DE GRUYTER Open Agriculture 2020; 5: 607–616

Research Article

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Effect of strain, sex and slaughter weight on growth performance, carcass yield and quality of broiler meat

https://doi.org/10.1515/opag-2020-0056
received December 13, 2019; accepted April 21, 2020

Abstract: This study examined strain, sex and slaughter weight effect on performance, meat quality and yield of broiler chicken. One hundred and fifty-day-old chicks (broilers) were distributed randomly in a 3 × 2 × 4 factorial experiment, with 50 birds per strain (Ross, Aboaca and Anak) and 25 birds per sex. After trial, 32 birds per strain and 16 per sex were slaughtered at 4 different body weights (1,000, 1,500, 2,000, and 2,500 g) to determine carcass yield and meat quality. The results revealed significant strain and sex effect ($P < 0.05$) on growth performance of the broiler chicken. Ross strain had the highest feed intake (4883.25 g) and final body weight (2440.25 g) compared to Aboaca and Anak strains. Female broiler having heavier body weight (2431.66 g) and feed intake (4864.83 g) than the males for all strains. Aboaca birds had the highest carcass yields for all slaughter weight than Anak and Ross. The slaughter weight, irrespective sex and strains significantly influenced the carcass yield ($P < 0.001$) with birds slaughtered at 2,500 g having ($P < 0.001$) highest values compared to other slaughtered weights. As slaughter weight increases, cooking loss and thermal shortening decreases while water holding capacity and shear force values increases. Overall, Aboaca strain was considered to have best performances for production.

Keywords: broiler, strain, sex, slaughter weight, performance, carcass traits

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1 Introduction

Broiler birds are specifically bred for rapid growth (Packard 2014) to attain mature body size within 7–10 weeks depending on the strain, sex and management (Alzenbarakji 2011; Abdollahi et al. 2017). There are numerous strains of broilers worldwide. The strains that are used by farmers depend among many factors on the type of strain available in the locality or country. Flemming et al. (1999) recognized Ross, Cobb, Hubbard, Arbor Acres and Isa Vidette as strains of broilers that are commonly grown in many places. Likewise, Olawumi et al. (2012) identified Arbor Acres, Marshall, Hubbard, Anak and Aboaca are breeds of broilers that are commonly used for commercial purposes. Most of the hatchery sells unsexed broiler chicks. However, male broiler is mostly preferred because it grows faster and has higher live weight (Ojedapo et al. 2008; Olawumi et al. 2012).

Broiler meat has been reported to be healthier than red meat because it has low cholesterol and fat content (Farrell 2013). In addition, broiler meat is succulent, a good source of animal protein, minerals and vitamins that are key to human growth (Obasoyo et al. 2005). Unlike pork and beef, no religious beliefs forbid their consumption (Olawumi and Fagbuaro 2011). Many factors such as genotype (strain), diets content, sex, design of pen and stocking density have been reported to affect the performance, meat quality and carcass yields of broiler chickens. Many reports have shown that genotypes significantly influence feed intake, body growth parameters (such as body weight, shank length, comb, wattle and feather) and the efficiency of feed utilization of broiler chickens (Taha et al. 2011; Ezebor and Akporahuarho, 2015; Udeh et al. 2015). However, Thutwa et al. (2012) and Hristakieva et al. (2014) reported that nonstatistical strains influence in average daily feed intake, average daily weight gain and efficiency of feed utilization.

Olawumi and Fagbuaro (2011) observed that sex affects the average daily weight gain, average daily feed intake and carcass characteristic of broiler chicken. Ojedapo et al. (2008) reported that male breeds of Anak and WadiRoss were statistically ($P < 0.05$) higher in average live body weight, average shank length, average drumstick weight and average visceral organs than their female counterparts because they have higher average daily feed intake. Marcu et al. (2013) observed and stated that strain has significant effects on carcass overall characteristics such as dressed weight, breast, drumstick, thigh, back and shank weights and edible giblet weights. Likewise, Pripwai et al. (2014) observed that sex influenced dressed weight, thigh's meat to bone ratio and wing weight. However, Udeh et al. (2015) and Castellini and Mugnai (2014) reported that there was no significant difference among the carcass yields of Ross, Arbor Acres and Marshall strains and sexes of broilers.

