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Comparison of Growth Curve in Male Layer Chickens

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Abstract

This study was aimed to obtain the growth curve of body weight in male layer chickens (Lohman MB 202) based on Logistic and Gompertz models. The frequently data of body weight from one day age to adult age were used for growth curve prediction. Total of one thousand birds from private sector poultry farm in Tasikmalaya Regency, Indonesia were used in this study as the data source. The growth curve estimation was calculated based on Logistic (L) and Gompertz (G) models using Curve Expert 1.4. computer program. The final weight (asymptote) in birds was reached of 1111.27 g (L) and 1685.13 g (G). Therefore, the weight of inflection (Wi) of birds were reached of 555.64 g (L) and 619.53 g (G). The time of inflection (ti) and maximum growth rate (GR) of birds in both models were 6 weeks and 19 g/week respectively. In conclusion, both models had similar coefficient of determination (R2) value. However, the growth curve of Gompertz model was confirmed as better growth curve for body weight of birds than that of Logistic model due to lower of root mean square error (RMSE) value.

Keywords: Body weight, growth curve, inflection and male layer.

Introduction

Growth is an economic trait in poultry production and affected by genetics and environmental factors. Growth can be expressed as an increase body size per time unit.[1] Growth is a constant function throughout the animal's lifetime from embryonic phases up to fully-grown age and its mathematically described by growth curve models. Growth curve for poultry usually have the features: an accelerating phase of development from hatching, a point of inflection in the development curve at which the growth rate is supreme, a phase where growth amount is slowing and a limiting value (asymptote) complete weight.[2] In addition, the growth curve is to define the consistent change generated by the live weight or some portion of the animal through the age increasing, which commonly is a S-shaped (sigmoid) curve.[3]

The application of mathematical model on growth curve can give a collection of parameters that might be accustomed describe growth pattern overtime. moreover, it'll alter the breeders to expect the burden of animals at a selected age and to discover the stage that related to the reduction in rate of growth.[4] Moreover, growth curve of farm animal has been accustomed observe dynamically of growth course, to forecast the poultry growth law and instruct the feeding and management programs to enhance the choice and breeding effects.[5]

The growth curve of livestock can be estimated with several nonlinear regression model of Brody, Bertalanffy, Gompertz, Logistic, Richards and Weibull. However, the Logistic and Gompertz jobs have secure growing methods with opinion of inflection at about 50% and 30% of the asymptote in birds correspondingly.[6] Moreover, previous studies were worked with Logistic and Gompertz models to evaluate growth curve of broiler.[7,8] But recently, study

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that explain male layer growth curve is not reported.

Growth performance of male layer chicks are moderate, and yield and preferable meat in the carcass does not meet consumer expectations.9 On the other hand, in the Philippines and some other parts of Asia, day-old layer males are used as a human "snack food". In some African and Asian nations, male layer chicks are raised up for meat by way of backyard poultry that feed for most of their diet. In some shops in Malaysia, layer males, which have been raised up to market weight and processed, are truly sold at an advanced value per pound than are broilers.10 Also, in Africa and Asia there are many dishes that benefit from a cockerel instead of a standard broiler.[11] In Indonesia, male layer chickens were kept by many farmers for meat production. In Indonesia, the day of chick (DOC) of male layer were kept by many farmers for meat production. The objective of the current study is to assess the growth curve of male layer chicken. The results of this study can be used for obtaining the suitable management system for male layer chickens.

Materials and Methods

This study was conducted in one of the specific sector poultry farms located at Tasikmalaya Regency, West Java, Indonesia. A total of one thousand male layer chickens (Lohman MB 202) were used in this study. Birds were kept in floor pen. The illumination procession provided 22 h of nonstop light per daytime. The vaccination of Newcastle disease (ND) and Gumboro were given to each bird. A marketable basal regime was given to the birds as presented in Table 1. Feed and intake water were obtainable ad libitum. Birds were measured at fixed intervals of one week for 8 weeks.

