EFFECT OF FEED RESTRICTION ON BROILER PERFORMANCE: CONFORMATION TRAITS AND ISOMETRY OF GROWTH.

S.N. IBE and E.N. NWACHUKWU

Department of Animal Science University of Nigeria Nsukka.

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ABSTRACT

The effect of quantitative feed restriction on broiler conformation traits, namely breast width, keel length, thigh width and shank length, and on growth of these linear body structures relative to overall body growth was investigated using two hundred and forty Cobb broiler chicks. Three levels of restriction, namely 5, 10 and 15% of *ad libitum* intake, were randomly imposed on different groups. Birds restricted-fed in the starter phase of growth were full-fed in the finisher phase, and vice versa.

Conformation traits, particularly breast width, keel length and thigh diameter, were generally more adversely affected by feed restriction in the starter than in the finisher phase. However, there was evidence of compensatory growth for all parameters, except the breast. Feed restriction did not significantly affect the relative growth pattern of the breast, keel and thigh, which was positively allometric. Relative growth of the shank was, however, affected by different levels of restriction.

Key Words: Broiler, conformation, isometry, growth

INTRODUCTION

Apart from body weight, a number of conformation traits are known to be good indicators of body growth and market value of broilers (Gilbreath and Upp, 1952; Ibe, 1985). Conformation is thought to be affected by feed restriction (Lilburn, 1985). However, there is a dearth of information in literature on the effect of feed restriction on conformation traits, such as exists for body weight (Gous and Stielau, 1976; Beane *et al.*, 1979), and on their relationships with each other and with body weight.

The relationship between body weight and conformation traits has been found to have important implication in the production of broilers with desirable body conformation (Ibe and Nwakālor, 1987). Cock (1963) had noted that the relationship between body weight and shank length (a conformation parameter) has an important bearing on the table quality of chickens.

Recent phenomenal increase in feed cost have forced some poultry farmers in Nigeria to engage in indiscriminate restriction of feed to their stocks. This study was therefore designed to determine the effects of different levels of quantitative feed restriction either in the starter or finisher phase of growth on different conformation traits and on the growth of different body structures relative to overall body growth (i.e. allometric/isometric growth).

MATERIAL AND METHODS

Stock, Management and Traits

Two hundred and forty day-old Cobb broiler chicks were started in a deep litter pen, with an average brooder temperature of 32°C. Feed was given to all the birds *ad libitum* in the first week, which constituted the adjustment period. At the end of this period, the chicks were randomly assigned to seven treatment groups with three replicates per group, as follows: Control *(ad libitum-fed)*; RS5FF, RSLOFF and RS15FF (restricted by 5, 10 and 15%, respectively in the starter but full-fed in the finisher phase); FSRF5, FSRF10 and FSRF15 (full-fed in the starter but restricted by 5, 10 and 15%, respectively in the finisher phase). Each replicate of eleven was housed in a pen measuring 2.70m x 1.55m, providing 0.38m^2 floor space per bird. However, due to shortage of pens, birds in three groups, namely FSRF5, FSRF10 and FSRF15, were not replicated initially.

Birds were fed commercial starter and finisher rations analyzed to provide 20% and 17% crude protein,. respectively. Feed restriction was done by giving restricted group[s 5%, 10% and 15% less on the previous day's feed consumption by the control group. All birds were vaccinated against newcastle and gumboro diseases in their first week. Daily prophylactic does of an antibiotic ('Terramycin' chick formula), a coccidiostat ('Furapprol') and a vitamin supplement (Biovit) were given to them in drinking water.

The following parameters were measured weekly: body weight, W; breast width, BW (width of the anterior portion of the sternum; keel length, KL (length from the anterior to the posterior end of the keel or metasternum); thigh diameter, TD (measured at the point of largest diameter), and shank length, SL (length measured from the hock joint to the tarso metatarsus-digit 3 joint).

