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Performance Characteristics and Prediction of Body Weight in Three Commercial Strains of Broilers

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ABSTRACT
The performance of three commercial broiler strains was assessed, in a 3×3 factorial experiment, using three commercial feeds with a view to finding the strain×feed combination that will enhance performance. Three broiler strains (FIDAN, CHI and FTO) and three commercial feeds (Vital, Top and Amobyn) - these are all local names known to farmers and a total of one hundred and thirty-five birds were used. There were forty five birds per feed type and fifteen birds per strain, replicated three times with five birds per replicate. Data collected on feed intake, body weight, weight gain, feed conversion, body length, shank length and heart girth were analyzed in a Completely Randomized Design (CRD). Results showed that body weight, body length, shank length and heart girth differed significantly ($p<0.05$) among strains and feed types with heart girth also showing significant strain×feed interaction. Similarly, the linear fitted function predicted body weight, from linear body measurements, better than the quadratic and cubic functions. Strain 2 (S2) and feed type2 (F2) with the best performance in body weight and the morphometric traits will bring better returns to the farmers and should thus be selected whereas the linear fitted function will predict body weight better than the cubic and quadratic functions.

INTRODUCTION

There have been a tremendous development and expansion in the broiler industry during the last couple of decades around the world such that the body weight gain of the broiler strain has increased markedly, with feed utilization being improved remarkably due to the new technology that is being applied in poultry nutrition as well as in genetics which has brought about broiler strains with higher performances today than ever before[1].

The nature of the response which different genotypes express in various environments is assessed by their performance in traits measured as well as in the traits that are of interest to farmers[2-4]. Several factors influence broiler's performance such as the nature of hybrid exploited, management, feed quality and microclimatic conditions. These are essential if the envisaged performance and efficiency is to be achieved[5]. However, the greatest scientific and technological development of the poultry industry in the last couple of decades demanded the evaluation of different commercial broiler strains, as well as different management techniques in order to improve production efficiency. This may help in proper decision making and farming strategy for production of commercial broiler strains[6].

The main objective of the various practices in animal breeding seeks to improve the production traits that are economically valuable to farmers[7,8], body weight is one of such traits in animal selection. Traits of economic importance are closely related to such explanatory variables as age, breed and morphological characters. Breeders need to establish relationships that exist among body weight and linear measurements or the animal to organize a breeding programme in the herd in order to come up with animals that will have body weight and conformation in such a combination that will support efficient production and good returns to investments made[9]. Body weight has been estimated in animals using linear body measurements[10,11]. Weighing is the easiest way to evaluate the body weight of an animal but where there are no scales especially in rural communities where scales are not readily available; farmers sell birds on the basis of physical appraisal and the choice of buyers thus reducing their bargaining power for premium price[12]. Thus developing a rapid routine evaluation procedure from reliable predictors will be most valuable to peasant farmers in rural communities where affordable facilities for measurement evaluation is lacking.

This work was therefore carried out to evaluate the performance of some of the commercial strains of broilers available in the local market with a view to selecting the strain that will maximize production performance using available feed as well as predict body weight using linear body measurements.

MATERIALS AND METHODS

Three broiler strains-FIDAN (S1), CHI (S2) and RTO (S3) along with three commercial feeds-VITAL (F1), TOP FEED (F2) and AMOBYNG (F3) all of which are commercial names that local farmers are very conversant with were used in an experiment to assess the performance of broilers with a view to selecting the strain, feed combination with the best performance. A total of one hundred and thirty five birds, comprising forth five birds birds per feed type and fifteen birds per strain replicated three times with three birds per replicate in a 3×3 factorial experiment comprising two factors feed (A) and strain (B) each having three levels in a completely randomized design. Data were collected on feed intake and body weight (using a scale), weight changes, feed conversion as well as on some linear body measurements (body length, shank length and heart girth – using a measuring tape). The data collected were analyzed using the SAS, computer software. The Duncan multiple range test was used to separate significantly different means[13].

