients of correlation (r) ranged from 0.025 to 0.989 while in cocks it ranged from 0.036 to 0 .989. Among the morphometric traits in hens, the highest value was observed between wing span and total leg length (r= -0.920; p<0.01) followed by body length and total leg length (r= 0.604; p<0.01) and between body weight and body length (r= 0.567; p<0.01). However in cocks, the highest value was observed between total leg length and breast circumference (r= 0.362; p<0.01) followed by body length and wing span (r= 0.311; p<0.01) and between body weight and body length (r= 0.306; p<0.01).

Among the morphological indices in hens, the highest correlation was recorded between body weight and condition index, followed by long-leggedness and stockiness (r= 0.865, -0.548 and -0.527 respectively; p<0.01) with no significant correlation with massiveness. In cocks, highest correlation was observed between body weight and condition index, followed by stockiness and massiveness (r= 0.989, -0.337 and 0.303 respectively; p<0.01) with no significant correlations with long-leggedness.

;Other single variables highly related to comformational indices in hens were breast circumference and stockiness (r= 0.980; p<0.01), wing span and long-leggedness (r= -0.817; p<0.01), total leg length and long-leggedness (0.795; p<0.01), body length and condition index (0.790; p<0.01). In cocks, they are breast circumference and stockiness (r= 0.962; p<0.01), total leg length and long-leggedness (r= 0.859; p<0.01) and body length and long-leggedness (-0.492; p<0.01). High positive relationships among traits suggest that they are under the same gene action and therefore the improvement of any of the traits guarantee the improvement of the other (Ngapongora *et al*., 2004; Ogah *et al*., 2009). The differing phenotypic correlation coefficients in both sexes suggest sexual differences in the genetic design of the birds which agrees with the observation that additive genetic variance-covariance structure of the morphological traits is sex-influenced (Jensen *et al*., 2003).

Although the univariate analysis revealed differences in the body weight and linear body measurements the multivariate analysis could provide better resolution, thereby limiting the number of variables contributing to sexual dimorphism in chickens. Only a single standardized canonical discriminant function was extracted`. The significance of the discriminant function tested with the minimization of Wilks' lambda (lambda= 0.290) and Bartlett's test (chisquare= 262.875; p<0.01) provided validity for the analysis. The discriminating power of the variables as shown by the standardized canonical coefficients was highest in total leg-length, chronologically followed by body weight, wing length and body length with respective values of 0.972, 0.499, -0.450, and -0.340. Three other variables (breast circumference and body length) not qualified to enter the model were deleted. The reduction in the number of measurements saves time and energy required to distinguish between the sexes.

The present findings disagree with the observation of Martinez-Gomez and Curry (1998) that wing chord and tarsus length were the two most important traits for sex separation in birds

CONCLUSION

The study showed that there were marked sexual differences in the morphological measurements of hens and cocks with higher values in most cases recorded for cocks. Low, moderate and high positive and negative phenotypic correlations were observed among the muscular and skeletal proportions. Total leg length was the most discriminating variable between the sexes, followed by body weight and wing length. Breast circumference and body length were not included in the canonical discriminant model. This means that the three variables were sufficiently robust to be used in the field to determine the gender of live birds. The use of biometrics and discriminant analysis therefore, may considerably increase the reliability of separating the sexes of indigenous birds.

REFERENCES

Adetayo AS, Babafunso SE (2001). Comparison of the performance of Nigerian indigenous chickens from three agro-ecological zones. *Reseach and Rural Development.* Vol 13.

Baeza E, Williams N, Guemene D, Duclo MJ (2001). Sexual dimorphism for growth in Muscovy duck and changes in insulin-like growth factor I (IGF- I), growth hormone (GH) and triiodothyronine (T3) plasma levels. *Reprod. Dev.,* 41: 173-179.

Byarugaba DK (2007). Structure and importance of the commercial and village based poultry industry in Uganda. Animal Production Service (AGAP) of Food and Agricultural Organization, Italy.

Demeke S (2004). Egg production performance of local and white leghorn hens under intensive and rural household conditions in Ethiopia. *Livestock Reseach and Rural Development.* Vol 16

Grobbelaar JAN, Sutherland B, Molalakgotla (2010). Egg production potentials of certain indigenous chicken breeds in South Africa. *Animal Genetic esource.* 46: 25-32

Ijaiya AT, Egena SSA, Kolawole R (2010). Frequency and effect of spur gene on metric parameters in the Nigerian local chicken in Niger state, Nigeria .*J. Tech. Res.,* 5: 24-33.

Jacob González-Solís, John P, Croxall, Andy GW (2000). "Sexual dimorphism and sexual segregation in foraging strategies of northern giant petrels, *Macronectes halli*, during incubation". *Oikos* 90 (2): 390–398..

Jaturashitta S (2004). Meat management. Mingnuang press, Chiang Mai, Thailand.

Jensen H, Saether BE, Ringsby TH, Tufto J, Griffith SC, Ellegren H (2003). Sexual variation in heritability and genetic correlations of morphological traits in house sparrows *(Passer domesticus). J. Evol. Biol.,* 16: 1296-1307.

Kamran S, Barbara K, Gerald K (2007). "Sex differences in population genetics, home range size and habitat use of the parti-colored bat (*Vespertilio murinus*, Linnaeus 1758) in Switzerland and their consequences for conservation". *Biological conservation* 137 (1): 28–36.

