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IN VIVO PREDICTION OF LIVE WEIGHT AND CARCASS TRAITS USING BODY MEASUREMENTS IN INDIGENOUS GUINEA FOWL

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Abstract: The objectives of this study were to evaluate the relationship between live measurements and carcass traits, and develop linear regression models to predict live weight and set of carcass traits in an indigenous guinea fowl. Twenty eight adult indigenous birds of both sexes were used for the study. Live weight and body measurements were obtained before slaughter while carcass traits were taken on hot carcass. Result obtained from descriptive statistics showed that, mean performance were 1208±6.86g, 22.17±0.13 cm, 8.94±0.07cm, 2.96±0.03cm, 34.23±0.19cm, 850.15±7.18g, 267.23±1.69g, 72.39±0.64g and 70.38% for body weight, body length, thigh length, keel length, chest circumference, carcass weight, breast weight, thigh weight and dressing percentage. All the traits except for keel length were positively ($P<0.001$) correlated to body weight. Chest circumference had the highest predictive power in live weight estimate (R^2 .558), while body weight stand out as the single most important variable in carcass weight and breast weight prediction (R^2 .820 and .902) This suggest that carcass weight and breast weight prediction can best be obtained using body weight, providing direction in developing model for selection and improvement of guinea fowl for meat production.

Key words: Guinea fowl, relationship, body measurement, carcass trait.

Introduction

Guinea fowl (*Numidia meleagris*) originate from Africa, where it exist in large number in the wild (*Gracey et al., 1999 and Saina, 2005*). The production of guinea fowl as an alternative poultry is gaining ground throughout the world, especially in developing nations with increasing demand for its meat because of the advantage of the grainy flavour (*Mareko et al., 2006*)
As a result of the increasing interest in farming guinea fowl and the gradual domestication of the bird, it is required to develop breeding strategies that will

bring about improvement in its performance and in supply of meat and egg. There are little or no available literatures on selection direction towards increasing live weight or carcass of guinea fowl for now. *In vivo* prediction of carcass component based on single trait are usually discouraged as not reliable. *Raji et al.* (2009) and *Wawro* (1990) proposed that more accurate results can be obtained when several parameters are used as independent variables in predicting and improving carcass performance in birds, this was substantiated when multiple traits where use in a regression analysis .

Carcass meatiness in poultry depends first of all on the components of breast and leg muscles (*Wilkiewicz-Wawro et al., 2003*). Selection should be aimed at developing these areas. Body measurements can be useful in breeding work particularly in weight and carcass improvement (*Wawro and Wawro, 1989; Wawro 1990* and *Wawro and Jankowski 1990*).

Most models were developed by multiple linear regression procedure where collinearity among the independent variables was not evaluated . However collinearity problem among independent variables should be expected as these are both genetically and phenotypically correlated (*Simm and Dingwall, 1989*) and it is known that model based on multicollinearity variable can limit inference and the accuracy of prediction (*Chatterjee et al., 2000*). In fact the use of collinear variables as independent variables does not improve the model precision, and create instability in the regression coefficients estimation (*Shahin and Hassan 2000*).

The objective of this work was to evaluate the relationship between live measurements and carcass traits and to determine the usefulness of body measurements in predicting live weight and some carcass traits in guinea fowl.

Material and methods

Experimental animals and their management

Twenty eight indigenous guinea fowl made of thirteen males and fifteen females were bought from Kano main market and transported to Lafia. The birds were kept for two weeks at a rearing pen in the Teaching and Research Farm of College of Agriculture, Doma Road , Lafia , and were placed on optimum feeding for the period of their stay with concentrate diet containing 18% CP and a metabolizable energy of 2700 kcal/kg and are supplied with freshly clean water *ad libitum*. After two weeks the birds were used for the analysis, body measurement were taken and carcass traits were measure after being starved for 12 hours from feed and slaughtered.

Parameter Measured

Live body measurement include, body weight(BWT), body length (BL), wing length (WL), thigh length (TL), keel length (KL) and chest circumference(CC). While carcass measurement traits include carcass weight (CCW), breast weight (BRW), thigh weight (THW) and dressing percentage .Kitchen scale and graduated measurement tape was used to obtain the data. To ensure accuracy, each measurement was taken twice , same person throughout took all measurements and weighing , thus eliminating error due to personal difference. The data from males and females are combined since there was no significant difference between the sexes in the above mentioned traits.

