

Effects of strain x sex interaction on carcass traits and meat quality of three strains of commercial meat-type chicken

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Target audience: *Poultry producers, Animal breeders, Researchers and Animal Physiologist.*

Abstract

A total number of 288 day-old broilers of Arbor Acre, Hubbard and Marshal were randomly allocated to four treatments of 96 chicks each, with each treatment having three replicates of 8 birds comprising the sexes each with the aim of ranking the commercial meat-type strains as well as their sexes based on their carcass evaluation at 56 days of age. The traits considered were live weight, dressed weight, slaughter weight, eviscerated weight, breast weight, back weight, thigh + drumstick, wing weight, head and neck. Other traits measured were intestine, proventriculus + gizzard, liver and heart. Parameters on sensory values evaluated were Aroma, colour, flavor, tenderness, juiciness, texture, saltiness and overall acceptance. The obtained results indicated significant ($P < 0.01$) effect of sex on the carcass parameters. Male broilers recorded higher mean values (2558.33g) of live weight, slaughter weight, dressed weight and other carcass traits than its female counterpart. Also, there was significant ($P < 0.01$) effect of strain x sex interaction on live weight and slaughter weight. Males of Arbor Acre had the highest mean value (2650 g) of live weight, while the females of all the strains recorded lower values. In addition, there was no significant ($P > 0.05$) effect of sex on Aroma and flavor at 8 weeks, while other sensory values recorded favored male birds of all strains. The obtained results indicated that most carcass traits are strain and sex dependent. Also, the results revealed that males of Arbor Acre and Hubbard strains gave greater chicken proportions than Marshall Broiler. Therefore, males of Arbor Acre and Hubbard broiler strains could be raised for maximum profit and increase animal proteins consumption.

Keywords: *Trait, strain, interaction, effect and sex.*

Description of Problem

In Nigeria, the demand for white meat has increased tremendously in recent time due to health issues arising from red meat consumption. White meat such as chicken meat is superior to red meat in health aspects because of its comparatively low content of fat and cholesterol which is of great importance to man (1). Chicken meat is unique in that its price is comparatively low, easy to partition into smaller parts and no religious or

traditional restriction against its consumption (2). There are several factors affecting the productive and carcass performance of broiler chickens, such as breed or strain, sex, nutrition, housing and stocking rate. The success of poultry production has been strongly related to the improvements in growth performance and carcass yield and composition. Current commercial broiler chicken strains like Arbor Acre, Anak Titan, Ross, Lohmann, Pawl, Hubbard and Kucbor (3) were the result of

successful selection programme for rapid growth and body conformation.

This improvement in growth performance and carcass characteristics has resulted to physiological, immunological, biochemical and anatomical changes in broilers (4). It was reported that breed/strain significantly affected live weight (5; 6), carcass weight (7), breast and leg muscle weight (6), fat and edible giblets weight (6; 8) and back and drumstick weights (8) of broiler chickens. Previous researches also revealed significant sex effect on live weight (5) and carcass traits (9) of broiler chicken breeds. The joint effects of strain and sex on carcass characteristics had been widely reported in literature. This refers to the ranking of strains and sexes on a scale of performance in respect of traits measured. The existence of interactions between strain and sex would indicate the presence of sexual dimorphism in carcass evaluation within and between strains. Therefore, the aim of the study was to evaluate the strain with superior carcass value and meat quality as well as to estimate the interaction of strain and sex with improved carcass value.

Materials and Methods

Location of the Study

The study was carried out in the Poultry unit of the Teaching and Research Farm, Faculty of Agricultural Sciences, Ekiti State University, Ado-Ekiti, Nigeria. Ado-Ekiti is situated entirely within the tropics. It is located between longitudes 40° 51' and 50° 45' East of the Greenwich meridian and latitudes 70° 15' and 80° 51' North of the Equator. It lies south of Ikere Ekiti, East of Ilawe and bounded by Iyin Ekiti in the East and in the South. The town enjoys a tropical climate with two distinct seasons, the rainy season (April - October) and the dry season (November - March). Temperature ranges between 21° C and 28° C with high humidity of above 50-90%. The South - Westerly winds and the

North East Trade winds blow in the raining and dry (Harmattan) seasons, respectively.

