African Journal of Agricultural Research Vol. 7(16), pp. 2438-2445, 26 April, 2012
Available online at http://www.academicjournals.org/AJAR
DOI: 10.5897/AJAR11.1220
ISSN 1991-637X © 2012 Academic Journals

Full Length Research Paper

Growth performance of different strains of indigenous Tswana chickens under intensive management system

Patrick M. Kgwatalala*, Moremedi Nogayagae and Shalaulani J. Nsoso

Department of Animal Science and Production, Botswana College of Agriculture, Private Bag 0027, Gaborone, Botswana.

Accepted 13 September, 2011

Indigenous Tswana chickens are traditionally kept under free range production system and their growth performance under an intensive management system have not been evaluated. The purpose of this study was therefore to evaluate the growth performance of the naked neck, dwarf and normal-feathered strains of indigenous Tswana chickens under an intensive management system. A total of 74, 43 and 44 Tswana chickens of the normal, dwarf and naked neck strains, respectively, were wing-tagged and evaluated for growth performance (body weight, body length and shank length) from 4 to 20 weeks of age. The chickens were raised under deep litter management system and were fed commercial broiler feeds *ad libitum*. Sex had a significant (P < 0.05) influence on body weights, shank length and body length of only the normal and naked neck strains. Males of all the strains were generally heavier and had longer bodies and shanks than their age-matched female counterparts. Generally, naked neck males and females were the heaviest and had the longest bodies and shanks, while dwarf males and females were the lightest and had the shortest bodies and shanks. The naked strain had superior growth performance compared to the normal-feathered and dwarf strains.

Key words: Growth, Tswana chickens, intensive management.

INTRODUCTION

Indigenous Tswana chickens account for about 13% of the 23 million national poultry population and are the most common type of poultry raised in rural areas of Botswana (Moreki, 1997). They are a source of high quality protein (meat and eggs), provide income and are part of the cultural life of the society. Their products (meat and eggs) are preferred by the majority of people in rural areas because of their pigmentation, taste, leanness and suitability for special dishes (Horst, 1989; Crawford, 1992). Tswana chickens are mainly owned by women and, as such, provide an avenue for empowerment of the disadvantaged members of these largely patriarchal societies. Indigenous Tswana chickens are generally raised in small flocks (2 to 20 chickens) of mixed ages under the traditional free range management system with minimal supplementary feeding, housing and health care. They are self reliant and hardy with the capacity to withstand harsh environmental conditions including high disease incidence, poor nutrition and high temperatures, all qualities that forms the basis for low-input, sustainable agriculture for the rural and resource-poor communities (FAO, 1998a, b). Despite all these good qualities, inadequate attention has been given to the characterization of indigenous Tswana chickens or to the setting up of realistic breeding goals and management practises for their improvement. Assessing the productivity of indigenous Tswana chickens under the extensive rearing system is very difficult because most farmers do not keep any production records of their chicken flocks (Badubi et al., 2006).

Moreki (1997) and Badubi et al. (2006) reported the existence of several strains/breeds within the indigenous Tswana chickens population such as normal, dwarf, naked neck, frizzled, rumpless and creeper or dwarf phenotypes. The naked neck, rumpless, dwarf and frizzled strains occur at a relatively low frequency within

*Corresponding author. E-mail: pkgwatal@bca.bw, pkgwatal@yahoo.com. Tel: +267 365 0100. Fax: +267 3928753.

Table 1. Nutritional composition of feeds given to Tswana chickens.

Composition	Chick starter (g/kg)	Grower pellets (g/kg)
Protein	200	180
Moisture	120	120
Fibre	50	60
Calcium	8	7
Fat	25	25
Phosphorus	6	5.5
Lysine	12	10

the indigenous Tswana chicken population and are at risk of extinction if deliberate efforts are not taken towards their conservation. In contrast to exotic breeds of chickens, there is limited information on the growth potential of various strains of indigenous Tswana chickens and their performance under improved management has not been characterized. The conservation and characterization of various strains of indigenous Tswana chicken should be given high priority because they contain valuable genes (disease resistance and heat tolerance genes) for future breed developments and transgenesis applications to counter the effects of global warming or climate change on poultry production and productivity. Adequate information on growth potential of various strains of indigenous Tswana chickens is also essential to poultry farmers so as to guide or assist in the choice of stock. The objective of this study was therefore to evaluate the growth performance of the naked neck, normal and dwarf strains of indigenous Tswana chickens raised under intensive management system.