Shim et al. (2012) reported statistical differences in genotype by sex interaction effects on average daily weight gain, average daily feed intake, and feed utilization efficiency. In addition, they observed that genotype differences in growth rate and mortality increased with age. It was also reported that sex and genotype affect the carcass yields such as drumstick, wing, back, thigh and breast weight of Ross, Marshall and Arbor strains of broilers (Olawumi et al. 2012; Udeh et al. 2015).

It is generally acknowledged that nutrition, breed, oldness, and sex are major factors that influence carcass and meat quality of broiler chickens (Puchała et al. 2015; Uhlíová et al. 2018). Subsequently, these may affect parameters such as cooking losses, meat colour and shear force that relate to sensory evaluation. Consumer acceptability depends greatly on these parameters as they are indicators of the quality of the meat (Saláková et al. 2009).

In other to optimize their profit, broiler producers usually consider broiler strains and sex that mature early (Shim et al. 2012). Therefore, there is need to evaluate and have correct knowledge of growth performance, carcass characteristics, meat quality and best weight to slaughter for different strains and sexes to help breeders, farmers and processors in making a decision for the benefits of their business. And because this information about Aboaca, Anak and Ross strains of broiler chickens are not available. This study aimed to compare the average daily feed intake, feed conversion efficiency and average daily weight gain of Ross, Aboaca and Anak strains, genders, and to determine the carcass characteristics, primal cuts with meat quality of the same strains of broiler for males and females slaughtered at four different weights.

2 Materials and methods

2.1 Ethical statement and experimental site

The experiment was conducted in compliance with the international standard and ethical rules in the use of animals for experimental purposes. The research was carried out at the Poultry Unit of Teaching and Research Farm of the University of Ibadan, Ibadan, Oyo State, Nigeria. Ibadan lies on the latitude 7°23′28.19″N and longitude 3°54′59.99″E of the equator. The altitude is 227 m above sea level and mean temperature is approximately 28.6°C while the annual mean rainfall is 1,341 mm.

2.2 Management of birds

Three commercial strains vent-sexed day-old broiler chickens of both male and female (Ross, Aboaca and Anak) were purchased from Agricted Hatchery Farms, Ibadan. One hundred and fifty-day-old broiler chicks, 50 broiler chicks per strain and 25 chicks per sex were used during a 9-week feeding trial. The broiler chicks were distributed randomly in a 3 × 2 × 4 factorial experimental, with five replications of 10 chicks per replicate (five for each sex). The brooding room that is completely enclosed has been previously fumigated with formalin and potassium permanganate with 2:1 ratio, and provided with heaters and lighting (200 Watt bulbs). The temperature of the room was monitored and regulated based on the age of the chicks, starting with 35°C at 1-day old and decreased 3°C weekly until the 5

Table 1: Experimental diet composition and its proximate analysis (%)

Ingredient	Starter diet	Finisher diet
Yellow maize	53.5	50
Soya meal	24	21
Fish meal (72%)	5	3
Bone meal	3	3
Oyster shell	3	5
Salt	0.3	0.3
Broiler premix	0.5	0.5
Palm oil	2	5
Wheat offal	8.5	12
Total	100	100
Calculated nutrient composition		
Crude protein (CP)	21.5	20
Metabolizable energy (ME, kcal/kg)	3,001	3,100

weeks end of brooding period then adjusted at 21°C in the growing period that started from 6 weeks till the end of the study. The photoperiods were 23L:1D in the first week and 20L:4D for 5 weeks, and then 24L:0D for the rest of the experiment. Chicks were classified into three strains (Ross, Aboaca and Anak), sex (male or female) and four slaughter weights (1,000, 1,500, 2,000, and 2,500 g). Medication was administered as and when due. Throughout the feeding trial, all the birds have unrestricted access to feeds and water. The two types of feeds given to the birds are starter broiler's mash (1–4 weeks) containing 3,001 kcal/kg/ME, 21.5% CP and finisher broiler's mash (5–9 weeks) containing 3,100 kcal/kg/ME, 20% CP (Table 1).

