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APPLICATION OF STEPWISE REGRESSION ANALYSIS IN BODY WEIGHT PREDICTION OF CROSSBRED CHICKENS

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ABSTRACT

Prediction of body weight with linear measurement traits of 531 day-old crossbred chickens was determined by stepwise regression analysis for mixed sexes at 4 and 8 weeks and separate sexes at 12, 16 and 20 weeks. The best single predictor of body weight was shank length in Isa Brown x naked neck (IBxNa) at 4 weeks (coefficient of determination, R^2 = 65%) and frizzle feathered x Isa Brown (FxIB) at 8 weeks (R^2 = 96%). For males, it was drumstick length (DL) in IBxNa (R^2 = 90%) at 12 weeks and in Isa Brown x frizzle feathered (IBxF) at 16 (R^2 = 85%) and 20 (R^2 = 81%) weeks. Those of females were body length (BL) (R^2 = 91%), body girth (BG) (R^2 = 90%) and body width (BW) (R^2 = 90%) in naked neck x Isa Brown (NaxIB) at 12, 16 and 20 weeks, respectively. The best partial predictors of body weight were BG and wing length at 4 weeks (R^2 =97%) and BG, BL and keel length (KL) at 8 weeks (R^2 =97%) in IBxF; BW and DL (R^2 =76%) in normal feathered x Isa Brown (NxIB) males at 16 weeks and BW and DL (R^2 =97%) in NxIB females at 20 weeks. Body weight of chickens should best be predicted using body girth, body length, keel length, body width and drumstick length in single or partial state in each genotype for mixed and separate sexes at different ages.

Key words: Stepwise regression, prediction, body weight, linear measurements, sex, crossbred chickens.

INTRODUCTION

Stepwise regression is a multiple linear regression which employs forward and backward steps in analysis to exclude some variables, leaving only those that fit the model (Agostinelli, 2002). By so doing, it reduces the multicollinearity among independent variables which is associated with unstable estimates of regression coefficients and reduces the accuracy of prediction (Chatterjee *et al*. 2000). The reliability of prediction depends on positive linear relationship between the dependent variable and the predictor as well as the coefficient of determination.

Predicting body weight using linear measurement traits is not biased by gut fill, and is more reliable than the conventional method of weighing by scale. Most prediction studies have focused on pure breeds, crossbreds or mixed sexes (Dzungwe *et al*. 2018) using entry method of multiple linear regression analysis. The objective of this study was to predict body weight of mixed and separate sexes of main and reciprocal crossbred Isa Brown and local chicken of Nigeria.

MATERIALS AND METHODS

The experiment was conducted at the Poultry Unit of the Teaching and Research Farm of Michael Okpara University of Agriculture, Umudike. Sixty nine parent stock of Isa Brown (9 cocks and 27 hens), frizzle feathered (3 cocks and 8 hens), naked neck (3 cocks and 7 hens) and normal feathered (3 cocks and 9 hens) chickens were used to produce, in 12 hatches, 123, 49, 116, 137, 42 and 64 F_1 progeny belonging to Isa Brown x frizzle feathered (IBxF), Isa Brown x naked neck (IBxNa), Isa Brown x normal feathered (IBxN), frizzle feathered x Isa Brown (FxIB), naked neck x Isa Brown (NaxIB) and normal feathered x Isa Brown (NxIB) genotypes, respectively. The progeny were intensively well managed and used for the experiment. Body weight and linear measurement traits studied were measured at 4 and 8 weeks for combined sexes and 12, 16 and 20 weeks for males and females separately. Measurements of the traits are fully described by Isaac (2020).

Regression analysis for prediction was done using the Stepwise Multiple Linear Regression procedure of IBM SPSS (2011). The summative general linear model used for the regression is given in expression (1).

$Y_i = a + \sum_{i=k}^{k} b_k X_k$ ... (1), where, Y_i = body weight of different genotypes (i = 1, … , 6), a = intercept, $b_i - b_k$ = partial regression coefficients and $X_i - X_k$ = linear measurement traits.

