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Sexual Dimorphism in Predicting Body Weight of Two Broiler Strains.

Adedibu, I.I[1] and Ayorinde, K.L[2].

[1*]Department of Animal Science. Ahmadu Bello University, Zaria, .Kaduna state, Nigeria
[2]Department of Animal Production, University of Ilorin. Kwara State, Nigeria.
Corresponding author iiipinyomi@yahoo.com

Target Audience: Researchers, Poultry farmers

Abstract.

A study was carried out to determine if the relationship between liveweight and linear body measurements, as well as predictability of both liveweight and linear body measurements were influenced by sex in two strains of broiler chickens (Arbor Acre and Anak). One hundred and twenty day old broiler chicks comprising sixty two males and fifty eight females were used in the study. The birds were wing tagged at day old. Liveweight and linear parameters such as wing length (WL), thigh length (TL), drumstick length (DL), shank length (SL), body length (BL), body girth (BG) and keel length (KL) were measured on individual birds fortnightly (at day old, 2, 4, 6 and 8 weeks). The result of the study showed that sexual dimorphism existed in the relationships between liveweights and linear measurements at 2, 4, 6 and 8 weeks of age in the Arbor Acre broilers, while in Anak broilers the effect of sex was significant at 2 weeks and 8 weeks of age only. Sex influenced the linear body measurement(wing length, thigh length, drumstick length, shank length, body length, body girth and keel length) that could predict liveweights at all ages in the Arbor Acre and Anak broilers.

Keywords: liveweight, sexual dimorphism, linear measurements, broilers

Description of problem.

Sexual dimorphism is a natural phenomenon in all growing animals whereby there are manifestations of visible and significant differences between the male and female species (1, 2, 3). In the domestic chicken, this is observed from body weight gains, size, shape, and behaviour of the birds. The vast differences in body weight of male and female domestic chicken have considerable economic impact. Females grow more slowly, reach lower weights at market ages and are less efficient utilizers of feed than males (4) and even though they eat the same amount of feed during this period, the males have better feed efficiency (5). Within a few days after hatch, males are heavier than females, eat more and these differences increase day by day and eventually reach statistical significance (4). At growing and finishing stages, the males are heavier than females (6,7,8). Several authors have reported effects of sexual

dimorphism on linear body measurements (9, 10, 11, 2, 12). Similar effects of sexual dimorphism on linear body measurement and liveweight have been reported in other livestock species, such as quail (13), lambs (14), rabbits (15), and Yankasa sheep (16). Sexual dimorphism of meat chicken has been known to be a challenge when a homogenous group is required (17, 12). This study was carried out to determine if the relationship between liveweight and linear body measurements is influenced by sex of broiler birds, and if the predictability of liveweight using linear body measurements is influenced by sex of broiler birds.

Materials and Methods.

The study was carried out at the Animal Pavilion of the Department of Animal Production, Faculty of Agriculture, University of Ilorin. One hundred and twenty day old (62 male, 58 female) broilers comprising of two strains of bird, Arbor Acre and Anak, were used for the study. Each bird was wing tagged at day old, weighed and the linear parameters taken on arrival at the experimental site. The birds were raised on the deep litter system throughout the eight week experimental period. All routine vaccinations and medications were administered as and at when due. The birds were fed *ad libitum* with commercial broiler feed (Vital® feed).

Body weight and other body linear measurements were taken on individual birds fortnightly (at day old, 2, 4, 6 and 8 weeks) early in the morning before feeding the birds. Wing length (WL) was measured by stretching the right wing so that it was as straight as possible and a ruler used to take the length from the joint between the coracoid and humerus to the tip of the phalanges. Leg measurements were taken on the right leg using a ruler. The thigh length (TL) was taken as the length of the femur, drumstick length (DL) spanned the length of tibia while shank length (SL) was taken as the distance from the tip of the metatarsus to the hock. Body weight (BW) was taken using a triple beam balance at day old and at two weeks of age by placing individual birds on the loading pan while a top loading scale was used for subsequent measurements by placing individual birds on the loading pan and its weight read – off. Body length and body girth were measured using a measuring tape. Body length (BL) was taken as the distance between the posterior end of the nasal cavity and pygostyle with the neck of the bird stretched as far as possible without harming the bird. Body girth (BG) was taken as the highest circumference of the breast (sternum) after the wings have been held away from the body of the broiler. The keel length (KL) was the distance between the anterior and posterior ends of the sternum (breast bone). All linear measurements were in centimeters while the body weights were in gramme.

