EFFECT OF STRAIN AND SEX ON PERFORMANCE AND CARCASS CHARACTERISTICS OF BROILER CHICKENS REARED UNDER TEMPERATURE AND HUMIDITY STRESS

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ABSTRACT
Research was conducted to compare the improvement in carcass traits and performance of male and female Abor acre ++, Ross 308, Cobb 500, Marshall and Hubbard stains of broiler chickens, reared under temperature and humidity stress. The birds were 150, obtained from a commercial farm at day old. The environment temperatures and relative humidity were recorded daily to evaluate the thermal comfort weekly. The results indicated that the mean temperature at maximum was recorded in the second week which was above the universally acceptable comfort temperature of 26 °C for the strains of broilers at age of 2-3 weeks. The trend of WG at 1-7 weeks, Hubbard strain recorded the highest live weight (LW) and weight gain (WG) at 1 – 7weeks of age. The best feed conversion ratio (FCR) was obtained within 1 – 7 weeks of age among the Hubbard strain. Males and females of Hubbard strain had the highest carcass weight (1.81g), breast yield (BY), carcass yield (CY), drumstick yield (DY) and thigh yield (TY) at 6 weeks. Strains and sex results varied intermittently. Hubbard strain under hotter environmental conditions performed better at 6 weeks. Males performed better than females. Hubbard and Arbor acres++ are recommended because they attained maturity weight of 2kg at 6 weeks.
Keywords: Heat stress, broilers, strains, sex, performance

INTRODUCTION
Birds are mostly subjected to heat stress when the air temperature and the humidity uncontrollably increase their core body temperature. Most at times as the temperature increase towards 29.44^{0}C or 85^{0}F, the birds will try to lose heat through evaporative cooling and panting. Panting adds more heat through muscle activities. Therefore, the birds will increase its water intake, which may not always be enough to keep up with the losses through respiration and urination. When not relieved, the changes will worsen, and the bird may suddenly die.

Heat stress results in estimated total annual economic loss to the U.S. livestock production industry of $1.69 to $2.36 billion; from this total, $128 to $165 million occurs in the poultry industry (St- Pierre *et al.*, 2003). In a recent study, Sohail *et al.* (2012) reported that broilers subjected to chronic heat stress had significantly reduced feed intake (16.4%), lower body weight (32.6%), and higher feed conversion ratio (+25.6%) at 6 weeks of age. Report also indicated that heat stress has drastic effect on performance of broiler chickens. Similarly, chronic heat exposure negatively affects fat deposition and meat quality in broilers, in a breed dependent manner (Lu *et al.,* 2007). A recent study by Zhang *et al.* (2012) demonstrated that chronic heat stress decreased the proportion of breast muscle, while increasing the proportion of thigh muscle in broilers. The most important economic production performance characteristics of broiler chickens are body weight (BW), feed intake (FI) and feed conversion ratio (FCR). Nowadays, the broiler industry is focusing on raising birds based on carcass characteristics (Ajayi and Ejiofor, 2009).

In Nigeria, most of the broiler chicken strains are imported and sex and strain of broiler chickens have influence on performance (Sudik *et al*., 2020). The available local broiler chicken strains may perform better because of their adaptability features to withstand heat stress within Nigeria but are often neglected. There are numerous strains of broiler worldwide, strains are used by farmers depending on availability within that locality or country. Arbor Acres, Ross, Hubbard, Anak and Cobb are commonly used for commercial production in many countries all-over the world.
Several reports indicate that genotype affects BW, FI, and FCR of broiler chickens **(**Udeh *et al.*, 2015; Taha *et al.*, 2011). However, Abdulla, *et al.* (2010) reported insignificant strain differences in BW and FCR. Another stated that strain has significant effect on carcass characteristics (Marcu *et al.,* 2013). On the other hand, Udeh *et al.* (2015) found no difference in the yield of carcass or cuts among Ross, Arbor Acres, and Marshall Strains. Reports also indicated that sex affects the performance traits of chickens (Olawumi, *et al.*, 2012; Shim *et al.*, 2012). There was no difference in FCR of the strains of broiler chckens **(**Udeh *et al.,* 2015). Sex also