Statistical analysis

Data collected were analysed for preliminary descriptive statistics (mean ± se, minimum, maximum and coefficient of variation). Pearson's correlation subroutine was used to determine the coefficient of simple correlation between live weight , body measurements and the target carcass components (carcass weight , breast weight and thigh weight). Sex effect was found not to be significant. Step wise multiple regression was performed to estimate live weight and carcass weight using body measurements traits to produce the best regression model for each dependent variable based on the regression coefficient (R^2). Step wise regression is a standard procedure for variable selection, which is based on the procedure of sequentially introducing the predictor into the model one at a time. It starts as the forward selection but at each stage the probability of deleting a predictor as backward elimination is considered. The number of predictors retained in the final model is determined by the level of significance accounted for inclusion and exclusion of predictors for the model (*Chatterjee et al., 2000*). Due to the influence of collinearity on the reliability of coefficient of determination (R^2) as outline by variance inflation factor, VIF was determine for each stepwise to ascertain the usability of the R^2 obtained (*Rook et al 1998*). The following was used as VIF= $1/\ 1- R^2$
Where,
R^2 =coefficient of determination

Statistical package SPSS 14.0(2004) was used for the analysis

Results and Discussion

Means and their corresponding standard errors, minimum, maximum and coefficient of variation for all live body measurements and carcass traits are presented in Table 1. Wing length, chest circumference had the lowest variability, similarly the other traits had variability below ten percent this might be as a result of breed identity and specificity indicating homogeneity of the population. The mean body weight obtained was 1208g, comparable to what *Galor* (1985) and *Ayorinde* (1991) obtained for exotic guinea fowl reared in Nigeria. Though the values recorded here were higher than what *Ayeni* (1983) and *Dahouda et al.* (2009) obtained from same strain of indigenous guinea fowl (1110g) and far lower than what *Saina et al.* (2005) obtained 1480g from Zimbabwe guinea fowl. The variation might be genetic or breed effect. The weight here are far lower compared to chickens of about same age, as broilers reach 2kg at 8 weeks. The light weight and small body frame of guinea fowl may be a naturally selected trait meant for rapid take off (flight) and fast running as part of adaptive traits for survival in the wild (*Mareko et al., 2006*) . The result of carcass weight, breast weight and thigh weight obtain here is similar to what *Dahouda et al.* (2009) recorded on Benin guinea fowl fed with mucuna.

Table 1. Descriptive statistics of live body weight, linear traits and carcass characteristics of indigenous guinea fowl

Variable	mean±se	minimum	maximum	cv
Body weight (g)	1208±6.86	1010	1250	5.04
Body length (cm)	22.17±0.13	19.40	23.60	5.24
Wing length (cm)	19.38±0.08	18.20	21.00	3.70
Thigh length (cm)	8.94±0.07	8.00	10.00	6.54
Keel length (cm)	2.96±0.03	2.50	3.30	7.57
Chest circumf.(cm0	34.23±0.19	31.00	38.00	4.91
Carcass weight(g)	850.15±7.18	684.00	940.00	7.46
Breast weight (g)	267.23±1.69	225.00	288.00	5.58
Thigh weight(g)	72.39±0.64	59.00	78.00	7.76
Dressing percentage%	70.38			

Phenotypic correlation

Pearson's coefficient of correlation matrix for body weight, body measurements and carcass traits of the guinea fowl are shown in Table 2. All the traits except keel length showed positive and significant correlations with body weight ($P<0.001$). However, highest correlations were recorded between carcass traits and body weight. Similar finding have been reported by *Vali et al.* (2005), *Raji et al.* (2009), *Alkan et al.* (2010) for different line of Japanese quails. The breast and the thigh are the area where there are higher muscles deposition in the body of the bird hence their high relationship with body weight. This indicates that selection for any of these carcass traits will lead to improvement in the other. Similarly it is an indication that any of these body dimension could serve as a predictor of body weight (*Yakubu and Ayoade 2009*). Apart from body weight, body length, wing length and thigh length show a high positive and significant (P<0.001) correlation with carcass component. *Bochno et al.* (1999) obtained similar result in broilers, *Kleczek et al.* (2006) and *Wilkiewicz-Wawro and Szypulewska* (1999) in Muscovy duck. This shows that these morphometric traits are also reliable predictors of carcass composition in the guinea fowl.

