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Comparative Live Weight, Growth Performance, Feed Intake, Carcass Traits and Meat Quality in Two Strains of Tswana Chickens Raised Under Intensive System in South East District of Botswana

K Thutwa, SJ Nsoso, PM Kgwatalala and JC Moreki

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

A B S T R A C T

Phenotypic parameters for growth, carcass and meat quality traits were measured in the normal feathered and naked neck strains of Tswana chickens to compare the strains performance on these traits under improved management. Ninety-three chickens were used (56 normal and 37 naked neck chickens). Feed intake was recorded daily while body weight and feed utilization were measured fortnightly from hatching to 20 weeks of age. After 20 weeks, 60 chickens were randomly selected for slaughter and carcass traits (carcass and carcass parts weights) measured and yield calculated. Meat quality was evaluated from 40 carcasses. These results showed that males had significantly higher (2436.44 g and 2375.54 g for naked neck and normal chickens, respectively) body weights than females (1585.27 g and 1690.62 g for naked neck and normal chickens, respectively) at 20 weeks of age. There was no significant (P>0.05) difference in growth performance between the two strains. Although feed utilization of the strains did not differ significantly, naked neck males tended to have higher feed efficiency than the naked neck females and normal strain. In addition, naked neck males outperformed naked neck females and normal chickens in carcass traits. The sex and genotypes did not affect meat quality significantly. These results imply that both sexes of these strains can be kept for meat production.

Keywords: Carcass, growth performance, meat quality, phenotypic parameter

Corresponding author: JC Moreki, Department of Animal Science and Production, Botswana College of Agriculture, Private Bag 0027, Gaborone, Botswana

INTRODUCTION

The population of Tswana chickens is estimated to be about 1.1 million in Botswana (Central Statistics Office, 2010). Tswana chickens are widely distributed throughout the country with 14 chickens per household. Generally indigenous chicken production in Africa is characterized by lack of regular health control programmes, unimproved shelter and scavenging to meet the nutritional needs (Yongolo, 1996). Local chickens are an important source of high quality protein (meat and eggs) and they also provide small cash income (Tadelle *et al*., 2000), hence they provide food security and alleviate poverty.

Little research has been done on characterization of indigenous chickens under either traditional or improved management conditions (Tadelle *et al*., 2000). Therefore, this study was undertaken to compare growth, feed utilization, carcass and meat quality traits in Tswana chickens.

MATERIALS AND METHODS

Housing of chickens

Chickens were kept in a deep litter house partitioned according to the strains: naked neck (36) and normal (57) chickens. The house had the brick wall of about 1 meter height and above it was chicken wire mash. The house was roofed with corrugated iron sheets.

Feeding and watering

All chicken strains were fed commercial broiler diets i.e., starter (pellets), grower and finisher. Feed and water were provided *ad libitum*. Starter diet was fed from one day old to four weeks of age; grower diet from 5 to 18 weeks and finisher from 19 to 20 weeks of age.

Management of diseases

The house was cleaned and disinfected before chick placement was done. Stresspac (i.e., electrolytes) was given to the chickens at 3, 4, 12 weeks of age when they showed stress signs after tagging and blood sampling. Lasota and Gumboro vaccines were administered at 5 and 14 weeks, respectively.

Data collection

Body weight

Data were collected from day one by weighing each chick and recording body weights. Thereafter, body weights were taken on individual birds fortnightly for the duration of the experiment. Feed intake was measured daily and feed efficiency determined fortnightly until 20 weeks of age.

Carcass traits

Thirty chickens (15 cocks and 15 hens) from each strain were randomly selected and sacrificed. The chickens were electrically stunned before heads were cut off. They were then bled for 3 minutes before being weighed again and de-feathered. The carcasses were eviscerated, dissected and the carcass parts weighed the same day of slaughter. Weight after de-feathering (before evisceration) and weights for carcass (dressed weight), intestines, breast, drumsticks, wings, thighs, back, liver, gizzard, heart, neck and shanks were recorded. Carcass weight was taken after evisceration and the carcass yield (dressing percentage) was calculated as a percentage of pre-slaughter body weight.