RESULTS AND DISCUSSION

The results of the stepwise regression are given in Tables 1and 2, respectively. The results indicated the intercepts, regression coefficients, in single (b) or partial states (b_1 and b_2) and their corresponding coefficients of determination (R^2) and standard errors in different models.

Group	S/N	Week 4			Week 8		
		Prediction Model	**R^2 (%)**	**SE**	**Prediction Model**	**R^2 (%)**	**SE**
IBxF	1	Y= -173.33+28.16BG	96	6.20	Y= -213.75+33.99BG	85	29.41
	2	Y= -181.88 +23.74BG+ 6.07WL	97	5.46	Y= -280.64+21.89BG+11.63BL	91	23.93
	3				Y= -339.75+16.86BG+11.20BL +24.34KL	97	21.09
IBxNa	1	Y= -68.97+51.54SL	65	9.86	Y= -91.46+47.23DL	84	20.94
	2				Y= -123.31+38.74DL+5.96BL	92	16.09
IBxN	1	Y= -32.17+14.80BG	74	5.95	Y= -326.58+71.30DL	90	22.20
	2	Y= -111.71+14.01BG+5.77BL	87	4.20	Y= -262.04+91.39DL-18.76WL	95	22.20
	3				Y=-394.79+70.47DL-17.75WL +20.57BG	65	19.86

Table 1: Stepwise regression models for predicting body weight from linear measurement traits of male and female chickens (mixed sexes) of different genotypes at 4 and 8weeks of age

FxIB	1	Y=-215.74+26.79WL	87	13.42	Y= -159.27+108.22SL	96	12.43
	2	Y=-259.07+17.73WL+14.94BG	92	11.24			
NaxIB	1	Y=-153.62+83.28SL	50	3.96	Y= -294.89+112.50KL	62	53.29
NxIB	1	Y= -143.09+25.37BG	71	14.05	Y= -296.64+35.57BW	63	44.86
	2	Y=-140.90+18.15BG+19.50KL	75	12.73	Y= -198.08+78.11BW-56.52BG	76	37.22
	3	Y=-154.56+14.13BG +19.38KL +9.17DL	80	12.10			

IBxF = Isa Brown x frizzle feathered main cross, IBxNa =Isa Brown x naked neck main cross, IBxN = Isa Brown x normal feathered main cross, FxIB = Frizzle feathered x Isa Brown reciprocal cross, NaxIB = Naked neck x Isa Brown reciprocal cross and NxIB = Normal feathered x Isa Brown reciprocal cross, R^2 = Coefficient of determination, SE = standard error, Y= Body weight, SL = Shank length, DL = Drumstick length, BW = Body width, BG =Body girth, BL = Body length, KL=Keel length and WL= Wing length

Group	S/N	Male			Female		
		12	16	20	12	16	20
		Prediction model	Prediction model	Prediction model	Prediction model	Prediction model	Prediction model
IBxF	1	Y= -59.01+50.35DL	Y= -397.47+79.74 DL	Y= -35.25+58.27DL	Y=-246.88+32.92BW	Y=-483.05+46.09BW	Y=-203.74+69.88DL

Table 2: Stepwise regression models for predicting body weight from linear measurement traits of male chickens of different genotypes at 12, 16 and 20 weeks of age

