Mathematical Modelling of Egg Production Curves of Shikabrown® Parents

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Abstract

This study was conducted to evaluate egg production curves of Shikabrown® parents, using mathematical models. A total of 200 birds: 100 from each of the two strains of Shikabrown® parents (sire and dam) lines at the Breeding Unit of Poultry Research Programme, National Animal Production Research Institute (NAPRI) were used for the study. The birds were obtained from the selected lines (sire and dam) and were denoted as Strain A and Strain B, respectively. Body weight (BWT), age at sexual maturity (ASM), egg number (EGGNO), and egg weight (EWT) were examined. Four non-linear models (Logistic, Richard, Gompertz, and Exponential) and a linear model were used to predict the efficiency of weekly bodyweight and egg production traits. The adequacies of the models were fitted using R Package, version 3.0.3. High coefficients of determination for BWT ($R^2 = 0.84 - 0.93$) were recorded in the models for both Strains. Strain A had higher R^2 (0.93) for BWT in Richard, Gompertz and Exponential models while Strain B recorded ($R^2 = 0.89$) in Logistic, Richard and Gompertz models. High coefficient of determination was obtained in a reproductive trait; egg number; in which almost all the models gave ($R^2 = 0.70$). Exponential model recorded a higher R^2 (0.93) for EGGNO in strain A. EWT in strain A recorded higher R^2 (0.96) coefficient of determination across the four nonlinear models except linear model with ($R^2 = 0.95$) for egg weight. Significant differences ($P < 0.05$) were observed in the birds' performance for BWT and EWT, with strain B having a higher BWT (1.59 ± 0.01) and Strain A having a higher EWT (48.75 ± 0.17). Similarly, age of birds in lay had a concomitant significant differences ($P < 0.05$) in their BWT as well as their EWT. The birds performed better for BWT and EWT in week 26 and 27 for both Strains. It was concluded that Strain significantly ($P < 0.05$) had effect on BWT and EWT of Shikabrown® parent with Strain B performing better than Strain A in the former trait and strain A better than strain B in the latter trait. R^2 identified differences between Strains in predicting egg production traits. Strain B was adjudged good and profitable because the Strain had the highest mean values in body weight and egg number and it is being recommended as one of the lines for future improvement of Shikabrown®.

Keywords: Mathematical models, Egg Production Curves, Body weight, ASM, Egg Number, Egg weight

Introduction

Egg production is the single most important phenotype for evaluating the productivity of laying birds. It helps in evaluating the efficiency of management and optimum

managerial practices that will sustain gain at optimum level (Aboul-Seoud, 2008). Egg production is known to be a complex quantitative trait; it depicts a considerable variation over time within the production

cycle of a hen. Several methods of expressing egg production and its component characters have been studied (Dogan *et al.*, 2010). Despite the application of different forms of analysis of variance, however, it remained difficult to give a clear explanation of the variation in egg production over time (Dogan *et al.*, 2010). However, studies by Oni (1997) have shown that when egg production in chickens is summarized on a weekly, biweekly or monthly basis, it gradually increases, attained peak and persist and then gradually decline. Peak in lay is usually attained a month after first egg is laid. Although variations to this exist among breeds, strains and lines. This regularity, though not a steady process over time, is generally denoted as egg production curve in poultry. Egg production curves are useful tools representing the evolution of egg production changes and of particular importance in both breeding and management. Fairfull and Gowe (1990) reported that mathematical models can be used to forecast income and flock performance to evaluate theoretical expectations or to predict whole record performance based on part record of egg production. Therefore, a mathematical model describing such a curve would enable poultry breeders and commercial egg producers to analyze egg production process as well as to predict annual production from part records (Fairfull and Gowe 1990; Oni, 1997). Shikabrown® chickens had been tested and certified as a good stock of chicken in the six geo-political zones of Nigeria. However, the institutional evaluation of the production pattern of the chicken was last done in 1997 (Oni, 1997). Change of climatic elements and its effect on livestock had been documented to fit broadly into one of two categories: loss of productivity and

increasing cost of production (Adesiji *et al.*, 2013; The Poultry Site, 2009). Evaluation of egg production patterns of Shikabrown® parents after the last one that was done at about 20 years ago is necessary. This study was therefore aimed at evaluation of egg production curves of Shikabrown® parents using mathematical models.

Materials and methods

Experimental Site

The research was conducted at the Poultry Unit of the National Animal Production Research Institute (NAPRI) Shika, Zaria. The institute is located in Northern Guinea Savannah zone of Nigeria on latitude 11°12'16.78''N and longitude 7°33'39.18''E with an elevation of 691 metres above sea level (Ovimaps, 2015).