significantly affected carcass traits (Marcu *et al.*, 2013; Kareem, *et al.,* 2016; Abdulla, *et al.,* 2010).
Several studies have reported the interactions between species and sex on the body weight, feed intake and feed conversion ratio. Olawumi *et al.* (2012) reported that there was an interaction effect between strains and sex on back length and weight of breast, thigh, drumstick, wing and leg. Ojelapo *et al.* (2008) reported insignificant interaction effects between strain and sex on shank, thigh and drumstick weights. Udeh, *et al.* (2015) reported that there was no significant difference among the carcass yields of Ross, Abor acres and Marshall strains and sexes of broilers and products quality such as colour, pH, driploss, cooking loss and shear value that plays a role in consumer acceptability. A lot of factors can influence broiler meat quality including sex and strain (Nogueira *et al.,* 2019).

In Nigeria, most commercial and local broiler farms keep different strain under different environmental conditions. Therefore, for the farmers to achieve better performance, it is necessary to meet the requirement of the animals, especially favorable environmental condition adequately created to suit the birds. Also, very limited climatic factors are taken into consideration in the production of broiler chickens. The climate of Nigeria is characterized by high ambient temperatures and relative humidity, it is therefore imperative to modify the environment of the broilers to minimize the negative effects of heat stress and decrease the thermal stress that can be detrimental to the existence of the birds (Musa *et al.,* 2006).

Studies have described the performance and carcass traits of modern broiler strains maintained within their thermal comfort zones, but there is a dearth of information on broiler chicken performance under different climatic conditions. This study determined the effect of heat on the production performance and meat quality of Abor acres++, Ross 308, Cobb 500, Marshall, Hubbard strains of broiler chickens.

MATERIALS AND METHODS

The study area was the Federal College of Frestry Jos, Plateau state, Nigeria. It is located on latitude and longitude 9.8965° N, 8.8583° E and has average temperatures range from 15.5 °C to 18.5 °C in the coolest months to 27.5 °C to 30.5 °C during the hottest months which usually occur in the dry season and humidity of 26 to 46% in months of February to April. Rainfall ranges from 2,000 mm per year in the southwest to 1,500 mm or less in the drier northeast. Rainfall for the town of Jos averages 1,411 mm per year (Plateau State ICT Development Agency ©, 2021.www.plateaustate.gov.ng). The research was conducted between March to April.

A total of 150 broilers (5 strains of 50 birds each) were selected from a flock of Abor acres++, Ross 308, Cobb 500, Marshall, Hubbard which were brought same time at day old. The 5 strains broilers were weighed and distributed into 5 partition room in a deep litter. Wood shaving was used to cover the floor, water and feed was provided *ad-libitum*. 50-watt bulbs were provided to heat and keep the place warm while yellow side curtains were used to help in control of the ambient temperature. The maximum and minimum of both environmental temperature and relative humidity were recorded every day by using a thermo-hygrometer.The thermal zone of comfort was determined weekly using the following interval:

H=
6,7+0.243*Tbs+(UR/100*10^7.5*Tbs/237.3+Tbs)

Where: H is the enthalpy (kcal/kg of dry air), Tbs is dry bulb temperature (^{0}C), UR is the relative humidity of the air (%). The result was multiplied by 4.18 for the unit of measurement (kj). The enthalpy values are divided into four bands represented by four colours: Comfort (green), alert (yellow), critical (orange) and lethal (red). As enthalpy tables were used for data until the sixth week for the evaluation of the thermal comfort in the seventh week, data for enthalpy in the sixth week were used as a reference.

There was 23 hour natural and artificial light regime from day 8 to 42. At day 7 there was 20 hour natural and artificial light from 8 to 42, then it was increased to 22hour for natural and artificial light hence-forward.
The birds were feed in two phases according to their age: 1 to 4 and 5 to 7 weeks (table 1). At 2, 3, 4, 5, 6, 7, 8 and 9 weeks of age, all the left-over feed from the birds were weighed. Each of the groups were individually weighed to determine the improvement of traits. The variables were used to determine the increases in body weight (WG), feed intake (FI), feed conversion (FC) and live-body weight (LW). Daily mortalities were recorded, and average feed intake and feed conversion were determined (Pascalau, *et al.,* 2017). At week 6 and 7, 4 birds from each strain (2 females and 2 males each) were deprived of feed for at least 6 hours before slaughtering to determine eviscerated carcass weight (CW), carcass yield (CY), breast yield (BY), thigh yield (TY) and drumstick yield (DY). CY was calculated based on the relationship between CW (without feathers, viscera, feet, head and neck) and LW. The cut parts yield was calculated based on the ratio between the cut parts weight and CW.