MATERIALS AND METHODS

Study area

The study was carried out at the Botswana College of Agriculture, Content Farm, Sebele, Gaborone from October 2010 to March 2011. During the study period, environmental temperature averaged 31.0℃ and ranged between 16.2 and 32.4℃.

Experimental animals

Twenty five females and 5 males of normal strain, 25 females and 5 males of dwarf strain and 25 females and 5 males of the naked-neck strain of indigenous Tswana were purchased from different parts of the country as the foundation stock. The males and females of each strain (mating ratio of 1:5) were housed together and fed a commercial layers mash to produce fertile eggs. A total of 150 eggs produced by each of the three strains were collected and incubated following the manufacturers recommendations for the operation of the incubator. The resulting F1 progeny chickens were used to evaluate growth performance in the three strains of indigenous Tswana chickens under an intensive management system.

Housing and management

The F1 progeny (21 females and 23 males of the naked neck strain, 43 females and 31 males of the normal strain, 21 females and 22 males of the dwarf strain) of indigenous Tswana chickens were housed separately according to strain in separate deep litter houses made from concrete blocks with corrugated iron sheet roofing from day old to 20 weeks of age. The chicks were fed chick starter mash *ad libitum* from day old to 2 weeks of age. At 3 weeks of age, the chicks were individually identified using wing bands and thereafter, fed grower pellets until they were 20 weeks of age. The nutritional composition of the chick starter and grower pellets fed to the chickens is shown in Table 1. Water was provided *ad libitum* during the brooding and growth phases. During the growth phase, chickens were also administered Newcastle disease vaccine and TASD Gumboro vaccine. Chickens were raised under natural light (~12 h light and 12 h dark periods) throughout the study period.

Measurement of growth parameters

Growth performance of the naked neck, normal and dwarf strains of indigenous Tswana chickens was measured as the increase in body parameters (body weight, shank length, body length and neck length) for individual chickens from 4 to 20 weeks of age (Table 2). Body weight and shank length were measured fortnightly from 4 to 20 weeks of age while body length and neck length were measured on a monthly basis from 4 to 20 weeks of age. Body weights were taken for individual live birds using an electronic balance. Body length was taken as the distance between the last cervical vertebrae before the thoracic vertebrae and the caudal vertebrae. Body length was basically the length of the synsacrum which is fused with the pelvic girdle and was measured using a flexible tape. Shank length was taken as the distance between the hock joint and the tarsometatarsus and was taken using vernier callipers. Neck length was measured as the distance between the first and the last cervical vertebrae before the thoracic vertebrae and was taken using a flexible tape.

Statistical analysis

Growth data were analyzed by SAS version 9.2.1 (2009) using General Linear Models procedures and the model included the fixed effects of strain (normal, naked neck and dwarf), sex (male and female) and the interaction between the two fixed factors. Results on the growth performance of the three strains of indigenous Tswana chickens are presented as least square means ± standard error. Mean separation was by paired t-tests with Scheffe's adjustment to correct for unequal number of chickens or sampling units between the strains. Differences between means were declared significantly different at $P \leq 0.05$.

Table 2. Body weights of male and female naked neck, normal and dwarf strains of indigenous Tswana chickens at various ages raised under an intensive management system.

Age (weeks)	Naked neck		Normal		Dwarf	
	Males	Females	Males	Females	Males	Females
4	369.86^{a}±22.23	366.43^{a}±24.16	329.67^{a}±17.49	329.10^{a}± 13.95	275.07^{a}±23.13	255.34^{a}± 24.16
6	613.30^{a}±29.12	570.80^{a}±31.65	516.87^{a}±22.91	507.85^{a} ±18.28	460.18^{a}±30.31	413.99^{a}±31.65
8	895.81^{a}±38.33	794.01^{a}±41.67	766.13^{a}±30.16	735.20^{a}±24.06	671.70^{a}±39.89	601.35^{a}±41.67
10	1197.81^{a}±45.95	1010.45^{a}±49.96	1008.08^{a}±36.16	913.04^{a}±28.84	896.53^{a}±47.83	737.85a±49.96
12	1515.55^{a}±54.66	1246.28^{a}±59.42	1307.56^{a}±43.01	1147.83^{a}±34.31	1166.62^{a}±56.89	963.22^{a}±59.42
14	1832.35^{a}±63.72	1424.73^{b}±69.27	1599.25^{a}±50.14	1348.57^{b}±40.61	1396.70^{a}±66.32	1123.67^{a}±69.27
16	2218.02^{a}±74.40	1604.22^{b}±77.71	1885.05^{a}±54.95	1507.17^{b}±45.56	1599.89^{a}±77.71	1299.14^{a}±77.71
18	2516.27^{a}±89.42	1793.95^{b}±93.39	2127.76^{a}±67.59	1660.74^{b}±54.76	1867.68^{a}±89.42	1559.05^{b}±93.39
20	2705.78^{a}±91.42	1976.55^{b}±100.14	2270.19^{a}±69.10	1790.19^{b}±55.98	1869.47^{a}±95.48	1597.56^{a}±95.48