Experimental Birds

A population of 100 birds each of two strains of Shikabrown® Parents (sire and dam) housed at the Breeding Unit of Poultry Research Programme of National Animal Production Research Institute (NAPRI) were used for the study. The birds were obtained from the selected lines (sire and dam lines) and were denoted as Strain A and Strain B, respectively. Strain A was identified with a gold plumage while Strain B with a silver plumage.

Management Practices

Populations of 100 birds each of two strains of Shikabrown® parents were used for the study. The birds were obtained from the selected lines (sire and dam lines) and were denoted as Strain A and Strain B, respectively. Strain A was identified with a gold plumage while strain B with a silver plumage. Production traits measured were Body weight (BWT) (Kg): Was measured on weekly basis using top-loading weighing scale. Age at Sexual Maturity (ASM): Was obtained on the day each pullet laid the first egg, recorded in days. Egg

number (EGGNO): Counted as the number of eggs laid by a hen in a week from point of lay to 12th week. Egg weight (EWT) (g): Measured using sensitive electronic balance scale on weekly basis from point of lay to 12th week.

Data Collection

At 20 weeks of age, 100 each of the two Strains were randomly picked and transferred to individual battery cage in order to monitor egg production. Eggs collected were recorded in daily egg record book and summarized at the end of every month. Records of body weight at 20 to 32 weeks of age were taken on weekly basis. For each bird, egg production was standardized into 28 days period, (Gavora *et al.*, 1982; Oni, 1997; Orunmuyi, 2007), starting from the day the pullet laid the first egg which was recorded up to 92nd day of egg production.

Analysis of variance

Data obtained on egg production traits (BWT, ASM, EGGNO and EWT) were analyzed using General Linear Model and Pearson Correlation Procedure of SAS (SAS, 2004).

Models Fitted

Each mathematical model was fitted independently to data collected on each strain of breeder hens. Denoting egg production in the 28-day period starting from the day of 1st egg by Y., the following models were studied:

1. Logistic

$$y_i = \frac{C}{[1 + \text{Exp}[-a * (\text{weeks} - b)]]}$$

Where:

a = growth rate

b = inflection point

c = asymptote

2. Richard

$$y_i = \frac{[d - c]}{c + [1 + \text{Exp}[-a * (\text{weeks} - b)]]^f}$$

Where:

a = growth rate

b = inflection point

c = asymptote 1

d = asymptote 2

f = power

3. Gompertz

$$y_i = a * \text{Exp}[-\text{Exp}[-b * (\text{weeks} - c)]]$$

Where:

a = asymptote

b = growth rate

c = inflection Point

4. Linear

$$y_i = a + b * \text{weeks} - c$$

Where:

a = intercept

b = slope

5. Exponential

$$y_i = a + b * \text{Exp}[c * (\text{weeks})]$$

Where:

a = asymptote

b = scale

c = growth rate

In all the models fitted, y represents the body weight in Kilograms, egg number or egg weight in grams respectively; t = is the age of hen or its productive cycle, in weeks or months. Similarly, the constants, a, b, c, d, and f represent the model parameters as defined by the above equations and have their specific significance in each model. Also the authors referred to the parameters in the model as constants to be evaluated and did not attribute any biological meaning to them, Narinc *et al.* (2014).

Statistical Criteria to Evaluate the Fitted Curves

The adequacy of fit of each model was evaluated by Akaike's Information

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Criterion

(AIC), Mean square error, MSE Coefficient of determination (R^2) and graphical evaluation.

Akaike's information criterion (AIC)

Akaike's information criterion (Akaike, 1974), that can be approximated to the least mean square method (Motulsky and Christopoulos, 2003), was calculated as follows:

$$AIC = n \cdot \ln \left[\frac{SS_{Error}}{n} \right] + 2 \cdot k$$

Where:

n is the number of data points, k is the number of parameters in the model, and SS_{Error} is the sum of the squared error.

Mean square error (MSE)

The Mean Square Error was calculated as follows:

$$MSE = \frac{\sum_{i=1}^n \sum_{j=1}^m (y_{it} - \hat{y}_{it})^2}{nm - p}$$

Where:

$y_{it} - \hat{y}_{it}$ Are the observed and predicted weekly egg production rates, respectively, of hen i at week t of laying,

n is the total number of hens, m is the total number of weeks of egg laying evaluated, nm is the total number of observed values in the data set, and

p is the number of model parameters.