Kolawole R (2010). Frequency and effect of spur gene on metric parameters in the Nigerian local chicken in a southern guinea savanna area of Nigeria. B. Tech. Thesis. Federal University of Technology, Minna, Niger state.

Le Behan – Dual E (2004). Genetic variability within and between breeds of poultry technological meat quality. *World Poultry Science Journal*, 60 : 331-340

Marion P (1994). Improved growth and survival of offspring of peacocks with more elaborate trains. *Nature*. 371 (6498): 598–599.

Martin BM (2008). Reconciling competing ecological explanations for sexual segregation in ungulates. *Ecology* 89 (3): 693–704..

Martinez-Gomez JE, Curry RC (1998). Distinguishing sex of Socorro mockingbirds by body measurements. *Ornithol. Neotrop.,* 9:103-110.

McCracken KV, Paton DC, Afton AD (2000). Sexual size dimorphism of the Musk duck. *Wilson Bull.,* 112: 457-466.

McGraw KJ, Hill GE, Stradi R, Parker RS (2002). The effect of dietary carotenoid acess on sexual dimorphism and plumage pigment composition in the American goldfinch, *Comparative Biochemistry and Physiology Part B-Biochemistry and Molecular Biology* 131 (2): 261–269.

Naidoo M (2003). Indigenous poultry production systems in northern Kwazulu-Natal, South Africa. Proceedings of the 1st National Workshop on Indigenous Poultry Development; Pietermaritzberg, South Africa. Pp 66-73.

Ngapongora JMN, Mbaga SH, Mutayoba SK (2004). Study on the growth performance of growing native Muscovy ducks under semi and fully confined rearing systems. www.husdyr.kvi.dk&U=w (04/03/09).

Oblakova M (2007). Weight development and body configuration of turkey-broiler parents Big-6. *Trakia J. Sci.,* 5: 33-39.

Ogah DM, Musa IS, Yakubu A, Mommoh MO, Dim NI (2009). Variation in morphological traits of geographical separated population of Muscovy duck *(Cairina moschata)* in Nigeria. Proceedings of the 5th World Poultry Science Conference. March 10-13. Taba. Egypt. pp. 93- 101.

Owen M, Cook WA (1977). Variations in body weight, wing length and condition of Mallard *Anas platyrhynchos* and their relationship to environmental changes. *J. Zool. Lond.,* 183:

Owens IPF, Hartley IR (1998). Sexual dimorphism in birds: why are there so many different forms of dimorphism? *Proceedings of the Royal Society B* 265 (1394): 397–407.

Robertson GJ, Mittelhauser GH, Chubbs T, Trimper P, Goudie RI, Thomas PW, Brodeur S, Robert M, Gilliland SG, Savard JL (2008). Morphological variation among harlequin ducks in the Northwest Atlantic. *Waterbirds,* 31: 194-203. Souza DL, Evangelista-Rodrigues A, Ribeiro MN, Alvarez FP, Farias ESL, Pereira

WE (2009). Morphometric analyses between *Apis mellifera* from region Sertao Paraiba State, Brazil. *Arch. Zootec.,* 58: 65-71.

SPSS (1989). Statistical Package for Social Sciences. SPSS Inc. Chicago IL.

Strelec V, Glaser R, Brus M, Volk M (2005). Analysis of production results in broiler chickens of various proveniences under test conditions.VI Simpozij Peradarski Dani Smeunarodnim Sudjelovanjem. Hrvatska. Porec, 11-14. Svibnja.

Tai C, Rouvier R (1998). Crossbreeding effect on sexual dimorphism of body weight in intergeneric hybrids obtained between Muscovy and Pekin duck. *Genet. Sel. Evol.,* 30: 163-170.

Teguia A, Ngandjou HM, Defang H, Tchoumboue J (2008). Study of the live body weight and body characteristics of the African Muscovy Duck *(Cairina moschata). Trop. Anim. Health Prod.,* 40: 5-10.

Thalmann S, Baker GB, Hindell M, Double MC, Gales R (2007). Using biometric measurements to determine gender of fleshfooted shearwaters, and their application as a tool in long-line by-catch management and ecological field studies. *Emu,* 107: 231-238.

Velando A (2002). "Experimental Manipulation of Maternal Effort Produces Differential Effects in Sons and Daughters: Implications for Adaptive Sex Ratios in the Blue-footed Booby". *Behavioral Ecology* 14 (4).

Willow RL, Michael S, Webster Claire WV, Hubert S (2009). "Plumage colour acquisition and behaviour are associated with androgens in a phenotypically plastic bird". *Animal Behaviour* 77 (6): 1525–1532.

Yakubu A, Salako AE (2009) . Path coefficient analysis of body weight and morphological traits of Nigerian indigenous chickens. *Egypt. Poult. Sci.* 29: 837-850

Yakubu A (2011). Discriminant analysis of sexual dimorphism in morphological traits of African Muscovy Ducks. *Arch. Zootec.* 60 (232): 1115-1123.

Zenatello M, Kiss JB (2005). Biometrics and sex identification of the rose-coloured starling *Sturnus roseus*. *Ringing and Migration,* 22: 163-166.