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Original Article

Genetic and Sex Differences in Carcass Traits of Nigerian Indigenous Chickens

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Abstract

Genetic and sex differences or variation in carcass characteristic and slaughter yield were studied using a total of 150 intensively reared and clinically normal chickens consisted of 50 each of normal feather, naked neck and frizzled matured chickens genotypes. The result showed that genotype as well as sex have significant effect (P<0.05) on carcass characteristics and slaughter yield at twenty weeks old. The slaughter weight means values ranged from 1693.00±71.43g to 2084.00±108.43g in normal-feathered to naked-neck chicken. The slaughter weight, carcass weight and dressing percentage were better in the naked neck chicken than other genetic groups. Moreover, male chickens showed significant (P<0.05) and higher slaughter weights, carcass weight, dressing percentage than females across all genotypes. Correlation coefficients (*r*) among carcass traits were all positive and very highly significant (P<0.01) and ranged from 0.14 which was not significant (P>0.05) between shank and wing to 0.99 (P<0.01) between WAB and SLWT, WAD and WAB, Head and WAB, Head and WAD and Breast and DS. Coefficient between carcass traits and organs were also significant (P<0.01) with *r* values ranging from 0.00 between kidney and all other cut parts to 0.89 between slaughter weight and abdominal fat. It could therefore be concluded that variations in the genetic make-up and sexual dimorphism in the chickens accounted for the observed differences in carcass characteristic. The present result on carcass characteristic of the chicken genotypes could serve as a base line data, which could be exploited in the improvement of the local stock. However, the application of molecular tools will give clearer understanding and better application of these differences.

Key words: Organ weights, carcass characteristics, slaughter yield, chicken

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Abbreviations

SLWT	Slaughter weight
WAB	Weight after bleeding
WAD	Weight after defeathering
CWGT	Carcass weight
EP	Empty proventriculus
INTL	Intestinal length
FG	Full gizzard
EG	Empty gizzard
DS	Drumstick
ABF	Abdominal fat

Introduction

The persistence short supply of protein for populace is the main problem which was compounded by the accelerated increase in human population especially in Nigeria and thus created pressure on every form of food supply. Poultry population in Nigeria is estimated to be around 172 million out of which chicken is estimated at 160 million, guinea fowl (8.3 million), ducks (1.7 million) and Local turkeys (1.05 million) (FAOSTAT, 2011). However, selection in local breeds has been targeted more at adaptation to tropical harsh environments and resistance to diseases rather than enhanced production (Minga et al., 2004). The expansion of Nigeria commercial poultry production has great potentials in improving animal protein status of the Nigerian populace (Adeniji, 2005). The fowl is one of the common domestic animals kept throughout the tropics and is descended from the red jungle fowl *Gallus gallus domesticus* (Vaisanen et al., 2009). White meat such as chicken meat is considered superior in health aspects to red meat because of comparably low contents of fat, cholesterol, and iron which are important for men. Consumers also acknowledge the relatively low price, the typically convenient portions, and the lack of religious restriction against its consumption (Jaturasitha, 2004).The meat from poultry contains several important classes of nutrient and many consumers relatively prefer the local chicken compared to their exotic counterparts because of its leanness and lower purchasing price. Proportions of major carcass tissues and distribution of these tissues throughout the carcass is important to carcass value. Manipulation of these traits depends on the combined genetic and nutrition.

Farm animals are usually evaluated based on growth and developmental traits. Indices such as nutrition, growth rate, sex, age and genotype have been implicated to affect growth response (Omeje and Nwosu, 1983; Jovbert, 1980). Carcass quality traits depend on a number of factors as genotype, sex and age and these factors have greater impact and the possibility of genetically improving carcass quality by selection based on genetic variability of body weight and body composition (Pikul et al., 1987). The large differences between genetic and phenotypic correlations for carcass traits may imply a relatively large influence of environmental conditions for these traits (Musa et al. 2006). Therefore, the success of poultry meat production has been strongly related to improvements in growth and carcass yield, mainly by increasing breast proportion and reducing abdominal fat.