Coefficient of determination (R^2)

The R^2 was calculated as follows:

$$R^2 = \frac{SS_{model}}{SS_{total}}$$

Where:

SS_{model} = is the sum of the squares of the model

SS_{total} = is the total sum of the squares.

Graphical evaluation of curve fitting

Data used for the fitted curve was evaluated using R Statistical Software, version 3.0.3 (2013).

Results

Tables 1 and 2 shows the descriptive statistics for egg production characteristics as affected by strains and age of production. In Table 1, significant ($P < 0.05$) difference existed for BWT and EWT except for ASM and EGGNO. Coefficient of variation ranged from low (9.13%) for EWT to high for EGGNO (28.46 %). BWT was better ($P < 0.05$) in Strain B with a higher value of (1.59 ± 0.01) compared to (1.55 ± 0.10) for Strain A. EWT in Strain A had higher value ($P < 0.05$) (48.75 ± 0.17) than its counterpart (47.92 ± 0.17). EGGNO and ASM were not affected by strain. EWT was significantly ($P < 0.05$) affected by Strain at 24, 26, 27 and 28 weeks of production. BWT attained higher growth ($P < 0.05$) at 27 and 28 weeks of production. Decline in BWT especially for Strain A and EWT in Strain B were recorded at week 28 and week 29, respectively.

Table 1: Effect of Strain on egg production traits

Traits	Strain A	Strain B	CV (%)
	Mean $\pm$ SE	Mean $\pm$ SE	
BWT (Kg)	1.55 $\pm$ 0.10 ^b	1.59 $\pm$ 0.01 ^a	18.26%
ASM (days)	158.30 $\pm$ 1.50	154.24 $\pm$ 1.50	16.67
EGGNO(g)	14.33 $\pm$ 0.24	14.48 $\pm$ 0.24	28.46
EWT(g)	48.75 $\pm$ 0.17 ^a	47.92 $\pm$ 0.17 ^b	9.13

Traits: BWT: Body weight, ASM: Age at Sexual Maturity, EGGNO: Egg number, EWT: Egg weight

^{ab} Means with different superscripts on the same row are significantly different ($P < 0.05$)

Table 2: Effect of Age on body weight and egg weight

Weeks	BWT	N	EWT
	Mean±SE		Mean±SE
21	1.48±0.02 ^c	200	48.00±0.46 ^{bcd}
22	1.57±0.02 ^{bcd}	200	48.73±0.41 ^{bc}
23	1.57±0.02 ^{bcd}	200	49.29±0.42 ^{ab}
24	1.61±0.02 ^{ab}	200	49.68±0.41 ^a
25	1.61±0.02 ^{ab}	196	49.63±0.39 ^a
26	1.63±0.02 ^a	196	49.89±0.40 ^a
27	1.64±0.02 ^a	196	49.90±0.40 ^a
28	1.64±0.02 ^{cde}	196	48.02±0.38 ^{bcd}
29	1.54±0.02 ^{de}	196	46.19±0.45 ^e
30	1.59±0.02 ^{abc}	194	46.76±0.44 ^{de}
31	1.54±0.02 ^{cde}	194	47.96±0.45 ^{cd}
32	1.54±0.02 ^{cde}	194	45.96±0.48 ^e

Traits: BWT: Body weight, ASM: Age at Sexual Mat urity, EGGNO: Egg number, EWT: Egg weight, N: Number, ^{abcde}Means with different superscripts on the same row are significantly different (P<0.05).

Figure 4 shows the effect of age on body weight of Shikabrown[®] parent. The curve showed that Strain B attained a mature bodyweight earlier, but showed little increase in body weight over the duration of the study. Strain A on the other hand, attained mature bodyweight late, but showed relatively steady increase in

bodyweight over the duration of the study. At 32 weeks, Strain A was significantly (P<0.05) higher in bodyweight than Strain B. As the birds advanced in age, their body weights also increased unlike strain B where there were periods of rising and falling in bodyweights of birds irrespective of age.