Site Preparation

The site was properly cleaned, washed with soap, Lysol and IZAL and fumigated adequately with 40% formaldehyde in water solution and allowed to rest for one week. The house was properly covered and pre-heated before the arrival of the birds so as to ensure that the birds were not predisposed to any disease causing microorganisms present in the site and to raise the temperature of the brooding environment to keep the chicks warm.

Experimental Birds and Management

A total number of 288 day-old broilers of Arbor Acre, Hubbard and Marshal commercial broiler hybrids were purchased from reputable hatcheries and were randomly allocated to four treatments of 96 chicks each, with each treatment having three replicates of 8 birds comprising the sexes per replicate. The four treatments are full - fed (control), second, third and fourth week skip-a-day feed restriction. Thereafter, the birds were given full feed until the end (56 days). The chicks were brooded using coal pot to supply heat for the first three weeks of life. Antibiotics and vitamins were administered as at when due. Also, vaccines against Infectious Bursae and Newcastle diseases were given at specified age intervals. Their beddings are made up of dry wood shavings to prevent coccidiosis outbreak and high level of hygiene was maintained throughout the experimental period to ensure conducive environment for growth, and reduced mortality.

Feed and Feeding

The birds were introduced to skip-a-day feed restriction with starter mash (1-4weeks) containing 3000 Kcal/KgME, 22% CP and finisher feed (5-8weeks) containing 3100

Kcal//KgMe, 21% CP and water was available *ad libitum*.

Data Collection

At the end of the 56 days trial, 12 birds from each strain (2 males and 2 females per replicate) were randomly selected, weighed and fasted for 24 hours prior to slaughter. Slaughtered birds were scalded, feathers manually plucked and eviscerated. The legs, shanks, neck and head were removed and carcasses were immediately weighed to obtain post slaughter dress carcass yield. The carcass was cut into breast, back, neck, head, drumstick and thigh and the weights of each taken. The giblets included the weights of liver, heart, proventriculus, intestine, gizzard and abdominal fat pad. The different parts were measured using top-load scale (Escali® Mercado series), digital PC30 weighing scale and tape rule, and were expressed in grams and centimeters, respectively.

Carcass Evaluation

At the end of the 56 days trial, 6 birds from each treatment (2 per replicate) were randomly selected, weighed and fasted prior to slaughter. Slaughtered birds were scalded, feathers manually plucked and eviscerated. The legs, shanks, neck and head were removed and carcasses were immediately weighed to obtain post slaughter dress carcass yield. The carcass was dismembered into breast, back, neck, head, drumstick and thigh and the weights of each determined. The giblets included the weights of liver, heart, proventriculus, intestine, gizzard and abdominal fat pad.

Sensory Evaluation

Samples for sensory evaluations were taken from the breast muscle and cooked to an internal temperature of 72⁰C. Total of twelve trained individuals aged between 22 and 35 years males and females were employed to

assess the coded meat samples. Equal bite size from each treatment was coded, replicated thrice and served for evaluation by the trainees on a 9-point hedonic scale for colour, flavour, tenderness, juiciness, texture and overall acceptability.

Statistical Analysis

Data collected from the completely randomized design with 3 strains, 2 sex and 4 treatment factorial arrangement (factorial experiment) was subjected to analysis of variance using (10) and the differences between means for strain x sex interactions were separated by Duncan's New Multiple Range test (11).