Table 1. Nutrient compound of the basal regime of male layer chicken (Lohman MB 202)

Component (%)	Starter (0-4 weeks)	Finisher* (5-8 weeks)
Water	12	13
Protein	21	21
Fat	7.4	7.0
Fiber	6.0	5.0
Ash	8.0	7.0
Calcium	0.9-1.2	0.9-1.2
Phospor	0.6-1.0	0.6-1.0

Two growth curve models of Logistic (L) and Gompertz (G) were performed using Curve Expert 1.4. computer program and relevant models are described in the Table 2s. The best growth curve was selected based on coefficient of determination (R2) and root mean square error (RMSE) values. Growth curve with highest of R2 value and lowest of RMSE values were confirmed as the best growth curve to predict body weight of birds from hatching to adult age.

Table 2. The growth curve functions

Model	Formula*			
Logistic	$Wt = \frac{A}{1 + Be^{-kt}}$	$W_i = A/2$	$t_i = (\ln.B)/k$	$GR = (k \times W_i)/2$
Gompertz	$Wt = Ae^{-e^{B-kt}}$	$W_i = A/e$	$t_i = B/k$	$GR = k \times W_i$

Results

Growth curve analysis

The growth curve analysis results with Curve Expert 1.4. computer program was presented in Table 3. The final weight (A) in L model was lower than G model. The average growth rate (k) in L model was higher than G model. The weight of inflection (Wi) in L model was lower than G model. Despite, both models had similar of time of inflection (ti) value (approximately 6 weeks) and maximum growth rate (GR) value (approximately 19 g/week). The coefficient of determination (R2) value in both models were similar (0.98) in both models but the lowest root mean square error (RMSE) value was observed in G model. Moreover, the growth curve in both models showed a sigmoid form (Figure 1). According to the both models, the highest of GR value in birds was occurred at 42-45 days (Figure 2) as noted in Table 3.

Table 3. Growth curve parameters, inflection point, maximum growth rate and goodness of appropriate standards

Model	A	B	k	W_i	t_i	GR	R^2	RMSE
Logistic	1111.27	18.97	0.07	555.64	6.01	19.45	0.98	19.04
Gompertz	1685.13	1.35	0.03	619.53	6.43	18.59	0.98	11.34

Predicted weight

The actual and predicted live weights in birds at 0-8 weeks age were presented in Table 4. Commonly, the predicted weight in both models were closed to actual weight. The predicted weight in L model at 0 week was too higher than actual weight. The predicted weight in G model at 7 and 8 weeks were closed to the actual weight. Moreover, the maximum weekly growth rate in both models were showed at 7th week.

Table 4. Measured and predicted live weights and growth rates according to two growth curves in male layer chickens (Lohman MB 202)

Parameter	Week								
	0	1	2	3	4	5	6	7	8
Actual									
Live weight (g)	35.00	70.00	124.00	224.00	334.00	450.00	571.00	690.00	819.00
Growth rate (g/week)	-	35.00	54.00	100.00	110.00	116.00	121.00	119.00	129.00
Logistic									
Predicted weight (g)	55.65	88.07	136.94	207.42	302.90	421.82	555.36	688.92	807.93
Growth rate (g/week)	-	32.42	48.87	70.48	95.48	118.92	133.54	133.56	119.01
Gompertz									
Predicted weight (g)	35.39	73.60	133.22	215.49	318.21	436.43	563.78	693.80	820.27
Growth rate (g/week)	-	38.21	59.62	82.27	102.72	118.22	100.35	130.02	126.47

