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Comparative Study of Three Indigenous Chicken Breeds of South Africa: Body Weight and Linear Body Measurements

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Abstract: The aim of this study was to undertake a comparative evaluation of the body weight and linear body measurements of three indigenous chicken breeds of South Africa, namely: Naked neck, Venda and Potchefstroom koekoek. A total of 222 records obtained from the three intensively reared breeds were used in the study. Data were collected at the experimental farm of the University of Limpopo, South Africa. Treatment means were separated using t-test and analysis of variance with the level of significance set at 5%. Body weight was correlated with the linear body measurements. The parameters evaluated were: Body Weight: BW, Body Length: BL, Body Girth: BG, Wing Length: WL, Shank Thickness: ST and Shank Length: SL. The measurements were taken at maturity (22 weeks of age). Results showed that males of the three breeds were statistically ($p<0.05$) heavier had longer body, better body girth, wing length, shank thickness and shank length than the females. Comparison of the three breeds also revealed that Potchefstroom koekoek chicken was significantly ($p<0.05$) better than the Naked neck and Venda chickens for the traits evaluated with the exception of shank length where no significant ($p>0.05$) differences were observed between the three breeds. No differences ($p>0.05$) were observed between the Naked neck and Venda chickens for body weight, body girth and shank thickness. BW was best correlated with SL (Naked neck; $r = 0.92$), ST (Venda; $r = 0.80$) and ST (Potchefstroom koekoek; $r = 0.80$). BW was best predicted using SL (Naked neck; -0.5129+0.0825SL), ST (Venda; -0.1381+ 0.4515ST) and ST (Potchefstroom koekoek; -0.2004+0.4621ST). It was concluded that breed differences do exist between the three indigenous South African chicken breeds studied and these differences are in favour of the males and the Potchefstroom koekoek chickens.

Key words: Indigenous chickens, body weight and linear measurements, Naked neck, Venda, Potchefstroom koekoek, Nigeria

INTRODUCTION

Africa is blessed with a large number of indigenous chicken breeds. Theses chickens probably went through several genetic changes leading to their sizes being reduced (in areas of food scarcity) or increased (in areas where food was plenty). The indigenous chickens are resistant to most of the endemic poultry diseases and pests ravaging their exotic cousins (Sil *et al*., 2002). They are generally less productive in terms of eggs and meat. Despite these drawbacks, the indigenous chickens play a vital role in the social economic life of those who keep them. Apart from being a source of meat and eggs, they are also a source of income for many resource-poor people particularly those living in the rural areas. They are valued also for their ability to scavenge, disease tolerance, meat quality and general hardiness (Ssewanyana *et al*., 2003). In rural communities, free-range chickens contribute significantly to the livelihoods of the households. They are easily disposed of when need arises by any of the family members. They provide manure are required for special festivals to meet social obligations and they are essential for many traditional ceremonies and treatment of illness. People, generally, prefer their meat which is said to be tastier (Kolawole, 2010). Sonaiya (1990) reported that the indigenous chicken is sadly rarely accorded primary consideration in economic development activities in most African countries, hence less research activities had been focussed on them for decades. This has limited their potentials.

Lately, there is growing interest in the study of the various chickens indigenous to Africa (Yami, 1995; Gueye,

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1998; Adetayo and Babafunso, 2001; Naidoo, 2003; Demeke, 2004; Ijaiya *et al*., 2010; Youssao *et al*., 2010; Grobbelaar *et al*., 2010). This might be due to the recognition of the indigenous chicken as a gene pool for important traits that have to do with adaptability, vigour, hardiness as well as resistance to diseases and pests (Byarugaba, 2007). Also, the distinctive colour of their carcass, the tough muscle of the meat, shell colour and yolk colour are of appeal to most consumers (Grobbelaar *et al*., 2010). The Southern African region has indigenous chickens adapted to that particular agro-ecological niche. Grobbelaar *et al*. (2010) listed some of the breeds as Potchefstroom koekoek, Venda, Ovambo, Naked neck, Natal game, Zulu and Nguni. These breeds have distinctive characteristics which have endeared them to many farmers or keepers. The three indigenous breeds of interest to the researchers: Potchefstroom koekoek, Venda and Naked neck have been described by Grobbelaar *et al*. (2010). Their research, however centred on the description and egg production potentials of the breeds. More information is however required on these breeds so as to be able to tap fully into their genetic potential. The aim of this study, therefore was to undertake a comparative evaluation of the three breeds with particular reference to their body weight and linear body measurements. Data generated could be used in selection programmes toward further improvement of the breeds.