Table 2. Phenotypic correlations among body weight, linear traits and carcass traits of guinea fowl

	BWT	BL	WL	TL	KL	CC	CCW	BRW
BL	.600***							
WL	.709***	.695***						
TL	.684***	.793***	.873***					
KL	-0.032	.202	.508***	.545				
CC	.747***	.769***	.934***	.923	.473***			
CCW	.906***	.680***	.894***	.772	.177	.879 ***		
BRW	.950***	.678***	.871***	.783	.160	.877***	.984***	
THW	.786***	.962***	.716***	.677	-0.05	.774***	.858***	.836***

***=P<0.001 BWT=body weight, BL=body length , WL =wing length ,TL=thigh length ,KL=keel length ,CC= chest circumference, CCW=carcass weight, BRW= breast weight and THL= thigh weight

Prediction of body weight, carcass weight and breast weight

Tables 3, 4 and 5 presented the result of stepwise multiple regression of body weight, carcass weight and breast weight on linear body measurements. In body weight prediction, it reveals that when chest circumference alone was used it accounted for 55.5% of the total variation in body weight, inclusion of keel length in the model increase the proportion of the explained variance to 74.3%. The accuracy of the model was further improved (R^2 = 80.9) when thigh length , body length and wing length were added to the equation. In predicting carcass weight, the result show that body weight alone accounted for 82% of the variation in carcass weight. The proportion of variance explained increases from 82 to 96.3% when wing length, keel length, thigh length and chest circumference were added. For breast weight prediction, body weight seems to be the major trait in determining breast weight. The result of stepwise regression analysis for predicting breast weight from live weight and linear traits show that body weight alone accounted for 90.2% of the variation in breast weight, this was progressively improved to 98.6% when wing length , thigh length and chest circumference were included. This result indicates that body weight can be predicted with a fair degree of accuracy from chest circumference, keel length and thigh length. This findings is consistent with what *Peter et al.* (2006) and *Yakubu et al*. (2009) observed in Nigeria indigenous chicken genotype, *Gueye et al.* (1998) in Senegal chicken and *Teguia et al.* (2007) in Muscovy duck. *Raji et al.* (2009) reported that the relationship between live body measurement for estimation of carcass component in vivo depends on the correlation between them, these observation was noticed here with higher correlation existing between body weight and carcass components (.906, .950 and .786) with carcass weight, breast weight and thigh weight respectively.

Table 3. Stepwise multiple regression of body weight on linear body measurements

Model	Explanatory variable Predictor	intercept	reg. coeff	SE	R^2	VIF
1	Chest circumference	282.763	27.034	2.759	.558	1.00
2	Chest circumference	391.381	35.521	2.373	.743	1.288
	Keel length		-134.420	17.769		1.288
3	Chest circumference	478.619	24.404	5.321	.766	6.851
	Keel length		-147.919	18.228		1.434
	Thigh length		37.265	16.074		7.563
4	Chest circumference	628.058	26.518	5.055	.796	6.851
	Keel length		-175.166	19.131		1.781
	Thigh length		63.412	17.171		9.728
	Body length		-16.546	5.126		3.424
5	Chest circumference	458.655	15.797	6.867	.809	13.518
	Keel length		-181.718	18.855		1.825
	Thigh length		62.107	16.728		9.740
	Body length		-15.929	4.999		3.436
	Wing length		28.168	12.584		8.286

Table 4. Stepwise multiple regression of carcass weight on body weight and linear body measurements