The analytical statistical model used was:

$$Y_{ijk} = \mu + G_i + S_j + (GS)_{ij} + e_{ijk}$$

Y_{ijk} = observation of the kth population, of the jth genotype and ith sex

μ = overall mean

G_j = fixed effect of jth genotype (j=3)

S_i = fixed effect of ith sex (i=2)

$(GS)_{ij}$ = fixed genotype x sex interaction effects

e_{ijk} = random error

Results

Effect of sex on broiler chickens live weight and carcass characteristics

Table 1 revealed the effect of sex on broiler chickens' live weight and carcass characteristics. The result showed that there was significant (p<0.01) effect of sex on the carcass parameters. Male broilers recorded higher mean values of 2558.33 g for live body weight, slaughter weight (2468.89 g), dressed weight (2351.39 g) at the end of 56days and other carcass traits with the exception of wing weight while the two sexes recorded similar mean values. For the giblets, male broilers equally showed superiority in mean values to females, with the exception of proventriculus + gizzard where the two sexes had similar mean values (p>0.01).

Table 1: Least squares means showing the effect of sex on live weight and carcass characteristics of the three broiler chickens.

PARAMETER (g)	MALE	FEMALE	SEM
Live Weight	2558.33 ^a	2187.50 ^b	37.87
Slaughter Weight	2468.89 ^a	2097.22 ^b	37.06
Dressed Weight	2351.39 ^a	1997.22 ^b	36.74
Eviscerated Weight	1899.06 ^a	1601.28 ^b	33.31
Breast Weight	597.78 ^a	457.78 ^b	24.27
Back Weight	473.89 ^a	364.31 ^b	20.87
Thigh + drumstick	547.22 ^a	441.11 ^b	11.47
Wing Weight	231.39	221.11	9.65
Head	77.76 ^a	60.51 ^b	2.00
Heart	14.08 ^a	11.61 ^b	0.45
Liver	49.60 ^a	39.96 ^b	1.72
Proventriculus + Gizzard	67.94	62.77	1.82
Intestine Weight	111.10 ^a	100.17 ^b	3.59
Neck	135.83 ^a	11.56 ^b	5.97

^{abc}Means with different superscripts along rows are significantly different ($p < 0.01$)

Effect of sex on the meat quality of the three strains of broiler

Table 2 shows the effect of sex on the meat quality of broiler chickens at 8 weeks. The result indicated that there was significant ($p < 0.01$) effect of sex on tenderness, juiciness, texture, saltiness, and overall acceptability, the male birds had higher and superior ($p < 0.01$)

mean values, while the female birds showed the least mean values of these sensory parameters at 8 weeks. The result also revealed that there was no significant ($p > 0.01$) effect of sex on Aroma and flavor at 8 weeks, as all the strains recorded similar ($p > 0.01$) mean values.

Table 2: Least squares means showing the effect of sex on the meat quality of the three strains broiler

SENSORY VALUES	MALE	FEMALE	SEM
Aroma	52.03	48.14	1.43
Colour	61.39	58.44	0.86
Flavour	58.78	56.22	0.98
Tenderness	61.33 ^a	57.89 ^b	0.85
Juiciness	61.50 ^a	58.42 ^b	0.82
Texture	59.64 ^a	56.25 ^b	0.85
Saltiness	58.03 ^a	54.47 ^b	1.07
Overall Acceptance	62.47 ^a	59.81 ^b	0.89

^{abc}Means with different superscripts along rows are significantly different ($p < 0.01$)

Effect of strain x sex interaction on live weight and carcass characteristics of broiler chickens

Table 3 shows the strain x sex interaction effect on live weight and carcass traits of the

three broiler chickens measured. The results revealed that there was significant ($p < 0.01$) effect of strain x sex on live weight and slaughter weight. Males of Arbor Acre had the highest (2650.00 g) mean value, while females

of all strains had lower mean values of live weight and slaughter weight. There was also significant ($p < 0.01$) strain x sex interaction effect on dressed weight of the broiler chickens. Males of Arbor Acre showed superior (2491.67 g) mean value, while females of Hubbard and Marshall recorded lower (1962.50 g) and (2000.0 g) mean values. For eviscerated weight, there was significant ($p < 0.01$) strain x sex interaction effect. Males of Arbor Acre (2030.33g) and Hubbard (1925.83g) showed superiority, while females of Hubbard (1541.67g) had the least mean value. Furthermore, there was significant ($p < 0.01$) strain x sex interaction effect on breast weight and back weight. Males of Arbor Acre (721.67g) and (571.67g) had superior values, while other strain x sex interactions recorded similar ($p > 0.05$) values in terms of breast weight and back weight.

