

MODELLING GROWTH CURVES IN COBB 500 STRAIN OF BROILER CHICKENS USING DIFFERENT ALGORITHMS

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ABSTRACT

This study was carried out to predict the body weight of Cobb 500 strain of broiler chicken reared with or without access to pasture using five mathematical models. The study was conducted at the Teaching and Research Farm of the Department of Animal Science, Faculty of Agriculture, Nasarawa State University, Keffi. A total of 200 randomly selected day-old chicks were used for the experiment. The birds were assigned to 2 groups in a completely randomized design: Group 1 birds had no access to pasture while Group 2 had access to pasture from week 4 to week 8 of the experiment. Each treatment group contained 25 birds and were replicated four times. Data on body weight of Cobb 500 broiler chickens were taken. The data on body weight were equally predicted using Logistic 3P, Logistic 4P, Logistic 5P, Gompertz 3P and Gompertz 4P model of JMP (SAS) statistical software. The results showed that Logistic 5P predicted body weight better than Logistic 3P, Logistic 4P, Gompertz 3P and Gompertz 4P models in birds with and without access to pasture with a corresponding coefficient of determination (R^2) values of 96.9 and 96.5%, respectively. The current findings indicate that Logistic 5P is the best growth model in birds fed and those not fed pasture; thus, appears promising in broiler chicken production.

Keywords: Prediction, Body weight, Mathematical models, broiler chicken, Pasture.

INTRODUCTION

The production of broiler chickens has the fastest ability to address the protein supply-demand imbalance in tropical regions (Yakubu *et al.*, 2010) and significantly contributes to job creation as well as generating revenue for both farmers and the government. Numerous studies focus on determining the growth models that are most suitable for specific mass-at-age datasets (Kühleitner *et al.*, 2019). Mathematical models can aid in establishing more suitable feeding schedules to effectively meet the elevated nutritional needs throughout different growth stages (Selvaggi *et al.*, 2015). Additionally, these models can facilitate enhancements in feed conversion by mainly shortening the growth duration, a goal that has been achieved through selection for growth rate and feed conversion efficiency (Marks, 1995). The Gompertz, Logistic, and Richards functions are commonly applied sigmoid models that are used to fit growth data (Selvaggi *et al.*, 2015).

Growth curves exhibit a sigmoidal shape with a point of inflection where the growth rate reaches its peak with an upper asymptote. The parameters of growth curves have been extensively utilized in studies focused on poultry selection since they are known to have a high heritability (Raji *et al.*, 2014; Mouffok *et al.*, 2019), enabling the estimation of future growth at any given age (Yakubu and Madaki, 2017). The modern commercial breeds of broiler chickens now require more stringent standards for housing, nutrition, and treatment. This is as a result of their extremely fast weight increase and efficient feed conversion for each kilogram of weight gained (Skomorucha and Muchacka, 2007). Therefore, this study was conducted to predict the body weight and determine the most suitable model for the growth curve of the Cobb 500 strain of broiler chicken reared with and without access to pasture.

MATERIALS AND METHODS

Location of the Study

The study was carried out at the Teaching and Research Farm of the Department of Animal Science, Faculty of Agriculture, Shabu-Lafia Campus of Nasarawa State University, Keffi, Nasarawa State, Nigeria. The Farm is located within the Nasarawa South agro-ecological zone of the State. The Farm's coordinates are 8° 29' 30" North and 8° 31' 0" East, respectively.

Experimental Design

A total of 200 randomly selected day-old chicks were used for the experiment. The birds were assigned to 2 groups in a completely randomized design: Group (1) birds had no access to pasture while Group (2) had access to pasture from week 4 to week 8 of the experiment. Each treatment group contained 25 birds and were replicated four times.

Experimental Management and Procedure

The birds in each management system were individually tagged and assigned identification numbers. The initial weight of each bird was taken. From week 1-4, the birds were raised on starter ration [crude protein (22.00%), metabolizable energy (2,800kcal/kg), crude fat (8.50%), crude fibre (5.00%) calcium (1.20%) and phosphorus (0.45%)]. From week 5 to 8, the birds were fed commercial broiler finisher ration containing (crude protein (20.00%), metabolizable energy (2,900 kcal/kg), crude fat (8.60%), crude fiber (5.40%), calcium (1.20%), and phosphorous (0.41%). Routine vaccinations and other management practices were observed strictly throughout the 8-week period of the experiment.

Data Collection

Initial and weekly body weights of birds (Cobb 500 strain) with and without access to pasture were collected on a weekly basis by weighing the birds using a digital weighing balance. The study lasted eight weeks.

Statistical Analysis

The body weights of the individual birds reared with and without access to pasture were fitted into the growth models (logistics 3P, 4P, and 5P; Gompertz 3P and 4P) to the body weight of the individual bird related to age. The performance of the model was determined based on coefficient of determination (R^2), root mean square error, Akaike information criterion and Bayesian information criterion.

RESULTS AND DISCUSSION

The results of the estimated growth curve of Cobb (500) strain are shown in Table 1. The models were arranged in ascending order as follows: Logistics 3P, Logistics 4P, Logistics 5P, Gompertz 3P and Gompertz 4P.

