The Journal of Animal & Plant Sciences 20(1): 2010, Pages: 1-4
ISSN: 1018-7081

APPROPRIATE GROWTH MODEL DESCRIBING SOME TESTICULAR CHARACTERISTICS IN NORDUZ MALE LAMBS

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ABSTRACT

The objective of this study was to determine the appropriate non-linear function describing growth of some testicular traits (testicular length, testicular diameter, scrotal circumference and scrotal length) in Norduz male lambs. Testicular characteristics at 90, 110, 130, 150, 170, and 190 days of age for all the lambs were measured. Four growth (Monomolecular, Logistic, Gompertz, and Richard's) models were used to explain relationship between each testicular trait-age. Growth models were based on averages of measurements on their testicular traits in each period of all the male lambs. As a result, appropriate growth models explaining growth at early age of testicular length, testicular diameter, scrotal circumference and scrotal length in Norduz male lambs were Logistic and Richard's non-linear model. Also, age and body weight had significant effect on these testicular traits.

Key Words: Growth models, testicular traits, Norduz male lamb

INTRODUCTION

In sheep breeding, reproductive performance is the most important factor in connection with increasing profitability (Bilgin *et. al.,* 2004). Knowledge of the parameters relating to ram testicles features provides valuable information for both lamb productivity with indirect selection in breeding and sperm production, the direction of new possibilities in the selection of rams. Therefore, parameters such as testicular traits are very important (Kaymakçı *et al*., 1988). In other words, testicular traits such as testicular diameter, testicular length, scrotal circumference, and scrotal length have been used as indirect selection criteria to improve fertility (Öztürk *et al.,* 1996). The testicular traits that can be easily measured in early stages of growth periods are vital characteristics with high heritability (Rege *et al.,* 2000; Bilgin *et al.,* 2004) and have highly correlations with one another (Salhab *et al*., 2001). Testicular traits on scrotal size and dimension are correlated genetically with ovulation rate of females (Bilgin *et al.,* 2004).

There are significant factors (genotype, rearing systems, season, age, body weight, etc.) influencing development of testicular characteristics (Ley *et al.,* 1990; Aral and Tekin, 1996; Aygün *et al.,* 1999; Gundogan *et al.,* 2002). It has been reported by many workers that, within factors, age and body weight had significant influence on testicular traits (Salhab *et al*., 2001; Özdemir and Altin, 2002; Yılmaz and Aygün 2002).

There were few studies on comparison of non-linear models on development of some testicular characteristics in sheep (Bilgin *et al.,* 2004) and bulls (Terawaki *et al.,* 1994; Quirino *et al.,* 1999). So far, there has been not a detailed study carried out on using non-linear models to determine growth of testicular traits such as testicular diameter, testicular length, scrotal circumference, and scrotal length in Norduz male lambs. The aims of this paper were to determine the appropriate non-linear models for describing growth of some testicular characteristics in Norduz male lambs and the effects of age and live weight on testis diameter, testis length, scrotum circumference, and scrotum length.

MATERIALS AND METHODS

Norduz sheep raised in Van, the Eastern Anatolian province of Turkey is a subtype of Akkaraman breed and has the best adaptation to harsh environmental and management conditions, poor feeding, and diseases.

The data were recorded on 30 Norduz male lambs born in Agricultural Farm of Yuzuncu Yil University, Van, Turkey. Testicular diameter, testicular length, scrotal circumference, and scrotal length at 90, 110, 130, 150, 170, and 190 days of age for all the male lambs were measured as recommended by Sönmez and Kaymakci (1987).

Growth Models fitted to each testis trait –age" data in Norduz male lambs can be written as follows:

Monomolecular: $W(t) = A*(1 - B*\exp(-k*t))^1$

Logistic with 3 parameters: $W(t) = A*(1+B*\exp(-k*t))^{-1}$

Gompertz: $W(t) = A*\exp(-B*\exp(-k*t))$

Richards : $W(t) = A*[1-b*\exp(-k*t)]^{M}$

Where, W (t): observed value at t age for testis diameter, testis length, scrotum circumference, and scrotum length,

A: asymptotic limit of testis traits when age approaches infinity;

B: integration constant for testis diameter, testis length, scrotum circumference, and scrotum length,

K: maturity constant for testis diameter, testis length, scrotum circumference, and scrotum length,

M: the shape parameter connecting inflection point in Richards's growth function, which become where the predictable growth rate varies from an increasing to a decreasing function for testis diameter, testis length, scrotum circumference, and scrotum length (Bilgin *et al*. 2004).

Determination coefficient (R^2) and Mean Square Error (MSE) were used to determine growth model explaining each trait-age relationship.

Growth of each testis trait was modeled by Levenberg-Marquardt non-linear least-squares algorithm in NCSS statistical package program (Anonymous, 2001).

In order to explain variation in testis traits of Norduz male lambs, age and body weight for these lambs were used as independent variables in multiple regression analysis. Testis diameter, testis length, scrotum circumference, and scrotum length were considered as dependent variables (Y).

$Y = a + b_1*age + b_2*body\ weight + e$

Where,

Y : dependent variable

a : intercept

b_1 : the regression coefficient of Y on age

b_2 : the regression coefficient of Y on body weight

e: random error term.