Means with different superscripts within strain at a particular age were significantly different from each other (P<0.05).

RESULTS AND DISCUSSION

Body weights of naked neck, normal and dwarf strains of Tswana chickens

Males of the naked neck and normal strains of indigenous Tswana chickens were significantly heavier (P<0.05) than their age-matched female counterparts from 14 to 20 weeks of age but there were no significant differences in body weights between males and females of the dwarf strain at all ages (Table 1). Significantly higher body weights in males than females of the naked neck and normal strains of indigenous at 20 weeks of age is consistent with Peters et al. (2010) who reported body weight of 1046.00±34.21 and 827.00±32.52 g in male and female Nigerian indigenous chickens, respectively. Generally, body weights of males of the naked neck, normal and dwarf strains of indigenous Tswana chickens were higher than that of their age-matched female counterparts at all ages. Significantly higher (P<0.05) body weights of male naked neck chickens relative to their female counterparts at 20 weeks of age is consistent with Vali (1992) who reported average body weights of 1416.1±30.0 and 1058.3±24.2 g at 19 weeks of age in male and female indigenous naked neck chickens of Iran, respectively. Higher body weights for male naked neck, normal and dwarf strains of indigenous Tswana chickens relative to their age-matched female counterparts is also consistent with Njenga (2005), who reported higher mature body weights for male naked neck, normal and dwarf strains of Kenyan indigenous chickens relative to their female counterparts. The body weights of the naked neck and normal strains of indigenous Tswana chickens at 20 weeks of age are generally higher than mature body weights of the naked neck (1.3 kg) and normal (1.16 kg) strains of indigenous chickens of Nigeria (Yakubu et al., 2008), the naked neck (1.55 kg) and Baladi (1.45 kg) Sudanese indigenous chicken types (Mohammed et al., 2005) and the naked neck (1.58 kg) and normal (1.45 kg) chicken types of Egypt (El-Safty et al., 2006).

There were no significant differences (P>0.05) in body weights between female naked neck and normal chickens and between female normal and dwarf chickens at all ages (Table 3). Similar body weights between female naked neck and normal chickens is contrary to Njenga (2005) who reported significantly higher (P<0.05) mature body weights in female naked neck chickens compared to their age-matched normal counterparts (1.4 kg versus 1.3 kg, respectively). Yakubu et al. (2008) also reported significantly higher (P<0.05) adult body weight in naked neck hens relative to their normal counterparts (1.30 kg versus 1.16 kg, respectively). Similar body weights between female normal and dwarf stains of indigenous Tswana chickens is however consistent with Njenga (2005) who reported similar body weights (1.3±0.32 kg versus 1.2±0.20 kg, respectively) between the normal and dwarf strains of indigenous Kenyan chickens. There were however, significant differences (P<0.05) in body weights between female naked neck and dwarf strains of indigenous Tswana chickens at 6, 8 and 12 weeks of age. Significantly higher body weights of female naked neck chickens relative to their age matched dwarf counterparts reported in this study is also consistent with Njenga (2005), who reported mature body weights of 1.4±0.33 kg and 1.2±0.20 kg in the naked neck and dwarf strains of indigenous Kenyan chickens, respectively. There were no significant differences (P>0.05) in body weights between the naked neck and normal males from 4 to 14 weeks of age but there were significant differences (P<0.05) in body weights between the two strains from 16 to 20 weeks of age (Table 4). Significantly higher body weights of male naked neck chickens relative to normal males at 16 to 20 weeks of age is consistent with Njenga (2005) who reported mature body weights of 2.2±0.52 kg and 1.4±0.14 kg in male naked neck and normal strains of indigenous Kenyan chickens, respectively. There were also significant differences (P<0.05) in body weights between

Table 3. Body weights of female naked neck, normal and dwarf strains of indigenous Tswana chickens at various ages raised under an intensive management system.