Analytical Procedure

Means and their standard errors were computed for each of the conformation traits in all treatment groups., Analysis of variance was performed on each of these within weeks and significant means were separated using the Student-Newman Keul's method (Zar, 1974). Regressions of body weight and each of the linear structural body parameters on age were done to ascertain their rates of growth per week. Also, regressions of each of the linear body parameters on body weight were performed to determine their growth relative to overall body growth, the so-called allometric/isometric growth models. The equations and procedures for estimating the initial growth constant and coefficient of allometry or distribution have recently been given by Ibe and Nwakalor (1987). Estimated coefficients were compared with 0.33, the coefficient of isometric growth (Cock, 1963) which is an indication of equal rate of growth between the body component and the body as a whole in the chicken.

RESULTS

Tables 1 to 4 give the weekly mean BW, KL, TD and SL, respectively for each of the treatment groups. Except in weeks 3 and 9, the control group had significantly ($P < .05$) more breadth of breast than the restricted groups. In week 9, there was no significant difference in breast width between the control and the group that was full-fed in the starter but restricted by 5% in the finisher phase (FSRF5). All restricted groups generally had comparable breast width, except at 2 weeks, at the end of the starter phase at 6 weeks and at market age of 9 weeks. The trend for KL, TD and SL was not as clear-cut as for BW. Significant ($P < .05$) differences were found between the

Table 1
Means[1] and standard errors[2] of breast width (cm) in different treatment groups at different ages

	Treatment Groups[3]						
Week[4]	Control	RS5FF	RS10FF	RS15FF	FSRF5	FSRF10	FSRF15
2	2.9^{c} (.027)	2.8^{b} (.028)	2.7^{a} (.024)	2.8^{b} (.025)	2.8^{b} (.029)	2.8^{b} (.021)	2.7^{a} (.021)
3	3.9 (.041)	3.8 (.055)	3.8 (.053)	3.8 (.049)	3.8 (.058)	3.7 (.046)	3.8 (.040)
4	5.1^{b} (.057)	4.9^{a} (.036)	4.8^{a} (.047)	4.7^{a} (.052)	4.8^{a} (.050)	4.9^{a} (.038)	4.9^{a} (.042)
	5.4^{b} (.085)	5.1^{a} (.033)	5.0^{a} (.056)	5.0^{a} (.030)	5.0^{a} (.038)	5.1^{a} (.032)	(.024)
6	6.5^{b} (.120)	6.0^{a} (.035)	6.0^{a} (.050)	6.4^{b} (.055)	6.4^{b} (.073)	6.5^{b} (.045)	(.039)
7	7.1^{c} (.047)	6.9^{b} (.050)	6.9^{b} (.068)	6.5^{a} (.068)	6.9^{b} (.064)	6.9^{b} (.029)	7.0^{b} (.030)
8	8.3^{b} (.101)	7.4^{a} (.057)	7.7^{a} (.084)	7.5^{a} (.081)	7.6^{a} (.104)	7.5^{a} (.061)	7.5^{a} (.060)
9	8.9^{c} (.100)	8.0^{ab} (.071)	8.1^{b} (.062)	7.8^{a} (.064)	8.7^{c} (.049)	8.2^{b} (.063)	8.0^{ab} (.054)

1 Means in a row bearing different superscripts are significantly different ($P < .05$)
2 In parentheses
3 See text for treatment codes
4 Week 1 was the adjustment period.

Table 2
Means[1] and standard errors[2] of keel lenth (cm) in different treatment groups at different ages

