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Comparison Of The Linear And Quadratic Models For Describing The Growth of Live Weight and Body Measurements In Anatolian Merino Male Lambs In Fattening Period

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Abstract: The linear and quadratic models were used to estimate growth of live weight and body measurements in Anatolian Merino male lambs from weaning (75 days) to 145 days of age. Lambs were fed for a 63 days feeding period after a week of adaptation period. The feed contained 2775 kcal/kg metabolic energy and 15 % crude protein. Both of the models showed good fit to the live weight and leg girth data (R^2=0.990 and 0.984). The quadratic model gave a better fit to withers height, rump height; chest girth, chest depth and body length data and allowed a suitable description of growth curve by its higher R^2 and lower MSE values ($p<0.01$).

Key words: Growth curves, live weight, body measurement, anatolian merino

INTRUDUCTION

A trait of interest in the domestic animals is growth. It can be defined as increase of tissues and cells in a certain period of time. However in the domestic animals interest is body weight.

A growth curve of a trait shows its changes in certain time of period. The magnitude of a growth curve may change according to species, their environment, and trait. Interpretation of a growth curve is important in terms biological aspects[1].

Initial periods of living organisms are mostly linearly modeled. Too later stages more sophisticated methods may be needed. Therefore, of the non-linear models, monomolecular and Gompertz models are commonly used to model the later stages. Few studies report that linear models were fitted and gave good results[2].

Growth curves were used for optimization of feeding, determination of optimum slaughtering age, and selection criteria[3].

Kocabaş *et al.*[4] attempted to determine the best growth model for body weight gain in Akkaraman, Malya x Akkaraman lambs for 9 weeks feeding period and in Awassi x Akkaraman lambs for 10 weeks feeding period.

They have reported that the linear model were fitted and gave good results for Akkaraman and Awassi x Akkaraman lambs except for Malya x Akkaraman lambs.

Akbaş *et al.*[5], studied on Kıvırcık and Dağlıç male lambs growth changes from birth to 420 days via growth curve models. In addition, goodness of fit of 15 different models was compared in terms of growth curve parameters. They have reported that the linear and quadratic models were the best choice for Dağlıç and Kıvırcık, respectively for growth performance. They also reported that from the non-linear models, Brody, Negative exponentials, Gompertz, Logistic and Bertalanffy models were fitted very well to male Kıvırcık and Dağlıç lambs body weight data (R^2=0.999 for Brody model).

The aim of this study is to determine the growth curve parameters of Anatolian Merino male lambs for live weight and body mensurement in the feeding period.

MATERIAL AND METHODS

In this study 21 Anatolian Merino lambs, which were raised in Altınova state farm, were used. Lambs were weaned at 75 days of age and transferred to Agricultural faculty, Farm of Department of Animal Sciences. They were exposed to a 63 days feeding period after a week of adaptation period. Lambs were kept in individual paddocks and adlibitum feeding method applied. The feed contained 2775 kcal/kg metabolic energy and 15 % crude protein.

Data on body weight and different body measurements from lambs were collected weekly. Ertuğrul[6] were followed for measurement criteria.

Linear ($Y = a+bt$) and Quadratic ($Y = a+bt+ct^2$) models were used to estimate the growth curves parameters. Where; Y: is the growth in the t^{th} time period, a: ultimate growth value that can be achieved, b: the initial weight, c: growth rate, t: age (as day).

Minitab package program was used in calculations. Coefficients of determination and Mean Square Error (MSE) were used to determine the fitness of the models

Goonwardane *et al.*[7]. Student's t-test was used to compare the model parameters.