Model	Explanatory variable Predictor	intercept	reg.coeff	SE	R^2	VIF
1	Body weight	- 290.696	.944	.051	.820	1.00
2	Body weight	-706.282	.570	.039	.948	2.011
	Wing length		44.782	3.307		2.011
3	Body weight	-705.901	.451	.047	.957	3.452
	Wing length		58.497	4.597		4.649
	Keel length		-41.015	10.356		2.314
4	Body weight	-771.845	.503	.051	.960	4.392
	Wing length		62.949	4.916		5.593
	Keel length		-28.770	11.523		3.014
	Thigh length		-13.407	6.082		5.694
5	Body weight	-751.271	.476	.051	.963	4.585
	Wing length		53.657	5.959		8.849
	Keel length		-28.922	11.105		3.015
	Thigh length		-23.283	7.007		8.141
	Chest circumference		8.194	3. 187		13.920

Several authors (*Sehested 1986, Teixeira et al., 2006, Wood and Maefie, 1980, Delfa et al., 1996*) observed that multiple regression models developed to predict lean meat weight are dominated by live weight or carcass weight. In the present findings, prediction of both the carcass weight and breast weight seems to have been mainly influenced only by the body weight 82 and 90.2%

Table 5. Stepwise multiple regression of breast weight on body weight and linear body measurements

Model	Explanatory variable Predictor	intercept	reg.coeff	SE	R^2	VIF
1	Body weight	- 13.918	.233	.009	.902	1.00
2	Body weight	-90.592	.164	.006	.980	2.011
	Wing length		8.262	.477		2.011
3	Body weight	-101.984	.167	.005	.982	2.084
	Wing length		9.741	.697		4.682
	Thigh length		-2.320	.825		4.371
4	Body weight	-97.271	.161	.005	.986	2.270
	Wing length		7.586	.826		7.956
	Thigh length		-4.613	.938		6.837
	Chest circumference		1.895	.466		13.919

Variance inflation factor (VIF) values for interrelationship between traits is shown along stepwise multiple regression, it represent the increase in variance due to high correlation between predictors (*Pimentel et al., 2007*). In the present study the VIF gave indication of existence of severe collinearity (13.518, 13.520 and 13.919) in Tables 3, 4 and 5.According to Gill (1986) VIF greater than 10 .00 indicate severe collinearity rendering the reliability of the predictive equation not effective. It can then be suggested that the best equation for predicting body weight, carcass weight and breast weight should be:

BWT=628.058+26.518CC +-175.166KL+63.412TL+-16.544BL
CCW= -771.845+.503BWT+62.949WL+-28.770KL+-13.407TL
BRW=-101.984+.167.BWT+9.741WL+-2.320TL

Conclusion

The result of this study shows that body weight, wing length and chest circumference had high positive and significant ($P<0.001$) correlation with carcass traits. Similarly body weight was shown to be a better predictor of the carcass components. This will help in providing a platform for designing breeding index for guinea fowl improvement.

In vivo predviđanje telesne mase i osobina trupa korišćenjem telesnih mera autohtone biserke

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Rezime

Cilj istraživanja je bio da se oceni odnos između telesnih mera žive životinje i osobina trupa, i razvije linearni regresioni model kojim se može predvideti telesna masa i skup osobina trupa autohtone biserke. Dvadesetosam odraslih grla biserke oba pola su korišćena u istraživanju. Telesna masa i telsne mere su utvrđivane pre klanja, a osobine trupa na toplom trupu. Rezultati dobijeni metodom deskriptivne statistike su pokazali da su srednje vrednosti bile 1208±6.86g, 22.17±0.13cm, 8.94±0.07cm, 2.96±0.03cm, 34.23±0.19cm, 850.15±7.18g, 267.23±1.69g, 72.39±0.64g i 70.38% za telesnu masu, dužinu tela, dužinu bataka, dužinu kobilice, obim grudi, težinu trupa, širinu grudi, težinu bataka i randman. Sve osobine, izuzev dužine kobilice, su bile u pozitivnoj korelaciji sa telesnom masom (P<0.001). Obim grudi je imao najveću moć predviđanja u proceni telsne mase (R^2 .558), dok telesna masa se izdvaja kao najvažnija promenljiva u predviđanju težine trupa i težine grudi (R^2 .820 i .902). Gore navedeno ukazuje da se predviđanje težine trupa i težine grudi može najbolje uraditi korišćenjem telsne mase, čime se dobija prava u okviru razvoja modela za selekciju i poboljšanje biserki koje se koriste za proizvodnju mesa.

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