	Treatment Groups[3]						
Week[4]	Control	RS5FF	RS10FF	RS15FF	FSRF5	FSRF10	FSRF15
2	2.9^{b} (.033)	2.8^{ab} (.038)	2.7^{a} (.037)	2.8^{ab} (.032)	2.8^{ab} (.031)	2.8^{ab} (.032)	2.7^{a} (.023)
3	4.3^{b} (.064)	4.0^{a} (.064)	4.0^{a} (.044)	4.3^{b} (.053)	4.1^{a} (.069)	4.1^{a} (.056)	(.050)
4	5.7^{b} (.064)	5.4^{a} (.063)	5.4^{a} (.061)	5.5^{b} (.138)	5.6^{b} (.055)	5.4^{a} (.043)	(.057)
5	6.8^{b} (.074)	6.4^{a} (.072)	6.4^{a} (.074)	6.3^{a} (.062)	6.4^{a} (.084)	6.5^{a} (.054)	6.5^{a} (.074)
6	7.8^{b} (.062)	7.3^{a} (.055)	7.2^{a} (.077)	7.1^{a} (.060)	7.8^{b} (.077)	7.7^{b} (.067)	7.6^{b} (.076)
7	8.4^{b} (.083)	8.0^{a} (.060)	8.0^{a} (.086)	7.9^{a} (.068)	8.0^{a} (.078)	8.0^{a} (.058)	7.9^{a} (.062)
8	9.4^{b} (.086)	9.1^{ab} (.090)	9.3^{b} (.097)	9.1^{ab} (.072)	9.1^{ab} (.084)	8.9^{a} (.135)	9.1^{ab} (.085)
9	10.3 (.100)	10.1 (.095)	10.2 (.013)	10.1 (.086)	10.2 (.079)	10.0 (.093)	10.1 (.087)

a,2,3,4 Same as in Table 1.

Table 3
Means[1] and standard errors[2] of thigh diameter (cm) in different treatment groups at different ages

Week[4]	Treatment Groups[3]							
	Control	RS5FF	RS10FF	RS15FF	FSRF5	FSRF10	FSRF15	
2	$.78^{ab}$ (.022)	$.74^{ab}$ (.014)	$.71^{a}$ (.012)	$.73^{ab}$ (.017)	$.74^{ab}$ (.013)	$.74^{ab}$ (.013)	$.70^{a}$ (.010)	(.010)
3	1.08^{c} (.017)	1.00^{b} (.019)	1.02^{b} (.018)	$.97^{ab}$ (.017)	1.00^{b} (.018)	$.94^{a}$ (.016)	1.01^{b} (.014)	
4	1.59 (.020)	1.53 (.023)	1.49 (.024)	1.46 (.015)	1.52 (.098)	1.51 (.016)	1.46 (.016)	
5	2.04 (.038)	1.97 (.029)	1.96 (.032)	2.02 (.104)	1.92 (.019)	1.95 (.022)	2.08 (.110)	
6	2.55^{c} (.047)	2.29^{a} (.025)	2.34^{a} (.028)	2.29^{a} (.026)	2.45^{b} (.021)	2.44^{b} (.020)	2.46^{b} (.019)	
7	2.82^{c} (.027)	2.62^{b} (.031)	2.63^{b} (.025)	2.51^{a} (.033)	2.68^{b} (.031)	2.62^{b} (.026)	2.79^{b} (.027)	
8.	3.01^{b} (.035)	2.78^{a} (.032)	2.90^{b} (.026)	2.89^{b} (.038)	2.95^{b} (.034)	2.95^{b} (.029)	2.86^{a} (.033)	
9	3.28 (.053)	3.17 (.036)	3.28 (.034)	3.20 (.040)	3.32 (.031)	3.26 (.042)	3.24 (.040)	

1,2,3,4 Same as in Table 1.

Table 4
Means[1] and standard errors[2] of shank length (cm) in different treatment groups at different ages