MATERIALS AND METHODS

The study was conducted at the experimental farm of the University of Limpopo, South Africa. The farm is situated 10 km North-West of the Turfloop campus of the University of Limpopo. The ambient temperatures around the area are >30°C during Summer and <25°C in Winter. It lies at latitude 27.55 South and longitude 24.77 East. The area receives a mean annual rainfall of <400 mm.

The chicks used in the experiment were hatched at the experimental farm of the university and raised under intensive management system in a closed confinement from day old to the point of lay (22 weeks). The birds were raised on deep litter. The birds were fed a 16.10% crude protein diet with energy level of 11.97 MJ kg^{-1} DM. The diet was composed of the following ingredients: maize (64%), maize gluten meal (11.67%), fish meal (5%), soya Hi pro (4.37%), full fat soya (4.91%), Di sodium phosphate (1.33%), DL-methionine (0.20%), L-lysine (0.20%), $CaCO_3$ (8.17%) and vitamin trace element premix (0.15%). Feed and water were offered *ad libitum*. Routine management procedures were strictly adhered to, particularly those related to health care and welfare issues.

Body weight of individual birds was measured using a 0.01 g sensitivity level electronic scale (RADWAG). The following measurements were recorded using tape rule (cm): Body Length (BL), Body Girth (BG), Wing Length (WL), Shank Thickness (ST) and Shank Length (SL). The linear body measurements were as described by Fayeye *et al*. (2006). The measurements were as described:

Body length: Distance from the tip of the beak through the body trunk to the tail.

Body girth: The circumference of the breast region.

Wing length: Length of the wing from the scapula joints to the last digit of the wing.

Shank length: Length of the tarso-metatarsus from the hock joint to the metatarsal pad.

Shank thickness: Diameter of the tarso-metatarsus just below the spur.

All the data collected from the experiment were analyzed using the t-test, ANOVA and correlation procedures of Instat+ for windows (Instat, 2006). Body weight of each breed was correlated with the linear body measurements of each breed. Body weight was also predicted in the chickens from the various linear body measurements. Significant level was set at $p<0.05$.

RESULTS AND DISCUSSION

The results of the effect of sex on the body weight and linear body measurements of the three indigenous chicken breeds are shown in Table 1. Male Naked neck, Venda and Potchefstroom koekoek chickens were significantly ($p<0.05$) better than the female Naked neck, Venda and Potchefstroom koekoek chickens, respectively in all the parameters studied. In the Naked neck chickens, sexual dimorphism accounted for 26.15, 13.56, 13.90, 20, 27.27 and 20.92% of the differences observed in the BW, BL, BG, WL, ST and SL of the chickens, respectively. Sexual dimorphism accounted for 18.58, 15.60, 17.18, 14.29, 14.74 and 14.67% of the differences in BW, BL, BG, WL, ST and SL of the Venda chickens while it accounted for 32.35, 8.15, 22.86, 3.90, 23.64 and 12.73% differences in BW, BL, BG, WL, ST and SL in the Potchefstroom koekoek chickens. The largest difference was observed for BW in the Potchefstroom koekoek chickens while the lowest difference was observed for WL, also in the Potchefstroom koekoek chicken.