Statistical Analysis.

The data were analysed using ANOVA Procedure of SAS statistical package (19). Linear correlation and Partial regression analyses between body weight

and the different body measurements were determined using the procedure described by (18). The model used for the analysis is as follows;

$Y = \alpha + \beta_1 X_1 + \beta_2 X_2 + \ldots\ldots\ldots B_k X_k$

Where

Y= liveweight (dependent variable)

α =intercept of the line on the Y – axis.

$\beta_1, \beta_2, \ldots \beta_k$= regression coefficients.

X_1, X_2,..X_k= various linear body measurements.

And stepwise (or partial) regression,

$$Y' = B'_1 X'_1 + \ldots\ldots\ldots B'_k X'_k$$

Results and Discussion.

Tables 1 and 2 show the effect of sex on growth characteristics in Arbor Acre and Anak strains of broiler chicken. There was no significant difference (P>0.05) between sex in all the linear body measurements and body weight at day old which supperceed earlier reports (20) on White Hyperco broilers. It was similarly reported (21) that sex of the Arbor Acre broilers does not influence day old body weight. In this study, there were significant differences (P<0.01) in body weight of both sexes in Arbor Acre at 2, 4, 6 and 8 weeks of age showing that sex effect on body weight sets in at 2 weeks of age and continued to 8 weeks of age. Sex effect on body weight of Anak was significant (P<0.01) only at 2 weeks and 8 weeks (P<0.05) of age. This result is similar to existing reports (22, 20, 23) that males were significantly heavier than females (P<0.01) which was attributed to differences in hormonal balance resulting in faster deposition of muscles in males than females (22), aggressiveness and dominance of males when feeding especially when they are reared together (3).

Table 1: Effect of sex on growth characteristics in Arbor Acre strain of broilers chicken.

	Day old		Week 2		Week 4		Week 6		Week8	
Character	M	F	M	F	M	F	M	F	M	F
BW(g)	48.61	46.17	314.84**	235.93	708.06**	640.74	1313.79**	1125.93	1739.66**	1531.48
BL(cm)	11.63	11.50	20.04*	19.31	24.97	24.70	32.16	31.50	35.28	34.40
SL(cm)	2.73	2.66	5.37**	4.96	6.77	6.68	9.60	8.61	9.90**	9.24
TL(cm)	3.01	2.93	5.50*	5.16	8.05	8.00	9.86	9.19	11.18*	10.31
KL(cm)	2.07	2.10	7.36	6.84	10.65	10.23	12.64**	11.90	14.93**	13.65
BG(cm)	9.14	8.95	14.23**	12.96	21.04	21.09	25.41	24.35	29.32*	27.79
DL(cm)	3.75	3.61	6.43	6.13	8.04**	7.77	10.76	10.57	12.22**	11.41
WL(cm)	4.97	4.55	10.11	9.80	15.31	15.04	17.51**	16.52	20.74**	19.68

*P<0.05 **P<0.01

Table 2: Effect of sex on growth characteristics in Anak strain of broilers chicken.

Character	Day old		Week 2		Week 4		Week 6		Week8	
	M	F	M	F	M	F	M	F	M	F
BW(g)	49.44	49.03	316.13*	288.89	725.00	667.86	1148.39	1072.00	1654.84**	1404..00
BL(cm)	12.88	12.88	20.39*	19.39	25.11	24.49	31.68	31.26	35.31	34.45
SL(cm)	2.49	2.65*	5.39	5.32	6.62	6.34	9.15	8.82	9.62	9.14
TL(cm)	3.16	3.11	5.47	5.43	7.90*	7.43	9.22	8.94	10.86**	9.86
KL(cm)	1.72	1.63	7.55	7.42	10.33*	9.84	11.50	11.54	14.16*	13.62
BG(cm)	9.46	8.88	13.79	13.87	20.13	19.53	23.41	22.98	28.24**	25.89
DL(cm)	3.80	3.71	6.78	6.83	8.22	7.98	10.82**	10.38	12.74**	11.34
WL(cm)	4.84	5.00	10.30	10.18	15.56*	15.00	17.02	16.62	20.61**	19.24

