GROWTH CHARACTERISTICS OF NOILER CHICKENS AS DETERMINED BY NONLINEAR ALGORITHMS

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ABSTRACTS
This study sought to determine the adequacy of two mathematical functions in modelling growth characteristics of male and female Noiler chickens. The study was conducted at the Livestock Teaching and Research Farm, University of Maiduguri. Body weights were obtained weekly for 20 weeks from two hundred (200) Noiler chickens and fitted to the Gompertz and Logistic models. The results of the study showed significant difference ($P<0.05$) between males and females only at 20 weeks of age, with values of 3002.7 and 2718.7, respectively. The asymptomatic weight of the models revealed that Gompertz model had higher values for both male and female Noilers than the logistic. The coefficient of determination (R^2) of Gompertz model (0.8122) was higher than that of logistic (0.8103) for male Noilers. Similar trend occurred in female Noilers with Gompertz having a higher R^2. The Akaike information criteria (AIC) value of 6927.5 for Gompertz model was lower compared that of logistics (6933.0) in the male Noilers. Gompertz also had lower value of AIC for female Noilers compared to the Logistic. The study reveal that the Gompertz model was the better growth model for explaining the growth patterns of both male and female Noilers.
KEY WORDS: Mathematical models, Noilers, Body weight, Sex

INTRODUCTION
Poultry production is one of the best available sources for production of high biological value animal protein in terms of eggs and meat (Yakubu *et al*., 2007). The poultry sector contributed about 25% of the agricultural domestic products of the Nigerian economy (FAO, 2010). Nigeria presently produces above 550,000 mt of poultry meat per annum and 770,000 mt of eggs (FAO, 2010). Poultry meat and eggs account for about 30% of total livestock output in Nigeria, of which eggs account for over 80 percent (Fayeye *et al*., 2005).

Mathematical functions called growth models (each with a non-linear structure and sigmoid shape) have been used to explain the growth patterns of poultry species (Narine *et al*., 2017). The main advantage of non linear models is parsimony, interpretability and prediction (Bates and Watts, 2007). Growth curve parameters are highly heritable and have been widely exploited in poultry selection studies (Maginon-Grasteav, 2001). Studies had been carried out for the prediction of future growth at any age in poultry (Raji *et al.,* 2014).

The Noiler chicken is a dual purpose breed of chicken developed by Amo farm sieberer hatchery limited for small holders to address the challenges of food insecurity and financial dependency among rural populace especially women. It has been emphasized that the introduction of tropically adapted genotypes with high performance is beneficial to the resource poor poultry farmers (Yakubu and Ari, 2018). Knowledge of growth of Noiler birds is important to evaluate their development at any age. The objective of this study was to determine the most appropriate model for describing growth of Noiler chickens.

MATERIALS AND METHODS
The study was carried out at the Poultry unit of the Livestock Teaching and Research Farm of the University of Maiduguri, Borno State, Nigeria. Maiduguri is located between Latitude 11°50 N and 13 ° 40 S and longitude 10°14E at an altitude of 354 m above sea level in the Northern Sudan Savanna belt of Nigeria (Kellou, 2005). The area falls within the Semi-arid zone of West Africa and characterized by short rainy season of about 3-4 months (June to September) and the mean annual rainfall ranges from 450-600 mm.

EXPERIMENTAL ANIMAL AND MANAGEMENT

A total of two hundred (200) day old Noiler chicks were obtained from a reputable hatchery. The birds were brooded for three (3) weeks on wood shavings using coal pots to supply heat, after which they were placed under deep litter management system for 140 days (20 weeks). All the birds were tagged individually for proper identification. They were fed with a commercial chick mash (1-8 weeks) containing 3000 Kcal/Kg of energy and 20% Crude protein (CP) and grower mash (8 – 20 weeks) containing 2650Kcal/kg of energy and16% crude protein (CP). Fresh clean water was given *ad libitum* and routine vaccination and other management practices were strictly adhered to.