At the end of the feeding trial, data were obtained on growth performance which include average feed intake, average final body weight and feed conversion ratio. Bodyweight and feed intake data were recorded weekly till the end of the study using a sensitive digital weighing scale (LCD Display Scale/Herf digital UK). Feed intake was calculated as the difference between feed given and feed not consumed. Final body weight was calculated as the maximum weight attained by the animals before slaughter. Feed conversion ratio was calculated as grams feed consumed divided by body weight.

2.3 Slaughter and measurement

Birds were slaughtered and processed at different slaughtering weight (1,000, 1,500, 2,000 and 2,500 g) at different time as soon as they reach the pre-determined slaughter weight between 6 and 9 weeks. At each point, each slaughter weight was selected across breeds at the same time to determine breed effect on slaughter weight. Eight birds per strain (four birds from each sex) for each slaughtering weight. Birds were selected from each strain and sex based on the stipulated slaughter weight and fasted for 12 h, but water was offered. The individual weight of the birds was obtained and recorded just before killing by cervical dislodgment after electrical stunning at 70 V. They were allowed to bleed for 5 min, then put in pre-heated water and were plucked, scalded and washed. Evisceration and the cutting of the carcass into different parts were done manually. Weight of various parts was taken using a sensitive scale (Camry electronic scale, made in USA). The carcass yield was expressed as a percentage of the eviscerated carcass in the live weight. Thermal shortening, water holding capacity, cooking loss, and shear force values were determined using the breast meat, and drumstick meat (right side) was used to determine shear force, cold and thermal shortening, cooking loss, and water holding capacity, whereas sensory characteristics were determined using only the breast meat (left side).

2.4 Shear force

The shear force values were determined using Warner-Bratzler attached to an Instron universal testing machine (Instron Corporation, Canton, MA, USA), with the following operating parameters: load cell, 50 kg, cross-head speed, 200 mm/min. About 1.27 cm diameter from each steak was removed and used for this experiment. The core perpendicular to the muscle fibre, across the middle, of each core sample was sheared once. The shear force value was thereafter calculated as the average of the maximum forces needed for each set of core samples to be sheared.

2.5 Water holding capacity

A fresh sample of breast meat of about 300 mg was put on a filter-press machine and then compressed for 3 min. This was done in duplicates. The water holding capacity was determined by the standard formula described by Hamm (1975) which entails using the ratio of the duplicated samples of the meat film area to the total area.

2.6 Cooking loss

Steaks broiler meat of 1.5 cm thick of about 30 g of weight was cut and put in a polyethylene bay at 24 h post-mortem. This was boiled in a water bath at 80°C temperature for 30 min and then cooled at room temperature for 30 min. Cooking loss percentage was determined using the formula described by Mahendraker et al. (1988).

2.7 Cold shortening and thermal shortening

A rectangular portion of meat from the right drumstick and breast meat from every slaughtered bird were carefully cut out, length and breadth measured, labelled and put in a refrigerator at 4°C for 5 h in a flat tray to determine the cold shortening. Thermal shortening was put in the oven at 1,000°C for 10 min as reported by Awonrin and Ayoade (1992).

2.8 Sensory evaluation

Sensory characteristics were determined by putting breast meats of about 2 × 3 × 1.5 cm in size on a polyethylene bags and then cooked at 80°C temperature in a water bath for 30 min. These cooked meat samples were then put on labelled white dishes. This was then served with drinking water to a 16-man panel consisting of both sexes with an age range between 21 and 35 years. Sensory characteristics that including Aroma, flavour, tenderness, juiciness, and overall acceptability, which consumer gives preference to were scored by the panel. A 9-point scale ranging from 1 = extremely undesirable to 9 = extremely desirable was used to evaluate the consumer preference score.