Among the local chickens in Nigeria, certain major genes such as naked neck (Na) and frizzle (F) have been identified in the native chicken population (Ibe and Nwohu, 1999) and are known to have productive adaptability advantage (Horst 1989) due to their thermoregulatory functions. Horst (1983) and Yunis and Cahaner (1999) attributed the adaptive potential of these group of chickens to the possession of major genes of frizzling (*Ff*) and naked neck (Na^{-}) which are involved in heat tolerance. They have highly conserved genetic system, with high level of heterozygosity which may provide biological material for the design of genetic stocks with improved adaptability and productivity (Ponsuksili et al., 1996; Wimmers et al., 2000). According to Adedeji et al. (2004), Naked neck and Frizzled-feathered chickens performed better than Normal feathered types in body weight and linear body measurement traits while by Peters et al. (2002) showed that the indigenous chicken genotypes had higher maturing rate than their exotic counterpart and which could be attributed to the possession of major genes that assisted in early adaptation to the environment. For accuracy and better judgement of their performance, growth rate of individual sex and carcass characteristics, the proportion of major carcass parts in our indigenous chicken needs to be established. This study therefore was design to determine the effect of genotype and sex on the carcass characteristics and slaughter yield of the chickens at 20 weeks of age.

Material and Methods

Study area

The research was carried out at the Poultry Unit of the Teaching and Research Farm of Ambrose Alli University Ekpoma, Edo State. Ekpoma. The study area as described in Isidahomen et al. (2011) lies between Lat 6.44^{o}N and Log 6.8^{o}E and has a prevailing tropical climate with a mean annual rainfall of about 1556mm. The mean ambient temperature ranges from 26^{0}C in December to 34^{0}C in February, relative humidity ranges from 61% in January to 92% in August with yearly average of about 82%. The vegetation represents an interface between the tropical rainforest and the derived savanna. The data was taken between January and March 2011. The average meteorological data during the period was; rainfall (38.95mm), temperature (26.5^{O}C), relative humidity (67.93%), sunshine (4.80) and wind speed (0.50m/s).

Experimental birds

A total of four hundred chickens comprising the three genotypes were being reared in the Chicken Experimental Unit. One hundred and fifty chickens comprising 50 each from frizzle feathered, naked-neck and normal-feathered birds of both males and females in equal proportions were used for the study. The chickens were reared under the same management system as described by Oluyemi and Roberts (2000). The birds and the research was approved by the Institutional Animal Use and Care Committee of the Ambrose Alli University, Ekpoma, Edo State, Nigeria

Feeds and feeding

- The birds were fed *ad libitum* on a commercial starter ration containing 20% crude protein and 2996Kcal/kg Metabolizable Energy from Day old to 4 weeks of age while growers' marsh containing 15.86% crude protein and 2716Kcal/kg Metabolizable Energy was offered the birds from 4-15 weeks of age. Finisher ration with 16.80% crude protein and 2823Kcal/kg Metabolizable Energy was provided from 15 to 24 weeks of age (Table 1). These rations were obtained from a reputable commercial feed mill. Clean water was supplied *ad libitum* throughout the experimental period. Routine vaccination and other management practices were strictly adhered to.

Table 1: Composition of the experimental diets

Ingredient	Starter diet	Growers diet	Breeders diet
Maize	45.95	55.45	56.95
Groundnut cake	25.00	15.00	20.00
Wheat offal	18.00	20.00	15.00
Fish Meal	3.00	1.50	2.00
Bone Meal	2.00	2.00	2.00
Limestone	5,00	5.00	5.00
*Premix	0.25	0.25	0.25
Salt	0.30	0.30	0.30
Lysine	0.25	0.25	0.25
Methionine	0.25	0.25	0.25
Total	100.00	100.00	100.00
Calculated CP (%)	20.17	15.86	16.80
ME (kcal/kg)	2996.40	2716.00	2823.14

