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Research Article
Effect of Feeding Commercial Broiler Diets on Growth Performance of Tswana and Orpington Chickens Reared upto 18 Weeks of Age Under Intensive System

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Abstract

Objective: This study was conducted to compare growth performance and carcass characteristics of Tswana and Orpington chickens. **Methodology:** A total of 120 day old chicks (60 Tswana and 60 Orpington) were randomly distributed to 4 replicates using a completely randomized design. Birds were raised under intensive system upto 18 weeks of age and fed commercial diets. Parameters recorded included feed intake, Body Weight (BW), Body Weight Gain (BWG), Feed Conversion Ratio (FCR), mortality, final live weight, dressed weight, dressing percentage and portions/primal cuts weight. Data were analyzed using the general linear model procedures in statistical analysis system (SAS). **Results:** There were no significant differences ($p>0.05$) in feed intake amongst the tested chicken lines. No significant sex differences ($p>0.05$) in BW between Orpington and Tswana chickens were observed. At 11 and 18 weeks of age BWG of Orpington males were significantly higher than Tswana males (135.58±8.00 and 132.74±8.51; 94.39±7.60 and 51.82±8.26, respectively). Males were significantly ($p<0.05$) heavier than their age-matched female counterparts. The FCR of Orpingtons was less than that of Tswana chickens. The highest mortality rate was recorded in Tswana chickens (8%) compared to Orpingtons (5%). At 18 weeks of age, the highest final live weight was recorded in Orpington (male 1862.74 g, female 1493.46 g) compared to Tswana chickens (male 1732.89 g, female 1467.90 g). Orpingtons had significantly ($p<0.05$) higher live weight, dressed weight, carcass weight and primal cuts weight compared to indigenous Tswana chickens. No differences ($p>0.05$) were observed for dressing percentage. **Conclusion:** These results imply that Orpingtons may be considered in future breed improvement programmes.

Key words: Genotype, rearing system, growth parameters, carcass characteristics

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Competing Interest: The authors have declared that no competing interest exists.

Data Availability: All relevant data are within the paper and its supporting information files.

INTRODUCTION

Animal growth follows a generalized sigmoidal response and the actual shape of the curve can be affected by nutrition, environment, health, gender and genotype[1]. This sigmoidal response indicates that growth is self-accelerating during the early growth phase until the inflexion when it becomes self-inhibiting for the final phase approaching maturity[2]. Van Lunen and Cole[3] opined that if it is assumed that the optimum level of nutrition is provided in a suitable environment and that the health status is high, the genetic potential for growth will have a strong influence on the shape of the growth curve. Based on the percentage increase over the weight at the end of the pre-laying phase, the most rapid growth or weight gains are achieved at a young age. As the chick grows older, weekly increments of weight decrease.

Growth performance of Tswana chickens is very poor relative to that of commercial broilers because of lack of selection for growth potential, poor nutrition, poor housing, high temperatures and poor health care given to the chickens under the traditional free range rearing system[4]. Tswana chickens require at least 14 weeks to attain weights[5] of more than 1 kg, whereas Orpington chickens attain 3-4 kg within 12-13 weeks of age[6]. On the other hand, modern broilers are generally ready for slaughter at 5 weeks of age.

It has been observed that although the growth performance of local chicken is less efficient than that of commercial broilers, the quality of their meat is more appropriate for premium chicken meat[7]. Jayasena *et al.*[8] suggested that the unique taste and high nutritional value of local chickens in comparison to broilers have yet to be clearly evaluated through scientific analyses and that it is important to elucidate the physicochemical factors that influence the taste and nutritional value of these chickens. This led to Dahloum *et al.*[9] to conclude that indigenous chickens deserve special attention and conservation. Little is known about the growth performance of Tswana chickens. Therefore, this study was carried out to compare growth performance and carcass characteristics of Tswana and Orpington chickens up to 18 weeks of age under intensive system.

MATERIALS AND METHODS

Experimental site: The experiment was carried out at Botswana University of Agriculture and Natural Resources (BUAN) Guinea Fowl Unit in Sebele at 24°33 S, 24°54 E at an altitude[10] of 994 m a.s.l. The study lasted for 18 weeks from September, 2014 to January, 2015. An open-sided poultry house with concrete floors and roofed with corrugated iron sheets was used. Average environmental temperature during study period was 35.5°C. Chickens were raised under natural light.