Result indicate that in thigh + drumstick, there was significant ($p < 0.01$) strain x sex interaction effect. Males of Arbor Acre (612.50g) recorded the highest value, while females of Hubbard (408.33g) showed the lowest value. There was also significant ($p < 0.01$) strain x sex interaction effect on wing length. Arbor Acre males (270.83g) had the highest value, while Hubbard males (181.67g) recorded the least mean value. With head, there was significant ($p < 0.01$) strain x sex interaction effect. Hubbard (80.54g) and Marshall (78.30g) males recorded superior values, while Arbor Acre (54.83g) and Marshall (61.76g) females and recorded the lowest values. Similarly, there was significant ($p < 0.01$) strain x sex interaction effect on heart. Males of Hubbard (14.97g) and Marshall (14.86g) recorded the highest values, while females of all the strains had similar mean values.

There was also significant ($p < 0.01$) strain x sex interaction effect on liver. Hubbard males recorded the highest mean value (50.95 g), while the females of Arbor Acre and

Marshall recorded lower mean values (39.20 g and 39.15 g) for liver. However, there was no significant ($p > 0.05$) strain x sex interaction effect on proventriculus + gizzard. With intestine weight, there was significant ($p < 0.01$) strain x sex interaction effect. Hubbard males and females recorded the higher mean values (115.70 g and 115.73 g) of intestine weight, while females of Arbor acre had the lowest mean value (89.86 g). Similarly, there was significant ($p < 0.01$) strain x sex interaction effect on neck. Male birds of Marshall showed superior mean value (162.50 g) compared to other interactions, while females of Arbor Acre, Hubbard and males of Hubbard recorded similar mean values of neck at 8 weeks.

Effect of strain x sex on the meat quality of the three broiler chickens

Table 4 shows the effect of strain x sex on broiler chickens sensory parameters. The results revealed that there was significant ($p < 0.01$) strain x sex interaction effect on sensory parameters in terms of aroma and colour. Arbor Acre males and females, Hubbard males as well as Marshall males and females showed superior mean values (54.67, 52.25, 50.50, 50.92 and 49.08) of aroma and colour. There was no significant ($p > 0.01$) strain x sex interaction effect on flavour. However, there was significant ($p < 0.01$) strain x sex interaction effect on tenderness. Arbor Acre and Hubbard males recorded the highest mean value (63.92 and 61.50) while other interaction showed similar ($p > 0.01$) mean values. Similarly, there was significant ($p < 0.01$) strain x sex interaction effect on the juiciness of the chickens meat. Male and female birds of Arbor Acre, males of Hubbard and Marshall showed superior mean values (61.42, 61.50, 62.00 and 61.08), while female birds of Hubbard and Marshall had the lower mean values (56.42 and 57.33) at 8 weeks. Similarly, there was significant ($p < 0.01$) strain x sex interaction effect on the broiler chickens

texture. Arbor Acre males had superior mean value (62.50), while females of Marshall recorded the lowest mean value (53.17). There was also significant ($p < 0.01$) strain x sex interaction effect on saltiness. Hubbard, Arbor Acre and Marshall males had the highest mean value (61.08, 56.42 and 56.58), while females all the three strains of broiler chickens showed similar ($p > 0.01$) mean values (53.75, 54.33

and 55.33).

Furthermore, there was significant ($p < 0.01$) strain x sex interaction effect on the sensory overall acceptability. Female birds of Arbor Acre, Hubbard, male birds of Arbor Acre, Hubbard and Marshall showed superior mean values (63.00, 58.75, 62.33, 63.08 and 62.00), while female birds of Marshall recorded the lower mean value (57.67).