Week[4]	Treatment Groups[3]						
	Control	RS5FF	RS10FF	RS15FF	FSRF5	FSRF10	FSRF15
2 (.025)	2.8 (.031)	2.8 (.021)	2.7 (.026)	2.7 (.025)	2.7 (.017)	2.7 (.016)	
3	3.6 (.031)	3.5 (.036)	3.4 (.036)	3.5 (.035)	3.5 (.035)	3.5 (.029)	3.6 (.032)
4	4.4^{b} (.035)	4.3^{ab} (.047)	4.3^{ab} (.038)	4.1^{a} (.040)	4.3^{ab} (.043)	4.4^{b} (.029)	4.3^{ab} (.038)
5	5.2 (.040)	5.1 (.026)	5.0 (.054)	5.1 (.048)	5.1 (.042)	5.0 (.034)	5.0 (.039)
6	5.7^{d} (.040)	5.5^{c} (.039)	5.5^{c} (.041)	5.5^{c} (.046)	5.3^{b} (.053)	5.0^{a} (.030)	5.0^{a} (.037)
7	6.4^{b} (.046)	6.1^{a} (.035)	6.0^{a} (.117)	6.0' (.043)	6.2 (.057)	6.1^{a} (.035)	6.1^{a} (.037)
8	6.9^{b} (.056)	6.7^{a} (.050)	6.8^{ab} (.067)	6.8^{ab} (.058)	6.8^{ab} (.058)	6.7^{a} (.050)	6.7^{a} (.052)
9	7.2 (.058)	7.1 (.066)	7.1 (.067)	7.2 (.053)	7.1 (.054)	7.1 (.044)	7.0 (.052)

1,2,3,4 Same as in Table 1.

control and some or all restricted groups for these three traits at certain ages. At other ages, no significant differences were observed. however, at market age in all cases, there were no significant differences between the control and all restricted groups.

Phenotypic correlations between body weight and the various linear conformation traits and between the conformation traits themselves in all treatment groups were positive and high (average 0.96).

The rates of growth of the body and the various linear body structures in the starter and finisher phases of growth are presented in Tables 5 and 6, respectively. In both phases, these rates were not significantly affected by treatment. Overall body growth (body weight change per week) was however faster in the finisher than in the starter phase, whereas each of the linear body parameters generally grew faster in the starter phase.

Table 7 gives the allometric growth equations for the various linear body parameters in different treatment groups for the entire growth period. The breast, keel and thigh showed positive allometric (disproportionate) growth in all treatments, as indicated by their distribution coefficients which are greater than 0.33. On the other hand, the shank showed very little negative allometric growth (i.e. coefficient less than .33) in all treatment groups, except in RS5FF and RSIOFF where there was isometric (proportionate) growth.

No mortality occurred in any of the treatment groups throughout the experimental period.

DISCUSSION

The high positive correlation between body weight and each of the conformation traits studied supports the observation by Gilbreath and Upp (1952) and Ibe (1985) that conformation traits are good indicators of body growth. Correlation coefficients were not affected by feed restriction.

The breast seemed to be most consistently adversely affected by feed restriction both in the starter and in the finisher phases of growth. This body structure is a major muscle mass in the broiler chicken and restriction in the quantity of feed given to the birds is expected to affect its development. however, the other linear conformation parameters, namely the keel, thigh and shank, showed some evidence of compensatory growth. Thus, although the groups restricted in the starter phase showed significantly ($P < .05$) less keel, thigh and shank development than the control at the end of the starter phase, on full feeding in the finisher phase, they showed comparable development with the control at market age. Compensatory growth of the body has been demonstrated in early restricted broiler chickens (Twining, Jr. *et al.,* 1974 and Gehle *et al.,* 1979) and poults (Proudman and Opel, 1981), followed by full feeding later.

The faster rate of growth of each of linear conformation structures in the starter than in the finisher phase is expected. Younger animals show faster development of the bone and other growth indicators than older ones. Moreover, starter rations are more highly fortified with protein for faster growth than finisher rations. These rates of growth are however not significantly affected by feed restriction.

Feed restriction did not significantly affect the relative growth pattern of the breast, keel and thigh, which showed positive allometric (disproportionate) growth, indicating that these body structures grew at a faster rate than overall body. The importance of positive allometric growth of the keel, for instance, in the development of large-breasted broilers has been emphasized (Ibe and Nwakalor, 1987). Large-breasted broilers are highly desirable, and in situations where consumer preference is for

Table 5
Rates of growth of the body and various linear body structures in different treatment groups in the starter phase