	2	Y= -96.35+32.04DL +45.88SL			Y=-379.3+24.83BW+ 44.89KL	Y=-661.98+39.26BW +19.18WL	Y=-390.92+44.74DL +62.20KL
IBxNa	1	Y= 203.99+59.53DL	Y= 215.51+77.15KL	Y= 62.16+58.28DL	Y=81.78+70.62SL	Y=-67.18+54.35 DL	Y=44.56+47.46KL
IBxN	1	Y= -214.54+27.92BL	Y= -315.41+44.07BW	Y= -605.23+56.99BW	Y=-283.07+37.03BW	Y=-508.80+49.62BW	Y=-822.36+62.22BW
	2	Y= -214.52+19.46BL +17.77WL			Y=-254.88+26.53BW +17.86DL		Y=-820.34+53.23BW + 27.73KL
	3						Y=-768.55+52.26BW +30.09KL -1.84WL
FxIB	1	Y= -29.08+111.46SL	Y= -242.76+76.61DL	Y= -419.49+93.51DL	Y=-177.67+127.72SL	Y= -210.47+69.79DL	Y=-468.15+91.62DL
	2	Y=-145.37+74.23SL +27.08DL	Y= -349.33+66.41DL +27.90KL	Y= 613.97+61.95DL +21.56BW	Y=-227.91+78.12SL +27.72DL	Y= -260.01+54.83DL +29.04KL	Y=-458.95+65.03DL +41.39KL
NaxIB	1	Y= -422.66+91.23 DL	Y=-544.58+102.69DL	Y= -483.06+188.64DL	Y=10.73+18.05BL	Y= 278.03+22.05BG	Y= 315.77+23.07BW
NxIB	1	Y= -660.72+72.65 BW	Y= -471.83+46.84BW	Y= -413.91+50.85BW	Y=-261.46+36.56BW	Y= -471.83+46.84BW	Y= -725.33+57.56BW
	2		Y= -1102.55+32.34BW +74.26DL	Y= -715.12+36.36BW +71.24KL	Y=-481.80+24.95BW +89.00SL	Y=-1102.55+32.34BW +74.26DL	Y=-1271.62+42.68BW +62.59DL

R^2 (%) in the models for males of IBxF, IBxNa, IBxN, FxIB, NaxIB, and NxIB at 12 weeks, = 50, 56, 90, 67, 73, 50, 53, 60, 69; at 16 weeks = 85, 73, 59, 51, 54, 73, 63, 76; at 20 weeks = 73, 63, 50, 55, 70, 49, 59; R^2 (%) for females at 12 weeks = 71, 74, 57, 70, 73, 57, 61,91,64, 70; at 16 weeks =77, 81, 70, 63, 50,53, 90, 63, 76; at 20 weeks = 60, 68, 70, 64, 67, 70, 51, 55, 90, 69, 75, respectively. See definitions of symbols as foot notes in Table 1.s

The positive regression coefficients obtained from most of the models indicated that a unit increase in any of the predictors resulted in increase in body weight. This practically implied that the chickens gained weight as their linear body traits increased. The high coefficients of determination observed for both the mixed and separate sexes in different genotypes indicated that the prediction of body weight using these linear measurements was practically reliable. However, the higher range of coefficients of determination at 8 weeks compared to 4 weeks was an indication that body weight would be more accurately predicted at 8 weeks in these chickens. The observed increase in the coefficient of determination with age was similar to the findings of Nwaogwugwu *et al.* (2018) with Japanese quail but disagreed with the higher coefficients obtained at younger age of rabbits and chickens by Akanno *et al*. (2007). Similarly, the higher coefficients of determination obtained in models for females compared to those of males at 12, 16 and 20 weeks affirm the findings of Benyi *et al.* (2015) that sex of an animal affects its body weight. However, the fewer number of predictors involved in the models for males, especially at 16 and 20 weeks**,** indicated that prediction of body weight was easier in males than females.

Shank length, drumstick length, body girth, body width, keel length and body length obtained as single predictors of body weight in IBxNa and NaxIB at 4 and 8 weeks and those in IBxF, IBxN, IBxNa and NaxIB chickens at 12, 16 and 20 weeks indicated that body weight could be easily predicted with these traits in their respective genotypes, thus confirming the report of Nwaogwugwu *et al*. (2018) that prediction is easier with single than multiple predictors.

CONCLUSION AND RECOMMENDATION

Body girth, body length, body width, drumstick length, keel length and shank length were the best predictors of body weight either in single or combined state with others. The predictors and prediction accuracy differed with genotype, sex and age of the chickens. These factors should be considered important during prediction of body weight of chickens.

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