Age (weeks)	Naked neck	Normal	Dwarf
4	366.43^{a}±24.16	329.10^{a}± 13.95	255.34^{a}± 24.16
6	570.80^{a}±31.65	507.85^{ab} ±18.28	413.99^{b}±31.65
8	794.01^{a}±41.67	735.20^{ab}±24.06	601.35^{b}±41.67
10	1010.45^{a}±49.96	913.04^{ab}±28.84	737.85^{b}±49.96
12	1246.28^{a}±59.42	1147.83^{a}±34.31	963.22^{a}±59.42
14	1424.73^{a}±69.27	1348.57^{a}±40.61	1123.67^{a}±69.27
16	1604.22^{a}±77.71	1507.17^{a}±45.56	1299.14^{a}±77.71
18	1793.95^{a}±93.39	1660.74^{a}±54.76	1559.05^{a}±93.39
20	1976.55^{a}±100.14	1790.19^{a}±55.98	1597.56^{a}±95.48

Means within a row bearing different superscripts are significantly different (P<0.05).

Table 4. Body weights of male naked neck, normal and dwarf strains of indigenous Tswana chickens at various ages raised under an intensive management system.

Age (weeks)	Naked neck	Normal	Dwarf
4	369.86^{a}±22.23	329.67^{a}±17.49	275.07^{a}±23.13
6	613.30^{a}±29.12	516.87^{ab}±22.91	460.18^{b}±30.31
8	895.81^{a}±38.33	766.13^{ab}±30.16	671.70^{b}±39.89
10	1197.81^{a}±45.95	1008.08^{ab}±36.16	896.53^{b}±47.83
12	1515.55^{a}±54.66	1307.56^{ab}±43.01	1166.62^{b}±56.89
14	1832.35^{a}±63.72	1599.25^{ab}±50.14	1396.70^{b}±66.32
16	2218.02^{a}±74.40	1885.05^{b}±54.95	1599.89^{b}±77.71
18	2516.27^{a}±89.42	2127.76^{b}±67.59	1867.68^{b}±89.42
20	2705.78^{a}±91.42	2270.19^{b}±69.10	1969.47^{b}±95.48

Means within a row bearing different superscripts are significantly different (P<0.05).

the naked neck and dwarfs males of indigenous Tswana chickens from 6 to 20 weeks of age. This however, is contrary to Njenga (2005) who reported a non significant difference in mature body weights between the naked neck and dwarf males of indigenous Kenyan chickens. Body weights between male normal and dwarf strains of indigenous Tswana chickens were not significantly different (P>0.05) at all ages.

Similar body weights between normal and dwarf males of indigenous Tswana chickens at all ages is consistent with Njenga (2005) who also reported similar mature body weights of 1.4±0.14 and 1.7±0.28 kg for the normal and dwarf males of indigenous Kenyan chickens, respectively. Similar body weights between the normal and dwarf strains (both males and females) of indigenous Tswana chickens is however contrary to the findings of some studies that reported a 30 and 40% reduction in body weight of dwarf females and males, respectively, relative to their normal counterparts (Bernier and Arscott, 1972; Islam, 2005; FAO, 2010). This disparity can be explained by the fact that there are several genes and loci related to dwarfism such as sex-linked dwarfism (dw, dw^{M}, dw^{B}) and autosomal dwarfism (adw) and the phenotypic expression of the genes also depend on the genetic background of the chickens and environmental influences. Further investigations are needed to identify the type of dwarfism gene(s) present in indigenous dwarf Tswana chickens.

Generally, male and female naked neck chickens had the highest body weights and male and female dwarf chickens had the lowest body weights at all ages. Superior performance of naked neck indigenous Tswana chickens found in the current study is consistent with earlier reports that found a favourable effect of the naked neck gene on growth performance of chickens raised under high ambient temperatures (Patra et al., 2002; Fathi et al., 2008; Reddy et al., 2008). The favourable effect of the Na gene on body weight in the present study might be attributed to its association with pronounced heat tolerance. The naked neck gene reduces feather

Table 5. Shank lengths of male and female naked neck, normal and dwarf strains of indigenous Tswana chickens at various ages raised under an intensive management system.