Group[3]	Growth Rate[1,2]				
	W (kg/wk)	BW (cm/wk)	NL (cm/wk)	TD (cm/wk)	SL (cm/wk)
Control	.24 (.005)	.86 (.026)	1.24 (.021)	.45 (.010)	.74 (.012)
RS5FF	.19 (.004)	.76 (.017)	1.14 (.020)	.41 (.008)	.71 (.013)
RS10FF	.20 (.005)	.81 (.019)	1.15 (.021)	.42 (.008)	.72 (.014)
RS15FF	.20 (.004)	.76 (.017)	1.10 (.027)	.42 (.008)	.69 (.014)
FSRF5	.21 (.005)	.85 (.021)	1.21 (.021)	.43 (.016)	.69 (.016)
FSRF10	.20 (.004)	.86 (.018)	1.23 (.018)	.44 (.077)	.62 (.017)
FSRF15	.20 (.004)	.90 (.018)	1.22 (.019)	.46 (.015)	.61 (.016)

1 Growth rates of all measured parameters are not significantly different.
Values in parentheses are σ S.E. of estimates
2 See text for codes
3 See text for treatment codes

Table 6
Rates of growth of the body and various linear body structures in different treatment groups in the finisher phase

Group[3]	Growth Rate[1,2]				
	W (kg/wk)	BW (cm/wk)	NL (cm/wk)	TD (cm/wk)	SL (cm/wk)
Control	.34 (.023)	.85 (.066)	.98 (.065)	.23 (.029)	.40 (.040)
RS5FF	.29 (.016)	.53 (.042)	1.10 (.059)	.27 (.024)	.51 (.034)
RS10FF	.35 (.024)	.63 (.050)	1.08 (.072)	.35 (.021)	.46 (.061)
RS15FF	.32 (.022)	.66 (.053)	1.12 (.053)	.35 (.026)	.57 (.037)
FSRF5	.34 (.026)	.91 (.055)	1.08 (.057)	.32 (.023)	.47 (.042)
FSRF10	.30 (.013)	.65 (.038)	.99 (.071)	.32 (.023)	.51 (.031)
FSRF15	.28 (.019)	.52 (.036)	1.12 (.057)	.27 (.025)	.47 (.034)

1,2,3 Same as in Table 5.

Table 7
Allometric growth equations and distribution coefficients for linear growth parameters in different treatment groups for the entire 9-week period

	Linear Parameter[1,2]			
Treatment[3]	BW	KL	TD	SL
Control	$6.59W^{.35}$	$7.71W^{.40}$	$2.38W^{.49}$	$5.77W^{.31}$
RS5FF	$6.49W^{.35}$	$7.85W^{.43}$	$2.43W^{.51}$	$5.92W^{.33}$
RS10FF	$6.49W^{.36}$	$7.76W^{.43}$	$2.42W^{.52}$	$5.85W^{.35}$
RS15FF	$6.38W^{.34}$	$7.80W^{.42}$	$2.42W^{.51}$	$5.90W^{.32}$
FSRF5	$6.49W^{.36}$	$7.69W^{.40}$	$2.39W^{.50}$	$5.74W^{.31}$
FSRF10	$6.50W^{.36}$	$7.74W^{.42}$	$2.42W^{.52}$	$5.73W^{.32}$
FSRF15	$6.52W^{.37}$	$7.76W^{.43}$	$2.43W^{.51}$	$5.70W^{.31}$

1 See text for parameter codes
2 W = body weight; power of W = distribution coefficient or coefficient of allometry
3 See text for treatment codes.

specific chicken parts (for example, large breasts or thighs), broilers that show faster growth of these body parts relative to overall body growth may be preferred. On the other hand, relative growth of the shank was affected significantly by different feed restrictions. There is evidence that feed restriction in the starter phase encouraged harmonious growth of the shank and the entire body, which has been shown to have very important implications on body conformation (Ibe and Nwakalor, 1987). Shank length has been shown to be a criterion of body size (Lerner, 1937) and is expected to be influenced by feed restriction.

Considering that the levels of feed restriction used in this study did not adversely affect the development of most of the conformation structures, their growth relative to overall body and mortality, commercial broilers can be restricted by as much as 15% of *ad libitum* intake during either the starter or finisher phase without significantly affecting their overall market worth.

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