Table 1: Effect of sex on body weight and linear body measurements of Potchefstroom koekoek, Venda and Naked neck chickens

Chicken	Male	Female	Difference (%)
	----------(Mean±SE)----------		
Naked neck			
BW (kg)	2.18±0.020[a]	1.61±0.04[b]	26.15
BL (cm)	45.00±0.030[a]	38.90±0.34[b]	13.56
BG (cm)	41.00±0.003[a]	35.30±0.36[b]	13.90
WL (cm)	21.50±0.210[a]	17.20±0.18[b]	20.00
ST (cm)	5.50±0.210[a]	4.00±0.003[b]	27.27
SL (cm)	32.50±0.200[a]	25.70±0.24[b]	20.92
Venda			
BW (kg)	2.06±0.060[a]	1.68±0.06[b]	18.58
BL (cm)	45.50±0.200[a]	38.40±0.34[b]	15.60
BG (cm)	42.50±1.020[a]	35.20±0.43[b]	17.18
WL (cm)	21.00±0.003[a]	18.00±0.58[b]	14.29
ST (cm)	4.75±0.100[a]	4.05±0.11[b]	14.74
SL (cm)	30.00±0.410[a]	25.60±0.37[b]	14.67
Potchefstroom koekoek			
BW (kg)	2.51±0.070[a]	1.70±0.08[b]	32.35
BL (cm)	43.33±1.120[a]	39.80±0.85[b]	8.15
BG (cm)	46.67±2.480[a]	36.00±0.83[b]	22.86
WL (cm)	19.67±0.320[a]	18.90±0.24[b]	3.90
ST (cm)	5.50±0.240[a]	4.20±0.12[b]	23.64
SL (cm)	29.33±0.700[a]	25.60±0.37[b]	12.73

Table 2: Effect of breed on body weight and linear body measurements of Potchefstroom koekoek, Venda and Naked neck chickens

Measurements	Naked neck	Venda	Potchefstroom koekoek
	----------Mean±SE----------		
BW (kg)	1.70±0.09[b]	1.74±0.10[b]	1.88±0.09[a]
BL (cm)	39.92±1.01[b]	36.92±1.01[c]	40.62±0.97[a]
BG (cm)	36.25±1.29[b]	36.42±1.30[b]	38.46±1.25[a]
WL (cm)	17.92±0.49[c]	18.50±0.49[b]	19.08±0.47[a]
ST (cm)	4.25±0.18[b]	4.17±0.18[b]	4.50±0.17[a]
SL (cm)	26.83±0.68	26.33±0.69	26.46±0.66

[a-c]Means denoted by different superscripts along the same row differ ($p<0.05$); SE = Standard Error; BW = Body Weight; BL = Body Length; BG = Body Girth; WL = Wing Length; ST = Shank Thickness; SL = Shank Length

Results of the effect of breed on the body weight and linear body measurements of the three indigenous chickens are shown in Table 2. Body weight, BL, BG, WL and ST were significantly ($p<0.05$) influenced by the breed of the chicken while SL was not ($p>0.05$). Potchefstroom koekoek chickens were observed to have better ($p<0.05$) body weight, body length, body girth, wing length and shank thickness compared to the Naked neck and Venda chickens. Naked neck chickens were not ($p>0.05$) from Venda chickens in terms of body weight, body girth and shank thickness but differed ($p<0.05$) from the Venda chickens in terms of body length and wing length.

The correlations between body weight and linear body measurements of Naked neck, Venda and Potchefstroom koekoek chickens are shown in Table 3-5. Body weight was positively correlated ($p<0.01$) with linear body measurements in the Naked neck chickens (Table 3). Similar correlations were also observed for most of the traits in Venda chickens (Table 4). However, no significant ($p>0.05$) correlations were observed between WL and BL, WL and BG and SL and WL in Venda chickens. In the

Table 3: Correlations between body weight and linear body measurements of Naked neck chicken

Parameters	BW	BL	BG	WL	ST	SL
BW	1.00					
BL	0.82**	1.00				
BG	0.86**	0.90**	1.00			
WL	0.83**	0.84**	0.80**	1.00		
ST	0.87**	0.86**	0.84**	0.92**	1.00	
SL	0.92**	0.88**	0.87**	0.86**	0.93**	1.00

BW = Body Weight; BL = Body Length; BG = Body Girth; WL = Wing Length; ST = Shank Thickness; SL = Shank Length; **($p<0.01$)

Table 4: Correlations between body weight and linear body measurements of Venda chickens