Table 3: Least squares means showing the effect of strain x sex interaction on live weight and carcass characteristics of the three broiler chickens

PARAMETER (g)	ARBOR ACRE		HUBBARD		MARSHALL		SEM
	Male	Female	Male	Female	Male	Female	
Live Weight	2650.00 ^a	2183.33 ^c	2608.33 ^{ab}	2179.17 ^c	2416.67 ^b	2200.00 ^c	69.84
Slaughter Weight	2585.83 ^a	2116.70 ^c	2500.00 ^{ab}	2070.83 ^c	2320.83 ^b	2104.20 ^c	68.94
Dressed Weight	2491.67 ^a	2029.17 ^c	2350.00 ^{ab}	1962.50 ^d	2212.50 ^b	2000.00 ^{cd}	68.78
Eviscerated Weight	2030.33 ^a	1658.75 ^{bc}	1925.83 ^a	1541.67 ^c	1740.00 ^b	1603.42 ^{bc}	64.24
Breast Weight	721.67 ^a	487.50 ^b	550.83 ^b	419.17 ^b	520.83 ^b	466.67 ^b	53.03
Back Weight	571.67 ^a	366.67 ^b	420.83 ^b	334.17 ^b	429.17 ^b	392.08 ^b	43.09
Thigh + Drumstick	612.50 ^a	473.33 ^c	500.00 ^{bc}	408.33 ^d	529.17 ^b	441.67 ^{cd}	20.05
Wing Weight	270.83 ^a	229.17 ^b	181.67 ^c	235.83 ^{ab}	241.67 ^{ab}	198.33 ^{bc}	16.57
Head	74.45 ^b	54.83 ^d	80.54 ^a	64.93 ^{bc}	78.30 ^{ab}	61.76 ^c	3.49
Heart	12.40 ^{ab}	11.88 ^b	14.97 ^a	11.72 ^b	14.86 ^a	11.25 ^b	0.85
Liver	49.23 ^{ab}	39.20 ^c	50.95 ^a	41.53 ^b	48.61 ^{ab}	39.15 ^c	3.03
Proventriculus + Gizzard	69.24	59.18	67.55	64.08	67.04	65.06	3.47
Intestine Weight	108.13 ^{ab}	89.86 ^c	115.70 ^a	115.73 ^a	109.46 ^{ab}	94.93 ^b	5.78
Neck	131.67 ^{ab}	117.50 ^b	113.33 ^b	98.33 ^b	162.50 ^a	130.83 ^{ab}	10.14

^{abc}Means with different superscripts along rows are significantly different ($p < 0.01$), SEM = Standard error of the means

Table 4: Least squares means showing the effect of strain x sex interaction on sensory parameters of the three strains of broiler chickens at eight weeks

SENSORY VALUES	ARBOR ACRE		HUBBARD		MARSHALL		SEM
	Male	Female	Male	Female	Male	Female	
Aroma	54.67 ^a	52.25 ^a	50.50 ^a	43.08 ^b	50.92 ^a	49.08 ^{ab}	2.34
Colour	61.25 ^a	61.00 ^a	61.42 ^a	55.00 ^b	61.50 ^a	58.83 ^{ab}	1.47
Flavour	58.42	56.75	59.33	54.67	58.58	57.25	1.84
Tenderness	63.92 ^a	58.25 ^b	61.50 ^{ab}	57.25 ^b	58.58 ^b	58.17 ^b	1.44
Juiciness	61.42 ^a	61.50 ^a	62.00 ^a	56.42 ^c	61.08 ^{ab}	57.33 ^b	1.34
Texture	62.50 ^a	59.00 ^{ab}	59.25 ^{ab}	56.58 ^b	57.17 ^b	53.17 ^c	1.39
Saltiness	56.42 ^{ab}	53.75 ^b	61.08 ^a	54.33 ^b	56.58 ^{ab}	55.33 ^b	1.81
Overall Acceptance	62.33 ^{ab}	63.00 ^a	63.08 ^a	58.75 ^{ab}	62.00 ^{ab}	57.67 ^b	1.62

^{abc}Means with different superscripts along rows are significantly different ($p < 0.01$), SEM = Standard error of the means.