Meat quality traits (pH and water holding capacity)

Out of 60 chickens slaughtered, 10 males and 10 females from each strain were randomly selected and the meat quality traits determined. The pH was measured 24 hours after slaughter using the pH meter that was calibrated using certified buffers pH 7.0, pH 4.0 and pH 10. Ten grams of meat sample was cut from the breast (*pectoralis* muscle) and the drumstick (*peroneus longus* muscle) and blended with 50 ml of distilled water (1:5 ratio) in a clean blender jar; pH measurements were taken at the temperatures between 20 and 25 ^{o}C. Water holding capacity was estimated by measuring drip loss of breast meat samples 2 days post slaughter after storing them (samples) at 4 ^{o}C and then 7 and 14 days after slaughter using the bag method (Honikel, 1997).

Statistical analyses

Statistical analyses of the influence of different genotypes and sexes on growth, carcass and meat quality traits were performed using the proc General Linear Model Procedure of SAS 9.1 (SAS, 2003) by fitting the following model;

$Y_{ijk} = \mu + G_i + S_j + G_i*S_j + e_{ijk}$

Where: Y_{ijk} = observation trait of individual specified by subscripts, μ = population mean for that trait, G_i = strain effects, i = 1, 2, S_j = sex effects, j = 1, 2, G_i*S_j = interaction of strain and sex effects, E_{ijk} = random error ~N(0,σ^2). Least square means were separated using t- test.

RESULTS

Body weight

There was no significant difference (P>0.05) in growth rate and body weights of the two strains at the same age from one day old to 20 weeks. Generally, males were significantly (P<0.05) heavier than females in all strains at the same age from week 6 onwards (Figure 1).

Bodyweight gain

There was no significant difference in body weight gain in two strains (Figure 2). However, it is apparent that males tended to gain more weight than females in both strains at the same age.

Feed efficiency

Naked neck chickens used feed more efficiently than normal chickens (Figure 3). According to Figure 3, males had significantly better feed efficiency than females in both strains. This could be that generally males grow faster than females.

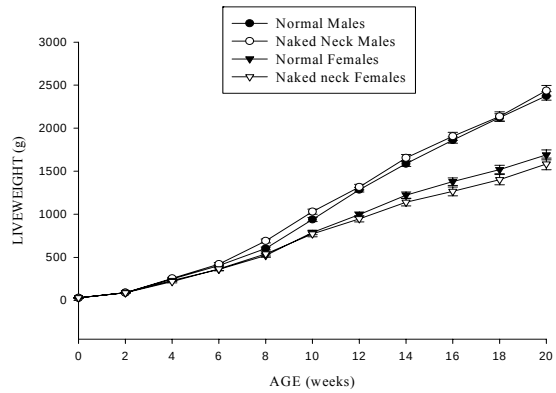

Fig. 1. Liveweight of indigenous normal and naked neck chicken strains from one day old to 20 weeks of age raised under intensive system in Botswana. Error bars = ± SEM.

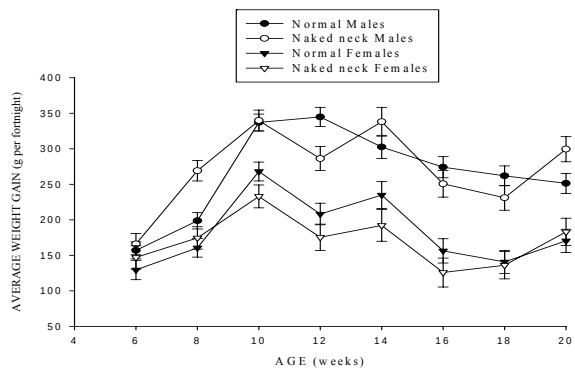

Fig. 2: Average body weight gain of indigenous normal and naked neck chicken strains from 6 to 20 weeks of age raised under intensive system in Botswana. Error bars = ±SEM

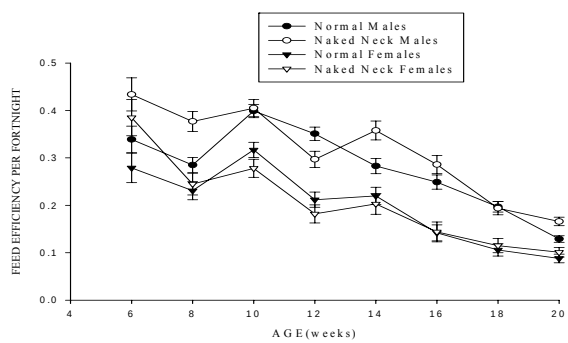

Fig. 3. Feed efficiency of indigenous normal and naked neck chicken strains from 6 to 20 weeks of age raised under intensive system in Botswana. Error bars = ±SEM

Carcass traits

Males had significantly (P<0.05) higher carcass weight after bleeding and de-feathering than females in both strains (Table 1). Carcass weight was not significantly different in males of both strains. However, the carcass of naked neck males tended to be heavier than that of normal males (Table 1).