Experimental design: A total of 120 chicks (60 Tswana chickens and 60 Orpington) were purchased from a local farmer in Gaborone and reared upto 18 weeks of age under intensive system. A Completely Randomized Design (CRD) was employed in this experiment with two treatments. Each treatment (Tswana and Orpington) was replicated four times with 15 birds per replicate.

Experimental birds and their management: Prior to the start of the experiment all chicks within a treatment were individually weighed and randomly distributed to 4 replicates. Chicks were separately kept under deep litter management system in an open-sided house from day old to 4 weeks of age. Each pen which, measured 1 m^2 was equipped with an electric brooder, 10 kg feeder and 10 L drinker. Chickens were vaccinated orally (via water) against newcastle disease using La Sota vaccine at 2 and 8 weeks of age. Birds were group fed per pen. At the beginning of the study, birds were given 2 weeks to acclimatize to experimental diets before data collection started. At 3 weeks of age, chicks were individually identified using leg bands and thereafter transferred to an open-sided house. Data were collected from 3-18 weeks of age.

Experimental diets: Birds were provided with chick broiler starter crumbs from day old to 4 weeks of age and broiler grower pellets from 5-18 weeks of age. Commercial broiler diets were obtained from one supplier. Feed and water were provided *ad libitum* throughout the experimental period. Birds were provided with pre-weighed diet once daily in the morning. Feed was weighed using a 5 kg electronic balance with accuracy of 0.001 g before every feeding and leftovers were weighed back at the end of the week before new feed was given to each replicate group. The nutrient composition of experimental diets is given in Table 1.

Measurement of parameters: Performance parameters such as Body Weight (BW), Body Weight Gain (BWG), final live weight and feed intake were determined from 3-18 weeks of age. Mortality was recorded as and when it occurred. Initial weight of chicks was determined by weighing all birds using a 5 kg electronic scale. Thereafter, BW was recorded on a weekly basis, i.e., in the morning when their crops were empty.

Table 1: Nutrient composition of broiler starter and grower diets fed to experimental birds

Composition	Starter	Grower
Protein (min)	200.0	180.0
Moisture (max)	120.0	120.0
Fibre (max)	50.0	60.0
Calcium (min)	8.0	7.0
Calcium (max)	12.0	12.0
Fat (min)	25.0	25.0
Phosphorus (min)	6.0	5.5
Total lysine (min)	12.0	10.0

Feed intake was determined by giving pre-weighed feed allocations to each replicate group throughout the week and unconsumed feed weighed back at the end of the week. The BWG per bird was determined weekly by dividing the week total weights per pen by the number of birds, while Feed Conversion Ratio (FCR) was calculated by dividing feed intake by BWG[11].

At 18 weeks of age, 5 birds from each replicate were randomly selected and isolated into empty pens, starved of feed overnight and sacrificed the following day. Mechanical stunning was performed at BUAN slaughterhouse followed by severing the carotid arteries and jugular veins and draining of blood under gravity. Birds were scalded to facilitate mechanical plucking and thereafter manually eviscerated. The carcasses were then cut into portions/primal parts as described by Kleczek *et al.*[12] and the weights of individual cuts determined using electronic scale sensitive to 0.001 g.

Statistical analysis: Data were analyzed by SAS[13] version 9.2.1 using General Linear Model's (GLM) procedures and the model included fixed effects of breed (Orpington and Tswana), sex (male and female) and the interaction between breed and sex. Results are presented as least square Means±Standard Error. Mean separation was by paired t-test with Scheffe's adjustment to account for unequal number of sampling units in the replications due to mortality and sex differences. The differences between means were declared significantly different at $p \leq 0.05$.

RESULTS AND DISCUSSION

Feed intake: There were no significant differences in total feed intake amongst the tested chicken lines (Table 2). These results are in agreement with those of Reta *et al.*[14] in Ethiopia who found no significant difference in weekly feed intake between exotic line [Rhode Island Red (RIR)] and rural poultry flock (Fayoumi) when maintained in floor pens on deep litter system for a period of 20 weeks. Contrary to the present results, Hassen *et al.*[15] and Binda *et al.*[16] found a significant difference in feed intake between the exotic strains (Hybro and Hubbard and RIR) and the local ecotypes. The researchers reported that the exotic chickens consumed three times more feed and had better feed efficiency than the local ecotypes. In the present study, higher levels of feed intake were recorded for the Orpingtons compared to Tswana chickens (Table 2).