Discussion

In this study, it was observed that the male birds had higher and superior values than the females regardless of the strain. This can be attributed to sexual dimorphism, which is a natural phenomenon in farm animals. This result is in agreement with the findings of (12; 13) and (14) who observed higher live weight in male compared to female broilers at eight weeks. However, this observation contradicted the findings of (15) and (16) who reported that female broilers were known to have higher level of carcass yield. In agreement with the present study, (17) reported that male broilers had heavier body weight than females.

Differences in carcass compositions between the sexes could be attributed to metabolic differences between them (18). However, differences between the results of this study and others might be due to differences in genetic make-up and age of birds used in the experiments. In other carcass traits, male broilers had higher and superior values in slaughter weight, dressed weight, eviscerated weight, breast muscle weight, back weight thigh + drumstick and also with the giblets.

There was significant effect of sex and strain interaction on live weight and carcass traits of broiler chickens. Male birds of Arbor Acre and Hubbard had high values in slaughter weight, dressed weight and eviscerated weight, but with regards to breast muscle weight, back weight and thigh + drumstick, male birds of Arbor Acre recorded high mean values. This indicated the ranking order of interaction effects on broiler meat quantity, and that the traits depended on joint action of sex and strain. This result suggests that Arbor Acre and Hubbard males should be adopted for profitability and high productivity in broiler enterprise. This was consistent with the findings of (19) and (20) who reported significant strain x sex interactions effect on live weight of broiler chickens. In contrast,

(12; 5), and (8) observed non-significant strain x sex interactions effect on carcass traits of the three broiler chickens. However, (21) and (22) found significant strain x sex interaction effect on live weight.

The results implied that there was absence of joint effect of strain and sex on birds' performance, that is, the two factors acted independently of each other. There were separate effects of strain and sex on carcass characteristics that had been widely reported in literature, their interactions have not been given much attention. This refers to the ranking of strains and sexes on a scale of performance in respect of those traits measured.

In this study, juiciness, tenderness, saltiness and overall acceptability were significantly higher in males than females. The highest mean values in males indicated that the male had better meat qualities than the female. However, aroma, colour and flavour were not significantly different. In contrast to this study, (23) observed that tenderness was high in all cases but no difference with age. Similarly, (24) reported non-significant difference in some characteristics of subjective quality traits of breast meat. Sonaiya *et al.* (25) found no difference due to age. Therefore, from this study, male broilers could be selected for better meat quality characteristics. Meat quality is therefore, sex dependent.

It was revealed that strain x sex interaction was significant on all the sensory parameters except flavour. This means that the expression of these sensory parameters depended on joint-action of strain and sex. However, from the results, males of Arbor Acre, Hubbard and Marshall and females of Arbor Acre and Marshall recorded higher mean values in aroma and colour. However, Arbor Acre and Hubbard males recorded higher mean values in tenderness. Arbor Acre, Hubbard and Marshall males and females of Arbor Acre had higher mean values in

juiciness. However, all the strains recorded high mean values of overall acceptance except female of Marshall. This is in consonant with the findings of (26) who reported significant effect of strain by sex on the sensory parameters of broiler chickens.

Conclusion and Applications

1. The three broiler strains have different ancestors and genetic constitutions judging from the obtained results in this study. It was revealed that Arbor Acre and Hubbard strains had superior mean values of live weight, slaughter weight, dressed weight and eviscerated weight.
2. Male broiler chickens recorded better mean values in all the carcass traits as well as some of the sensory values such as; tenderness, juiciness, texture, saltiness and overall acceptability.
3. The joint-action of the two factors (strain and sex) gave similar mean values of live weight and slaughter weight.
4. Based on the carcass characteristics, Arbor Acre and Hubbard males had higher values of live weight and other carcass traits. It can be recommended that Arbor Acre and Hubbard strains be adopted for better carcass yield. It was also revealed that the males of the strains had superior values in all the parameters, hence, broiler producers can select male birds for better meat quality

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