Figure1: Effect of Strain on Body Weight of Shikabrown[®] Parent

Egg production curves of Shikabrown® parents

Figure 2 shows the effect of age on egg weight of Shikabrown® parent. Similar trend was also observed in both Strains for egg weight as did for body weight. Strain A showed a rapid rise in egg weight within 21st and 22nd weeks of age. The rate of increase in egg weight in the subsequent 22nd and 31st weeks of age although significant and steady, it was less rapid than between 21st and 22nd weeks and between the 31st and 32nd week. Strain B showed an increased egg weight at an earlier age than Strain A, but increase significantly over time (21st to 27th week). The egg weight declined subsequently from 28th to 31st weeks of age. The egg weight of Strain A was less than the egg weight of Strain B in the first five weeks of the study, however it was less than the egg weight of Strain A in the subsequent seventh weeks, with the egg weight of Strain A being significantly

($P < 0.05$) bigger at the 12th week of the study. Strain B roughly showed a plateau trend, meaning there was no significant ($P > 0.05$) increase in egg weight over time.

Figure 3 shows the variation in egg number over the duration of study (March, April and May). In March, Strain B laid higher number of eggs than Strain A. Both strains performed well in the month of April with Strain B having an edge over Strain A. In May, there was a significant ($P < 0.05$) distinction between the performance of Strain A, and Strain B, in egg number. Strain A performed appreciably better than Strain B with a decisively higher record of eggs laid in May. Generally, there was a steady increase in number of eggs laid by Strain A over the duration of the study, with the highest number of eggs laid in May. On the other hand, the number of eggs laid by Strain B increased from March to April, when it peaked, but declined in May.

Figure 2: Effect of Age on Egg Weight of Shikabrown® Parent

Figure 3: Variation in Egg Number of Shikabrown® Over Time

Tables 3 and 4 showed the values estimated for egg production traits in Strain A and B. It shows the relationship between model parameters and egg production traits. In both Strains, Exponential and Gompertz models recorded higher weight changes (a) for body weight. Exponential model had higher value in Strain A as compared to B (3062.09 and 2227.35) while Gompertz model also recorded similar pattern (2621.33 and 2132.02). Significant differences are recorded within models for the egg production traits studied. Egg weight in Strain A recorded the best prediction accuracy ($R^2 = 0.96$) across the four nonlinear models with the exception of linear model with ($R^2 = 0.95$) for egg weight. This is followed by body weight with the range of 0.92-0.93 for the prediction accuracy recorded in the models.

Coefficient of determination of ($R^2 = 0.70$) was obtained in a reproductive trait; egg number, in which similar value was recorded for Richard, Gompertz, Logistic and linear models. Exponential model recorded a higher R^2 of (0.93) for egg number in Strain A. Also within egg production traits of interest in strain B, body weight also recorded a higher R^2 value of 0.89 each in Strain A for Logistic, Richard and Gompertz models, followed by R^2 value of ($R^2 = 0.70$) in linear model, the least R^2 was ($R^2 = 0.84$) recorded for body weight in Exponential model. In Strain B also, similar value of ($R^2 = 0.70$) was recorded for egg number as was the case in Strain A. Egg weight was ($R^2 = 0.83$) for linear models in Strain B.

Table 3: Traits Comparison within Models for Strain A

Model	Trait	Parametric Estimates					Goodness of Fit		Validation	
		a	b	c	d	f	RMSE	R ²	AIC	AIC Wt
Logistic	BWT	0.09	19.86	2624.96			48.11	0.92	12421.03	1.47
	EGGNO	0.75	3.66	29.04			2.30	0.70	10.37.90	0.19
	EWT	0.13	16.57	63.25			1.21	0.96	48.89	0.13
Richard	BWT	0.02	-2.16.33	4384.30	3341.06	-67.66	47.60	0.93	12395.60	0.75
	EGGNO	1.12	3.82	5.51	25.51	1.03	2.32	0.70	1042.10	0.02
	EWT	0.04	-140.64	81.03	69.31	-1599.26	1.30	0.96	62.77	0.00
Gompertz	BWT	2621.33	0.10	15.64			47.86	0.93	12421.03	0.00
	EGGNO	35.33	0.41	3.37			2.30	0.70	1037.90	0.19
	EWT	64.57	0.11	13.86			1.19	0.96	48.45	0.16
Linear	BWT	592.19	48.72				48.15	0.92	1242.88	1.47
	EGGNO	-4.45	5.17				2.30	0.70	1036.90	0.42
	EWT	12.08	1.40				1.24	0.95	46.09	0.51
Exponential	BWT	3062.09	-3534.24	-0.03			47.59	0.93	12395.58	0.75
	EGGNO	73.70	-81.85	-0.01			47.59	0.93	12395.58	0.75
	EWT	66.52	-145.43	-0.10			1.16	0.96	47.96	0.20

BWT: Body weight, EGGNO: Egg Number, EWT: Egg Weight, RMSE = Root Mean Square Error, R² = Coefficient of determination, AIC (Model efficiency) = Akaike Information Criterion, AIC Wt (Model ranking) = Akaike Information Criterion, a= Growth rate, b = Inflection point, c = Asymptote 1, d = Asymptote 2, f = Power

Figure 4: Growth curves of strain A birds, estimated by Logistic, Richard, Gompertz, Linear and Exponential models for Shikabrown® Parent

Figure 5: Growth curves of strain B birds, estimated by Logistic, Richard, Gompertz, Linear and Exponential models for Shikabrown® Parent.