Table 2: Feed intake (g) of Orpington and indigenous Tswana chickens under an intensive management system

	Orpington		Tswana	
Age (weeks)	Male	Female	Male	Female
3	537.74±0.87	537.34±0.94	531.51±0.92	530.29±0.88
4	550.14±6.60	548.51±7.13	517.33±7.13	509.00±6.60
5	563.18±6.27	557.36±6.78	507.97±6.78	506.68±6.40
6	604.25±6.74	604.92±7.44	545.21±7.14	540.27±7.28
7	635.09±3.91	634.25±4.23	608.93±4.14	607.35±4.23
8	640.07±5.60	639.59±6.07	611.53±5.94	608.93±4.14
9	656.68±8.24	656.82±8.76	607.38±8.57	595.21±8.76
10	875.10±6.65	876.67±7.08	835.41±6.93	832.44±7.08
11	890.63±4.79	891.44±5.09	850.90±4.99	847.72±5.09
12	904.07±5.79	904.47±6.15	863.12±6.02	859.45±6.15
13	918.41±4.76	917.66±3.06	881.77±4.95	880.55±5.06
14	941.08±4.86	940.44±5.16	902.28±5.05	901.77±5.16
15	965.59±6.89	965.57±7.33	922.72±7.17	920.91±7.33
16	1069.88±4.78	1068.43±5.08	1021.79±5.08	1019.33±4.98
17	1108.49±5.89	1104.75±6.40	1081.58±6.26	1081.55±6.13
18	1143.11±7.78	1138.03±8.46	1112.99±8.10	1111.02±8.27

Table 3: Means and standard errors of body weights of Orpington and indigenous Tswana chickens reared upto 18 weeks of age under intensive management system

	Orpington		Tswana	
Age (weeks)	Male	Female	Male	Female
3	106.37±3.97	104.71±4.28	95.00±4.20	86.14±4.04
4	142.66±4.22^a	110.02±4.56^b	138.40±4.56^a	100.84±4.22^b
5	197.29±7.66^a	162.12±8.27^b	184.87±8.27^a	145.16±7.66^b
6	290.20±10.75^a	230.14±11.86^b	283.57±11.61^a	228.20±11.61^b
7	405.59±12.67^a	325.14±13.47^b	393.28±13.47^a	313.19±13.19^b
8	518.68±16.53^a	422.67±17.58^b	504.35±17.58^a	406.10±17.21^b
9	706.26±21.13^a	547.70±22.47^b	688.83±22.47^a	536.64±22.00^b
10	843.46±25.21^a	671.59±26.81^b	831.31±26.81^a	659.49±26.24^b
11	1021.04±27.55^a	801.49±29.29^b	967.06±29.29^a	788.95±28.67^b
12	1143.59±28.07^a	922.30±29.84^b	1060.27±29.84^a	888.34±29.22^b
13	1307.44±31.16^a	1038.42±33.13^b	1199.11±33.13^a	1018.33±32.44^b
14	1449.66±36.17^a	1154.14±38.46^b	1385.40±38.46^a	1125.33±37.66^b
15	1573.35±39.43^a	1239.95±41.92^b	1494.21±41.92^a	1218.63±41.04^b
16	1683.30±44.39^a	1348.15±47.20^b	1615.29±47.20^a	1329.25±46.20^b
17	1768.36±49.13^a	1417.67±52.23^b	1699.25±52.23^a	1408.44±51.13^b
18	1862.74±52.02^a	1493.46±55.31^b	1732.89±55.31^a	1467.90±54.14^b

Means with different superscripts within breed at a particular age were significantly different from each other ($p<0.05$)

Body weight and body weight gain: Weekly live BW at different ages of Orpington and Tswana male and female chickens increased significantly ($p<0.05$) from 4-18 weeks of age (Table 3). Growth trends in both sexes depicted linear increase in BW, however, the rate of increase in BW was higher

Table 4: Body weights (g) of male and female Orpington and indigenous Tswana chickens at various ages raised under an intensive management system