The improvement obtained from data for carcass traits of the experimental birds were subjected to SAS 9.0 software (SAS Institute, 2002), through the

General linear model (GLM) procedure of Analysis of Variance (ANOVA) according to the statistical model:

$Yij_{(k)}$=μ+ Straini + Sexj + Strain × Sexij + ϵij(k)

Where, $Y_{ij(k)}$= FI, WG, FC, LW, CW, CY, BY, TY and DY of birds of the i-th lineage in the jth sex; μ= overall mean effect; Strain= i-th effect; Sexj=j^{th} sex effect, strain x sexkj=interaction effect between i^{th} strain and j^{th} sex and eij(k)= experimental error. Variable means showing significant differences in the ANOVA which were calculated were separated using Tukey's multiple comparison test option of SAS (SAS Institute, 2001). All statements of significance are based on the probability level of 0.05 unless otherwise indicated.

RESULTS AND DISCUSSION

The result of the experiment on average of the mean, minimum and maximum temperatures and the average relative humidity were shown in table 2. The mean and maximum temperatures recorded from the second week of the life on the birds were above the recommended comfort temperatures of the strains. According to Abdulla *et al.*, (2010) the comfort temperature of broilers aged 2-3 weeks should be averagely 26 °C.

The minimum periods for the experimental days were observed at about 5:00 and the duration of the mild temperature over a 24hour period was shorter. The thermal comfort index enthalpy indicated that the birds were only in thermal comfort zone in the second week of their life (green band), and the lower and upper alert range (yellow) in the first and third week, respectively. After the 3^{rd} week, the birds were in a very critical environment (orange band), which possibly influenced their performance.

Feed consumption, weight gain, live weight, and feed conversion of different strains of males and females at 1 week of age were shown in table 3. The pre-initial period result indicated that there were interactions ($p < 0.05$) for feed consumption (FI) between male and female strains except in males of Ross 308 and Marshall indicating that they are the only one that act independently. There was also interaction between sexes of Ross 308 only.

Hubbard strains showed a superior WG to that of Abhor acre++, Ross 308, Marshal and Cobb. The effect of the strains on the WG of the birds at 1 week was as stated by Abdulla *et al* (2010), who verified that the Hubbard classic strain presented superior WG in relation to Abbor acres++, Ross 308, Cobb 500 and Marshall. Weight gain (WG) for strains and sexes interacted ($p < 0.05$) significantly, therefore in terms of Weight gain they factors act dependently.

There were no significant ($p>0.05$) effects of strain on FC observed in spite the fact that there was differences found between FI and strains which shows that the pre-initial period Abhor acre++, Ross 308, Cobb 500, Marshal and Hubbard birds gained more weight with similar efficiencies. It was observed that males had a higher WG (2.9%) and LW (3.4%) than the females, independent of the strain, the result in this study is consistent with finding of Kadlec, *et al.* (2012) who observed that WG and LW of male broilers of Ross, Cobb, Arbor acres strains at 1 week were higher than that of the females. Yassin *et al.* (2009) stated that the main morphological and physiological changes of the digestive, immunological, and thermoregulatory systems occur in the first seven days of life of the birds, which supports the importance of this period for their development. In addition to these factors, the rapid growth of broilers reduces the time of poultry in the field, thus increasing the importance of satisfactory performance in the first week after hatching. However, each strain has a growth potential over a specific period (Goliomytis *et al.,* 2003), thus, a greater live weight or weight gain which vary from one strain to another in the pre-initial period may not translate into greater growth over the life of the birds.

There were no significant interactions ($p>0.05$) between the strain and sex observed for the growth trait variables for the period of 1-3 week (table 4), in which FI and FC were influenced by the strain. The performance of the trait variables was influenced by sex except for FC.