*Premix contained:VitaminA1500i.u;VitD$_3$,3000iu;VitE12,iu;VitaminK2.4mg;thiamine3.0mg;Riboflavin,6.0mg;pyriooxine4.8mg; 1000mg;nicotinic acid 43mg;calcium panthotenic acid 12mg; 0.6mg;Vitamin B12 0.024mg;vitamin B2 5mg; folic acid 12mg; chlorine chloride,350mg manganese,56 mg, Iodin1mg; Zinc 50mg, copper, 400mg; Iodine,20mg; cobalt, 1.25mg, selenium ,4.8mg

Carcass parameters

At 20 weeks of age, the study made use of random samples of 50 chickens each of both sexes (25 male and 25 female chickens) selected from each genotype based on their mean live weights in each group. The birds were starved overnight and individually weighed using a 5-kg scale with a precision of 0.005. They were then slaughtered by severing the carotid arteries and jugular veins and blood drained under gravity; scalded to facilitate plucking with de-feathering done manually and eviscerated.

The following parameters as described by Kleczek et al. (2007) were taken: Head: Obtained by cutting off between the occipital condyle and the atlas; Neck: Obtained by cutting along the line joining the cephalic borders of the coracoids; Shank: Obtained by cutting off through the hock joint (sesmoid); Wing: Obtained by cutting through the shoulder joint; Thigh/Drumstick: Obtained by cutting through the hip joint (from the pubic process, through the groin towards the back, and then along the backbone, starting from the anterior border of the pelvis); Breast: Obtained by a double cut through the cartilaginous junctures of the ribs, from the inferior border of the backbone towards the coracoids and Back: Dorsal–lumbar quarter (the remaining part of the carcass).

Statistical Analysis

Data obtained for carcass traits were analysed using the General Linear Model of SAS (1999). The model was fitted for the effect of genotype, sex and their interaction. The model used was as specified below:

$Y_{ijk} = \mu + S_i + G_j + (SG)_{ij} + e_{ijk}$

where

Y_{ijk} = the parameter of interest;

μ = overall mean for the parameter of interest

S_i = fixed effect of i^{th} sex (j =1,2)

G_j = fixed effect of j^{th} genotype (k=1,2,3)

$(SG)_{ij}$ = interaction effect of i^{th} sex and j^{th} genotype

e_{ijk} = random error associated with each record (normally, independently and identically distributed with zero mean and variance $\sigma^2 e$).

Significant means were separated using Duncan's new multiple range test of SAS (2000) at probability level of 5%. Pearson correlation (*r*) was used to ascertain relationships between measurable traits.

Results and Discussion

Carcass traits

Chicken genotype significantly (P<0.05) affected carcass traits (Table 2). Naked neck chicken genotype had the highest mean value of slaughter weight followed by Frizzle and Normal chicken genotype. The corresponding mean values are as follows 2084.00±108.43, 1974.10±94.16 and 1693.00±71.43g, respectively. The result of this experiment revealed significant differences among genotypes in the carcass characteristics. The effect of genotypes was significant (P<0.05) on slaughter weight after bleeding, weight after de-feathering and carcass weight with the naked-neck chicken consistently having higher performance. Similar result had been reported for naked neck broilers (Eberhart and Waahburn, 1993). The naked neck gene (Na) reduces feather mass in heterozygous (*Na/na*) or homozygous (*Na/Na*) broilers by 20 and 40% respectively (Fathi et al. 2008) with obvious implications on thermal balance hence of capital importance to tropical environments (Debb and Cahaner, 2001; Ibe, 1993) while it is reported that there is 11 to 40% decrease in feather mass in frizzle layers which reduce insulation efficiency of their feather coverage resulting from their altered shape (Manner, 1992).