Table 1: Best predicted growth curve model of Cobb (500) strain reared without access or with access to pasture

| Breed/Model | a | B | C | d | e | Age & wt | AIC | BIC | RSME | R ² |
|--------------|-------|------|---------|---------|------|---------------|----------|----------|---------|----------------|
| WoA | | | | | | | | | | |
| Logistics 3P | 0.84 | 4.24 | | 2115.53 | | 4.5; 1170.872 | 9115.113 | 9133.374 | 135.300 | 0.964 |
| Logistics 4P | 0.10 | 4.34 | 118.07 | 2057.93 | | 4.5; 1164.894 | 9092.489 | 9115.302 | 133.096 | 0.965 |
| Logistics 5P | 1.32 | 5.17 | 5.29 | 2012.60 | 0.45 | 4.5; 1150.451 | 9082.711 | 9110.069 | 132.101 | 0.965 |
| Gompertz 3P | 0.45 | 3.74 | | 2404.15 | | 4.5; 1178.937 | 9235.807 | 9254.068 | 147.129 | 0.957 |
| Gompertz 4P | 0.629 | 3.94 | 198.47 | 2188.31 | | 4.5; 1181.848 | 9153.344 | 9176.156 | 138.841 | 0.962 |
| WA | | | | | | | | | | |
| Logistics 3P | 0.92 | 3.95 | | 2109.85 | | 4.5; 1318.900 | 9185.820 | 9204.081 | 142.109 | 0.962 |
| Logistics 4P | 1.26 | 4.14 | 200.87 | 2038.94 | | 4.5; 1323.839 | 9113.745 | 9136.557 | 135.076 | 0.965 |
| Logistics 5P | 23.27 | 5.32 | -44.959 | 1948.36 | 0.02 | 4.5; 1283.353 | 9037.887 | 9065.245 | 128.052 | 0.969 |
| Gompertz 3P | 0.51 | 3.40 | | 2320.31 | | 4.5; 1311.928 | 9351.816 | 9370.078 | 159.473 | 0.952 |
| Gompertz 4P | 0.79 | 3.75 | 254.113 | 2127.59 | | 4.5; 1329.961 | 9232.585 | 9255.397 | 146.696 | 0.959 |

a=maturity index; b=scale parameter; c= asymptotic weight; d=upper asymptote; e=power; AIC= Akaike information criterion; BIC=Bayesian information criterion; RSME=Root means square error; R²=adjusted coefficient of determination; AW = With Access; WoA = Without Access Age & wt = Age and weight at inflection point

The result shows that the coefficient of determination in birds without access to pasture ranged from 0.954 and 0.965 as compared to the coefficients of determination in birds with access to pasture (0.959 and 0.962). The age point at inflection was 4.5 weeks for birds without access to pasture and those with access to pasture. Body weights of the birds at inflection point were 1170.872, 1164.894, 1150.451, 1178.937 and 1181.848 for Logistics 3P, Logistics 4P, Logistics 5P, Gompertz 3P and Gompertz 4P (without access to pasture) and 1318.900, 1323.839, 1283.353, 1311.928 and 1329.961 for Logistics

3P, Logistics 4P, Logistics 5P, Gompertz 3P and Gompertz 4P (with access to pasture). The Logistic 5P shows the best model of predicting body weight of broiler chicken (Cobb 500 strain) for both birds with access to pasture and without access to pasture. The present contradicts the report of Achimugu *et al.* (2024) who reported that Logistics 4P was the best model for Arbor Acres strain of broiler chicken. This may largely be attributed to differences in strains. However, in a related study on goats, Logistic 5P was found to be the best growth model in females (Tyasi *et al.*, 2022).

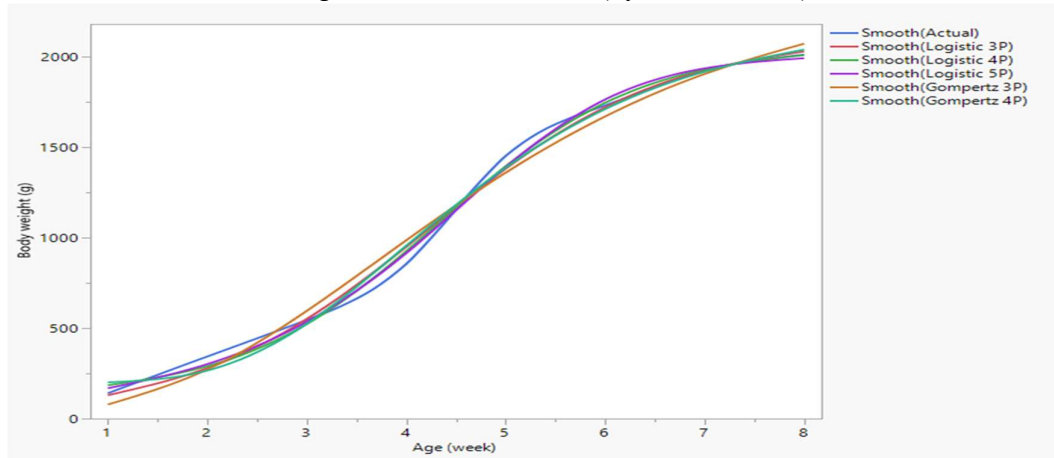


Figure 1: Graph of estimated growth curve modeling of Cobb (500) strain without Access to pasture