Abor acres++ strain had higher FI than Ross 308 while Cobb 500, Marshall and Hubbard were lowest. Abdulla *et al.* (2010) in a study conducted with four strains of broiler chickens at 2-3 weeks found that there exist differences in FI, where the FI of Ross was higher than that of Hubbard strains. The absence of the effect of the strains on WG and LW agrees with the results of Farran *et al.* (2000) who evaluated the performance of three broiler strains (Arbor acres, Lohman and Ross) at 1-3 weeks, and reported that there was no strain effect on LW.

Hubbard and Abor acres++ birds had lower FC than Ross 308. Ross, Cobb 500 and Marshall strains showed similarities. There was no significant difference in WG between the strains at 1-3 weeks, the lower FI of Hubbard than Abor acres++, Ross, Cobb 500 and Marshall strain resulted in improved FC indicating greater growth of Hubbard between 1-3 weeks.

The FI of males was higher than females, which agrees with the findings of Jawasreh *et al*. (2018), who also observed a higher FI (8.9%) of the males based on both sexes of three broiler strains.

There were no significant interactions ($p>0.05$) between strains and sex observed for any of the performance variables for 1-4 weeks (Table 5). Like the previous period (1- 3 weeks), Ross 308 birds presented the highest FI than Abor acres++, Cobb 500, Marshall and Hubbard at 0.03, 0.093, 0.097 and 0.119, respectively. However, there were differences between sexes of Cobb and Hubbard birds. The superiority of the Ross strain did extend to WG and LW, as these were like those observed in the Cobb and Hubbard strains. Despite The similarity in FI of the Cobb and Hubbard birds, the Marshall presented the highest WG with differences of 0,023, 0.044, 0,004 and LW, 0.093, 0,098,0.002, respectively than Abor acres++, Cobb500, Hubbard birds, suggesting a higher WG efficiency of Marshall after Ross 308 birds. It was observed that the FC of Ross 308 strain and sex as highest with difference of 0.019, 0.018, 0.055, 0.0.55 for Abor acres++, Cobb500, Marshall, Hubbard birds, respectively.

In table 6, FI and sex of Abor acres++ and Hubbard showed no significant ($p < 0.05$) different, while sex of Ross 308, Cobb 500 and Marshall were significantly ($p < 0.05$) different for FI. There was significant (p<0.050 difference in all the strains among males and females excerpt Abor acres++ and Ross 308. The highest FI among the strains was in Hubbard (3.367kg) and the differences between it and Abor acres++, Ross 308, Cobb 500 and Marshal were 0.153, 0.141, 0.115 and 0.024kg, respectively.

There WG showed no significant ($p>0.05$) different for sex and strains. Like in FI, the WG and LW in sexes and strains were highest in Hubbard. The results indicated that as FI is highest so also WG, LW and lower FC. Therefore, there is a positive correlation between FI and other variables (WG and LC) but lower in FC. Reduced feed consumption and decreased performance of broiler chickens exposed to heat stress has been reported (Udeh *et al.*, 2015).

The performance of the 5 strains studied at 1- 3 and 1-4 weeks suggested that birds of the Hubbard strain showed higher sensitivity to high environmental temperatures than Abor acres ++, Ross 308, Cobb 500 and Marshall birds because 1 week Hubbard birds showed higher WG and LW but in subsequent periods, the superiority of these variables was not maintained. In relation to sex, the same tendency of the previous period was also observed with males presenting higher FI, WG and LW values than the females which shows and improvement with 1.9% in FC. Males presented a higher growth and body protein deposition (Obike *et al.*, 2019), indicating a higher feed intake and lower feed conversion than the females.

The performance of traits between the sexes from 3 weeks when compared is an important tool for the poultry industry. Nowadays some markets require a differentiated product obtained by slaughtering poultry aged 5 to 6 weeks with an average slaughter weight of 1.450kg (Obike *et al.*, 2019). In this type of production where the birds are slaughtered at younger age, females are commonly used, since the abundant production of females of the advanced ages is not feasible owing to a greater deposition of body fat in relation to males and consequently a higher feed conversion. However, the use of male chickens for this type of production can be indicated for hot regions and for sheds with limited technology in ambient control, because with increased age the birds become more sensitive to high ambient temperatures, with a possible decrease in performance and increase in mortality risk, highlighting the importance of the studies that assess the effects of strains and sex under hot weather conditions.