Age	Males		Females	
(weeks)	Orpington	Tswana	Orpington	Tswana
3	106.37±3.97	95.00±4.20	104.71±4.28[a]	86.14±4.04[b]
4	142.66±4.22	138.40±4.56	110.02±4.56	100.84±4.22
5	197.29±7.66	184.87±8.27	162.12±8.27	145.16±7.66
6	290.20±10.75	283.57±11.61	230.14±11.86	228.20±11.61
7	405.59±12.67	393.28±13.47	325.14±13.47	313.19±13.19
8	518.68±16.53	504.35±17.58	422.67±17.58	406.10±17.21
9	706.26±21.13	688.83±22.47	547.70±22.47	536.64±22.00
10	843.46±25.21	831.31±26.81	671.59±26.81	659.49±26.24
11	1021.04±27.55	967.06±29.29	801.49±29.29	788.95±28.67
12	1143.59±28.07	1060.27±29.84	922.30±29.84	888.34±29.22
13	1307.44±31.16	1199.11±33.13	1038.42±33.13	1018.33±32.44
14	1449.66±36.17	1385.40 ± 38.46	1154.14±38.46	1125.33±37.66
15	1573.35±39.43	1494.21±41.92	1239.95±41.92	1218.63±41.04
16	1683.30±44.39	1615.29±47.20	1348.15±47.20	1329.25±46.20
17	1768.36±49.13	1699.25±52.23	1417.67±52.23	1408.44±51.13
18	1862.74±52.02	1732.89±55.3	1493.46±55.31	1467.90±54.14

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

Table 5: Body weight gain means and standard errors Orpington and indigenous Tswana chickens reared upto 18 weeks of age under intensive management system

	Orpington		Tswana	
Age				
(weeks)	Male	Female	Male	Female
3	27.15±2.76	23.03±2.56	26.60±2.70	22.54±2.60
4	40.31±4.56	32.24±4.16	35.60±4.86	30.98±4.38
5	55.70±5.47	52.10±5.91	46.47±5.91	44.32±5.47
6	91.84±6.31	66.86±6.96	98.70±6.82	74.94±6.82
7	108.26±4.07	95.00±4.33	105.10±4.33[a]	85.00±4.24[b]
8	113.09±6.02	97.53±6.41	111.07±6.41[a]	92.91±6.27[b]
9	147.58±8.80[a]	129.89±9.36[b]	134.48±9.36	126.54±9.16
10	137.20±7.59	123.89±8.07	132.48±8.07[a]	122.85±7.90[b]
11	135.58±8.00[a]	125.04±8.51[b]	132.74±8.51	123.06±8.33
12	122.55±8.76	120.81±9.32	93.21±9.32	99.39±9.12
13	143.85±10.31[a]	116.12±10.96[b]	138.84±10.96	129.32±10.73
14	142.22±11.61	115.72±12.34	136.29±12.34[a]	107.01±12.08[b]
15	123.69±10.62	85.81±11.29	108.82±11.29	93.30±11.05
16	111.95±12.26	108.02±13.04	110.07±13.04	109.62±12.76
17	85.06±10.13	69.52±10.77	87.88±10.27	79.19±10.55
18	94.39±7.60	75.78±8.08	51.82±8.26	59.46±7.91

Means with different superscripts within breed at a particular age were significantly different from each other (p<0.05)

in males compared to females, thus showing clear sexual dimorphism. There were no significant sex differences (p>0.05) in BW between Orpington and Tswana chickens from 4-18 weeks of age (Table 4). The result on BW in this study is in agreement with Hassen *et al*.[15] in Ethiopia, who fed RIR and indigenous chicken lines standard commercial diet under intensive conditions upto 22 weeks and found significant high final BW in RIR compared to indigenous chicken lines. Similarly, Ali *et al*.[17] in Tanzania, Mangonyama[18] in South Africa, Binda *et al*.[16] in Sudan found the exotic strains to be significantly heavier than native chicken ecotypes. In Botswana, Kgwatalala and Segokgo[4] found that Australorpx Tswana crossbred males were significantly heavier (p<0.05) than their age-matched indigenous counterparts from 10-18 weeks of age. The variation in growth rate between exotic meat strains and the indigenous fowl can be attributed to the differences in their genetic make-up since the exotic birds have been extensively selected for rapid growth while no selection has been done on the indigenous stock.

The present results show that both sexes exhibited a similar pattern of growth up to 10 weeks of age. Thereafter, males grew faster and attained higher mature BW than females (Fig. 1). This finding is in agreement with Missohou *et al*.[19] who found that males grow faster and attain higher mature BW than female birds after 10 weeks of age. Similar observations were made by Baeza *et al*.[20] in ducks. The researchers attributed the differences in growth rate between male and female ducks to sexual dimorphism.