2.9 Statistical analysis

All data were analyzed using SAS (2007) and the effect of strain (Aboaca, Ross and Anak) and sex (male and female) on broiler performance, meat yield and quality (thigh and breast muscle) was analyzed by PROC GLM procedure of SAS. In addition, the effect of strain (Aboaca, Ross and Anak), sex and weight at slaughter (1,000, 1,500, 2,000 and 2,500 g) on meat type, carcass characteristics, and sensory attributes were also analyses using the same statistical method. Fishers' least significance difference was used to determine significant differences for all parameters with $p < 0.05$ as a significant level.

3 Results and discussion

The strain with sex and their interaction effects on growth performance traits of these experimental broiler chicks are depicted in Table 2. There was a significant difference in feed intake and final body weight among the strains ($P < 0.05$). Regardless of sex, the Ross strain had the highest feed intake (4883.25 g) and final body weight (2440.25 g) compared with the Aboaca and Anak strains. This result indicates that genetic differences exist within the strains, with Ross chicken having greater growth potential than other strains. Benyi et al. (2015) reported similar observations and stated that Ross strain had higher average daily feed intake and average daily weight gain than Cobb strains. In contrast, Ojedapo et al. (2008) found that Ross strain had lower feed intake and body weight gain compared with the Anak strain. It has previously been reported that broiler chickens that provide higher potentials for weight gain will consume more feed than others due to their higher nutritional requirements to express their genetic potential (Cruz et al. 2018). Sex effects for the entire growth traits were statistically different ($P < 0.01$). Female broilers had

Table 2: Strain × sex effect on growth performance indicators of broiler chickens

Parameter	Initial weight (g)	Feed intake (g)	Final body weight (g)	Feed conversion ratio
Strain				
Ross	46.13^{a}	4883.25^{a}	2440.25^{a}	2.00
Aboaca	46.13^{a}	4862.58^{b}	2437.50^{b}	1.99
Anak	45.00^{b}	4842.83^{c}	2410.25^{c}	2.01
Sex				
Female	45.83^{a}	4864.83^{a}	2431.66^{a}	2.00
Male	45.66^{a}	4860.94^{b}	2427.00^{b}	2.00
SEM	0.36	1.11	0.28	0.01
P-value				
Strains	0.01	<0.001	<0.001	0.56
Sex	0.58	0.005	<0.001	0.21
Strain × Sex	0.92	0.27	<0.001	0.02

Means of the same parameter in the same column with different superscripts are significantly ($P < 0.05$) different.

Table 3: Strain, sex and slaughter weight effect on carcass characteristic of three commercial broiler chickens

Parameters (g)	Killing out weight	Dressed weight	Wing weight	Drumstick weight	Back weight	Thigh weight	Breast weight
Strains							
Ross	1591.20^{c}	992.50^{c}	143.53^{c}	159.43^{c}	257.95^{c}	189.04^{c}	241.72^{c}
Aboaca	1665.37^{a}	1084.72^{a}	155.22^{a}	182.16^{a}	263.91^{b}	198.19^{a}	280.74^{a}
Anak	1627.79^{b}	1065.83^{b}	152.59^{b}	171.23^{b}	292.37^{a}	195.53^{b}	257.66^{b}
Sex							
Female	1628.05^{a}	1054.78^{a}	150.60^{a}	167.52^{b}	276.94^{a}	197.03^{a}	259.54^{a}
Male	1628.19^{a}	1040.58^{b}	150.29^{a}	174.36^{a}	265.87^{b}	191.47^{b}	260.53^{a}
Slaughter weight							
1,000	918.66^{d}	490.50^{d}	69.07^{d}	72.02^{d}	133.54^{d}	88.72^{d}	121.28^{d}
1,500	1351.61^{c}	750.83^{c}	118.77^{c}	128.45^{c}	190.49^{c}	137.99^{c}	174.94^{c}
2,000	1816.33^{b}	1227.05^{b}	168.00^{b}	210.25^{b}	338.66^{b}	228.63^{b}	285.22^{b}
2,500	2425.88^{a}	1722.35^{a}	245.94^{a}	273.05^{a}	422.94^{a}	321.66^{a}	458.72^{a}
SEM	4.44	4.03	0.96	1.15	1.03	1.17	6.95
P-value							
Strains	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Sex	0.939	<0.001	0.437	<0.001	<0.001	<0.001	0.726
Slaughter weight	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Strains × sex	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Strains × slaughter weight	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.003
Slaughter weight × sex	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Strains × slaughter weight × sex	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001