The model of the linear fitted function is given by:

$$Y_{ijk} = \mu+G_i+N_j+G_iN_j+E_{ijk}$$

Y_{ijk} : Overall weight
μ : Overall mean
G_i : Fixed effect of the genotype (strain, I = 1, 2, 3)
N_j : Fixed effect of the diet (nutrition, j = 1, 2, 3)
G_iN_j : Interactions between genotype and nutrition
E_{ijk} : The random error and the prediction equations given by:

- $Y_1 = b_o + b_1x + e_i$....................................Linear function
- $Y_2 = b_o + b_1x + b_2x^2 + e_i$...................Quadratic function
- $Y_3 = b_o + b_1x + b_2x^2 + b_3x^3 + e_i$.................Cubic function

Where:
Y_1, Y_2, Y_3 are the dependent variables (body weights), X - represents the independent variables (body length, shank length and heart girth)

b_o : Intercept, b_1, b_2,
b_3 : Regression coefficients associated with the independent variable and e_i is the random error

RESULT

Performance of birds: Feed and strain were significantly ($p<0.05$) different among birds in body weight (Table1). Feed type 2 (A2-1186 g) had the highest body weight followed by feed type 3 (A3-990 g) and feed type 1 (A1-842 g). They differed ($p<0.01$) significantly from each other.

Strain 2 (B2-1086 g) differed ($p<0.05$) significantly from strain 1 (B1-983 g) and strain 3 (B3-945 g). However, strains B1 and B3 did not differ ($p<0.05$) significantly from each other.

Table 1: Performance of different strains of broilers fed different commercial feeds.

Parameter (g)	Factors: A (feed type) F1	F2	F3	SEM	B (strains) S1	S2	S3	SEM	Significance of difference A	B	AB
FInt	113.90	121.45	115.26	12.23	118.30	117.62	114.72	5.34	Ns	Ns	Ns
Bwt	842.00^{c}	1186.00^{a}	990.00^{b}	42.20	983.00^{b}	1086.00^{a}	948.00^{b}	42.20	**	*	Ns
BwtG	261.44	373.22	312.07	84.54	314.30	334.93	297.49	52.55	Ns	Ns	Ns
FCR	2.08	2.77	2.41	0.34	2.36	2.57	2.32	0.38	Ns	Ns	Ns

FInt: Feed intake, Bwt: Body weight, BwtG: Body weight gain, FCR: Feed conversion ratio,**p<0.01, *p<0.05, F123: Feed types, S123: Strains, SEM: Standard error of mean, Ns: Non significant, ^{abc}Means within a factor bearing different superscripts are significantly different

Table 2: Morphometric traits of different strains of broilers fed different commercial feeds

Parameter (cm)	Factors: A (feed type) F1	F2	F3	SEM	B (strain) S1	S2	S3	SEM	Significance of difference A	B	AB
HG	27.31^{c}	32.38^{a}	30.29^{b}	0.26	29.75^{b}	30.69^{a}	29.53^{b}	0.26	**	*	*
BL	17.32^{c}	19.09^{a}	18.45^{b}	0.14	17.97^{b}	18.62^{a}	17.88^{b}	0.14	**	**	NS
SL	5.81^{c}	6.36^{a}	5.99^{b}	0.06	6.01^{b}	6.28^{a}	5.88^{b}	0.06	**	*	NS

HG: Heart girth, BL: Body length, SL: Shank length, **p<0.01, *p<0.05, F123: Feed types, S123: Strains, SEM: Standard error of mean, Ns: Non significant, ^{abc}Means within a factor bearing different superscripts are significantly different

Table 3: Estimates in multiple linear, cubic and quadratic functions fitted for body weight-linear body measurements relationship in broiler strains