Table 1: Least square means of carcass, carcass parts, other edible parts and non-edible parts parameters of indigenous normal and naked neck chicken strains slaughtered at 20 weeks of age raised under intensive system

	Normal strain		Naked neck strain	
Parameter (g)	Males	Females	Males	Females
LWBS	2405.8±72.0[a]	1651.467±72.0[b]	2426.938±69.7[a]	1567.5±74.6[b]
WAB	2206.407±66.7[a]	1543.613±66.7[b]	2240.631±64.5[a]	1452.450±69.0[b]
WAD	1929.500±62.9[a]	1357.620±62.9[b]	2072.438±60.9[a]	1322.707±65.1[b]
Carcass W	1600.313±59.0[a]	1119.133±59.0[b]	1738.544±57.1[a]	1084.700±61.1[b]
Breast W	407.44±17.0[a]	304.333±17.0[b]	440.738±16.5[a]	300.436±17.6[b]
Drumstick W	131.737±4.9[a]	80.43±4.9[b]	140.996±4.8[a]	79.868±5.1[b]
Wing W	100.903±4.2[a]	70.42±4.2[b]	109.853±4.1[a]	69.654±4.4[b]
Thigh W	142.7±4.8[a]	94.79±4.8[b]	157.516±4.6[a]	94.532±5.0[b]
Back W	302.327±20.5[a]	219.667±20.5[b]	328.97±19.8[a]	218.836±21.2[b]
Liver W	32.92±2.4[ab]	29.293±2.4[a]	39.118±2.3[b]	27.136±2.4[a]
Gizzard W	53.46±4.0[a]	45.747±4.0[a]	47.043±3.8[a]	43.114±4.1[a]
Heart W	12.400±0.5[a]	7.907±0.5[b]	14.164±0.5[a]	7.500±0.6[b]
Neck W	144.653±4.7[a]	88.907±4.7[b]	126.586±4.5[a]	75.886±4.8[b]
Shanks W	42.447±2.0[a]	24.243±2.0[b]	48.122±1.9[a]	26.561±2.0[b]
Intestines W	98.453±8.1[a]	76.093±8.1[a]	100.606±7.8[a]	80.436±8.4[a]
Feather W	276.907±14.4[a]	185.993±14.4[b]	168.194±13.9[b]	129.743±14.9[b]
Blood W	199.393±7.0[a]	107.853±7.0[b]	186.306±6.8[a]	115.050±7.3[b]

[ab] means with different superscripts differ significantly (P<0.05) within a row. LWBS = live weight before slaughter, WAB = weight after bleeding, WAD = weight after de-feathering and W = weight.

There was no significant difference in carcass weights between the two strains, however, naked neck chickens had significantly higher carcass yield than normal chickens (Tables 1 and 2). Carcass and thigh yields tended to be higher in naked neck males while breast, wing and back yields were higher in naked neck females (Table 2). Normal males tended to have higher yield in drumstick only. Carcass yield was not significant (P>0.05) between the two strains of Tswana chickens (Table 2). The carcass parts weights (except thigh weight) did not differ significantly between the males and females of both strains (Table 1). As shown in Table 2, the breast meat had the highest yield than other parts. The two strains had similar (P>0.05) breast yields (Table 2).

There was no significant difference in weights of other edible parts between the two strains (Table 1). However, naked neck males tended to have higher yield of heart and shanks than normal males and females of both strains (Table 2). Additionally, naked neck females tended to have the higher yields of intestines. Normal males had significantly (P<0.05) higher neck yield. Normal females tended to have higher liver and gizzard yields than naked neck females (Table 2).

Normal males had significantly (P<0.05) more feathers than both normal females and naked neck strain (Table 1). Furthermore, normal chickens yielded significantly (P<0.05) more feathers than the naked necks (Table 2). Males had significantly (P<0.05) more blood than females (Table 1).

Meat quality

The ultimate pH was significantly higher (P<0.05) in drumstick than in breast in both strains (Table 3). No significant difference in pH of meat from naked neck and normal chickens was found. However, naked neck chickens tended to have higher meat pH than normal chickens (Table 3).

At 2 days after slaughter breast meat lost significantly lesser water than at 7 and 14 days post slaughter in both strains (Table 3). Sex and genotype did not affect drip loss.