Table 4: Traits Comparison within Models for Strain B

Model	Trait	Parametric Estimates					Goodness of Fit		Validation	
		A	b	c	d	f	RMSE	R ²	AIC	AIC Wt
Logistic	BWT	0.13	18.09	2072.48			64.17	0.89	13096.78	8.94
	EGGNO	0.65	3.83	30.91			2.30	0.70	1037.90	0.19
	EWt	0.13	16.38	63.29			2.02	0.84	2782.43	0.00
Richard	BWT	0.02	-74.92	2505.54	2462.66	-21.73	63.15	0.89	13079.45	5.05
	EGGNO	1.70	3.94	9.28	23.11	1.04	2.32	0.70	1037.90	0.19
	EWt	0.01	34.31	67.62	67.62	-10.95	2.00	0.84	2774.05	0.16
Gompertz	BWT	2132.02	0.10	15.05			63.70	0.89	13079.45	5.05
	EGGNO	39.61	0.34	3.64			2.30	0.70	1036.30	0.42
	EWt	64.62	0.10	13.62			2.00	0.84	1776.79	0.04
Linear	BWT	-4.45	5.17				2.30	0.70	1036.90	0.42
	EGGNO	-3.12	4.85				2.30	0.70	1036.30	0.42
	EWt	12.68	1.38				2.06	0.83	2807.04	1.07
Exponential	BWT	2227.35	-4922.58	-0.00			1.99	0.84	2770.79	0.80
	EGGNO	152.37	-156.77	-0.04			2.30	0.70	1037.90	0.42
	EWt	66.59	-139.47	-0.08			1.99	0.84	2770.79	0.80

BWT: Body weight, EGGNO: Egg Number, EWT: Egg Weight, RMSE = Root Mean Square Error, R² = Coefficient of determination, AIC (Model efficiency) = Akaike Information Criterion, AIC Wt (Model ranking) = Akaike Information Criterion, a= Growth rate, b = Inflection point, c = Asymptote 1, d = Asymptote 2, f = Power

Discussions

Differences in age at sexual maturity are subject to genetic variation. However it is not clear whether age at sexual maturity is inherited independently of body size (Agaviezorb *et al.*, 2011). Variation observed in ASM which is higher in strain A (158 days) as compared to strain B (154 days), could be as a result of different ($P<0.05$) body weight at maturity of the strains considered. This is in agreement with Charles and Tucker (1993), who found that layers of light strain consumed comparable little feed as opposed to heavy strains which consumed more feed. Similarly, Sowunmi *et al.* (1998) reported that the body weight at first egg depends to a large extent upon age. Those that mature when relatively young weigh less than those that do not begin laying until they are somewhat older.

In this present study, individual egg production was expressed in 28-d periods from the day the birds laid the first egg. Consequently, summation of such records in strain egg production data was free of the influence of sexual maturity (Oni, 1997). The curve trend revealed that the two strains differed significantly ($P<0.05$) in body and egg weights (Figures 1 and 2). Strain B had the highest body weight (1.59 ± 0.01 Kg) and strain A had the highest egg weight (48.75 ± 0.17 Kg). Generally, body weight increased with age of the birds in each strain. This result compares with the findings of Crawford (1990), Hossain and Ahmed (1993). Giordani *et al.* (1992) and Ebangi and Ibe (1994) all reported differences in growth rate of chickens as a result of genotype and age. Similarly, increase in body weight of each strain as they advanced in age, in this study is in line with the reports of Ojedapo *et al.* (2008) and Pingel *et al.* (1990) that age is a major determinant of growth and physiological