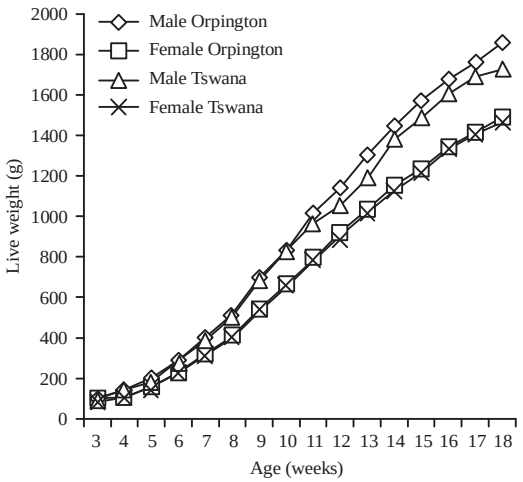

Fig. 1: Effect of sex on live weight of Orpington and indigenous Tswana chicken strains from 3-18 weeks of age raised under intensive system in Botswana

The BWG in Orpington chickens was significant (p<0.05) at 9, 11 and 13 weeks of age, whereas Tswana chickens were significantly different (p<0.05) at 7, 8, 10 and 14 weeks of age (Table 5). It, however, appears that males tended to gain more weight than females in both strains at the same age. The highest BWG was recorded in Orpington males (147.58 g) and females (129.89 g) at week 9 compared to Tswana males (138.84) and females (129.32) at week 13. At 11 and 18 weeks of age Orpington males exhibited significantly higher BWG than Tswana males (135.58±8.00 and 132.74±8.51, 94.39±7.60 and 51.82±8.26 g, respectively). No significant

differences in BWG (p>0.05) were observed between Orpington females and Tswana females at any particular age (Table 5). In agreement with the present result, Raach-Moujahed and Haddad[21] found that local chickens generally presented slower growth rate than modern commercial breeds.

The fluctuations in weekly BWG observed in this study could be associated with the highest ambient temperatures experienced from October-December, 2014. Ambient temperatures in October, November and December, 2014 were 38, 35 and 37°C, respectively[22]. These higher temperatures had effects on birds` appetite and negatively affected feed intake resulting in fluctuations in growth rate.

Feed conversion ratio: The highest FCR was recorded in females (Orpington: 6.70, Tswana: 8.49) compared to males (Orpington: 2.20, Tswana: 2.60) at week 4 (Fig. 2). However, Tswana chickens showed higher FCR than Orpington chickens, indicating that Tswana chickens are poor converters of feeds to meat, probably because they have not been selected for faster growth rate. Gabanakgosi *et al.*[23] fed Tswana chickens standard commercial broiler diets under intensive conditions and found the highest FCR of 3.87 at 18 weeks of age.

It is argued[24] that 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 than males. Body fat requires 9 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 female Tswana chickens in an intensive system beyond 10 weeks of age unless special emphasis is placed on reducing fat deposition. The decrease of feed utilization with age is in agreement with Leeson[24] who attributed this to birds using increased quantities of feed to maintain their body mass and less for growth. The FCR of 4.7 for Tswana chickens in the present study is superior to that reported for other local breeds (i.e., Tilili 11.9, Mecha, 11.6, Guangua 11.0) reared intensively and fed commercial starter and grower diets upto 22 weeks of age in Northwest Ethiopia[15]. It seems that the FCR difference could be influenced by breed.

Mortality: The highest mortality rate was recorded in Tswana chickens (8%) compared to Orpingtons (5%). Previous study by Demeke[25] found higher mortality rate in Ethiopian local chickens (24%) compared to White Leghorn chickens (4.1%) kept under intensive conditions, whereas under scavenging conditions local chickens had lower mortality rate (4.6%) compared to White Leghorn chickens (6.7%) at 12 weeks of age. The high mortality rate in the present study could be ascribed to birds not being used to confinement.