Parameters	BW	BL	BG	WL	ST	SL
BW	1.00					
BL	0.71**	1.00				
BG	0.76**	0.96**	1.00			
WL	0.66**	0.48	0.43	1.00		
ST	0.80**	0.61**	0.63**	0.71**	1.00	
SL	0.59*	0.86**	0.87**	0.20	0.57*	1.00

BW = Body Weight; BL = Body Length; BG = Body Girth; WL = Wing Length; ST = Shank Thickness; SL = Shank Length; *($p<0.05$); **($p<0.01$)

Table 5: Correlations between body weight and linear body measurements of Potchefstroom koekoek chickens

Parameters	BW	BL	BG	WL	ST	SL
BW	1.00					
BL	0.74**	1.00				
BG	0.77**	0.51*	1.00			
WL	0.37	0.08	0.26	1.00		
ST	0.80**	0.56*	0.82**	0.29	1.00	
SL	0.67**	0.52*	0.80**	0.37	0.77**	1.00

BW = Body Weight; BL = Body Length; BG = Body Girth; WL = Wing Length; ST = Shank Thickness; SL = Shank Length; *($p<0.05$); **($p<0.05$)

Potchefstroom koekoek, positive and significant ($p<0.05$; 0.01) correlations were observed for most of the traits (Table 5). However, the correlations between WL and BW; WL and BL; WL and BG; ST and WL and SL and WL were not significant ($p>0.05$) in Potchefstroom koekoek chickens. The highest correlations were between BW and SL (Naked neck; r = 0.92), ST (Venda; r = 0.80) and ST (Potchefstroom koekoek; r = 0.80).

Predictive equations relating body weight of the South African indigenous chickens to linear body measurements are shown in Table 6. Body weight and linear body measurements had significant ($p<0.05$; 0.01) associations. The value of the coefficient of determination (R^2) ranged from 0.14-0.84.

Male chickens of the three breeds were better than their female counterparts in all the traits studied. This is a clear instance of sexual dimorphism with its attendant effect on body weight and linear body measurements. Generally, males were bigger than the females. This is not too surprising as body weight accounted for the largest dimorphism in all the three breeds. This possibly is an adaptive feature used in dominating their environment. Reasons have been adduced for sex dimorphism in

Table 6: Predictive equations relating body weight to linear body measurements of naked neck, Venda and Potchefstroom koekoek chickens

Parameters	Predictive equation (BW)	SE	R^2	LS
Naked neck				
BL	= -1.4110+0.0779BL	0.017	0.68	**
BG	= -1.4010+0.0855BG	0.016	0.74	**
WL	= -0.3628+0.1151WL	0.025	0.69	**
ST	= 0.2250+0.3471ST	0.061	0.76	**
SL	= -0.5129+0.0825SL	0.011	0.84	**
Venda				
BL	= 0.1951+0.0419BL	0.013	0.50	**
BG	= -0.3508+0.0575BG	0.016	0.58	**
WL	= 0.3232+0.0768WL	0.028	0.44	*
ST	= -0.1381+0.4515ST	0.107	0.64	**
SL	= -0.1108+0.0704SL	0.030	0.35	*
Potchefstroom koekoek				
BL	= -1.9290+0.0938BL	0.026	0.55	**
BG	= -0.1557+0.0529BG	0.013	0.60	**
WL	= -1.4050+0.1722WL	0.013	0.14	*
ST	= -0.2004+0.4621ST	0.106	0.64	**
SL	= -1.5710+0.1304SL	0.044	0.44	*

BW = Body Weight; BL = Body Length; BG = Body Girth; WL = Wing Length; ST = Shank Thickness; SL = Shank Length; r^2 = Coefficient of determination; *($p<0.05$); **($p<0.05$); SE = Standard Error; LS = Level of Significance

poultry birds. Owens and Hartley (1997) were of the opinion that sexual dimorphism in size is associated with high levels of social polygamy/the sort of intrasexual competition described by traditional classifications of social mating systems. Baeza *et al.* (2001) observed that sexual dimorphism is attributable to the usual between sex differential hormonal action which invariably leads to differential growth rates.