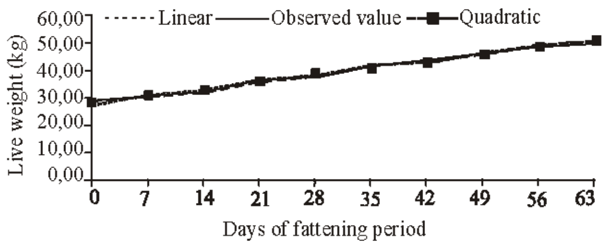

Fig. 1: Growth curves of live weight for the models and observed values

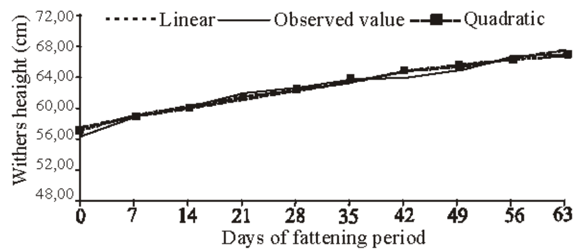

Fig. 2: Growth curves of withers height for the models and observed values

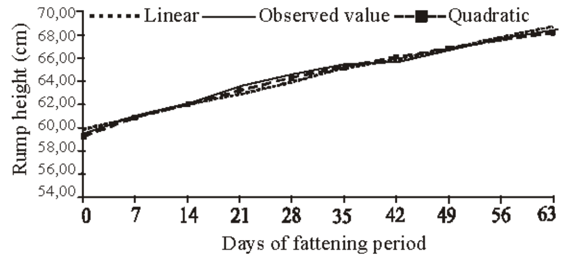

Fig. 3: Growth curves of rump height for the models and observed values

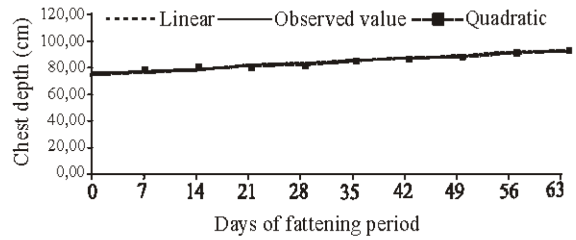

Fig. 4: Growth curves of chest girth for the models and observed values

RESULTS AND DISCUSSION

The parameters and their standart errors of growth curves explained the changes of live weight and body measurements for a fattening period of 63 days calculated in linear and quadratic models in Anatolian Merino male lambs are presented in Table 1. The curves of live weight for the models and observed values were given in Fig. 1. Estimates of and parameters for the linear and quadratic models describing live weight curve were similar ($p>0.05$).

Determination coefficients of the both models were very high (0.990). R^2 and MSE values obtained from models have been used to evaluate the best fit models[5,7,9]. The models give the highest R^2 and lowest MSE values are preferred. The difference between MSE values of the models for live weight was not statistically significant. Both of the models showed good fit to the live weight data and allowed a suitable description of the shape of growth curve. Similarly, Kocabaş *et al.*[4] reported that the linear model resulted in a good fit with R^2 value of 0.990 for the live weight changes from 10 to 19-29 weeks of age in Akkaraman and Awassi x Akkaraman lambs.

Esenbuğa *et al.*[9] stated that R^2 values determined using Brody Function for Morkaraman, Awassi and Tushin lambs were 0.99, 0.99 and 0.98, respectively. Akbaş *et al.*[5] studied the fitting performance of linear and non-linear models to monthly body weight data of Kıvırcık and Dağlıç male lambs. They concluded that among the linear models simple linear model gave the best fit for Dağlıç and quadratic model for Kıvırcık and among the non-linear models, Brody had the highest R^2 value. Lewis *et al.*[9] reported that the Gompertz model gave a better fit to growth of Suffolk sheep. Topal *et al.*[11] stated that the Gompertz model resulted in the best fit for the Morkaraman ewe lambs growth while the Bertalanffy model was the best for the Awassi ewe lambs.

Estimates of a parameters for the linear and quadratic models describing withers height curve were similar, but the difference between parameters of the models was statistically significant ($p<0.05$). R^2 values of the models for the withers height were similar. The difference between MSE values of the linear and quadratic models was significant ($p<0.01$). MSE value of the linear model was higher then the quadratic model's MSE value (Table 1). It can be said that the withers height curve is better described by the quadratic model. The curves of withers height for the models and observed values were given in Fig. 2.

Difference between parameters for the linear and quadratic models describing rump height curve was not statistically significant. But the difference between parameters of the models was significant ($p<0.01$). Also, the differences between the models for R^2 ($p<0.05$) and MSE values ($p<0.01$) were significant (Table 1). The quadratic model is the better fitting model by the higher R^2 and lower MSE values for the rump height curve. Figure 3 shows the curves of rump height for the models and observed values.