DISCUSSION

Growth (body weight and body weight gain)

The results on growth traits are consistent with Samaera (2003) who found that the live weight of Tswana naked neck chickens fed commercial diet was 1420 g at 19 weeks of age. However, the results of Samaera (2003) did not differentiate the sexes of the strain. Lack of significant difference in growth rates between two Tswana chicken strains contradicts the results of Norris *et al*. (2007) who reported that the normal Venda breed had significantly lower growth rate than the naked neck at the same age. Islam and Nishibori (2009), Singh *et al*. (2001) and Vali (1992) also found the indigenous naked neck chickens to be superior to indigenous full-feathered chickens in body weight.

Islam and Nishibori (2009) reported the body weight of Bangladesh naked neck to be 318 g and 1214 g at 8 and 16 weeks of age, respectively while the Tswana naked neck in the present study weighed about 600 g and about 1600 g at those weeks of age. The body weight of Tswana naked neck was also higher than that of Iran at 19 weeks of age. Vali (2008) reported that the Iran naked neck males and females weighed 1416.1 and 1058.3 g, respectively at 19 weeks of age while the Tswana naked neck males and females in the current study weighed 2286.69 and 1493.80 g, respectively at that age even though they were both kept under improved management.

The significant heavy body weight of males than females in both Tswana strains in this study is in agreement with Badubi *et al*. (2006) who found that Tswana males were superior to females. This was also reported by Igbal and Pampori (2008) in indigenous chickens of Kashmir. In agreement with the results of this study, Vali (2008) reported that the influence of sex on body weight was significant at 6, 8 and 10 weeks of age. When compared with the study of Badubi *et al*. (2006), the two strains in the present study have shown that under improved environment Tswana chickens can perform much better than under the unimproved environment.

Table 2: Yields of carcass, carcass parts, other edible and non-edible parts of indigenous normal and naked neck chickens at 20 weeks of age raised under intensive system in Botswana

	Normal strain		Naked neck strain	
Parameter (%)	Males	Females	Males	Females
Carcass Y	66.46±1.1[a]	67.64±1.1[a]	71.36±1.1[b]	69.27±1.1[ab]
Breast Y	25.43±0.9[a]	27.44±0.9[a]	25.48±0.8[a]	27.96±0.9[a]
Drumstick Y	8.20±0.2[a]	7.19±0.2[b]	8.16±0.2[a]	7.378±0.2[b]
Wing Y	6.28±0.2[a]	6.33±0.2[a]	6.38±0.2[a]	6.40±0.2[a]
Thigh Y	8.95±0.2[a]	8.463±0.2[a]	9.15±0.2[a]	8.70±0.2[a]
Back Y	18.71±1.2[a]	19.45±1.2[a]	19.15±1.2[a]	19.96±1.3[a]
Liver Y	2.06±0.1[a]	2.53±0.1[b]	2.24±0.1a[b]	2.52±0.1[b]
Gizzard Y	3.46±0.3[ab]	4.09±0.3[a]	2.81±0.3[b]	3.95±0.3[a]
Heart Y	0.77±0.03[a]	0.71±0.03[a]	0.83±0.03[a]	0.70±0.03[a]
Neck Y	9.03±0.2[a]	8.05±0.2[b]	7.38±0.2[b]	6.99±0.2[b]
Shanks Y	2.65±0.1[a]	2.16±0.1[b]	2.78±0.1[a]	2.43±0.1[ab]
Intestines Y	6.13±0.6[a]	6.83±0.6[a]	5.86±0.5[a]	7.46±0.6[a]
Feather Y	11.48±0.6[a]	11.42±0.6[a]	6.94±0.6[b]	8.32±0.7[b]
Blood Y	8.25±0.2[a]	6.57±0.2[b]	7.69±0.2[a]	7.32±0.2[b]

[ab] means with different superscripts differ significantly (P<0.05) within a row. Y = Yield.

Table 3: Ultimate pH and water holding capacity (drip loss) for meat of indigenous normal and naked neck chicken strains slaughtered at 20 weeks raised under intensive system in Botswana.

	Normal strain		Naked neck strain	
Parameter	Males	Females	Males	Females
Drumstick pH	6.15±0.1[a]	6.29±0.1[a]	6.33±0.1[a]	6.42±0.1[a]
Breast pH	5.78±0.04[b]	5.80±0.04[b]	6.02±0.04[ab]	5.94±0.04[b]
Drip loss				
After 2days	2.020±0.4[a]	2.429±0.4[a]	2.447±0.4[ab]	2.341±0.5[a]
After 7days	4.335±0.5[b]	5.072±0.6[b]	5.254±0.5[b]	4.931±0.6[b]
After 14days	6.782±0.6[b]	7.544±0.7[bc]	8.142±0.6[c]	8.741±0.7[c]

[ab] means with different superscripts differ significantly (P<0.05) within a row.