*P<0.05 **P<0.01

Sex effect on body length was observed in the 2 week old Arbor Acre and Anak broilers in favour of the males which differed from the reports (3) that there was no significant differences (P<0.05) in 2 and 4 – week old Hubbard broiler breeders, but there were significant differences (P<0.05) at 6 and 8 – weeks of age. The males had significant (P<0.01) shank length at 2 and 8 weeks of age in Arbor Acre and at day old in Anak broilers. This is in contrast to the earlier findings (3) which indicated significant differences at 4, 6, and 8 weeks of age. Thigh length showed significant sex differences in Arbor Acre at 2 and 8 weeks of age and Anak broilers at 4 and 8 weeks of age. Keel length was significantly (P<0.01) different in the 6 and 8 weeks old Arbor Acre, and 4 and 8 weeks old Anak. Body girth was significantly (P<0.01) different at 2 and 8 weeks of age in the Arbor Acre; and at 8 weeks of age in Anak unlike in (3) who reported significant differences at 4, 6, and 8 weeks but not at 2 weeks of age. Drumstick length was significantly (P<0.01) different in the 4 and 8 weeks old Arbor Acre; and in 6 and 8 weeks old Anak. There were significant (P<0.05) differences on the wing length of the Arbor Acre at 6 and 8 weeks of age, and in Anak broilers at 4 and 8 weeks of age. The overall result showed that the males had higher linear body measurements than the females. This result is similar to results obtained by (9, 11, 2). Sexual dimorphism in favour of male birds could be attributed to differences in hormonal profile, aggression and dominance during feeding (24).

Table 4: Effect of sex on simple correlation between liveweight and linear measurements in Arbor Acre broilers.

Age	0		2		4		6		8	
Sex	M	F	M	F	M	F	M	F	M	F
Parameter										
BL	0.15	0.56**	0.43*	0.68**	0.34*	0.22	0.44*	0.44*	0.53**	0.71**
SL	-0.14	0.21	0.32	0.47*	0.09	-0.04	0.28	0.40*	0.44*	0.30
TL	0.05	0.39*	0.52**	0.42*	0.21	0.35*	0.10	0.35*	0.28	0.39*
KL	-0.25	-0.44*	0.19	0.62**	0.09	0.20	0.37*	0.70**	0.54**	0.62**
BG	0.02	-0.04	0.70**	0.82**	0.20	0.16	0.43*	0.56**	0.74**	0.28
DL	0.00	0.55**	0.13	0.41*	0.25	0.32	0.10	0.27	0.38*	0.17
WL	-0.04	-0.15	0.17	0.61**	0.50**	0.01	0.71**	0.45*	0.58**	0.49**

*P<0.05 **P<0.01

At day old, there were no significant correlations between body weight and all the linear body measurements in the male Arbor Acre and Anak broilers (Tables 4 and 5). The lack of relationship may be due to the influence of egg size on day old body weight (21) as no environmental factors had influenced the weight yet. In the female Arbor Acre however, there were significantly positive relationships between body weight and body length (P<0.01); body weight and drumstick length (P<0.01); body weight and thigh length (P<0.05). In the female Anak broilers, the only significant correlation was between liveweight and wing length. The implication is that the female broiler chicken could be selected at day old for intensive feeding because of the strong relationships between liveweight and body length; liveweight and drumstick length as these two linear measurements positively influence live weight hence an increase in body length and drumstick length would mean an increase in meatiness of the birds. At 2 weeks of age, body length of Arbor Acre males (P<0.05) and females (P<0.01), and Anak males and females (P<0.01) were highly and significantly correlated with body weight which could be an indication of meatiness; hence it could be used to predict body weight. Body girth of the male Anak broilers was significantly correlated with body weight (P<0.05) and in the female Anak broilers, body girth was significantly correlated with body weight (P<0.01).

Table 5: Effect of sex on simple correlation between liveweight and linear measurements in Anak broilers.