Carcass cut parts

All the various carcass cut parts of the bird differed significantly (P<0.05) among genotypes. Naked neck consistently had higher means for all the cut parts except for the shank. For all the carcass parameters, the normal feather seemed to have the lowest significant (P<0.05) value for all the traits among the three genotypes. For organ weights similarly, genotype significantly (P<0.05) affected all the organs (Table 3) with naked neck chicken having higher means in all the organs except for empty proventriculus and abdominal fat. However, some of the organ weights were not significantly (P>0.05) different from that of Frizzle feather chicken (empty gizzard, full gizzard heart, lungs). The naked neck gene had a significant higher effect on the male carcass composition resulting in a greater breast yield. This result agrees with the report of Pesti et al. (1994) and Cahaner et al. (1993). According to Yunis and Cahaner (1999), the effect of the *Na* allele on breast yield could be attributed to lower subcutaneous fat deposition or to increased blood flow in the breast area which becomes a cooling site because of mass reduction in its feather coverage. The relative organ weights were significantly affected by genotype which also favored the naked neck chickens. Better performance has also been reported for naked-neck (*Na*) gene which apparently resulted from a higher rate of protein deposition (Merat, 1990; Cahaner et al., 1993).

Carcass characteristics as affected by sex

Effect of sex on carcass characteristics were also significant (P<0.05) (Table 4). Sex significantly (P<0.05) affected all the parameters measured. The experiment further revealed that male chickens of all genotypes showed remarkable and better carcass yield than their female counterparts for all the traits except for intestinal length. The values obtained for the dressing percentage agrees with the findings of Joseph et al. (1992) where dressing percentage of male local chicken was reported to be significantly higher than that of female. The carcass weight obtained for the male was higher than that of the female as well. These findings correspond with the report of Theerachai (2009) where male local chicken was reported to have higher proportion of total carcass and also consistent with that of Garcia et al. (1993) strengthening the argument for inherent genetic differences. They reported sexual dimorphism at slaughter and carcass yield of the chicken used in their study. These result revealed that males generally had higher values for slaughter weight, weight after bleeding, slaughter weight after defeathering, carcass weight and other organ weights measured in this study which is in accordance with the report of Cahaner et al. (1993). This phenomenon known as sexual dimorphism has been revealed by several reports to usually favour male compared to female especially in poultry (Garcia et al., 1991; Ikeobi et al., 1995; Ilori et al., 2010; Peters et al., 2010). Fayeye et al. (2006) attributed this difference to genetic effect of sex which arises from the male physiological activities. It has also been reported that sex differences were usually due to differences in hormonal profile, aggressiveness and dominance especially when both sexes are reared together (Ibe and Nwosu 1999; Ilori et al., 2010). Adedeji et al. (2004) stated that the aggressiveness of males over the females especially when reared together put the females at a disadvantage for feed and water. On the contrary, these authors and others like Gueye (1998) and Aini (1999) reported higher abdominal fat for female chickens compared to their male counterpart but this was not the case in this study. Variability was higher in abdominal fat in male and this might not be unconnected with the high influence of environment on these traits. The result for kidney was always constant and was not affected by genotype, sex or their interaction.

Interaction effect of genotype and sex on carcass traits

Least square means for interactions between genotype and sex are presented in Tables 5 and 6. The interactive effect of genotype and sex significantly (P<0.05) affected all carcass traits and organ weights except for kidney and liver. For carcass traits, naked-neck cocks consistently have higher means followed by frizzle-feathered cocks, normal-feathered cocks, naked-neck hens, frizzle-feathered hens while the least was usually found in normal-feathered females except for wing, breast and neck where both naked-neck and frizzle-feathered cocks have the same values. On the other hand for organ weights, both naked-neck and frizzle-feathered males consistently have higher values for all the organs except intestinal length and empty proventriculus. The traits are higher in both naked neck and frizzle-feathered males followed by normal-feathered males or female frizzle-feathered and then the other females. For intestinal length, both male and female frizzle-feathered chickens coupled with naked-neck males had higher values while normal feathered chickens had the least values. Frizzle-feathered cocks and hens with naked-neck cocks had the highest EP followed by female naked-neck, normal-feathered male chicken and the females.