Means with different superscripts within a column are significantly ($p < 0.05$) different.

higher average body weight and higher average daily feed intake than the males ($P < 0.05$). This difference could be attributed to the impact of growth hormone causing growth and fatness in female chicken than in male (Sakomura et al. 2005). However, this result is not in agreement with the reports of Ojedapo et al. (2008), López et al. (2011) and Benyi et al. (2015). They all reported that male broilers had heavier live weight and feed intake than the females. Different authors have reported that chicken growth performance is mainly determined by gender, genotype and weight at slaughter (Le Bihan-Duval et al. 1998; López et al. 2011). Meanwhile, growth performance across the treatments shows that strains, sex, and their interaction had no significant effect on the feed conversion ratio.

Significant differences were observed in carcass yields across strains, sex with weight at slaughter ($P < 0.05$; Tables 3 and 4). Within the strains, Aboaca birds had the highest dressed weight (1084.72 g) and breast weight (280.74 g) compared to Anak and Ross strains. This is unanticipated, as one expects Ross birds that had the highest body weight (Table 2) should yield highest live and dressing weight. This indicates that Aboaca birds had higher carcass yield and lower visceral weights compared with Ross and Anak chicken. The results obtained from this research work corroborates the findings of Olawumi and Fagbuaro (2011), Fernandes et al. (2013) and Musa et al. (2006). They all reported significant genotype differences in carcass yield and growth performance of broiler chickens. Regarding sex, male broilers had lower carcass weight than female broilers. As expected, broiler chickens with higher growth potentials (i.e., higher live weight) will present a higher meat production capacity (carcass yield) (Cruz et al. 2018). The outcome of this study confirmed the reports of Ojedapo et al. (2008) who stated that male broilers of Wadi Ross and Ross strains had lower dressed weight than their respective females.

On the contrary, the female broilers chicken had higher weight ($P < 0.05$) for back and thigh than the male broilers. However, female broilers chicken had lower weight for breast meat, drumstick and wing weight than the male broiler. The outcome of this trial aligned with the observation of Ojedapo et al. (2008) who reported that sexes significantly influenced the carcass characteristic of broiler chicken with males having smaller back weight but greater drumstick weight. Olawumi and Fagbuaro (2011) also found that breast

Table 4: Strain and slaughter weight effect on carcass characteristic of three commercial broiler chickens

Parameters (g)								
Strain	**Slaughter weight**	**Killing out weight**	**Dressed weight**	**Wing weight**	**Drumstick weight**	**Back weight**	**Thigh weight**	**Breast weight**
Ross	1,000	906.50^{c}	496.80^{b}	73.28^{a}	75.39^{da}	134.30^{b}	85.33^{b}	127.23^{a}
Aboaca		930.67^{a}	484.33^{a}	65.06^{c}	67.26^{b}	126.56^{c}	93.19a	113.8^{b}
Anak		918.83^{b}	490.50^{b}	68.87^{b}	73.41^{a}	139.76^{a}	87.65^{b}	122.73^{a}
Ross	1,500	1285.00^{c}	664.67^{c}	105.17^{b}	115.67^{c}	175.16^{c}	123.00^{c}	148.17^{c}
Aboaca		1404.16^{a}	807.50^{a}	125.83^{a}	142.17^{a}	190.08^{b}	149.83^{a}	199.58^{a}
Anak		1365.66^{b}	780.33^{b}	125.34^{a}	127.53^{b}	206.23^{a}	141.15^{b}	177.07^{b}
Ross	2,000	1765.00^{c}	1173.83^{b}	154.00^{c}	193.50^{b}	339.66^{b}	217.50^{b}	264.50^{b}
Aboaca		1883.33^{a}	1260.33^{a}	178.83^{a}	238.58^{a}	300.33^{c}	237.41^{a}	305.67^{a}
Anak		1800.66^{b}	1247.00^{a}	171.16^{b}	198.50^{b}	376.00^{a}	231.00^{a}	285.50^{b}
Ross	2,500	2408.33^{c}	1634.83^{c}	241.67^{b}	253.17^{b}	382.67^{c}	330.33^{a}	427.00^{c}
Aboaca		2443.33^{a}	1786.73^{a}	251.16^{a}	280.67^{a}	438.67^{b}	312.33^{b}	503.83^{a}
Anak		2426.00^{b}	1745.50^{b}	245.00^{b}	285.33^{a}	447.50^{a}	322.33^{a}	445.33^{b}
SEM		3.14	2.85	0.68	0.81	0.73	0.82	4.94
P-value								
Strains		<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Slaughter weight		<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001