DATA COLLECTION AND MODELS

The body weight was measured for each bird once a week for the duration of the experiment. Body weight was taken using a weighing balance calibrated in grames (g) and the data fitted into the following growth models

1. Logistic model's: the following equation describes the logistics (Roberison,1923) growth model Wt=Wa/[1+exp –K(t-Ti)] where
   Wt =the body weight at time t,
   Wa = asymptptic body weight,
   K= the exponential growth rate, and Ti the age at the inflection point.
2. Gompertz –Laird model: the laird form of the Gompertz equation (Laird *et al.,*1965) was fitted to the data. The following equation describes the Gompertz-Laird growth curve;
   Wt =Woexp [(L/K) (1 – exp Kt)] where
   Wt =weight of bird at time t,
   Wo = initial body (hatch)weight,
   L=instantaneous growth rate (per week).
   K =rate of exponential decay of the initialspecific growth rate,
   L= it measure the rate of decline in growth rate

DATA ANALYSIS

The data generated from body weight were subjected to analysis using statistix 9.0. The data was subjected to one-way Analysis of variances with sex as the fixed factor. Significant means were compared by least significant difference.

DETERMINATION OF GOODNESS OF FIT

The asymptotic body weight (A), Akaike's information Criterion (AIC) and coefficient of determination (R^2) were used for model comparisons. Goodness of fit for each model was determined by using the coefficient of determination (R^2), and Akaike's Information Criterion (AIC).

RESULTS AND DISCUSSION

The effect of sex on body weight of Noiler birds at different ages are presented in Table 1. The results showed that sex had significant influence ($p<0.05$) only on body weight at 20 weeks of age. At this age the males had superior body weight (3002.7±111.8g) than their female counterparts (2718.7±84.99g). This agrees with the findings of Rondelli *et al.* (2003) and Keshri *et al.* (1985) who reported that at growing stages, males were heavier than females. The result of the present study also agreed with Dogan *et al.*(2010) which investigated the values of 3657g for female and 4362g for male though the values were higher than the present studies.

Table 1. Effect of sex on Body weight (kg) of Noiler chickens at different Ages.

	Age (week)							
Sex	2	4	6	12	14	16	18	20
Male	102.05 ±5.55	252.73 ±13.72	414.51±2 6.08	1686.5±9 0.41	1975.7±2 20.5	2316.2±1 02.3	2624.3±1 04.3	3002.7±1 11.8[a]
Female	107.22 ±4.22	251.31 ±10.43	409.97±1 9.83	1600.0±6 8.74	2076.6±1 67.7	2121.9±7 7.81	2378.1±7 9.7	2718.7±8 4.99[b]

ab means within column with different superscripts are significantly different (P<0.05)

Table 2 presents the model parameters and goodness of fit criteria for body weight of male and female Noiler chickens. Brown *et al.* (1996) stated that asymptomatic weight (A parameter) values offered the best opportunity for direct comparison of model. The asymptomatic weight of the models showed that Gompartz model had a higher value for both the male and female Noilers than logistic. The results of this study was in line with the report of Raji *et al*. (2014) in Japanese quails. The models with higher coefficient of determination (R^2) and lower Akaike information criterion (AIC) are the best models for describing the parameter in question (Brown *et al*., 1996). The coefficient of determination for both male and female Noilers were higher in Gompertz model than Logistic model. While the AIC for body weight of male Noilers was lower (6927.5) in Gompertz than (6933.0) for Logistic model. The AIC in female Noilers followed similar trend with Logistic model having higher values than Gompertz.Gompertz model that were determined the best in the present study were found to be in agreements with the literature reports performed using different genotypes (Aggrey,2002 and Ahmadi and Golian 2008).