development. Omeje and Nwosu (1986) opined that these relationships could be utilized in the genetic improvement of growth through selection. The rising and falling in egg weight followed the trend observed for body weight. Such effects could be attributed to climatic effects, heat stress, as well as, on the health and feed consumption of layers (Hani *et al.*, 2011). The growth curves of the Shikabrown® parent as presented by the models for both strains are presented in Figures 1 and 2. Goodness of fit criteria was generally high for most of the models ($R^2=0.84-0.96$) for BWT and EWT. This is in line but numerically lower than the results of Narinc *et al.* (2010) who reported higher R^2 values of ($R^2=0.98-0.99$) and also DarmaniKuhi *et al.* (2003), who also reported a range of ($R^2=98.87-99.99\%$) in chicken. The high R^2 values in the present study indicate that the models adequately described the observed Shikabrown® data on egg production traits. Forni *et al.*, (2008) observed that model goodness of fit is generally evaluated by using Root Mean Square Error and Coefficient of Determination. The effect of strain on model parameter showed that the constant 'a' (growth rate/maximum potential for egg production per strain) for EGGNO was significantly ($P<0.05$) higher (152.37) for strain B (dam line) than (73.70) for strain A (sire line). This agrees with the report of (Oni, 1997), who reported maximum egg per period for strain B. This is not surprising since selection to improve number of eggs is concentrated on the female line, while the emphasis on the male line is to improve BWT and EWT.

The high coefficient of determination obtained from Richard and Gompertz, agrees with the results of these writers (Ricklefs, 1985; Aggrey, 2002; Anthony *et al.*, 1991 and). The Richard and Gompertz

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models have been shown to give good descriptions of growth in species such as cattle, chicken, ostrich, turkey, quails and emus (Ersoy *et al.*, 2005). The Gompertz growth model has been cited as the model of choice for chicken data based on its overall fit and biological meaning of model parameters. In addition, it has good fitting for weight information whose inflection points occur, when approximately 35-40 % of growth has been achieved (Braccini, 1993). This is in agreement with the findings of Narushin and Takma (2003). They reported Gompertz and Richards models as the best models to predict growth patterns. In this study, the Richards equation provided a better fit than the Gompertz equation. This is in agreement with the report by DarmaniKuhiet *al.* (2003) and Faridi *et al.* (2011) they found Richards equation to be a better model for describing growth data in broilers than the Gompertz equation. This could be due to the higher number of model parameters in Richard model: which has five (5) model parameters than in Gompertz which has three (3) model parameters.

As far as the goodness of fit is concerned, the best value (the lowest) of the AIC gives the closest representation of data (Marc, 2007). However, the suitability of the model for egg production curves depends not only on its general goodness of fits but also on the ability of describing the asymptotic phase of the curve (Macciotta *et al.*, 2011). In this study, the asymptotic phases were recorded for Richard, logistic, Gompertz and Exponential models except for linear model. Brown *et al.* (1976) had earlier reported that 'a' parameter values offer the best opportunity to make direct comparisons among models. Comparisons of asymptotic weight obtained with the different models showed as earlier stated that Exponential model had the highest value (3062.09) followed by Gompertz

(2621.33), Linear (592.19), Logistic (0.09) and then Richard model (0.02). This is in agreement with the report of Kucuk and Eyduran (2009) that compared Monomolecular, Gompertz and Logistic models and ranked the Monomolecular first and Logistic last in terms of asymptote body weight. However the result contrasted with the results reported by Aggrey (2002), who ranked the Richards ahead of Gompertz and Logistic. And also Narinc *et al.* (2010), ranked Gompertz first, Richards next and Logistic last. Similar R^2 value of (0.70) obtained for egg number; a reproductive trait, in almost all the models used for the two strains suggests that the strains had similar age at sexual maturity as buttressed in (Table 1). Also this implies that the birds' genetic potential can be further exploited for more genetic gain. The estimation and analysis of the asymptotic weight is essential and project the flock efficiency, as underweight animals have delayed onset of sexual maturity and tend to lay fewer eggs (Kirikci *et al.*, 2007).

Conclusions

Body weight of Strain B (1.59 ± 0.01 Kg) was significantly superior to that of strain A (1.55 ± 0.10 Kg). Egg weight of Strain A (48.75 ± 0.17 g) was significantly superior to strain B (47.92 ± 0.17 g). The genetic make-up for egg number seems to be similar for the two strains. Values for egg number for strain A (14.33 ± 0.24) and strain B (14.48 ± 0.24) were statistically similar. In strain A, Richard model outperformed the other models in modeling body weight and egg weight with R^2 values of 0.89 and 0.93, respectively. The RMSE generated for Richard model for the two traits were 63.70 and 47.60, respectively. Egg number of strain A was best modeled by Exponential model with R^2 value of 0.93 and RMSE of 47.59.

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