Age (weeks)	Naked Neck		Normal		Dwarf	
	Males	Females	Males	Females	Males	Females
4	5.58^{a}±0.19	5.83^{a}±0.20	5.47^{a}±0.15	5.22^{a}±0.11	4.22^{a}±0.19	4.02^{a}±0.19
6	7.12^{a}±0.20	7.25^{a}±0.21	6.87^{a}±0.16	6.71^{a}±0.12	5.39^{a}±0.20	5.21^{a}±0.20
8	8.32^{a}±0.20	8.23^{a}±0.22	8.21^{a}±0.17	7.89^{a}±0.12	6.46^{a}±0.20	6.11^{a}±0.21
10	10.06^{a}±0.26	9.92^{a}±0.28	10.11^{a}±0.21	9.32^{a}±0.16	8.25^{a}±0.26	7.42^{a}±0.28
12	11.31^{a}±0.24	10.64^{a}±0.26	11.21^{a}±0.20	10.23^{a}±0.15	9.33^{a}±0.24	8.21^{a}±0.28
14	12.33^{a}±0.27	10.94^{b}±0.30	12.11^{a}±0.22	10.54^{b}±0.17	10.02^{a}±0.27	8.49^{a}±0.29
16	13.09^{a}±0.29	11.08^{b}±0.30	12.51^{a}±0.23	10.60^{b}±0.17	10.34^{a}±0.28	9.00^{a}±0.30
18	13.15^{a}±0.30	11.14^{b}±0.32	12.73^{a}±0.24	10.68^{b}±0.18	10.44^{a}±0.29	9.10^{a}±0.32
20	13.20^{a}±0.31	11.26^{b}±0.33	12.85^{a}±0.24	10.84^{b}±0.18	10.65^{a}±0.29	9.34^{a}±0.32

Means with the different superscripts within strain at a particular age were significantly different from each other (P<0.05).

Table 6. Shank lengths of female naked neck, normal and dwarf strains of indigenous Tswana chickens at various ages raised under an intensive management system.

Age (weeks)	Naked neck	Normal	Dwarf
4	5.83^{a}±0.20	5.22^{a}±0.11	4.02^{b}±0.19
6	7.25^{a}±0.21	6.71^{a}±0.12	5.21^{b}±0.20
8	8.23^{a}±0.22	7.89^{a}±0.12	6.11^{b}±0.21
10	9.92^{a}±0.28	9.32^{a}±0.16	7.42^{b}±0.28
12	10.64^{a}±0.26	10.23^{a}±0.15	8.21^{b}±0.28
14	10.94^{a}±0.30	10.54^{a}±0.17	8.49^{b}±0.29
16	11.08^{a}±0.30	10.60^{a}±0.17	9.00^{b}±0.30
18	11.14^{a}±0.32	10.68^{a}±0.18	9.10^{b}±0.32
20	11.26^{a}±0.33	10.84^{a}±0.18	8.82^{b}±0.32

Means within a row bearing different superscripts are significantly different (P<0.05).

cover by up to 20 to 40% (Singh et al., 2001; Fathi et al., 2008) thus leading to better heat dissipation which consequently minimizes heat stress. This in turn preserves energy that would have been used for thermal homeostasis and the preserved energy is subsequently channelled to productive functions including body weight gain (Yakubu et al., 2008).

Shank lengths of naked neck, normal and dwarf strains of Tswana chickens

There were no significant differences (P>0.05) in shank length between male and females of the naked neck and normal strains from 4 to 12 weeks of age (Table 5). There were, however, significant differences (P<0.05) in shank length between males and females of the naked neck and normal strains from 14 to 20 weeks of age with the shanks of males being significantly longer than that of their age-matched female counterparts. Significantly higher values for shank length in males than females of the naked neck and normal strains at 20 weeks of age is consistent with Peters et al. (2010) who reported significantly longer (P<0.01) shanks in males than females (7.80±0.376 versus 5.70±0.34 cm, respectively) in Nigerian indigenous chickens. However, sex had no significant influence (P>0.05) on shank length of the dwarf strain of indigenous Tswana chickens although the shanks of males were slightly longer than that of their female counterparts at all ages. There were no significant differences (P>0.05) in shank length between naked neck females and their age-matched normal counterparts at all ages (Table 6). There were however, significant differences (P<0.05) in shank lengths between the naked neck and dwarf females and between the normal and dwarf females at all ages. The shank lengths of female normal and dwarf strains of indigenous Tswana chickens at 20 weeks of age reported in the current study are consistent with shank lengths of 7 to 8 and 9.5 to 10.5 cm reported by Hussain et al. (1982) in the dwarf and normal layers, respectively. The 12% reduction in shank length at 20 weeks of age in female dwarf indigenous Tswana