Another possible explanation for the appearance of extreme sex-related differences is the strong female selection for high quality males or competition among males for limited access to females which leads to fixation of larger body size and other secondary sexual characters in males (McCracken *et al.*, 2000). According to Remes and Szekeley (2010), difference in sizes of males and females is a key evolutionary feature that is related to ecology, behaviour and life histories of organisms. Such dimorphism has been reported in local chickens in some African countries (Ngoupayou, 1990; Fayeye *et al.*, 2006; Youssao *et al.*, 2010; Ijaiya *et al.*, 2010) in indigenous pigeons (Hassan and Adamu, 1997) in the Muscovy duck (Mignon-Grsaleau *et al.*, 1998; Raji *et al.*, 2009; Ogah, 2011a; Yakubu, 2011) and in turkey (Ogah, 2011b).

Differences were also observed in the parameters evaluated when a comparison of the three indigenous breeds was carried out. Potchefstroom koekoek chickens were better than the Naked neck and Venda chickens in all the parameters except shank length The body weights of the South African indigenous breeds (1.70, 1.74 and 1.88 kg for Naked neck, Venda and Potchefstroom koekoek, respectively) were observed to be larger than those reported for other indigenous birds in Nigeria (Momoh and Kershima, 2008; Yakubu and Salako, 2009), in Senegal (Gueye *et al.*, 1998) in Cameroun and in Benin republic (Youssao *et al.*, 2010). These are however, close to the 1.76 kg reported for Nigerian indigenous chickens by Ijaiya *et al.* (2010) and generally lower than the values reported for indigenous chickens in Uganda (Kyarisiima *et al.*, 2004). The better performance of the Potchefstroom koekoek might not be surprising as it has been reported to also have better egg laying ability compared to the Naked neck and Venda chickens (Grobbelaar *et al.*, 2010). The closeness of some of the body weights of the African indigenous chickens suggests the possibility of a common ancestry. This may require further studies especially of the molecular nature with the aim of analysing the genetic diversity of the breeds.

Correlations between BW and linear body measurements were all significant and positive. This means that BW and linear body traits could be selected for improvement at the same time in the chickens since an increase in BW is expected to lead to a corresponding increase in the linear body traits. The best correlation coefficients were observed for the Naked neck chicken. The implication is that more improvement will be expected for the traits in the Naked neck chicken than in the Venda and Potchefstroom koekoek chickens. Similar significant correlations between BW and linear body measurements have been reported by Gueye *et al.* (1998) in indigenous Senegalese chickens, Ogah *et al.* (2009), Raji *et al.* (2009) and Ogah (2011a) in indigenous Muscovy ducks in Nigeria and Ogah (2011b) in indigenous Nigerian turkeys. The predictive equations showed that there were significant relationships between BW and linear body measurements. The R^2 values ranged from low to high meaning that with the exception of WL and SL (Venda) and WL and SL (Potchefstroom koekoek), the equations could be used to predict BW efficiently and accurately. High R^2 values for any trait with BW means that the trait tends to increase as BW increases. According to Ozoje and Mgbere (2002), since the final body weight of an animal is a reflection of its component parts, predictive equations provide a readily available tool in body weight estimation. This is particularly useful in rural areas or in areas where scales are not available. The equations show that BW is highly dependent on growth in the other component parts of the indigenous chickens. The R^2 values obtained for the Naked neck chickens in this study were higher than those reported by Gueye *et al.* (1998) and Momoh and Kershima (2008) for Senegalese indigenous chickens and Nigerian local chickens

respectively. Body weight was best predicted in the Naked neck chickens compared to the Venda and Potchefstroom koekoek chickens, respectively.

CONCLUSION

The following conclusions could be drawn based on the results of this study:

- There is a high degree of sexual dimorphism in the three South African chicken breeds evaluated
- The Potchefstroom koekoek chicken had better performance in terms of the parameters studied with the exception of shank length
- There is a high degree of correlations between BW and the linear body measurements of the three breeds; the best correlations were observed for the Naked neck chickens
- Body weight could be predicted in the three indigenous breeds with a high degree of accuracy and efficiency, hence the equations could be used to estimate BW in the three breeds in situations where weighing scale is not readily available

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