There was interaction at 1- 7 weeks between strain and sex observed for the performance of the variables are presented in table 7). A study on the trend of WG conducted by Mehaffey *et al.* (2006) with 5 broiler strains at 1- 7 weeks of age observed similarities between the LW of 4 genetic group; Hubbard was the highest in LW than the average LW of the other strains. The best FC observed during 1-7 weeks of age was in the birds of the Hubbard line, being superior to the birds of Abor acres++, Ross, Cobb 500 and Marshall. The males presented the highest FI, WG and LW, and better FC than that of females. Marcu, *et al.* (2013**)** in a study with Cobb, Ross, and Hybro strains from 1 to 7weeks of age, also observed higher FI and WG in males than in females. Brewer *et al.* (2012), comparing the effects of four strains and sex on broiler chickens, observed that the LW of males, regardless of strains, was higher than that of females.

The Cobb FI was 5.2% and 9% lower than that in birds of the Hubbard and Ross strains, respectively, and there were no differences between them as stated by Olawumi *et al.* (2012) who studied different broiler strains (Cobb, Hubbard, Ross, Arbor and Isa) from 1 to 47 day of age and observed that Cobb birds also had a lower feed intake than Hubbard (2.1%) and Ross (0.2%) , but found out that there was no significant different between the two later strains.

Carcass weight (CW), carcass yield (CY), breast yield (BY), thigh yield (TY) and drumstick yield (DY) of different strains of males and females at 6 weeks of age is presented in table 8. The result showed that there was significant difference (p<0.05). Hubbard sexes had the highest CW (1.81g) with differences with the other strains as 0.14, 0.09, 0,23 and 0,13g for Abor acres++, Ross 308, Cobb 500 and Marshal, respectively. The Hubbard birds presented the highest carcass weight (CW), carcass yield (CY), breast yield (BY), thigh yield (TY) and drumstick yield (DY), superior to that of Abor acres++, Ross 308, Cobb 500 and Marshal strains.

Carcass weight (CW), carcass yield (CY), breast yield (BY), thigh yield (TY) and drumstick yield (DY) of different strains of males and females at 8 weeks of age is presented in table 9. The result indicated that strains and sex in variables of CW (kg), CY (%), BY (%), TY (%) and DY (%) significantly (p< 0.05) differed in almost all the variables except Hubbard sex that did not significantly (p> 0.05) differ in CW (kg), CY (%), BY (%), TY (%) and DY (%). Hubbard strain was highest in all the traits measured. These findings are the same with that of Abdullah *et al*. (2010) who evaluated the carcass traits of the Hubbard, Ross and Lohman strains at 7 weeks and found that the Hubbard line presented a CY, 10.0% higher than the Ross strain. Scheuemann *et al.* (2003) evaluated breast muscle growth in different commercial strains and observed that birds with higher BY had a longer period of muscle deposition, thus increasing the weight and yield of their muscle. The breast is considered an important cut that corresponds to the highest proportion of the broiler carcass, so that small differences in the yields of the cut can economically be of importance. Therefore, some poultry companies emphasize breast weight and yield in their breeding programmes to provide lineages that specially address the industrial segments that priories BY, emphasizing the importance of evaluating the traits in studies with broiler chickens.

CONCLUSSION

Hubbard under hotter environment had higher body weight, carcass, average daily body weight gain (ADG) and feed conversion ratio (FCR) compared to Arbor acres++, Ross 308, Cobb 500 and Marshall strains. Males had better BW, ADG, FI, FCR and carcass weights. Strain – sex interaction was observed for performance and carcass traits. At 6 weeks Hubbard and Arbor acres++ reached matured weight of 2kg.

RECOMMENDATIONS

Hubbard strain is recommended in Nigeria especially in hot environments because they performed better under heat stress and higher production performance was observed from 6 weeks. Also, rearing sex-segregated flocks could be beneficial. Small holder farmers that wish to rear broilers and to buy live weight for roasting should look for Hubbard and Arbor acres++ because they attained maturity weight of 2kg at 6 weeks.