Means with different superscripts within a column are significantly ($p < 0.05$) different.

meat weight, drumstick weight and wing weight are higher in male than in female broilers. In contrast, Cruz et al. (2018) found that male broiler chickens had lower average breast weight but higher leg weight than female broilers. The Aboaca strain showed the highest weight ($P < 0.01$) for breast, drumstick, thigh, back and wing compared with Ross or Anak strains. A similar result was reported by Olawumi and Fagbuaro (2011) in their study who found that Marshall strain of broiler recorded superior weight in breast, wing, drumstick, back and thigh than their counterparts, Arbour Acres and Hubbard broiler strains.

The carcass yield in respective of the strain or sex was significantly ($P < 0.01$) influenced by slaughter weight as shown in Tables 3 and 4. As expected, broilers slaughtered at 2,500 g had highest weight for breast, drumstick, wing, thigh and back meat compared with those slaughtered at 1,000, 1,500 and 2,000 g slaughtered weights ($P < 0.01$). This agreed with the reports of Uhlíová et al. (2018) who observed that broiler chicken slaughtered at 16 weeks had higher dressed weight and carcass yield than those slaughtered at 8 weeks of age. Fernandes et al. (2013) also observed in their study that birds slaughtered at age 43, 45 and 46 days produced lower carcass yields than those slaughtered at the age of 49 days.

All the strains showed substantial ($P < 0.05$) interaction effect among the strains, slaughtering weight and sex ($p < 0.001$), strains and sex, strains and slaughtering weight, sex, and slaughtering ($p < 0.001$) in dressed weight and carcass yields. The results obtained show that most carcass quality is strain, sex and slaughter weight dependent. This depicts the importance of strains, sex, and weight at slaughter in terms of the performance of the broiler during the assessment. This result is in line with the finding of Olawumi et al. (2012) who observed significant interaction ($p < 0.05$) among the strains and sexes on carcass traits of broiler at 8 weeks. Nevertheless, there was no strain and sex interaction consequence on carcass yields as reported by Ojedapo et al. (2008). However, this study seems to be the first to determine interaction among strains, sex, and weight at slaughter.

For meat quality parameters, the strain showed a great influence ($p < 0.05$, Tables 5 and 6) for cooking loss, water holding capacity and thermal shortening but no substantial effect in tenderness ($p > 0.05$). The result obtained in this study did not agree with the report of Musa et al. (2006) who observed statistical strains effect on tenderness but no significant strain effect on cooking loss of broiler breast meat. However, meat from Ross had the highest cooking loss value (31.21), followed by Anak (30.93) and least in Aboaca (27.49). The amount of water retained in meat after cooking has been reported to influence the juiciness, palatability and saleable weight of the products (Strydom et al. 2016). Water is usually

Table 5: Strain, sex and slaughter weight effect on meat quality indicators of three commercial broiler chickens