Age (weeks)	0		2		4		6		8	
Sex	M	F	M	F	M	F	M	F	M	F
Parameter										
BL	0.01	0.21	0.59**	0.63**	0.56**	0.73**	0.44*	0.01	0.52**	0.32
SL	0.17	-0.13	0.42*	0.08	0.33*	0.38*	0.05	0.35*	0.70**	0.00
TL	-0.11	0.03	0.36*	0.23	0.06	0.30	0.49**	0.29	0.77**	0.22
KL	-0.03	0.26	0.27	0.00	0.26	0.59**	0.65**	0.63**	0.50**	-0.32
BG	-0.18	-0.20	0.36*	0.50**	0.31	0.55**	0.71**	0.70**	0.47**	0.02
DL	0.09	0.28	0.51**	0.26	0.58**	0.57**	0.41*	0.23	-0.12	0.26
WL	0.03	0.43*	-0.51**	0.34*	0.35*	0.48*	0.70**	0.48*	0.67**	-0.02

*P<0.05 **P<0.01

The result was similar to the report of (3) indicating no sex effect in the relationship between body weight and body girth at 2 weeks of age. The correlation between body weight and drumstick length in Arbor Acre female (P<0.05) and male Anak (P<0.01) broilers at 2 weeks of age indicated the effect of sex. The pattern in the relationship between body weight and linear measurements that were significant in the 2 week old Arbor Acre and Anak broilers indicated a bias for females.

At 4 weeks of age, body length (P<0.05) and wing length (P<0.01) of the male Arbor Acre were significantly correlated to body weight, and drumstick length. Thigh length of the female was significantly correlated to body weight (P<0.05); All the linear measurements were significantly correlated with body weight except thigh length in the female Anak broilers. However, body length, shank length, drumstick length and wing length of the male Anak broilers were positive and significantly correlated with body weight. The correlation values were higher in the females indicating sex influence in the linear measurements that were related to body weight.

At 6 weeks of age, the body parts were significantly related to body weight in the female than in the male Arbor Acre. On the other hand, linear measurements were significantly correlated with body weight in the males than in the females. Reports on Hubbard broilers (3) indicated also a bias in favour of the females.

At 8 weeks of age, the keel length, body length and wing length of the female Arbor Acre had significantly high correlation with body weight (P<0.01), thigh length with body weight (P<0.05) and in the male Arbor Acre, keel length, body length, body girth and wing length were positively and highly significantly correlated with body weight while shank length was positive (P<0.01) significantly correlated with bodyweight. In the 8 week old male Anak broilers, all the linear measurements, except drumstick length, were positively highly and significantly correlated with body weight (P<0.01). None of the linear body

measurements of the female Anak broilers was significantly correlated with body weight.

Table 6: Stepwise regression equations for estimating liveweight of male and female Arbor Acre broilers.

Sex	Age (weeks)	Model	Parameter	Intercept (a)	Regression Coeff (b)	R^2	Adjusted R^2
Male	0	-	None	-	-	-	-
	2	1	BG	-449.14	53.73	0.49	0.48
		2	BG	-538.34	45.63	0.59	0.56
			TL		37.17		
	4	1	WL	-466.74	76.72	0.25	0.22
	6	1	WL	-696.91	114.83	0.51	0.49
	8	1	BG	-1108.33	97.13	0.55	0.53
		2	BG	-1914.78	89.50	0.65	0.62
			KL		104.05		
Female	0	1	BL	11.54	3.01	0.32	0.28
	2	1	BG	-205.18	34.05	0.68	0.67
		2	BG	-300.15	31.13	0.75	0.73
			SL		26.75		
	4	-	-	-	-	-	-
	6	1	KL	-669.52	151.40	0.50	0.48
		2	KL	-2058.26	152.12	0.81	0.80
			BG		56.67		
		3	KL	-2181.29	145.71	0.85	0.83
			BG		54.66		
			TL		27.01		
		4	KL	-2491.42	140.63	0.87	0.85
			BG		55.21		
			TL		25.27		
			DL		35.29		
	8	1	BL	-643.05	63.22	0.50	0.48
		2	BL	-1809.04	47.90	0.61	0.58
			KL		124.05		

Non of the linear body measurements could predict liveweight of the day old male Arbor Acre whereas body length accounted for 28% of the liveweight of the female Arbor Acre indicating that there was slight sexual dimorphism in the use of linear body measurement at day old in the Arbor Acre broilers (Table 6).