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Table 1: Gross and nutrient composition of broiler diet (%)

Ingredients	Starter diet (0-4weeks	Finisher diet (5 – 7weeks)
Maize	58.78	66.84
Deoiled rice bran	0.00	2.10
Soyabean meal	28.21	19.66
Fish meal	6.00	6.00
Soyabean oil	4.42	3.16
Dicalcium phosphate	1.05	0.55
Limestone powder	0.90	1.05
Min. and vit mix	0.32	0.32
Salt	0.10	0/10
Lysine	0.00	0.11
Methionine	0.15	0.06
Threonine	0.00	0.05
Nutrient composition (% dry matter basis):		
ME, Kcal/kg diet	3200	32.00
Crude protein (%)	23.00	20.00
Ether extract (%)	7.17	6.18
Crude fiber (%)	2.44	2.55
Lysine (%)	1.12	1.00
Methionine (%)	0.50	0.38
Calcium (%)	1.00	0.90
Ave. phosphorus (%)	0.45	0.35

Table 2: Minimum, maximum, and mean environmental temperature (ºC) and relative humidity (%), standard deviation, and enthalpy comfort index (ECI) weekly

Period (weeks)	Temperature (ºC)			Relative humidity (%)			IEC (KJ/Kg dry air)
	Minimum	Maximum	Mean	Minimum	Maximum	Mean	
1	28.5	30.5	29.5±34	28.9	46.6	37.6±93	41.72
2	27.8	29.7	28.5±11	28.3	42.3	35.3±14	39.54
3	28.2	30.2	29.2±37	28.6	42.6	35.6±22	39.82
4	27.4	28.8	28.1±43	26.3	45.7	36.0±83	40.24
5	27.2	30.2	28.7±72	26.8	46.2	36.5±69	40.70
6	28.8	29.3	29.1±37	27.2	45.1	36.2±34	40.29
7	26.9	28.8	27.9±91	26.8	45.1	36.0±69	40.12

Table 3: Mean of feed consumption (FI), weight gain (WG), live weight (LW), and feed conversion (FC) of different strains of males and females at 1 week of age.

Variable	Sex (S)	Strains (St) Abor acres++	Ross 308	Cobb 500	Marshall	Hubbard	Pooled SEM	St	S	St x S
	Male	0.132a	0.122b	0.135a	0.121b	0.112c	0.024	0.002	<0.0001	0.61
FI (kg)	Female	0.128a	0.117c	0.129a	0.124b	0.117c				
	Mean	0.130a	0.115c	0.132a	1.223b	0.115c				
	Male	0.119b	0.109cd	0.132a	0.113bc	0.104d	0.020	0.003	<0.0001	0.32
WG (Kg)	Female	0.114b	0.105c	0.119a	0.115b	0.104c				
	Mean	0.117b	0.107c	0.121a	0.114b	0.104c				
	Male	1.160ab	1.150d	0.156ba	0.165a	0.154b	0.016	0.0005	<0.0001	0.36
LW (kg)	Female	1.152c	1.144d	0.169a	0.162b	0.153c				
	Mean	1.156b	1.147c	0.163a	0.164a	0.154b				
	Male	1.131a	1.132a	1.138a	1.131a	1.132a	0.025	0.004	0.046	0.003
FC	Female	1.111a	1.113a	1.114a	1.113a	1.114a				
	Mean	0.121a	1.123a	1.126a	1.122a	0.123a				

a-d Means within each column for strain and gender bearing different letters differ.

Table 4: Mean of feed consumption (FI), weight gain (WG), live weight (LW), and feed conversion (FC) of different strains of males and females at 1-3week of age.

Variable	Sex (S)	Strains (St) Abor acres++	Ross 308	Cobb 500	Marshall	Hubbard	Pooled SEM	St	S	St x S
	Male	0.996a	0.983b	0.971c	0.958cd	0.953cd	0.025	<0.0001	0.04	0.33
FI (kg)	Female	0.952a	0.937b	0.929c	0.905cd	0.907cd				
	Mean	0.974	0.960	0.950	0.932	0.930				
	Male	0.653d	0.664b	0.668b	0.658c	0.684a	0.032	0.003	<0.0001	0.41
WG (Kg)	Female	0.647a	0.638b	0.626c	0.636b	0.637b				
	Mean	0.650	0.651	0.647	0.347	0.661				
	Male	0.652d	0.658d	0.709c	0.715b	0.726a	0/017	0.32	0.71	<0.0001
LW (kg)	Female	0.669b	0.656c	0.668b	0.609d	0.678a				
	Mean	0.661	0.657	0.689	0.662	0.702				
	Male	1.465a	1.466a	1.465a	1.428c	0.379b	0.028	0.0002	<0.0001	0.003
FC	Female	1.454a	1.454a	1.455a	1.427c	1.408b				
	Mean	0.460	1.460	1.460	1.425	0.894				

a-d Means within each column for strain and gender bearing different letters differ significantly at P < 0.05.