Discussion

According to the present study the mean body weight at first week of age was found 70 g. The mean body weight and weight obtained at the first week in this study was lower than the weight gain reported by the Habig et al (2016).[12] Habig et al (2016) studied the Lohmann Brown males and reported 80.9 g mean body weight at first week of age which is also higher than the results presented by Koenig et al (2012). This difference in the mean weight is associated with the day-old chick weight and line under study. The body weight gain is significantly influenced by the line and the space covered at its sitting and standing position. Furthermore, higher weight gain and uniformity was observed in Lohmann dual males than the Lohmann brown males. The results of the presented study at fourth and seventh week of age are comparable with the results demonstrated by Koenig et al (2012), who reported the mean weigh 344g and 681g respectively. Kreuzer et al (2019)[13] studied the Lohmann Brown, Hubbard and Lohmann Dual purpose male layer and found the higher mean weight in the Broiler males throughout the study followed by the dual-purpose male layers and lastly the Lohmann male layers. The performance of the dual-purpose male layer was higher than the slow growing broiler males and the layer males at lower dietary protein levels. The Final weight gain in this study was lower than the reported weight gain by the other researchers. Giersberg et al. (2018)[14] reported the final male layer weight gain for Lohmann Brown and dual-purpose stains 1.3 and 1.5 kg, respectively. Meanwhile the authors also reported the weight daily gain of 9 to 13 g and 18 to 20 for organic and conventional rearing system. Leenstra (2014) studied the effect of the rearing system on the male layers and reported the higher weight gain at floor system than cage system and the rearing system significantly influenced the weight gain at third, seventh and eleventh week of their age. The curve fitting of the G model is more closer than the L model and higher accuracy in the weight estimation can be done with the G model with higher R2 and less root mean square error (RMSE).

The final weight (A) of birds in the current study were lower than some Broiler strains as presented in Table 5. The maturing rate (k) in studied birds were closed to strain Ross 30815 and Hubbard JA5716 Broilers. The k value in studied birds were higher than in Creole chickens.[17] The weight of inflection (Wi) in studied birds were lower than some Broiler strains (Table 5). N'dri et al. (2018)[18] obtained Wi of 554.01 g and 586.10 g in Cote d'Ivoire chicken breeds and lower than in this study. The time of inflection (ti) in studied birds were closed to strain Hubbard JA57 Broiler.[16] The growth rate (GR) in studied birds were lower than some Broiler strains (Table 5). The growth curve of G model was better than L model to predict the body weight from hatching to final weight. Previous studies reported that G model was accurate to explain the growth curve of Broiler,[19,20,16,7] Ghanaian,[21] nondescript Italian[22] and Polish Greenleg Patridge.[23]

Table 5. The growth curve parameters, maturing rate, inflection point and growth rate of commercial Broiler chickens in certain previous reports

Strain	Sex	Model	A	B	k	W_i	t_i	GR	Reference
Ross 308	U	L	3338.00	1.70	0.08	1669.00	6.66	66.76	Moharrery and Mirzaei (2014)
Ross 308	U	G	5729.00	0.23	0.03	2108.00	7.50	63.24	Moharrery and Mirzaei (2014)
Ross 308	U	L	3010.32	31.52	0.84	1505.16	4.13	628.17	Eleroğlu et al. (2016)
Ross 308	U	G	4364.53	4.62	0.36	1605.79	4.31	568.82	Eleroğlu et al. (2016)
Ross PM3	M	L	2844.15	37.23	0.74	1422.08	4.89	526.17	Topal and Bolukbasi (2008)
Ross PM3	M	G	5453.80	4.92	0.27	2005.07	18.22	541.37	Topal and Bolukbasi (2008)
Ross PM3	F	L	3097.27	47.27	0.78	1548.64	4.94	603.97	Topal and Bolukbasi (2008)
Ross PM3	F	G	6282.35	5.31	0.27	2309.69	19.67	623.62	Topal and Bolukbasi (2008)
Strain	Sex	Model	A	B	k	W_i	t_i	GR	Reference
Hubbard JA57	M	L	2854.00	27.16	0.08	1427.00	6.33	57.08	Narinc et al. (2010)
Hubbard JA57	M	G	4362.00	4.37	0.03	1605.00	6.88	48.15	Narinc et al. (2010)
Hubbard JA57	F	L	2477.00	23.51	0.07	1239.00	6.18	43.37	Narinc et al. (2010)
Hubbard JA57	F	G	3657.00	4.14	0.03	1345.00	6.56	40.35	Narinc et al. (2010)
Hubbard S757	M	L	3635.00	61.79	0.39	1817.50	10.40	354.41	Eleroğlu et al. (2014)
Hubbard S757	M	G	6496.47	5.84	0.15	2390.18	12.11	358.53	Eleroğlu et al. (2014)
Hubbard S757	F	L	2790.37	49.38	0.39	1395.16	10.02	272.06	Eleroğlu et al. (2014)
Hubbard S757	F	G	4876.10	5.41	0.15	1793.97	11.54	269.10	Eleroğlu et al. (2014)
Hubbard GB-JA	M	L	2906.35	62.52	0.37	1453.18	11.04	268.84	Eleroğlu et al. (2014)
Hubbard GB-JA	M	G	6109.60	5.81	0.13	2247.79	13.99	292.21	Eleroğlu et al. (2014)
Hubbard GB-JA	F	L	2133.33	50.26	0.38	1066.67	10.37	202.67	Eleroğlu et al. (2014)
Hubbard GB-JA	F	G	3725.34	5.36	0.14	1370.58	12.01	191.88	Eleroğlu et al. (2014)