Table 7. Shank lengths of male naked neck, normal and dwarf strains of indigenous Tswana chickens at various ages raised under an intensive management system.

Age (weeks)	Naked neck	Normal	Dwarf
4	5.58^{a}±0.19	5.47^{a}±0.15	4.22^{b}±0.19
6	7.12^{a}±0.20	6.87^{a}±0.16	5.39^{b}±0.20
8	8.32^{a}±0.20	8.21^{a}±0.17	6.46^{b}±0.20
10	10.06^{a}±0.26	10.11^{a}±0.21	8.25^{b}±0.26
12	11.31^{a}±0.24	11.21^{a}±0.20	9.33^{b}±0.24
14	12.33^{a}±0.27	12.11^{a}±0.22	10.02^{b}±0.27
16	13.09^{a}±0.29	12.51^{a}±0.23	10.34^{b}±0.28
18	13.15^{a}±0.30	12.73^{a}±0.24	10.44^{b}±0.29
20	13.20^{a}±0.31	12.85^{a}±0.24	10.65^{b}±0.29

Means within a row bearing different superscripts are significantly different (P<0.05).

Table 8. Body lengths of male and female naked neck, normal and dwarf strains of indigenous Tswana chickens at various ages raised under an intensive management system.

Age (weeks)	Naked neck		Normal		Dwarf	
	Males	Females	Males	Females	Males	Females
4	11.12^{a}±0.31	11.12^{a}±0.34	10.39^{a}±0.25	10.71^{a}±0.20	9.66^{a}±0.33	9.70^{a}±0.31
8	13.81^{a}±0.28	13.95^{a}±0.31	13.53^{a}±0.23	13.48^{a}±0.18	13.34^{a}±0.29	12.77^{a}±0.28
12	19.14^{a}±0.35	19.27^{a}±0.38	19.02^{a}±0.28	18.59^{a}±0.22	17.99^{a}±0.36	17.65^{a}±0.36
16	23.04^{a}±0.30	21.68^{a}±0.31	21.68^{a}±0.23	20.58^{b}±0.18	21.21^{a}±0.30	19.96^{a}±0.30
20	24.75^{a}±0.39	22.36^{b}±0.41	22.40^{a}±0.31	20.91^{b}0.24	22.08^{a}±0.39	20.46^{a}±0.40

Means with different superscripts within strain at a particular age were significantly different from each other (P<0.05).

hens relative to their age-matched normal counterparts is however lower than the 20% reduction in shank length reported by Rashid et al. (2005) in crossbred dwarf white leghorn hens, relative to crossbred normal white leghorn hens and the 30% reduction in shank length reported by Yeasmin and Howlider (1998) in Deshi chickens of Bangladesh.

There were no significant differences (P>0.05) in shank length between the naked neck males and their age-matched normal counterparts at all ages (Table 7). There were however significant differences (P<0.05) in shank lengths between the naked neck and dwarf males and between the normal and dwarf males at all ages. Compared to their age-matched normal and naked neck counterparts, male dwarf chickens had a 17 and 20% reduction in shank length, respectively, at 20 weeks of age. The 17% reduction in shank length in dwarf males compared to their normal counterparts at 20 weeks of age is consistent with the 16% reduction in shank length observed in crossbred dwarf white leghorn chickens compared to the crossbred normal white leghorns reported by Rashid et al. (2005) in Bangladesh. Missohou et al. (2003) however, reported a 25% reduction in shank length in the dwarf compared to the normal strain in Senegalese indigenous chickens. The slight discrepancies in shank lengths of both female and male dwarf Tswana chickens relative to those reported in the literature could be due to the fact that there are several genes and loci influencing the dwarf phenotype and the fact that the final dwarf phenotype is dependent on the genetic background of the chickens and environmental influences (FAO, 2010). Generally, naked neck males and females had the longest shanks and dwarf males and females had the shortest shanks at any particular age.