Table 5: Mean of feed consumption (FI), weight gain (WG), live weight (LW), and feed conversion (FC) of different strains of males and females at 1-4 weeks of age

Variable	Sex (S)	Strains (St) Abor acres++	Ross 308	Cobb 500	Marshall	Hubbard	Pooled SEM	St	S	St x S
FI (kg)	Male	1.648c	1.685a	1.632d	1.649c	1.658b	0.041	0.73	0.44	0.28
	Female	1.529cd	1.572a	1.536b	1.532c	1.537b				
	Mean	1.599	1.629	1.584	1.510	1.510				
WG (Kg)	Male	1.112c	1.139a	1.075d	1.138a	1.133b	0.021	0.62	<0.0001	0.04
	Female	1.019b	1.136a	1.010c	1.039a	1.037a				
	Mean	1.066	1.138	1.045	1.089	1.085				
LW (kg)	Male	1.142c	1.175a	1.116d	1.175a	1.174a	0.41	0.21	0.06	0.79
	Female	1.038b	1.176a	1.036b	1.172a	1.171a				
	Mean	1.081	1.173	1.076	1.174	1.172				
FC	Male	1.509a	1.511a	1.504b	1.464d	1.471c	0.72	0.17	<0.0001	0.62
	Female	1.510d	1.547c	1.518d	1.483a	1.477b				
	Mean	1.510b	1.529a	1.511b	1.474c	1.474c				

a-d Means within each column for strain and gender bearing different letter differ significantly at $P < 0.05$.

Table 6: Mean of feed consumption (FI), weight gain (WG), live weight (LW), and feed conversion (FC) of different strains of males and females at 1- 6 weeks of age.

Variable	Sex (S)	Strains (St) Abor acres++	Ross 308	Cobb 500	Marshall	Hubbard	Pooled SEM	St	S	St x S
FI (kg)	Male	3.211d	3.232cd	3.353b	3.348c	3.386a	0.058	0.51	<0.0001	0.21
	Female	3.206d	3.226c	3.210d	3.337b	3.348a				
	Mean	3.209	3.229	3.282	3.343	3.367				
WG (Kg)	Male	2.002ab	1.830b	1.823b	2.012a	2.061a	0.039	0.09	0.62	0.99
	Female	1.983ab	1.959ab	1.782c	1.721d	2.001a				
	Mean	1.985	1.895	1.803	1.867	2.031				
LW (kg)	Male	1.121d	1.829c	1.932b	1.832c	2.002a	0.075	0.43	<0.0001	0.42
	Female	1.117d	1.828b	1.824b	1.581c	1.950a				
	Mean	1.119	1.329	1.878	1.707	1.976				
FC	Male	1.603cd	1.609c	1.757a	1.692b	1.316d	0.027	0.94	0.32	0.57
	Female	1.511bc	1.402cd	1.764a	1.368b	1.342d				
	Mean	1.557	1.506	1.761	1.530	1.329				

a-d Means within each column for strain and gender bearing different letters differ significantly at $P < 0.05$.

Table 7: Mean of feed consumption (FI), weight gain (WG), live weight (LW), and feed conversion (FC) of different strains of males and females at 1-7 weeks of age.

Variable	Sex (S)	Strains (St) Abor acres++	Ross 308	Cobb 500	Marshall	Hubbard	Pooled SEM	St	S	St x S
	Male	4.311bc	4.329b	4.127c	4.281b	4.468a	0.021	0.10	0.06	0.31
FI (kg)	Female	4.100c	4.201b	3.955d	4.242b	4.409a				
	Mean	4.206	4.265	4.041	4.192	4.439				
	Male	2.401cd	2.432c	2.276d	2.682b	2.701a	0.056	0.07	<0.0001	0.04
WG (Kg)	Female	2.122d	2.229c	2.208cd	2.531b	2.689a				
	Mean	2.262	2.331	2.242	2.669	2.695				
	Male	2.368d	2.477c	2.505b	2.742ab	2.770a	0.043	0.24	0.005	0.43
LW (kg)	Female	2.274d	2.285cd	2.347c	2.510b	2.551a				
	Mean	2.321	2.381	2.426	2.626	2.661				
	Male	1.627d	1.874a	1.748c	1.845ab	1.612a	0.033	0.95	0.06	0.22
FC	Female	1.529d	1.742cd	1.773c	1.882a	1.505b				
	Mean	1.578	1.808	1.761	1.364	1.559				