Table 2. Model Parameters and goodness of fit for Body Weight of Male and Female Noilers

Trait	Parameter	sex	A	B	C	AIC	R^2
BW (g)	Gompertz	Male	3891.9	1.5858	0.1396	6927.5	0.8122
		Female	3365.9	1.5832	0.1518	1231.9	0.7250
	Logistic	Male	3133.6	3.5544	0.2900	6933.0	0.8103
		Female	2817.2	3.5081	0.3021	1232.5	0.7233

Where: BW = body weight, A = asymptomatic weight, B = scale parameter (constant),
C = relative growth rate, AIC = Akaike Information Criteria, R^2= Coefficient of determination

CONCLUSION

The results of this study showed that the body weight parameter of male and female Noiler chickens differed (p<0.05) and such differences were more obvious during the later growing phase with the male having greater values. The comparison of the two growth models in terms of asymptomatic body weight and goodness of fit criteria revealed that the Gompertz model was better for describing the growth pattern of both male and female Noiler chickens.

REFERENCES

Aggrey, S. E. (2002). Comparison of three nonlinear and spine regression models for describing chicken growth curve. *Journal Poultry Science* 81:1782-1788.

Ahmadi, H.and Golian, A.(2008).Non linear hyperbolastic growth models for describing growth curve in classical strain of broilers chickens. *Resource Journal of Biological Science. 3(11);1300-1304*

Bates, D.M. and Watts, D.G. (2007). Nonlinear Regression analysis and its application. Wiley Ser. Probab. Stat. John Wiley and Sons, New York, USA.

Brown, J. E., Fitzhugh, H. A and Cartwright T. C. (1996). A comparison of nonlinear models for describing weight -age relationships in cattle. *Journal of Animal Science* 42: 810 – 818.

Dogan/ N.,Tulin, A., Emre, K.and Deniz, I.C.(2010).Analysis of fitting growth model in Mediu growing chickens raised indoor systems. *Trends in Animal and Veterinary Science Journals* 1(1);12-18.

FAO,(2010). Small Scale poultry production (Technical guide) by Sanaiya and Swan FAO. Animal production and Health manual No 1.

Fayeye, T. R., Ayorinde, K. L., Ojo, V. and Adesina, O.M. (2006). Frequency and influence of some major genes on body weight and size parameters of Nigerian local chickens. *Livestock Resource and Rural Development*.18;1-8

Kellou, K. M. (2005). Development of multinational block for dry season supplementary feeding of sheep in a semi- arid environment. Msc. Thesis Department of Animal Science University of Maiduguri Nigeria. Pp 23-38

Keshri, R. C., Verma, S. S., Sinha, S. P., Sharma, R. P., Singh, P. B., Ray, A. K. D. and Shyamsunder, G. (1985) .The relationship between pure bred broiler strain . *Indian Journal of Poultry Science. 20 (4);297-299*

Laird, A. K., Tyler, S. A. and Burton, A. D. (1965). Dynamic of Normal growth. *Growth* 29: 233-248. 248

Mignon-Grastea, S., Beaumont, C and Ricard, F.H. (2001). Genetic analysis of a selection experiment on the growth curve of chickens. Journal of Poultry Science.80:849-54:7SS

Narine, D., Oksuz, N. and Aygum, A. (2017). Growth curve analyses in poultry science. *Journal of Poultry Science*, 73:395-408.

Raji, A. O., Alade, N. K. and Duwa, H. (2014). Estimations of model parameters of the Japanese quail growth curve using Gompertz model. *Journal of Arid Agriculture*, 63 (4):29-35

Robertson, T .B.(1923) .The chemical basis of growth and senescence. Monograph of Experimental Biology. J.B. Lippincott. Philadelphaia, PA.

Rondelli, S., Martinez, O. and Gracia, P. T. (2003). Sex effect on production parameters, carcass and body fat composition of two commercial broilers chickens. *Journal of Poultry Science 5 (3); 169-173.*

Statistix for windows Manual. Copyright@1985-2008. Analytical Software.Version 9.0, Tallahasse FL, USA, 2008.

Yakubu, A. and Ari, M. M. (2018). Principal component and discriminate analyses of bodyweight and conformation traits of Sasso, Kuroiler and indigenous Fulani chickens in Nigeria. *Journal of Animal and Plant Science*.

Yakubu, A., Salako, A. E. and Ige, A. O. (2007). Effect of genotype and housing system on the laying performance of chickens in different seasons in the Semi Humid Tropics. *International Journal of Poultry Science, 6:43-49.*