Strain	Parameters	Functions	SE	R^2	SIG
FIDAN	HG, BL, SL	Y_1 = - 465.55+ 26.48X_1 – 20.12X_2 +101.56X_3	62.48	0.09	**
		Y_2 = 5.32+ 0.005X + 0.05E –008X2	0.32	0.94	**
		Y_3 = 5.60 + 0.006X + -0.06E –008X^2 + -1.42E -011X^3	0.32	0.94	**
CHI	HG, BL, SL	Y_1 = -364.42 + 23.62X^1 – 16.22X^2 + 98.23X^3	56.35	0.84.	**
		Y_2 = 5.14 + 0.002X + 0.022E –008X^2	0.28	0.89	**
		Y3 = 5026 + 0.004X + - 0.04E – 008X^2 + -1.12E -011X^3	0.28	0.88	**
RTO	HG, BL, SL	Y1 = -334.42 + 22.23X_1 – 14.22X_2 + 91.26X_3	52.68	0.82	**
		Y2 = 5.14 + 0.001X + 0.014E –008X^2	0.30	0.86	**
		Y3 = 5.18 + 0.002X + -0.03E -008X2 + -1.04E -011X3	0.30	0.85	**

HG: Heart girth, BL: Body length, SL: Shank length, SE: Standard error, SIG: Significance, R2: Coefficient of determination, Y1: Linear function, Y2: Quadratic function, Y3: Cubic function, X1: HG, X2-BL, Y3: SL, **p<0.01

Feed intake (A1-113.90 g, A2-121.45 g, A3-115.62g, B1-118.60 g, B2-117.62 g, B3-114.72 g), Body weight gain (A1-261.44 g, A2-373.22 g, A3-312.07g, B1- 314.30 g, B2-334.93 g, B3-297.49 g) and Feed Conversion Ratio (A1- 2.08, A2-2.77, A3-2.41, B1-2.36, B2-2.57, B3-2.32) did not differ (p<0.05) significantly from each other in both factors (feed type and strains).

Morphometric traits: In Table 2, feed type showed a highly (p<0.01) significant variation in all the morphometric traits with feed type 2 (A2-32.38) having a highly (P 0.01) significant larger heart girth than feed type 3 (A3-30.29) and feed type1 (A1-27.35) both of which also differed from each other. The body length of feed type 2 (A2-19.09) was higher than those of feed type 3 (A3-18.05 and feed type 1 (A1-17.32). The shank length of feed type 2 (A2-6.36 cm) was significantly (p<0.01) higher than feed type 3 (A3-5.99 cm) and feed type 1 (A1-5.81 cm). Feed types 3 and 1 differed significantly (p<0.01) from each other in both body length and shank length.

Strains showed significant (p<0.05) differences in all the parameters considered. Strain 2 (B2-30.69 cm) had a significantly (p<0.05) larger heart girth than strain 1 (B1-29.75 cm) and strain 3 (B3-29.53cm). Strain 2 (B2-18.62 cm) had a highly significant (p<0.01) longer body length than strain 1 (B1-17.97cm) and strain 3 (B3-17.88 cm) while strain 2 (B2-6.28 cm) had a significantly (p<0.05) longer shank than strain 1 (B1-6.01 cm) and strain 3 (B3-5.88 cm). However strain 3 (B3) did not differ significantly (p<0.05) from strain 2 (B2) in all the parameters considered.

Heart girth showed a significant (p<0.05) interaction between feed types and strains whereas there were no significant (p>0.05) interaction between feed types and strains in body length and shank length.

Body weight prediction: The equations and coefficient of determination (R^2) for the fitted functions with respect to the various strains of birds is presented in Table 3. The coefficient of determination (R^2) were high for all the functions ranging from 0.82-0.94 with the multiple linear function being better in all the strains. The cubic and quadratic functions gave the highest coefficient of determination (R^2) than the multiple linear functions.

However, the quadratic and cubic functions gave zero regression (unstandardized) coefficients as such the linear multiple functions predicted the body weight of birds in the study better than the quadratic and cubic functions.