a-d Means within each column for strain and gender bearing different letters differ significantly at P < 0.05.

Table 8: Mean of carcass weight (CW), carcass yield (CY), breast yield (BY), thighs yield (TY), and drumstick yield (DY) of different strains of males and females at 6 weeks of age.

Variable	Sex (S)	Strains (St) Abor acres++	Ross 308	Cobb 500	Marshall	Hubbard	Pooled SEM	St	S	St x S
	Male	1.83b	1.85b	1.68c	1.82b	1.92a	0.071	0.07	0.06	0.04
CW (kg)	Female	1.50d	1.58c	1.48d	1.64ab	1.69a				
	Mean	1.67	1.72	1.58	1.68	1.81				
	Male	70.62d	71.58c	72.24b	73.21b	73.32a	0.032	0.24	<0.0001	0.04
CY (%)	Female	69.82d	70.47cd	71.42c	72.10b	72.43a				
	Mean	70.22	71.03	71.83	72.66	72.88				
	Male	31.42c	31.29d	32.38b	32.18bc	33.48a	0.031	0.95	<0.0001	0.31
BY (%)	Female	31.11c	31.28cd	31.22c	31.32b	32.68a				
	Mean	31.27	31.29	31.80	31.75	33.08				
	Male	13.20d	14.02c	13.18d	14.26b	14.50a	0.052	0.08	0.07	0.76
TY (%)	Female	13.61a	13.11b	12.38d	12.33cd	12.62c				
	Mean	13.24	13.57	12.78	13.30	13.56				
	Male	13.6d1	14.36a	13.64d	14.34a	14.16c	0.032	0.12	<0.0001	0.42
DY (%)	Female	13.98b	14.00a	13.73c	13.11cd	13.08d				
	Mean	13.61	14.18	13.69	13.73	13.62				

a-d Means within each column for strain and gender bearing different letters differ significantly at P < 0.05.

Table 9 Mean of carcass weight (CW), carcass yields (CY), breast yield (BY), thighs yield (TY), and drumstick yield (DW) of different strains of males and females at 7 weeks of age.

Variable	Sex (S)	Strains (St) Abor acres++	Ross 308	Cobb 500	Marshall	Hubbard	Pooled SEM	St	S	St x S
	Male	1.76bc	1.78b	1.71c	1.92ab	1.97a	0.072	0.12	0.07	0/22
CW (kg)	Female	1.50c	1.51c	1.52c	1.63b	1.78a				
	Mean	1.63	1.65	1.62	1.78	1.81				
	Male	74.32d	74.62b	74.51c	75.77ab	75.88a	0.057	0.10	0.005	0.43
CY (%)	Female	73.11c	73.21bc	74.35b	72.82d	74.74a				
	Mean	73.71	73.92	74.43	73.56	75.31				
	Male	31.59d	32.32b	32.11c	31.12cd	33.79a	0.043	0.24	0.63	<0.0001
BY (%)	Female	32.18c	33.16d	33.12ab	32.76c	33.67a				
	Mean	31.89	32.74	32.62	33.73	31.94				
	Male	12.71d	12.87cd	13.16c	14.11b	14.67a	0.052	0.13	<0.0001	<0.0001
TY (%)	Female	12.27d	12.36c	12.11cd	12.53b	12.82a				
	Mean	12.49	12.62	12.64	13.32	13.75				
	Male	13.76d	13.85cd	14.18c	14.62b	14.79a	0.062	0.84	<0.0001	0.14
DY (%)	Female	13.19cd	13.11d	13.28c	13.62b	13.76a				
	Mean	13.43	13.48	13.73	14.12	14.28				

a-d Means within each column for strain and gender bearing different letters differ significantly at P < 0.05.