VIF (Variance inflation factor) are used as an indicator of multicollinearity. The VIF is an index which measures how much the variance of a coefficient (square of the standard deviation) is increased because of collinearity. VIF for each independent variable should be less than 10. Multiple regression analyses were done using REG procedure of SAS statistical package program (SAS, 1998).

RESULTS AND DISCUSSION

Parameter estimates, determination coefficient (R^2), Mean Square Error (MSE) for non-linear functions fitted to various testicular traits of Norduz male lambs are summarized in Table 1. When determination coefficient and RMSE values were taken into consideration, all the non-linear models gave similar and effective results.

According to determination coefficient and RMSE values, Richard's and Logistic non-linear models could be suggested to be the best non-linear function for four testicular traits. Especially, determination coefficients of these two models gave very close to each other. Bilgin *et al.* (2004) reported that the best growth model explaining the relationship between scrotal circumference and age (days) for Awassi male lambs was Tanaka model (0.9995, R^2), followed by Logistic with 3 parameters

Table 1. Parameter estimates, determination coefficient (R^2), Mean Square Error (MSE) for non-linear functions fitted to various testicular traits of Norduz male lambs

	A	B	k	M	R^2	MSE
Testicular Length						
Monomolecular	10.54	0.007	8.85		0.981867	0.04202827
Logistic	8.75	4.470	0.018		0.983564	0.03788568
Gompertz	9.33	0.012	62.82		0.982868	0.03970796
Richards	8.05	4.968	0.033	112.58	0.984621	0.05346574
Testicular Diameter						
Monomolecular	4.24	0.0178	52.12		0.976656	0.01911536
Logistic	4.02	16.160	0.032		0.983124	0.01381892
Gompertz	4.10	0.025	74.31		0.980141	0.01626147
Richards	3.80	29.372	0.265	138.38	0.994672	0.00654472
Scrotal Circumference						
Monomolecular	33.07	0.005	0.88		0.979231	0.3915515
Logistic	25.32	4.370	0.02		0.983218	0.3163765
Gompertz	27.56	0.011	66.9		0.981266	0.3531891
Richards	21.15	21.01	0.13	146.53	0.995171	0.1365690
Scrotal Length						
Monomolecular	16.95	0.014	46.24		0.981569	0.2257147
Logistic	15.42	12.218	0.027		0.982514	0.2141369
Gompertz	15.96	0.020	75.66		0.982371	0.2158922
Richards	15.54	1.720	0.025	87.55	0.982541	0.3207244

(0.9668, R^2), Gompertz (0.9561, R^2), and Bertalanffy models (0.9521, R^2), respectively. The determination coefficients of Logistic and Gompertz non-linear models for scrotal circumference in the present paper were higher than those of Bilgin *et al.,* (2004).

Table 2 presents coefficient of determination (R^2), Root of Mean Square Error (RMSE), regression equations and Variance Inflation Factor (VIF) values for different testis traits in Norduz male lambs. When these traits were taken into consideration, the influences of age and and body weight were statistically positive-significant for all the traits (P<0.001) (Table 2). That is, testicular length, testicular diameter, scrotal circumference and scrotal length values would be expected to increase with increasing age and body weight in multiple regression analyses. Determination coefficient (R^2) for testicular length, testicular diameter, scrotal circumference and scrotal length values were found 0.7997, 0.7517, 0.7446 and 0.8093 respectively. When VIF values from multiple regression analysis were examined, it was observed not to be multicollinearity problem because VIF values were found much less than 10.

Table 2. Coefficient of determination (R^2) and regression equation for several testis traits in Norduz male lambs

	Regression Equation	R^2	R^2_{Adj}	RMSE	VIF
Testicular Length	TL = -2.42 + 0.022 age*** +0.17 body weight***	0.7997	0.7974	0.714	1.144
Testicular Diameter	TD = -2.06 + 0.012 age*** +0.11 body weight***	0.7517	0.7488	0.487	1.144
Scrotal Circumference	SC = -4.56 + 0.067 age*** +0.38 body weight***	0.7446	0.7418	2.190	1.144
Scrotal Length	SL = -5.22 + 0.054 age*** +0.29 body weight***	0.8093	0.8072	1.413	1.144

***P<0.001 ; the regression of each testicular trait on age were significant. ***P<0.001 ; the regression of each testicular trait on body weight were significant

Ω : VIF values for age and body weight in all the testicular traits

Our findings on significant influences of age and body weight on testicular length and testicular diameter were in agreement with the results of Salhab *et al.,* (2001). Besides, the findings on significant influences of age and body weight on scrotal circumference in the present study were in consistent with some other researchers working on scrotal circumference (Rege *et al.,* 2000; Salhab *et al.,* 2001; Yılmaz and Aygün 2002; Karakuş and Cengiz 2007).

The differences among all the studies in the literature may be due to breed, age, season, and feeding strategies and other environmental/ management practices.

Conclusion: It may be concluded that the best growth model for describing growth of testicular length, testicular diameter, scrotal circumference and scrotal length in Norduz male lambs were Logistic and Richard's non-linear model. Significant effects of age and body weight on testicular length, testicular diameter, scrotal circumference and scrotal length were found (P<0.001).

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