Table 1: The parameter estimates, their standard errors (SE), determination coefficients (R^2) and mean square errors (MSE) for linear and quadratic models describing growth curves of live weight and body measurements in Anatolian merino male lambs

		Model Parameters				
Traits	Models	a ±SE	b ± SE	c ± SE	R^2 ± SE	MSE ±SE
Live weight	Linear	28.279±0.5017	0.3609±0.01313	-------	0.990±0.0084	0.80±0.028
	Quadratic	28.374±0.7430	0.3514±0.05327	0.00015±0.00079	0.990±0.0089	0.79±0.027
Withers height	Linear	57.952±0.3616	0.1541±0.00946^{a}	-------	0.971±0.0060	0.41±0.014^{A}
	Quadratic	57.250±0.3766	0.2241±0.02699^{b}	-0.00108±0.00040	0.986±0.0045	0.20±0.007^{B}
Rump height	Linear	59.950±0.2867	0.1399±0.00750^{A}	---------	0.978±0.0048^{a}	0.26±0.009^{A}
	Quadratic	59.319±0.2508	0.2028±0.01798^{B}	-0.00097±0.00027	0.992±0.0030^{b}	0.09±0.003^{B}
Chest girth	Linear	77.202±0.3703	0.2813±0.00969	--------	0.991±0.0062	0.43±0.014^{a}
	Quadratic	77.525±0.5209	0.2491±0.03734	0.00050±0.00055	0.992±0.0062	0.39±0.011^{b}
Chest depth	Linear	22.777±0.3098	0.0656±0.00810	---------	0.891±0.0052^{A}	0.30±0.012^{A}
	Quadratic	23.206±0.3959	0.0228±0.02840	0.00066±0.00042	0.919±0.0047^{B}	0.22±0.006^{B}
Body length	Linear	55.883±0.1496	0.1550±0.00390	--------	0.995±0.0025	0.07±0.002^{A}
	Quadratic	55.740±0.2079	0.1693±0.01490	-0.00022±0.00022	0.996±0.0025	0.06±0.002^{B}
Leg girth	Linear	55.498±0.3275	0.1876±0.00857	---------	0.984±0.0055	0.34±0.015
	Quadratic	55.672±0.4769	0.1703±0.03419	0.00027±0.00051	0.984±0.0057	0.33±0.013

On each trait: ^{A,B}: P<0.01; ^{a,b}: P<0.05

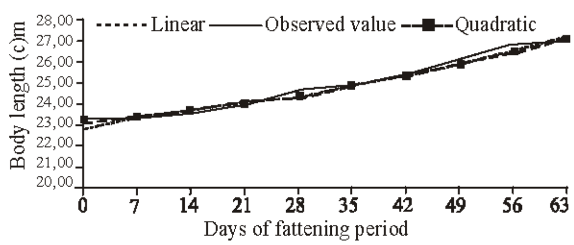

Fig. 5: Growth curves of chest depth for the models and observed values

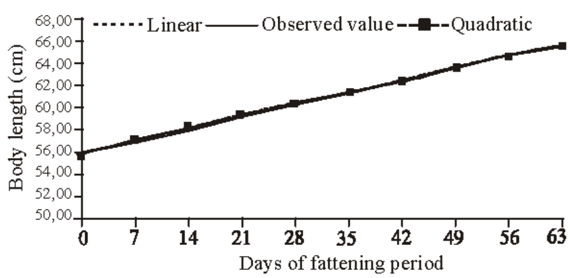

Fig. 6: Growth curves of body length for the models and observed values

There were no differences between the parameters of the models describing chest girth curve (Table 1). R^2 values of the models for chest girth were similar and very high (above 0.990). MSE value of the linear model was higher than the quadratic model's MSE value. The quadratic model gave a better fit for the chest girth curve. Curves of the chest girth for the models and observed values were given in Fig. 4.

