

# GROWTH MODELS ANALYSIS OF MALE AND FEMALE MUSCOVY DUCKS IN A SEMI-ARID ENVIRONMENT

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## ABSTRACT

The study was carried out in Maiduguri, the capital city of Borno State to estimate the genetic parameters of growth traits of Muscovy ducks (*Cairina moschata*). A total of three hundred (300) ducklings which were used for the experiment for the period of eight months from May to December, 2021. The data on the ducklings were taken on body weight (BW) from day old to 20 weeks based on sex. All the data were fitted to four growth models (Gompertz, Logistic, Richard and Weibull) and was analysed using statistix version 9.1. The estimates of growth model function revealed that the Gompertz model estimated the highest asymptotic weight and Logistics was least. Based on goodness of fit criteria (SME, SD, AICs and R<sup>2</sup>) the Gompertz was the best model in both Male and female ducks as it had lowest MSE and AICs while Logistic had the least fit because of its highest estimate of MSE and AICs in both sex. The four growth models adequately described the growth patterns of male and female Muscovy ducks. Gompertz model should be used for the description of growth in ducks.

**Keywords:** Growth model; Body Weight; Body Measurements; Muscovy Ducks, Parameter

## INTRODUCTION

Duck is one of the indigenous poultry species in Nigeria and its production is at the rudimentary stage (Oguntunji and Ayorinde, 2015). Ducks have contributed greatly in the improvement of the nutritional standard of human population (Pingel, 2009). Ducks have unique advantage over chicken by utilizing foodstuffs that normally go unharvested, control harmful insects, slugs, snails and unwanted aquatic plants, thrive under harsh condition with limited shelters, resist diseases and parasites and also converts feed efficiently (Adzitey and Adzitey, 2011).

The Muscovy duck (*Cairina moschata*) is a common household bird among rural dwellers in Nigeria and play significant role as a source of protein and income to peasant farmers (Oluyemi and Ologbobo, 1997). They are essential parts of many human societies around the world, supplementing chicken in eggs and meat supply, particularly with the ever increasing human population (Ogah and Momoh, 2013). Muscovy ducks make up 74% of the ducks in Nigeria, and its meat is low in fat and considered to be healthier (Adesope and Nodu, 2002).

Body weight and body conformation traits are very important parameters in poultry production being fundamental attributes for assessing growth and feed efficiency as well as important yardstick in management and economic decision making (Assan, 2015). The growth of domestic animals may be described by several non-linear models (NLM), as a function of time and a number of parameters that can be presented as biologically interpretable constants in a mathematical equation. The Gompertz, von Bertalanffy, Brody, Richards, and Logistic growth models are commonly used to explain animal growth. (Ersoy *et al.*, 2006). The study was aimed to determine the growth model function that best describe the growth of male and female Muscovy ducks in semi-arid regions.

## MATERIAL AND METHODS

The study was carried out in Maiduguri, the capital city of Borno State, Nigeria. Maiduguri is located at the North Eastern corner of Nigeria and situated between Latitudes 11°15' and 12° North and the Longitude 13° 05' and 14° East and at an altitude of 345 m above sea level (Raji *et al.*, 2014). The area falls within the Sahelian region of West Africa, which is characterized by fluctuating climatic and seasonal variations. The area has a very short period of 3 – 4 months of rainfall, recording average of 645.9 mm/annum, with a long dry season of about 8 – 9 months. The ambient temperature is as low as 20° C during the dry cold season in December- January and as high as 44° C during the dry hot season in April and May. Relative humidity is 45% in August which usually lowers to about 5% in December and January.

### Experimental Birds and Their Management

A total of three hundred (300) ducks which were used for the experiment for the period of eight months (0 – 20 weeks) of age from May to December, 2021. The ducks were managed intensively and were vaccinated against Gumboro and New castle disease. These ducks were individually tagged using a permanent marker under their wings to enhance accurate identification of measurements which was closely monitored and reapplied every time the birds were measured throughout the experiment. The body weights of ducklings were determined using a top loading weighing scale (g) and this was taken on a weekly basis and was based on sex from day old to the first ten (10) weeks of age and then at two weeks interval afterwards until 20 weeks. Four growth models were used to estimate body weight from the data as follows:

**Logistic**  $Y_t = c / \{1 + \exp(-a * (\text{weeks} - b))\}$  ----- 1

Where:

a = growth rate

b = inflection point

c = asymptote

exp = exponential constant

**Richards**  $Y_t = (d - c) / \{1 + \exp(-a * (\text{weeks} - b))\}^f$  ----- 2

Where:

a = growth rate

b = inflection point

d - c = asymptote final

f = power

exp = exponential constant

**Gompertz**  $Y = a * \exp(-\exp(b - c * X))$  ----- 3

Where:

a = asymptotic weight

b = growth rate

c = inflection point

Exp = exponential constant

**Weibull-type**  $Y = a - b * \exp(-c * X^d)$  ----- 4

Where:

Y = the body weight at a particular age,

X = age in weeks,

a = the asymptotic weight or maximum growth response,

b = scale parameter related to initial weight,

c = the intrinsic growth rate and

d = the shape parameter

exp = exponential constant

In all the models fitted, y represents the body weight in grams; t = is the age of duckling in weeks (Raji *et al.*, 2014).