At 2 weeks of age, body girth and thigh length could be used to predict liveweight of male Arbor Acre (56%) while body girth and shank length were the predictors in the female Arbor Acre (73%). Although there were similarities in linear measurement (body girth) that can be used to predict liveweight at 2

weeks of age in both sexes, there may be an indication that there are sexual dimorphism at that age. In the 4 week old Arbor Acre, wing length could predict only 22% of liveweight in the males but none of the linear body measurements could be used as a predictor of liveweight in the females showing that there was sexual dimorphism in the use of linear body measurements in predicting liveweights. In the 6 weeks old Arbor Acre, wing length was the predictor of male liveweight (49%) but keel length, body girth, thigh length and drumstick length were the predictors for liveweight of the females (85%) indicating that there was sexual dimorphism in the use of linear body measurements for prediction. Body girth and keel length were the predictors of liveweight (62%) in the 8 week old male Arbor Acre and body length and keel length were the predictors of liveweight of the female Arbor Acre (58%). Keel length was the linear body measurement both sexes had in common for predicting liveweight at 8 weeks of age.

In Table 8, the linear body measurements of the male Anak broilers at day old was not able to predict liveweight (0%) whereas wing length could predict only 15% of the liveweight in the female, hence indicating very low sexual dimorphism at day old. Body length, drumstick length, and shank length were useful in predicting liveweight of the 2 week old male Anak boiler (54%). Body length and wing length predicted 47% of liveweight of the 2 week old female Anak broilers indicating that sex could have influenced the linear measurements which could predict liveweight at 2 weeks of age. At 4 weeks of age, the liveweight of the male Anak broilers could be slightly predicted using drumstick length (32%); and the female liveweight can be predicted using body length and shank length (57%). In the 6 week old male Anak broilers, body girth and body length were the linear measurements predictive of liveweight (54%) and in the female, body girth and keel length were the predictors of body weight (54%). At 8 weeks of age, liveweight of the male Anak broilers could be predicted using thigh length, shank length and keel length (79%) while in the 8 weeks old female Anak broilers, liveweight could be predicted using drumstick length, body girth, keel length and shank length (75%).

Table 7: Stepwise regression equations for estimating bodyweight of male and female Anak broilers.

Sex	Age (weeks)	Model	Parameter	Intercept (a)	Regression Coeff (b)	R^2	Adjusted R^2
Male	0	-	-	-	-	-	-
	2	1	BL	-136.00	22.18	0.35	0.33
		2	BL	-199.21	18.35	0.49	0.45
			DL		20.81		
		3	BL	-365.57	13.26	0.58	0.54
			DL		24.62		
			SL		45.32		
	4	1	DL	27.57	84.83	0.34	0.32
	6	1	BG	177.27	41.40	0.50	0.48
		2	BG	-542.75	37.66	0.57	0.54
			BL		25.54		
	8	1	TL	-750.20	221.43	0.60	0.58
		2	TL	-1609.52	161.51	0.72	0.70
			SL		156.95		
		3	TL	-2588.07	142.20	0.81	0.79
			SL		149.52		
			KL		88.96		
Female	0	1	WL	20.10	5.78	0.18	15
	2	1	BL	30.47	22.18	0.40	0.37
		2	BL	-197.14	18.35	0.51	0.47
			WL		20.81		
	4	1	BL	-890.83	63.64	0.54	0.52
		2	BL	-729.82	90.06	0.60	0.57
			SL		-127.50		
	6	1	BG	83.21	43.03	0.49	0.47
		2	BG	-317.52	31.36	0.58	0.54
			KL		57.96		
	8	1	DL	-1011.30	212.99	0.56	0.54
		2	DL	-1613.30	177.00	0.68	0.65
			BG		39.02		
		3	DL	-1915.37	121.85	0.74	0.71
			BG		31.63		
			KL		82.17		
		4	DL	-2301.59	67.80	0.79	0.75
			BG		33.82		
			KL		75.95		
			SL		112.38		
		5	BG	-2278.40	36.78	0.77	0.74
			KL		96.68		
			SL		154.70		

Conclusion.

(1) Sex did not influence the relationship between liveweight and linear measurements in the day old Arbor Acre and Anak broilers. Sexual dimorphism existed in the relationships between liveweights and linear measurements at 2, 4, 6 and 8 weeks of age in the Arbor Acre broilers whereas the effect of sex on the relationship between liveweight and linear body measurements of Anak broilers were significant only at 2 and 8 weeks of age.

(2) The existence of sexual dimorphism can be attributed to differences in hormonal balance resulting in faster deposition of muscles in males than females, aggressiveness and dominance of males when feeding especially when they are reared together.

(3) In this study, sex influenced the linear body measurements that could predict liveweights at all ages in the Arbor Acre and Anak broilers.

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