The present results indicate separate rankings of the two genotypes under the two sexes as the naked-neck males sometimes performed better than the frizzle-feathered males followed by the normal-feathered males and the females which further confirms the effect of genotype by sex interaction in our local chickens. As expected, the relative advantages of naked neck and frizzle alleles were more significant especially among the males. The reduction in feather coverage coupled with the male advantage over the females to dominate competition for resources could have put them at an edge over the others.

Table 2: Least square means, standard errors (±SE) and coefficients of variation (CV) (%) for carcass traits as affected by genotype

Parameters	N	Naked neck	CV	Frizzle	CV	Normal	CV
SLWT (g)	50	2084.00±108.43[a]	36.79	1974.10±94.16[b]	33.73	1693.00±71.34[c]	29.83
WAB (g)	50	1962.00±71.43[a]	35.10	1826.50±79.36[b]	30.72	1678.00±71.43[c]	30.10
WAD (g)	50	1823.00±0.63[a]	36.46	1614.00±0.43[b]	28.71	1568.00±0.43[c]	32.21
CWGT (g)	50	1431.55±91.51[a]	39.66	1147.50±23.93[b]	14.75	890.00±7.14[c]	5.68
Head	50	52.5±0.64[a]	8.66	51.00±0.43[a]	5.94	51.00±0.43[a]	5.94
Shanks	50	45.5±1.50[b]	23.31	53.00±0.00[a]	19.04	39.00±1.29[c]	23.31
Drumstick	50	361.50±750[a]	16.50	318.00±6.86[b]	15.25	270.00±7.14[c]	18.71
Back	50	235.50±0.79[a]	2.58	214.00±0.00[b]	5.72	197.00±2.14[c]	7.69
Breast	50	273.50±4.36[a]	11.69	256.00±4.29[b]	11.84	224.00±5.29[c]	16.69
Neck	50	83.50±0.93[a]	7.86	77.00±1.29[b]	11.81	73.00±0.71[c]	6.91
Wing	50	123.5±0.00[a]	6.95	99.5±0.00 [c]	34.01	104.0±0.00[b]	4.86

[a,b,c,d]Means in the same row with different superscripts are significantly different (P<0.05)

Table 3: Least square means, standard errors (±SE) and coefficients of variation (CV) (%) for organs weights parameters as affected by Genotype (n=50)

Parameters	Naked neck	CV	Frizzle	CV	Normal	CV
EP	9.5±0.00[b]	5.32	10.00±0.00 [a]	2.54	8.50±0.00[c]	5.94
Intestinal length	149.50±0.07[a]	0.34	147.00±0.00[b]	3.54	129.00±0.31[c]	0.74
Empty gizzard	29.50±0.07[a]	1.71	29.00±0.00[a]	2.19	25.00±0.10[b]	0.23
Full gizzard	46.50±0.34[a]	5.43	46.50±0.36[a]	5.43	40.00±0.320[b]	1.74
Heart	11.50±0.36[a]	21.96	11.50±0.36[a]	2.22	8.00±0.10[b]	0.27
Liver	24.50±0.21[a]	6.18	24.00±0.54[a]	1.54	23.56±0.39[a]	3.54
Lungs	9.50±0.36[a]	26.58	9.50±0.21[a]	19.95	6.00±0.04[b]	17.4
Kidney	2.00±0.60 [a]	0.92	2.00±0.14[a]	2.11	2.00±0.50[a]	1.75
Abdominal fat	27.50±1.21[b]	31.22	29.88±0.87[a]	20.29	24.45±0.06[c]	15.86

[a,b,c,d]Means in the same row with different superscripts are significantly different (P<0.05)

Table 4: Least square means, standard errors (±SE) and coefficients of variation (CV) (%) for carcass characteristics as affected by sex (n=75)