DISCUSSION

The results in this work showed feed and strain to be significantly (p<0.05) different in body weight and the morphometric characteristics. Feed type 2 had a significantly (p<0.05) higher body weight than the other two. Similarly, strain2 had a higher body weight than strains 1 and 3. This agrees with other works that had reported significant differences in the performance of different strain of birds. Udeh et al.[13] reported significant ($p<0.05$) differences among four strains of broilers (Anak, Arbor Acre, Ross and Marshal) with Anak and Arbor Acre being heavier than Ross and Marshal. Different live body weights among strains was reported by Shahin and Abd El Azeem[14] with Hubbard being significantly ($p<0.05$) heavier than Anak. The differences in the live weight of the broiler strains may be explained by different factors such as genotype, feed, sex, strains, environmental conditions etc[1]. Amoa *et al*.[15] found the Ross strain to be higher in the body weight than Anak and Marshal. Similarly the authors reported that daily weight gain, feed intake and conversion ratio differed ($p<0.05$) significantly among strains. This does not agree with the results of this work as there were no significant ($p<0.05$) differences in feed intake, body weight gain and feed conversion ratio for both strain and feed indicating the strain's ability to adapt to the different feeds. However, this result does not agree with other works which had it that strain difference is implicated in the variation in feed intake noticed in the birds. Accordingly, different strains showed variations in the quantity of feed consumed which also affects the way such feeds are utilized for production performance as well as growth pattern[15-17]. Feed intake, body weight, weight gain and feed conversion ratio showed no significant ($p<0.05$) interaction in the two factors which showed that the factors did not depend on each other in terms of actions. This presupposes that the diets had similar effects despite the differences in strain.

The morphometric traits showed differences between feed and strain that were highly ($p<0.01$) significant in this work with feed type 2 (F2) having a significantly ($p<0.001$) longer body girth, body length and shank length than feed type 3 and 1 which also differed ($p<0.01$) from each other. Similarly, strain 2 (S2) differed significantly ($p<0.01$) in body length but differed ($p<0.05$) in body girth and shank length from strains 1 and 3 that did not differ from each other. This result is in agreement with that of Ajayi and Ejiofor[16] where heart girth, keel length and shank length differed ($p<0.05$) significantly among Anak and Ross broiler strains.

Heart girth showed significant interaction between feed type and strains. Thus the different strains will respond differently to the different feed types with respect to the growth of the heart girth. Feed type and strain showed no significant interactions in body weight, body length and shank length an indication of the fact that the interaction of feed and strain did not affect the performance of the birds with respect to these parameters as such any of the feed will support their growth irrespective of the strain. The differences observed in body weight and the morphometric traits are indications that there is variation in the growth pattern of the birds[18].

It is possible to predict body weight from linear body measurements using prediction equations which allows for postulations to be made in what happens to the parameters in an equation in the face of a unit change in their values. The multiple linear regressions in this study, predicted body weight better than the cubic and quadratic functions. It showed that a unit change in body weight caused a positive change in body length and shank length while it caused a negative change in heart girth in all the strains. This is an indication of the fact that heart girth decreased while body length and shank length increased with a unit change in body weight.

The highest coefficient of determination (R^2) value was obtained for heart girth in this study using the simple linear regression equation which indicates that heart girth is the best regressor. The values are in the range that has been reported by others for chickens[9,15]. However, the multiple regression function gave the best coefficient of determination (R^2) value which is an indication of the fact that the prediction of body weight will be better when all linear body measurements are combined. This supports the fact that growth in an individual is the sum total of the growth of its various component parts[19,20].

Establishing the relationship between body weight and body linear measurements as well as between the linear body measurements themselves becomes imperative as this gives information about performance as well as carcass characteristics that are useful[21]. This according to Akanno will guide breeders in organizing breeding programmes that will enhance optimum performance and as such economic returns in that it will allow for proper combination of body weight and good conformation by providing information on the use of linear body measurements to predict body weight.

There is an important economic value of morphological traits in chickens added to their importance in being able to describe genetic variations as well as adaptive attribute. This because growth in animals depends on the growth of the various parts of the animal thus as the various parts grow, they invariably make up the manifested conformation of the animal which is important in the physical assessment of the animal. This according to Semakula *et al*.[12] has implications for farmers in the rural areas where animals are purchased on the basis of their physical features and body conformation.

CONCLUSION

Strain 2 (S2) and feed type 2 (F2) gave the highest performance in terms of body weight and the morphometric traits in this study. It is therefore safe to postulate that these strain (S2) and feed type (F2) will give the best performance that will optimize returns to farmers and therefore should be selected whereas the linear fitted function will best predict body weight.

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