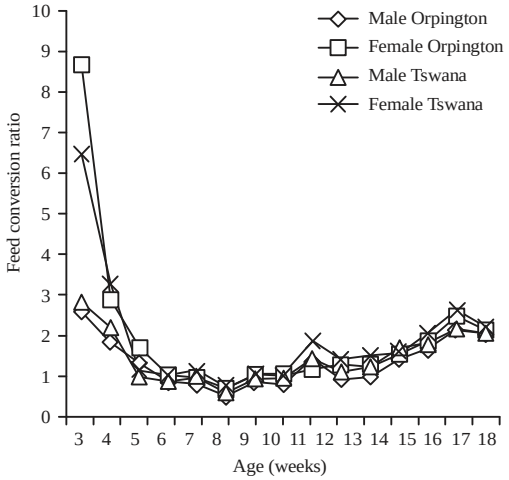

Fig. 2: Feed conversion ratio of Orpington and indigenous Tswana chicken strains from 4-18 weeks of age raised under intensive system in Botswana

Table 6: Least square means for carcass traits of Orpington and indigenous Tswana chickens at 18 weeks of age

	Orpington		Tswana	
Carcass traits	Male	Female	Male	Female
Live weight (g)	1862.11±68.55[a]	1493.44±75.78[b]	1732.88±65.63[a]	1467.72±80.34[b]
Dressed weight (g)	1634.01±67.28[a]	1309.00±74.38[b]	1556.31±64.62[a]	1294.52±78.90[b]
Carcass weight (g)	1337.09±67.24[a]	1116.35±74.89[b]	1273.95±64.86[a]	1054.44±79.43[b]
Dressing percentage	74.21±1.75	73.45±1.94	71.42±1.68	68.61±2.06
Breast weight (g)	407.43±17.02[a]	319.24±18.81[b]	378.11±16.29[a]	295.38±19.96[b]
Back weight (g)	276.58±14.63[a]	199.73±16.17[b]	264.48±14.01[a]	178.90±17.15[b]
Drumstick weight (g)	253.96±9.57[a]	187.46±10.58[b]	249.86±9.17[a]	158.29±11.23[b]
Thigh weight (g)	251.84±9.04[a]	184.44±9.99[b]	249.19±8.65[a]	158.74±10.60[b]
Wing weight (g)	214.82±6.88[a]	166.72±7.61[b]	203.78±6.59[a]	142.51±8.07[b]
Neck weight (g)	141.26±5.09[a]	91.84±5.63[b]	134.46±4.88[a]	83.76±5.97[b]
Liver weight (g)	38.61±1.90	33.50±2.10	33.69±1.82	29.13±2.23
Gizzard weight (g)	16.51±3.91[a]	47.54±4.32[b]	51.05±3.74	45.83±4.58
Heart weight (g)	11.14±0.61[a]	8.32±0.68[b]	10.82±0.59[a]	6.76±0.72[b]

Means with different superscripts within breed at a particular age were significantly different from each other (p<0.05)

Carcass characteristics and live weight: Orpingtons had significantly ($p<0.05$) higher live weight, dressed weight, carcass weight and primal cuts weight compared to Tswana chickens (Table 6). These findings are in agreement with Yousif *et al.*[26] who found higher live weight, dressed weight, carcass weight and primal cuts weight in commercial strains (Hybro and Hubbard) compared to three Sudanese native chicken ecotypes (Bare-neck, large Baladi and Betwil). In contrast with the present results, Franco *et al.*[27] in their study with the native Mos rooster and the hybrid Sasso T-44 reported that although live weight and carcass weight were higher in the hybrid line, Mos breed had significantly higher percentage of edible products (drumstick, thigh and wing) than Sasso T-44. Also, Rizzi *et al.*[28] found that at 44 weeks of age, 2 Italian dual-purpose breeds had significantly heavier breasts, thighs and drumsticks than hybrid hens.

Table 6 shows that Orpington had higher dressing percentage than Tswana chickens. Orpington males had the highest dressing percentage (74.21%), followed by Orpington females with 73.45%, Tswana males with 71.42%, whereas Tswana females had the lowest dressing percentage (68.61%). Choo *et al.*[7] stated that carcass yield is affected by a number of factors including genetics, feed, slaughtering conditions, live weight and sex.

CONCLUSION

The present results show better growth performance and carcass characteristics in Orpington than Tswana chickens. In addition, Orpington strain exhibited better FCR than Tswana chickens under intensive management. However, Orpington strain seemed to be affected negatively by high ambient temperature though their performance was higher than that of Tswana chickens which are adapted to the local environmental conditions. Based on the findings of the present study, Orpingtons may be considered in future breed improvement programmes on account of their better growth performance.

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