Parameter	Cooking loss (%)	Tenderness	Water holding capacity	Thermal shortening
Strains				
Ross	31.21^{a}	1.57^{a}	55.67^{a}	2.17^{a}
Aboaca	27.49^{b}	1.78^{a}	53.18^{b}	1.65^{c}
Anak	30.93^{a}	1.65^{a}	53.00^{b}	1.80^{b}
Sex				
Female	30.02^{a}	1.61^{a}	57.20^{a}	1.84^{a}
Male	29.73^{a}	1.72^{a}	50.70^{b}	1.91^{a}
Slaughter weight				
1,000 g	35.96^{a}	0.80^{d}	35.75^{d}	2.44^{a}
1,500 g	25.82^{c}	1.22^{c}	49.71^{c}	2.21^{b}
2,000 g	30.14^{b}	1.94^{b}	63.27^{b}	1.76^{c}
2,500 g	27.57^{b}	2.70^{a}	67.07^{a}	1.09^{d}
Meat types				
Breast muscle	29.83^{a}	1.87^{a}	–	1.85^{a}
Drum stick	29.91^{a}	1.46^{b}	–	1.90^{a}
SEM	3.54	0.23	0.98	0.34
P-value				
Strains	0.0074	0.077	<0.001	<0.001
Sex	0.786	0.135	<0.001	0.163
Slaughter weight	<0.001	<0.001	<0.001	<0.001
Meat type	0.941	<0.001	–	0.337
Strains × sex	0.819	0.176	0.388	<0.001
Strains × slaughter weight	0.398	0.079	<0.001	0.007
Sex × slaughter weight	0.008	0.010	–	0.235
Strains × meat type	0.157	0.742	–	<0.001
Sex × meat type	0.326	0.248	–	0.689
Slaughter weight × meat type	0.122	<0.001		<0.001
Strains × sex × slaughter weight	–	–	<0.001	–
Strains × sex × slaughter weight × meat type	0.053	<0.001	–	<0.001
SEM	3.54	0.23	0.98	0.34

Means with different superscripts within a column are significantly ($p < 0.05$) different.

lost in meat during cooking through evaporation and drip loss (Strydom et al. 2016). This result suggests that meat from Aboaca chicken would be more juicy, tender and palatable than other strains due to decrease in water loss after cooking. The difference in water holding capacity within the strains, with Ross birds having the highest value has been attributed to differences in genotype and muscle fibre sizes (Jaturasitha et al. 2008). However, sex effect on traits related to the quality of meat was not significant except in water holding capacity. This is in contrast with the findings of Abdullah and Matarneh (2010) who reported statistical sex effect on cooking loss ($P < 0.05$) and insignificant sex consequence on water holding capacity ($P > 0.05$). Similarly, López et al. (2011) reported no significant effects of strains, sex and their interaction on water holding capacity, shear force value, and cooking loss of broiler breast meat slaughtered at the age of 6 weeks. However, the finding reported that shear force value was higher ($P < 0.001$) in breast meat than in thigh meat. Tenderness, according to Ismail and Joo (2017) is largely influenced by the content and structure of muscle fibre, the quantity and strength of connective tissue and the extent of proteolysis in rigor muscles. Broiler breast muscle is known to possess more fibre size than thigh muscle (Koomkrong et al. 2015). The outcome of this study aligned with the observation of Smith et al. (2012) who reported that breast muscle had higher shear force value that thigh muscle. Furthermore, weight at slaughter has significant consequences ($p < 0.001$) on all the meat quality indicators considered in this trial. The water holding capacity and the shear force values progressively increase as weight at slaughter increases while the cooking loss and thermal shortening decrease. This result is in line with the report of Uhlíová et al. (2018) who observed that the shear force values go higher as the age of slaughtering of the birds increases while the cooking loss decreases. The sensory

Table 6: Strain and slaughter weight effect on carcass characteristic of three commercial broiler chickens