Parameters	Male	CV	Female	CV
SLWT (g)	2122.00±51.36 [a]	10.67	1275.00±4.46 [b]	4.73
WAB (g)	2009.00±45.09 [a]	7.97	1214.00±5.73 [b]	3.73
WAD (g)	1759±51.09 [a]	8.84	1112±4.76 [b]	3.88
CWGT(g)	1287±46.18 [a]	37.42	924±8.32 [b]	7.36
Cut-up parts(g)				
Head	50.40±0.53 [a]	2.59	46.20±0.24 [b]	0.00
Shank	45.80±0.75 [a]	6.35	38.00±0.07 [b]	25.28
Drumstick	302.40±5.85 [a]	6.78	242.40±2.01 [b]	9.29
Wing	113.20±1.49 [a]	8.95	94.40±1.43 [b]	22.01
Breast	231.80±5.91 [a]	5.05	176.00±4.55 [b]	9.46
Back	194.80±2.31 [a]	1.80	188.00±1.87 [b]	7.10
Neck	81.20±0.32 [a]	5.93	72.20±0.52 [b]	6.02
Organ weights(g)				
EP	9.00±0.08 [a]	4.91	7.80±0.14 [b]	9.13
Intestinal length	134.00±1.05 [b]	6.39	136.00±0.97 [a]	6.57
Full Gizzard	44.08±0.33 [a]	9.29	42.80±0.14 [b]	4.45
Empty Gizzard	27.40±0.17 [a]	7.77	27.20±0.14 [b]	6.86
Heart	8.80±0.40 [a]	23.73	6.80±0.21 [b]	5.48
Liver	23.20±0.18 [a]	3.85	22.60±0.13 [b]	2.01
Lungs	9.40±0.18 [a]	27.33	7.80±0.10 [b]	11.74
Kidney	2.20±0.04 [a]	0.00	2.00±0.06 [b]	0.00
Abdominal Fat	29.37±0.46 [a]	16.39	23.44±0.21 [b]	10.62

[a,b,c,d] Means in the same row with different superscripts are significantly different (P<0.05)

Table 5: Least squares means and standard errors (±SE) for organ weights as influenced by interactive effect of genotype and sex

Genotype	Sex	Parameters								
		EP	INTL	FG	EG	Heart	Liver	Lung	Kidney	ABF
Frizzle	Male	10±0.15^{a}	147±0.94^{a}	49±0.54^{a}	29±0.28^{a}	14±0.19^{a}	24±0.32	11±0.17^{a}	2±0.00	36±0.29^{a}
	Female	10±18^{a}	147±0.89^{a}	44±0.48^{b}	29±0.23^{a}	9±0.28^{b}	24±0.28	8±0.14b^{c}	2±0.00	24±0.22^{b}
Normal	Male	9±0.18a^{b}	129±0.79^{b}	40±0.53^{c}	25±0.32^{b}	8±0.17^{b}	24±0.34	6±0.12^{c}	2±0.00	25±0.31^{b}
	Female	8±0.28^{b}	129±0.80^{b}	40±0.44^{c}	25±0.29^{b}	8±0.19^{b}	24±0.29	6±0.15^{c}	2±0.00	24±0.28^{b}
Naked	Male	10.16^{a}	150±0.95^{a}	49±0.47^{a}	30±0.32^{a}	14±0.17^{a}	26±0.26	12±0.17^{a}	2±0.00	36±0.30^{a}
	Female	9±0.17^{ab}	149±0.97^{a}	44±0.51^{b}	29±0.29^{a}	9±0.23^{b}	23±0.29	7±0.12b^{c}	2±0.00	19±0.19^{c}

^{a,b,c,d}Means within the same column having different superscripts are significantly different (P<0.05)

Table 6: Least square means and standard errors (±SE) for carcass traits as influenced by interactive effect of genotype and sex