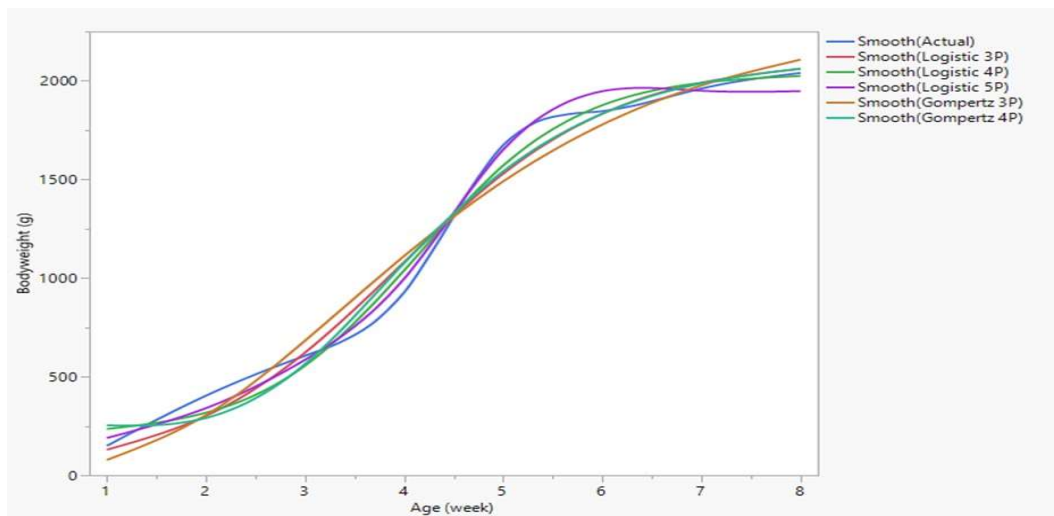


Figure 2: Graph of estimated growth curve modeling of Cobb (500) strain with Access to pasture

CONCLUSION

Based on the outcome of this research work, Logistic 5P is the best model that performed better than the other models based on the lower values of its Akaike information criterion, Bayesian information criterion and Root square mean error. The graph of the growth curve in both figure 1 and 2 can be exploited in breeding programme establishment for maximum productivity in broiler chicken production.

REFERENCES

Achimugu. J., Yakubu. A., Musa, I.S., Idahor. K.O., Jayeoba, O.J. and Hussaini, Y.I. (2024). Predictive model evaluation for growth, feed intake and under-wing temperature in two broiler chicken strains under two housing conditions. UMAB PoLSER, 2(2): 57-67.

- Kühleitner, M., Brunner, N., Nowak, W-G., Renner-Martin, K., & Scheicher, K. (2019). Best-fitting growth curves of the von Bertalanffy-Pütter type. *Poultry Science*, 98(9): DOI: 10.3382/ps/ppez122.
- Marks, H.L. (1995). Genetics of growth and development. In: World Animal Science, Poultry Production (P. Hunton ed.). Elsevier, Amsterdam. 170-182.
- Mouffok, C., Semara, L., Ghoulmi, N., & Belkasmi, F. (2019). Comparison of some nonlinear functions for describing broiler growth curves of Cobb500 Strain. *Poultry Science Journal*, 7(1): 51-61.
- Raji, A.O., Alade, N.K., & Duwa, H. (2014). Estimation of model parameters of the Japanese quail growth curve using Gompertz model. *Archivos de Zootecnia*, 63: 429-435.
- Selvaggi, M., Laudadio, V., Dario, C., & Tufarelli, V. (2015). Modelling growth curves in a nondescript Italian chicken breed: An opportunity to improve genetic and feeding strategies. *Journal of Poultry Science*, 52: 288-294.
- Skomorucha, I. & Muchacka, R. (2007). Effect of stocking density and management on the physiological response of broiler chickens. *Annals of Animal Science*, 7: 321-328.
- Tyasi, T.L., Yakubu, A. Akinsola, O.M., & Ngambi, J. (2022). Evaluation of growth curve for South African non-descript indigenous goats using non-linear models. *Acta Agriculturae Scandinavica A- Animal Science*, 71(1-4): 82-88.
- Yakubu, A., Ayoade, J.A., & Dahiru, Y.M. (2010). Effects of genotype and population density on growth performance, carcass characteristics and cost-benefits of broiler chickens in north central Nigeria. *Tropical Animal Health and Production*, 42(4): 719-727.
- Yakubu, A., & Madaki, J. (2017). Modelling growth of dual-purpose Sasso hens in the tropics using different algorithms. *J. Genet. Mol. Biol.*, 1(1):1-9.