Parameters (g)					
Strain slaughter weight		**Cooking loss (%)**	**Tenderness**	**Water holding capacity**	**Thermal shortening**
Ross	1,000	36.74	0.81	35.83	4.23
Aboaca		36.35	0.77	35.33	3.34
Anak		34.79	0.82	36.88	3.62
Ross	1,500	28.20	1.34	49.90	6.12
Aboaca		27.96	1.19	54.07	4.49
Anak		24.30	1.14	45.16	4.53
Ross	2,000	30.86	1.94	61.37	6.59
Aboaca		31.98	1.85	64.48	5.59
Anak		27.59	2.04	63.95	6.59
Ross	2,500	27.90	2.51	64.89	3.29
Aboaca		31.54	2.47	68.81	3.18
Anak		23.26	3.13	67.51	3.33
SEM		1.06	0.07	0.49	0.17
P-value					
Strains		0.001	0.07	<0.001	<0.001
Slaughter weight		<0.001	<0.001	<0.001	<0.001

Means with different superscripts within a column are significantly ($p < 0.05$) different.

Table 7: Strain, sex and slaughter weight effect on the sensory evaluation of three commercial broiler chickens

Parameter	Aroma	Flavour	Tenderness	Juiciness	Texture	Overall
Strains						
Ross	5.63	5.50	6.68	6.52	6.43	7.02
Aboaca	5.63	5.29	6.58	6.63	6.63	6.93
Anak	5.92	5.69	6.87	6.69	6.56	7.09
Sex						
Female	5.81	5.54	6.82	6.70	6.50	7.09
Male	5.64	5.44	6.60	6.53	6.58	6.94
Slaughter weight						
1,000 g	6.08	5.68	7.55	6.61	6.62	7.11
1,500 g	5.55	5.51	6.87	6.55	6.64	7.07
2,000g	5.61	5.25	6.44	6.57	6.37	6.85
2,500 g	5.66	5.52	5.98	6.74	6.53	7.03
SEM	0.27	0.25	0.23	0.21	0.22	0.20
P-value						
Strains	0.24	0.08	0.199	0.53	0.41	0.52
Sex	0.28	0.48	0.10	0.17	0.56	0.21
Slaughter weight	0.08	0.23	<0.001	0.71	0.41	0.42
Strains × sex	0.67	0.74	0.16	0.01	0.002	0.01
Strains × slaughter weight	0.31	0.40	0.10	0.15	0.29	0.02
Sex × slaughter weight	0.61	0.755	0.79	0.66	0.83	0.71
Strains × sex × slaughter weight	0.76	0.52	0.78	0.26	0.63	0.27

Means with different superscripts within a column are significantly ($p < 0.05$) different.

characteristics of the broiler meat used in this study are shown in Table 7. Sensory analysis is a useful instrument for the assessment of meat quality and meat products. In terms of evaluation, the aroma, flavor, juiciness, texture and overall acceptance of the broiler meat were not significantly influenced by strains, sex, weight at slaughter and their interaction ($p > 0.05$). This result corroborates the finding of Smith et al. (2012) who reported no significant difference in sensory attributes of broiler breast muscle. However, weight at slaughter significantly influenced the tenderness of the breast muscle. As expected, animals slaughtered at higher weight presented tougher meat than those slaughtered at lower weight. Several reports have shown that the meat tenderness normally decreases with animal age (Shorthose and Harris 1990).

4 Conclusions

Findings from this study revealed that strain and sex have significant influence on body weight of broiler chicken. Regardless of slaughter weight, the Aboaca strain presented the highest carcass yield and better meat quality than other strains. More so, female broiler chicken revealed higher body weight, carcass characteristic and better meat quality compared to the male broiler chicken. However, strain and sex have no significant effect on the sensory attributes of broiler meat. We therefore recommend that farmers should consider using Aboaca strain for high carcass yield during processing. Also, broiler chicken should not be considered for slaughter at any weight less than 2,000 g for optimal yield. Aboaca strain was higher in average body weight at 9 weeks when compared to Ross or Anak strain.

Acknowledgments: The authors are grateful to the South Africa Medical Research Council for their financial support towards this publication.

Conflict of interest: The authors declare that there is no conflict of interest in the submission of this manuscript.

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