Genotype	Sex	Parameters							
		SLWT	WAB	WAD	CWGT	Head	Shank	DST	Wing
Frizzle	Male	2633±50.4^{b}	2382±49.54^{b}	2072±57.68^{b}	1315±42.34^{b}	54±0.67^{b}	53±0.59^{b}	366±4.54^{b}	133±1.55^{a}
	Female	1315±43.27^{d}	1271±32.1^{d}	1155±31.14^{cd}	980±39.54^{cd}	48±0.57^{c}	53±0.56^{b}	270±4.89^{d}	66±0.98^{d}
Normal	Male	2193±49.28^{c}	2178±47.24^{c}	2068±43.5^{b}	940±38.57^{cd}	54±0.63^{b}	48±0.49^{c}	320±5.45^{c}	109±0.96^{b}
	Female	1193±42.44^{e}	1178±33.21^{d}	1068±30.76^{d}	840±37.56^{d}	48±0.49^{c}	30±0.38^{e}	320±4.34^{c}	99±0.86^{c}
Naked	Male	2843±51.2^{a}	2643±55.45^{a}	2481±57.87^{a}	2272±47.54^{a}	57±0.66^{a}	56±0.42^{a}	374±5.69^{a}	132±0.87^{a}
	Female	1325±43.57^{d}	1280±34.45^{d}	1165±41.34^{cd}	991±27.77^{cd}	48±0.44^{c}	35±0.33^{d}	269±5.78^{d}	115±0.9^{b}

^{a,b,c,d}Means within the same column having different lowercase letters are significantly different (P<0.05)

Table 7: Phenotypic correlations between carcass traits of birds used for the study

	SLWT	WAB	WAD	CGWT	Head	Shank	DS	Wing	Breast	Back	Neck
SLWT	1.00										
WAB	0.99^{xxx}	1.00									
WAD	0.98^{xxx}	0.99^{xxx}	1.00								
CGWT	0.77^{xxx}	0.75^{xxx}	0.76^{xxx}	1.00							
Head	0.97^{xxx}	0.99^{xxx}	0.99^{xxx}	0.77^{xxx}	1.00						
Shank	0.73^{xxx}	0.72^{xxx}	0.71^{xxx}	0.61^{xxx}	0.69^{xxx}	1.00					
DS	0.97^{xxx}	0.96^{xxx}	0.94^{xxx}	0.75^{xxx}	0.92^{xxx}	0.81^{xxx}	1.00				
Wing	0.75^{xxx}	0.73^{xxx}	0.70^{xxx}	0.59^{xxx}	0.70^{xxx}	0.14^{ns}	0.69^{xxx}	1.00			
Breast	0.94^{xxx}	0.94^{xxx}	0.92^{xxx}	0.74^{xxx}	0.90^{xxx}	0.8^{xxx}	0.99^{xxx}	0.68^{xxx}	1.00		
Back	0.62^{xxx}	0.62^{xxx}	0.63^{xxx}	0.57^{xxx}	0.59^{xxx}	0.84^{xxx}	0.79^{xxx}	0.23^{xx}	0.84^{xxx}	1.00	
Neck	0.93^{xxx}	0.91^{xxx}	0.89^{xxx}	0.81^{xxx}	0.88^{xxx}	0.57^{xxx}	0.92^{xxx}	0.88^{xxx}	0.93^{xxx}	0.65^{xxx}	1.00

*P<0.05, **P<0.01, ***P<0.001, ns= not significant (P>0.05).

Table 8: Phenotypic correlations between carcass traits and organ weights of birds used for the study