These results have shown that Tswana chickens require at least 14 weeks to attain weights of more than 1 kg. Compared to the indigenous chickens of Malawi which were also fed commercial balanced diets and kept under intensive system, the Tswana strains performed better. Safalaoh (1998) reported that Malawi chickens required up to 20 weeks of age to attain the weights of more than 1 kg. This variation may be due to genetic factors or environmental factors not investigated. Branckaert *et al.* (2000) and Guèye (1998) argued that the local breeds have always been considered low producers. The study of Ravikumar *et al*. (2002) reported that the rearing of local chickens with improved management, proper vaccination and disease control and selection for production traits yielded good results in tribal areas of Jabalpur. Although there was no significant difference in growth rate between the naked neck and normal chickens, the naked neck were slightly superior to the normal chickens in terms of body weight.

Feed utilization

The better utilization of feed by males than females is due to the fact that females tend to deposit proportionally more fat in the carcass (Leeson, 2000). Body fat requires nine times much energy to produce as does muscle. This is because fat contains more energy than protein per unit of weight. The present results infer that it will be uneconomical to produce Tswana females in an intensive system beyond 10 weeks of age unless special emphasis is placed on reducing fat deposition. This also applies to males more than 14 weeks of age. The decrease of feed utilization with age is in agreement with Leeson (2000) who reported that this situation is attributable to heavy birds using increased quantities of feed to maintain their body mass, and less for growth. The results on feed efficiency concur with that of Singh *et al*. (2001) who reported naked neck to have better feed efficiency than normal feathered ones. The inconsistency of feed utilization (feed efficiency) in the chickens was probably due to factors not investigated in this study such as health and environmental temperatures.

Carcass traits

The carcass parts from this study were much heavier than those recorded by Samaera (2003) on the Tswana strains even though there was only a difference of one week of slaughter age. This may be due to the fact that the chickens used in this study were from different areas of Botswana leading to high variation while those of Samaera (2003) were from one area. The weights of naked neck breast, thigh, drumstick, wing and neck in the current study were double that of Samaera (2003)'s findings in the same strain.

In consistent with Samaera (2003), the naked neck males in the present study had higher dressing percentage than normal males and females of both strains. Islam and Nishibori (2009) also found that indigenous naked neck of Bangladesh was superior in dressed percentage to indigenous normal feathered chickens. The carcass weight followed a trend almost similar to body weight before slaughter. Similar results were reported by Safalaoh (1998) in Malawi. The absence of significant difference in dressing percentage (carcass yield) of males and females of the two strains is in disagreement with the findings of Igbal and Pampori (2008).

The similar breast yield in two strains differed with the findings of Van Marle-Köster and Webb (2000) who found that the naked neck of South Africa yielded the highest breast muscle when compared to other native lines. The females had higher breast yield than males in the two strains although between normal sexes this was not significant. However, the males had heavier breasts than females, and therefore males would probably be more profitable for meat production than females.

The absence of the significant difference in feather yield between the sexes of the same strain reported in the present study was also reported by Igbal and Pampori (2008) on indigenous chickens of Kashmir. It is apparent that feather yield was higher in normal than naked neck chickens because naked neck chickens do not have feathers on the neck. The significantly higher blood yield in males than females found in the present study was also reported by Igbal and Pampori (2008) in indigenous chickens of Kashmmir.

Meat quality

The breast pH for all the strains falls within the 5.7 to 6.0 range which is said to be the highest quality. This suggests that the breast can be used to produce meat products of higher quality than drumstick. Rose (1997) reported that breast meat often has a higher economic value than meat from other parts of the poultry carcass. The absence of significant difference in water holding capacity (drip loss) of breast meat between the two strains is in agreement with Jaturasitha *et al*. (2008) in Northern Thailand. The drip loss which increased with the duration of the storage time indicated that the meat quality decreases with storage time.

Conclusion

The genotype and sex did not influence meat quality. Although there was no significant difference in growth between strains, sex influenced growth and feed utilization significantly. Naked neck males outperformed naked neck females and normal chickens in carcass weight and yield and carcass parts weights and yield, indicating that the naked neck males may be good for meat production. Therefore, it is concluded that more research is needed to ascertain how the naked neck gene influences growth and carcass traits.

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