Body lengths of naked neck, normal and dwarf strains of Tswana chickens

There were no significant differences (P>0.05) in body lengths between males and females of the naked neck strain at 4, 8, 12 and 16 weeks of age but there was a significant difference (P<0.05) in body length between naked neck males and females at 20 weeks of age (Table 8). There were also no significant differences (P>0.05) in body length between normal males and females at 4, 8 and 12 weeks of age. There were however, significant differences (P<0.05) in body length between normal males and females at 16 and 20 weeks of age. Significantly higher body lengths for male naked neck and normal strains of indigenous Tswana chickens

Table 9. Body length of female naked neck, normal and dwarf strains of indigenous Tswana chickens at various ages raised under an intensive management system.

Age (weeks)	Naked neck	Normal	Dwarf
4	11.12^{a}±0.34	10.71^{a}±0.20	9.70^{a}±0.31
8	13.95^{a}±0.31	13.48^{a}±0.18	12.77^{a}±0.28
12	19.27^{a}±0.38	18.59^{ab}±0.22	17.65^{b}±0.36
16	21.68^{a}±0.31	20.58^{ab}±0.18	19.96^{b}±0.30
20	22.36^{a}±0.41	20.91^{ab}±0.24	20.46^{b}±0.40

Means within a row bearing different superscripts are significantly different (P<0.05).

Table 10. Body length of male naked neck, normal and dwarf strains of indigenous Tswana chickens at various ages raised under an intensive management system.

Age (weeks)	Naked neck	Normal	Dwarf
4	11.12^{a}±0.31	10.39^{a}±0.25	9.66^{a}±0.33
8	13.81^{a}±0.28	13.53^{a}±0.23	13.34^{a}±0.29
12	19.14^{a}±0.35	19.02^{a}±0.28	17.99^{a}±0.36
16	23.04^{a}±0.30	21.68^{ab}±0.23	21.21^{b}±0.30
20	24.75^{a}±0.39	22.40^{b}±0.31	22.08^{b}±0.39

Means within a row bearing different superscripts are significantly different (P<0.05).

relative to their female counterparts at 20 weeks of age is consistent with Peters et al. (2010), who reported significantly higher body lengths in males than females in Nigerian indigenous chickens (30.67±0.43 versus 27.47±0.61 cm in males and females, respectively). Sex had no significant influence on body length of dwarf chickens at any particular age.

There were no significant differences in body length between female naked neck and their age-matched normal counterparts and between the normal and their aged-matched dwarf counterparts at all ages (Table 9). Similar body lengths between the naked neck and normal strains of indigenous Tswana chickens found in the current study is consistent with Peters et al. (2010), who also reported similar body lengths between the naked neck and normal strains of Nigerian indigenous chickens (29.00±0.58 and 29.25±0.62 cm for the naked neck and normal Nigerian indigenous chickens, respectively). There were however, significant differences in body lengths between the naked neck and dwarf females at 12, 16 and 20 weeks of age. There were no significant differences (P>0.05) in body length between the naked neck males and their age-matched normal counterparts at 4, 8, 12 and 16 weeks of age, but there was a significant difference (P<0.05) in body length between the two strains at 20 weeks of age (Table 10). There were also no significant differences (P>0.05) in body lengths between the normal and dwarf males at all ages. Naked neck males were significantly longer than their age-matched dwarf counterparts only at 16 and 20 weeks of age. At 20 weeks of age, male dwarf chickens had a 10% reduction in body length compared to their age-matched naked neck counterparts.

Generally, naked neck males and females had the longest bodies and their dwarf counterparts had the shortest bodies at any given age. The naked neck gene thus seems to have a positive influence on body size including some increase in the length of long bones while the dwarf gene has the opposite effect of reducing body size including some reduction in the length of the long bones (FAO, 2010). Sex had no significant influence on neck length in the naked neck, normal and dwarf strains of indigenous Tswana chickens. There were also no significant differences in neck length between the three strains of indigenous Tswana chickens for both males and females.

ACKNOWLEDGEMENT

The authors are thankful to Botswana College of Agriculture for providing funds for the research.

