Y. Y. Ü. Fen Bilimleri Enstitüsü Dergisi
Yıl : 2009, Cilt : 14, Sayı : 1, Sayfa : 1-3

Determination of The Best Non-Linear Model for Describing Growth of Scrotal Circumference in Karakaş Male Lambs

Kadir KARAKUŞ[1], Ecevit EYDURAN[2], Turgut AYGÜN[2]

[1]Gevaş Vocational High School, Yüzüncü Yıl University, Gevaş, Van, Turkey
[2]Department of Animal Science, Faculty of Agriculture, Yüzüncü Yıl University, 65080, Van, Turkey

Abstract :This study was conducted to determine the most appropriate non-linear function for describing growth of scrotal circumference in Karakaş male lambs and to examine the effects of age and body weight on scrotal circumferences. For this aim, research data were obtained from 16 Karakaş male lambs born in Agricultural Farm of Yuzuncu Yil University, Van, Turkey. Scrotal circumference at 90, 110, 130, 150, 170, and 190 days of age for all the lambs were measured. Four non-linear functions (Monomolecular, Logistic, Gompertz, and Richard's) were used to explain the relationship between the scrotal circumference and age.
Consequently, the best non-linear model explaining scrotal circumference-age relationship in Karakaş lambs was Richard's non-linear model with approximately 0.95815 (R^2). Also, it was determined that 65.07 % of total variation in scrotal circumference was explained by age ($P<0.001$) and body weight ($P<0.001$) factors in multiple regression analysis.
Key Words: Growth models, Scrotal circumference, Karakaş lamb

Karakaş Erkek Kuzularında Skrotum Çevresinin Büyümesini Tanımlayan En Uygun Non-Linear Modelin Belirlenmesi

Özet :Bu çalışma, Karakaş erkek kuzularında skrotum çevresinin büyümesini tanımlayan en uygun non-linear fonksiyonu belirlemek ve skrotum çevresi üzerine yaş ve canlı ağırlığın etkisini incelemek amacıyla yürütülmüştür. Bu amaç için, araştırma verileri Yüzüncü Yıl Üniversitesi, Araştırma ve Uygulama Çiftliğinde doğan 16 baş Karakaş erkek kuzulardan elde edilmiştir. Tüm kuzuların skrotum çevresi ölçüleri 90, 110, 130, 150, 170 ve 190 günlük yaşta alınmıştır. Skrotum çevresi ile yaş arasındaki ilişkiyi açıklamak için dört doğrusal olmayan model (Monomoleküler, Logistik, Gompertz ve Richard's) kullanılmıştır.
Sonuç olarak, Karakaş erkek kuzularında, skrotum çevresi ile yaş arasındaki ilişkiyi en iyi açıklayan doğrusal olmayan modelin Richard's (0.95815, R^2) olduğu tespit edilmiştir. Aynı zamanda, çoklu regresyon analizinde skrotum çevresindeki varyasyonun % 65.07'sinin yaş ($P<0.001$) ve canlı ağırlıktan ($P<0.001$) kaynaklandığı belirlenmiştir.
Anahtar Kelimeler: Büyüme modelleri, Skrotum çevresi, Karakaş kuzu

Introduction

Testis traits such as testis diameter, testis length, scrotum circumference, and scrotum length have been used as indirect selection criteria in fertility improvement (Öztürk *et al.*, 1996) as the highly genetic correlation between scrotal circumference and spermatologic characteristics were determined (Rege *et al.*, 2000). Also, these traits that can be measured in early stages of growth periods are important traits having high heritability (Rege *et al.*, 2000; Bilgin *et al.*, 2004). It was reported that testis characteristics had highly correlations with each other (Salhab et al., 2001). There are several factors (breed, rearing systems, season, age, body weight, etc.) affecting development of testis characteristics (Ley *et al.*, 1990; Aral and Tekin, 1996; Aygün *et al.*, 1999; Gundogan *et al.*, 2002). Of these factors, age and body weight were reported to have significant effects on scrotal circumference (Özdemir and Altin, 2002; Yılmaz and Aygün 2002). There were few studies on comparison of growth models for describing development of scrotal circumference in sheep (Bilgin *et al.*, 2004) and bulls (Terawaki *et al.*, 1994; Quirino *et al.*, 1999). However, there was no reported information on using non-linear models to describe growth of scrotal circumference in Karakaş male lambs.