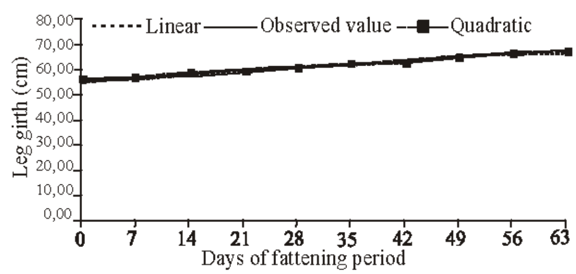

Fig. 7: Growth curves of leg girth for the models and observed values

The parameters of the linear and quadratic models describing chest depth curve were similar (Table 1). The quadratic model has higher R^2 and lower MSE values ($p<0.01$). It is revealed that the quadratic model is better describing model for the chest depth curve. Chest depth curves for the models and observed values were given in Fig. 5.

The parameters of the models describing body length curve were given in Table 1 and the curves of the models and observed values were shown in Fig. 6. The differences between the model parameters were not statistically significant. R^2 values of the models for the body length were similar. But the MSE value of the quadratic model was again lower ($p<0.01$). From the point of view of lower MSE value, quadratic model represented a better description of the shape of body length curve.
Estimated parameters of the models describing leg girth curve were given in Table 1 and the curves of the models and observed values related to leg girth were shown in Fig. 7.

The parameters of the linear and quadratic models defining leg girth curve were similar. The differences between R^2 and MSE values of the models for leg girth were not statistically significant. Both of the models showed good fit to the leg girth data and permitted a pertinent definition of the shape of leg girth curve.

In conclusion, the linear and quadratic models were similar in respect of giving suitable descriptions for the shape of live weight and leg girth curves. On the other hand, the quadratic models gave a better fit to withers height, rump heigth, chest girth, chest depth and body length growth by its higher R^2 and lower MSE values.

REFERENCES

1. Thornley, J.H.M. and I.R. Johnson, 1990. Plant and crop modelling. A Mathematical approach to plant and crop physiology. Clarenrond Press, Oxford, USA.
2. Akbaş, Y., 1996. Growth curve parameters and their using possibilities as improvement criteria. Ege Üniversitesi Ziraat Fakültesi Dergisi, 33: 241-248.
3. Blasko, A., and E. Gomez, 1993. A note on growth curves of rabbit lines selected on growth rate or litter size. Animal Production, 57: 332-334
4. Kocabaş, Z., T. Kesici and A. Eliçin, 1997. Growth curve in Akkaraman, Awassi x Akkaraman and Malya x Akkaraman lambs. Turkish J. Vet. Anim. Sci., 27: 267-275.
5. Akbaş, Y., T. Taşkın and E. Demirören, 1999. Comparison of several models to fit the growth curves of Kıvırcık and Dağlıç male lambs. Turkish. J. Vet. Anim. Sci. , 23 (Suppl. 3), 537-544.
6. Ertuğrul, M., 1996. Small Ruminant Breeding Practices. Ankara Üniversitesi Ziraat Fakültesi Yayin No: 145, Ankara.
7. Goonewardane, L.A., R.T. Berg, R.T. Hardin, 1981. A growth study of beef cattle. Can. J. Anim. Sci., 61: 1041-1048.
8. Brown, J. E., Jr. Fitzhugh and T.C. Cartwright, 1976. A comparison of nonlinear models for describing weight-age relationships in cattle. J. Anim. Sci., 42: 810-818.
9. Esenbuğa, N., Ö.C. Bilgin, M. Macit and M. Karaoğlu, 2000. Growth curves in Awassi, Morkaraman and Tushin lambs. Atatürk Üniversitesi Ziraat Fakültesi Dergisi, 31: 37-41.
10. Lewis, R.M., G.C. Emmans, W.S. Dingwall and G. Simm, 2002. A description of the growth of sheep and its genetic analysis. Anim. Sci., 74: 51-62.
11. Topal, M., M. Özdemir, V. Aksakal, N. Yıldız and U. Doğru, 2004. Determination of the best nonlinear function in order to estimate growth in Morkaraman and Awassi lambs. Small Rumin. Res., 55: 229-232.