The male layer chicken in this study showed lower growth rate than Broiler chicken. It can be caused by genetical factor. Broiler chicken was developed for meat production with fast growth trait. Hence, layer chicken was developed for egg production with medium body size trait. According to Figure 1, the final weight of male can be obtained at more than 100 days (14 weeks). Hence, obtaining the final weight in male layer chicken needed a long time and feed cost. In strain Ross 308 Broiler, the final weight was reached of about 3000-4000 g at 11 weeks age.8 Commonly, harvest time in male layer chicken at 8 weeks age with slaughter weight about 1 kg. Therefore, most of this chicken was supplied to restaurants in Indonesia because of better meat taste than Broiler meat.

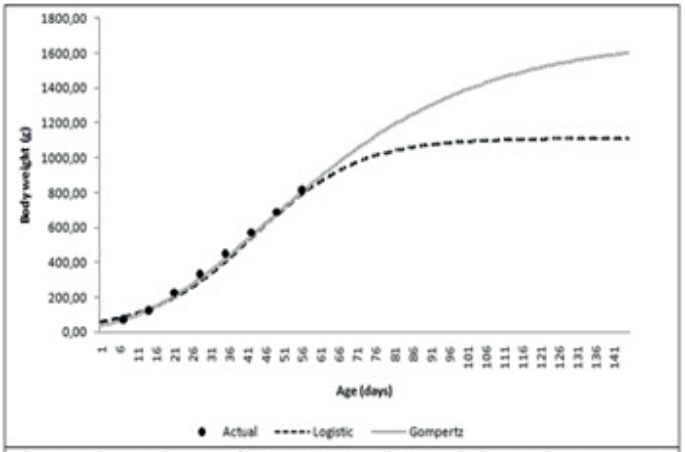

Figure 1. The growth curve of body weight in male layer chickens (Lohman MB 202)

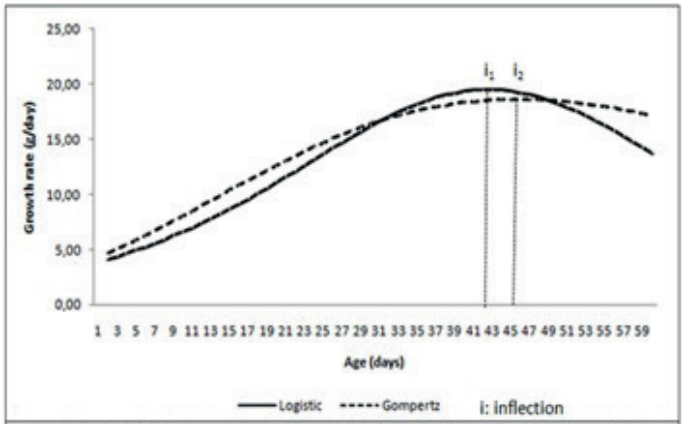

Figure 2. The absolute growth rate of body weight in male layer chickens (Lohman MB 202)

Conclusion

The weight of male layer chicken (Lohman MB 202) was reached of 555.64 g (L) and 619.53 g (G) at about 6 weeks age. The growth curve of G model had lower of RMSE value than L model and suggested that the G model was accurate to predict body weight of studied birds. According to G model, the body weight (Wt) of studied birds can be predicted with mathematical formula of

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