REFERENCES

Badubi SS, Rakereng M, Marumo M (2006). Morphological characteristics and feedresources available for indigenous chickens in Botswana. Livest. Res. Rural Develop.t 18(1), http://www.cipav.org.co/lrrd/lrrd18/1/badu18003.htm

Bernier PE, Arscott GH (1972). Fifteen years of observations on the dwarf-grene in the domestic fowl. Annales de Genetique Séléction de

Animale, 4: 183-215.
Crawford RD (1992). A global review of the genetic resources of poultry. In: Hodges (1992) ed. The management of global animal genetic resources. Proceedings of an FAO Expert Consultation. Rome, Italy, April 1992, 205-211.
El-Safty SA, Ali UM , Fathi MM (2006). Immunological parameters and laying performance of naked neck and normally feathered genotypes of chicken under winter conditions of Egypt. Int. J.Poult. Sci., 5: 780-785.
Fathi MM, El-Attar AH, Ali UM, Nazmi A (2008). Effect of the neck neck gene on carcass composition and immune competence in chicken. Br. Poult. Sci., 49: 103-110.
FAO (2010). Chicken genetic resources used in smallholder production systems and opportunities for their development, by P. Sørensen. FAO Smallholder Poultry Production Paper No. 5. Rome.
FAO (1998a). Farm Animal Genetic Resources: Biodiversity for Food and Agric. Food Agric. Organ. United Nation.
FAO (1998b). Local animal breeds still threatened by extinction, No. 4. Food and Agriculture Organisation of the United Nation.
Horst P (1989). Native fowl as a reservoir for genomes and major genes with direct and indirect effects on productive adaptability and their potential for tropically oriented breeding plans. Archive fur Geflugelkunde. 53: 93-101.
Hussain SA, Horst P, Mukherjee TK, Tawfik ES (1982). Genotype-Environment Interaction in layers involving dwarf gene (dw) and its normal (Dw) allele. Animal Production and Health in the Tropics. pp. 195-198.
Missohou A, Dieng A, Horst P, Zarate VA, Nesseim T, Tchedre K (2003). Effect of dwarf (dw) and frizzle (F) genes on the performance of layers under Senegalese conditions. Trop. Anim. Health Prod., 35: 373-380.
Mohammed MD, Abdalsalam YI, Kheir AM, Jin-yu W, Hussein MH (2005). Comparison of the egg characteristics of different Sudanese Indigenous Chickens. Int. J. Poult. Sci., 4: 455-457.
Moreki JC (1997). Village poultry production in fifteen villages of Botswana: Phase I (Surveys) of the Poultry Development Project, AG. 205 (51/205). Department of Animal Health and Production, Ministry of Agriculture, Gaborone, Botswana.
Njenga SK (2005). Productivity and socio-cultural aspects of local poultry phenotypes in coastal Kenya. M.Sc. Thesis submitted to the Department of Animal Breeding and Genetics, Danish Institute of Agricultural Science Research Center, Foulum and Network for smallholder Poultry Department, The Royal Veterinary and Agricultural University (KVL), Denmark.
Patra BN, Bais RKS, Prasad RB, Singh BP (2002). Performance of naked neck versus normally feathered coloured broilers for growth, carcass traits and blood biochemical parameters in tropical climates. Asian-Australian J. Anim. Sci., 12: 560-563.
Rashid MA , Howlider MAR , Alam J, Abdur MD, Rashid MH, Azmal SA (2005). Effect of dwarfism on reproductive and meat yield parameters of crossbred chickens. Int. J. Poult. Sci., 4: 372-377.
Reddy BLN, Sharma RP, Niranjan M, Chatterjee RN (2008). Evaluation of performance of Naked neck (Na/Na,Na/na) and dwarf (dw/dw, dw/-) gene lines under low selection intensity. Indian J. Anim. Sci., 78: 975-79.
Singh CV, Kummer D, Singh YP (2001). Potential usefulness of the plumage reducing Naked Neck (Na) gene in poultry production at normal and high ambient temperatures. World's Poult. Sci. J., 57: 139-156.
SAS Institute (2009). User's Guide Version, 9.2.1, 2002-2009, SAS institute Inc., Cary, NC, USA.
Yeasmin T, Howlider MAR (1998). Comparative physical features, egg production and egg quality characteristics of normal and dwarf indigenous (Deshi) hens of Bangladesh. J. Appl. Anim. Res., 13: 191-196.