## RESULTS AND DISCUSSION

### Growth Model Parameters for Body Weights of Muscovy Ducks

The estimated growth model parameters and curve of body weight for Male and female Muscovy ducks using Gompertz, logistic, Richards and Weibull growth functions are presented in Table 1. The R<sup>2</sup> value was generally high for all models for males and females (0.99). This is an indication that all models adequately described the growth of males and females ducks. In all the models, parameter (a) which is the asymptote weight or maximum stationary weight ranged from 2055.30 g to 2164.30 g for the male and 1413.60 g to 1487.30 g for female ducks, respectively.

Parameter (b), the scaling parameter or constant of integration ranged from -2.79 to 2087.70 g for male and -0.89 to 1416.90 for female while parameter (k) which is the maturity index ranged from 0.01 to 0.44 for male and 0.02 to 0.43 for female Muscovy ducks, respectively. The asymptotic weight estimated in this study by the Gompertz model is consistent with the findings in other poultry birds (Zhao *et al.*, 2015; Al-Samarai, 2015). Zhao *et al.* (2015) and Al-Samarai (2015) reported highest values in Gompertz model for asymptotic weight on some improved indigenous chickens of China and meat type chickens of Iraq, respectively. However, lower values of asymptotic weight were

reported by Aggrey (2002), and Ngeno *et al.* (2010) for local chickens in Ghana. Variation in the asymptotic weight of these ducks could be attributed to the sample size, genetic differences and various possible interactions among these factors, which could ultimately influence the growth path of body weight as age increased.

Based on the MSE, SD, AICs and  $R^2$  criteria in the present study, the Gompertz was the best model in both male and female ducks as it had the lowest MSE and AICs while Logistic was the worst model because of its highest estimate of MSE and AICs in both sex. The results are in agreement with previous researches where also reported better goodness of fit in Gompertz models compared to other models in poultry (Rizzi *et al.*, 2013; Zhao *et al.*, 2015). Gompertz's model was reported to give the best fit in terms of estimation of body weight and parts (Goliomytis *et al.*, 2003) which were similar to the present study. However, this is contrary to the work of Menchesa *et al.* (1996) who reported that Richards' function gave better estimates of body weights of broilers. Therefore, based on these criteria, Gompertz model could be considered as the most appropriate model for describing the growth of Muscovy ducks. The asymptotic weight represents the maximum growth response for birds which are mostly affected by genotype and environment interactions (Narinç *et al.*, 2010). Coefficient of determination measures the amount of variability accounted for by the fitted model (Akpa, 1999) and  $R^2$  values of 70% and above indicate good measure of fitness as reported by (Olorunju, 1991).

## CONCLUSION

The four growth models adequately described the growth patterns of male and female Muscovy ducks. However, based on goodness of fit criteria (MSE and AICs) the Gompertz model was the best. Gompertz model should be used for the description of growth in ducks.

**Table 1: Estimates of Growth Model Parameters and Goodness of Fit Test for Body Weight of Muscovy Ducks**

| Parameter     | Gompertz | Logistic | Richards | Weibull |
|---------------|----------|----------|----------|---------|
| <b>Male</b>   |          |          |          |         |
| <i>a</i>      | 2164.30  | 2055.30  | 2162.10  | 2109.10 |
| <i>b</i>      | 1.59     | 3.20     | -2.79    | 2087.70 |
| <i>k</i>      | 0.27     | 0.44     | 0.27     | 0.01    |
| <i>d</i>      |          |          | 0.01     | 1.98    |
| Conv          | 9        | 10       | 100      | 81      |
| MSE           | 17506    | 19607    | 17569    | 18212   |
| SD            | 132.31   | 140.03   | 132.55   | 134.95  |
| AICs          | 2819.00  | 2851.60  | 2821.10  | 2831.40 |
| $R^2$         | 0.99     | 0.99     | 0.99     | 0.99    |
| <b>Female</b> |          |          |          |         |
| <i>a</i>      | 1487.30  | 1413.60  | 1477.50  | 1449.80 |
| <i>b</i>      | 1.45     | 2.96     | -0.89    | 1416.90 |
| <i>k</i>      | 0.26     | 0.43     | 0.27     | 0.02    |
| <i>d</i>      |          |          | 0.09     | 1.89    |
| Conv          | 10       | 9        | 15       | 77      |
| MSE           | 16209    | 16949    | 16255    | 16492   |
| SD            | 127.31   | 130.19   | 127.49   | 128.42  |
| AICs          | 2796.31  | 2809.70  | 2798.70  | 2802.80 |
| $R^2$         | 0.99     | 0.99     | 0.99     | 0.99    |

*a* = Asymptote weight, *b* = Scale parameter (constant), *k* = Relative growth rate, *d* = Shape parameter, Conv = convergence criteria,  $R^2$  = Coefficient of determination, MSE = Mean Square Error, SD = Standard Deviation and AIC = Akaike's Information Criteria.

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