	SLWT	WAB	WAD	CWGT	Head	Shank	DS	Back	Breast	Neck	Wing
EP	0.59^{xxx}	0.55^{xxx}	0.52^{xxx}	0.58^{xxx}	0.49^{xxx}	0.92^{xxx}	0.74^{xxx}	0.88^{xxx}	0.75^{xxx}	0.55^{xxx}	0.14^{ns}
INTL	0.22^{x}	0.16^{ns}	0.12^{ns}	0.50^{xxx}	0.09^{ns}	0.43^{xxx}	0.41^{xxx}	0.66^{xxx}	0.45^{xxx}	0.43^{xxx}	0.20^{x}
FG	0.68^{xxx}	0.61^{xxx}	0.56^{xxx}	0.77^{xxx}	0.55^{xxx}	0.65^{xxx}	0.76^{xxx}	0.66^{xxx}	0.75^{xxx}	0.77^{xxx}	0.55^{xxx}
EG	0.33^{xxx}	0.27^{x}	0.24^{x}	0.62^{xxx}	0.21^{x}	0.54^{xxx}	0.50^{xxx}	0.70^{xxx}	0.53^{xxx}	0.50^{xxx}	0.23^{x}
Heart	0.82^{xxx}	0.77^{xxx}	0.72^{xxx}	0.82^{xxx}	0.71^{xxx}	0.65^{xxx}	0.84^{xxx}	0.56^{xxx}	0.81^{xxx}	0.86^{xxx}	0.69^{xxx}
Liver	0.68^{xxx}	0.68^{xxx}	0.70^{xxx}	0.88^{xxx}	0.74^{xxx}	0.59^{xxx}	0.59^{xxx}	0.35^{xxx}	0.54^{xxx}	0.57^{xxx}	0.33^{xxx}
Lungs	0.78^{xxx}	0.72^{xxx}	0.68^{xxx}	0.87^{xxx}	0.68^{xxx}	0.72^{xxx}	0.81^{xxx}	0.63^{xxx}	0.78^{xxx}	0.80^{xxx}	0.55^{xxx}
Kidney	0.00^{x}	0.00^{x}	0.00^{x}	0.00^{x}	0.00^{xxx}	0.00^{x}	0.00^{x}	0.00^{x}	0.00^{x}	0.00^{x}	0.00^{x}
ABF	0.89^{xxx}	0.85^{xxx}	0.81^{xxx}	0.77^{xxx}	0.82^{xxx}	0.69^{xxx}	0.84^{xxx}	0.43^{xxx}	0.77^{xxx}	0.78^{xxx}	0.61^{xxx}

*P<0.05, **P<0.01, ***P<0.001, ns= not significant (P>0.05)

Pearson correlation coefficients of carcass traits

Table 7 showed that correlation coefficients between carcass traits were very highly significant (P<0.01). Correlation coefficients (*r*) among carcass traits were all positive and very highly significant (P<0.01) and ranged from 0.14 which was the only one not significant (P>0.05) between shank and wing to 0.99 (P<0.01) between WAB and SLWT, WAD and WAB, Head and WAB, Head and WAD and Breast and DS. The correlation coefficients among carcass traits and organ weights are presented in Table 8 and showed that correlations between parameters studied were generally positive and mostly very highly significant (P<0.01). No correlation existed between kidney and all the carcass traits while non significant (P>0.05) correlations existed between EP and wing, INTL and WAB, INTL and WAD and between INTL and head. Strong associations were observed between most parameters with *r* ranging from 0.00 between kidney and all of the cut parts to 0.89 between abdominal fat and slaughter weight.

Strong and positive correlations among most parameters demonstrate inter-relationship among these parameters except for no relationship between kidney and the carcass traits. All the carcass traits and majority of the associations between organs weights and carcass traits have positive, very high and significant (P<0.001) direct relationship with each other which means that for all these traits except for kidney, there existed increase in a linear fashion as live weight increases in these set of birds. Any of the traits could be used as indicator of live weight and could be used complementarily in selection. These are in accordance with other findings especially in other chicken strains like broiler chicken where they reported positive and significant correlations between live weight, carcass weight, breast weight and organs (Musa et al., 2006; Ojedapo et al., 2008; Zerehdraran, 2005). According to Muhiuddin (1993), if the positive phenotypic correlations translate into positive genetic correlations thus, selection for one will improve the other as a correlated response.

Conclusions

Our study showed that variation in the genetic makeup and sexual differences of chickens accounted for observed differences in carcass characteristics. Naked neck chickens performed better in all the parameters measured. The use of naked neck and probably the frizzle-feathered gene as seen in their performance in this study should be encouraged in the expansion of chicken genetic base especially in crossbreeding programs with both local and exotic strains. This will help to better improve them in terms of meat quality and quantity as these local chickens seem to have major genes that are responsible for thermoregulation and hence their better tolerance to harsh tropical environment.

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