The first aim of this study was to determine the most appropriate non-linear model for describing growth of scrotal circumference in Karakaş male lambs and the second aim was to examine the effects of age and body weight on scrotal circumference.

Materials and Methods

The data were recorded from 16 Karakaş male lambs born in Agricultural Farm of Yuzuncu Yil University, Van, Turkey. Scrotal circumference at 90, 110, 130, 150, 170, and 190 days of age for each lamb were measured as described by Sönmez and Kaymakci (1987).

Non-linear models for describing "growth of scrotal circumference –age" relationship in Karakaş male lambs were given below:

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 scrotal circumference at t age, *A*: asymptotic limit of scrotal circumference when age approaches infinity; *B*: integration constant; k: maturity constant; *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 (Quirino *et al.*, 1999; Bilgin et al. 2004).

Determination coefficient (R^2) and Mean Square Error (MSE) were used to determine the most appropriate non-linear function.

The data on growth of scrotal circumference were evaluated using Levenberg-Marquardt non-linear least-squares algorithm in NCSS statistical package program (Anonymous 2001).

In order to account for the variation in scrotal circumference of Karakas male lambs, age and body weight were used as independent variables in multiple regression analysis (SAS,1998).

Scrotal Circumference= $a + b_1$*age + b_2 *body weight+e

Where, "a" is constant, "b_1" and "b_2" are regression coefficient and e is random error.

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.

Results and Discussion

Parameter estimations, determinations coefficient (R^2) and Mean Square Errors (MSE) for different non-linear models are presented in Table 1. When determination coefficients (R^2) for all non-linear models were taken into consideration, the best one to explain "scrotal circumference-age" relationship was found as Richard's models, followed by Logistic with 3 parameters, Gompertz, and Monomolecular models. As considering MSE values, it was determined that model with the least MSE value was Richard's model, followed by Logistic with 3 parameters, Gompertz, and Monomolecular models. Because, Richard's growth model is the most ideal model that had the highest determination coefficient (R^2) value and the lowest MSE value.

In a study conducted by Bilgin *et al.* (2004), it was found that the most appropriate non-linear model for 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 (0.9668, R^2), Gompertz (0.9561, R^2), and Bertalanffy models (0.9521, R^2), respectively.

R^2 values reported by Bilgin *et al.* (2004) were R^2 values higher than in Table 1.

Table 1. Parameter estimations, determination coefficients (R^2) and Mean Square Errors (MSE) for the non-linear functions in Karakaş male lambs

Models	A	B	k	M	R^2	MSE
Monomolecular	22.95	0.0074	-1.17	-	0.920849	0.8216782
Logistic	19.61	3.5900	0.017	-	0.927400	0.7536706
Gompertz	20.73	0.012	50.74	-	0.924139	0.7875276
Richards	17.01	419.34	2.27	163.85	0.958148	0.6517095

Coefficient of determination (R^2) and regression equation for scrotal circumference in Karakaş male lambs were given in Table 2. It was determined that 65.07 % of total variation in scrotal circumference was explained by age and body weight factors (Table 2). Besides, VIF values were found as 1.34. This means that no multicollinearity in multiple regression analysis was found.

As seen from Table 2, significant effects of age ($P<0.001$) and body weight ($P<0.001$) on scrotal circumference were found. That is, the regression of scrotal circumference on age was found as 0.041 ($P<0.001$), holding body weight constant. Similarly, the regression of scrotal circumference on body weight was found as 0.341 ($P<0.001$), holding age constant. Our findings on significant effects of age and body weight on scrotal circumference were agreement with those reported by many authors (Aygün and Karaca, 1995; Rege *et al.*, 2000; Salhab *et al.*, 2001; Özdemir and Altin, 2002; Yılmaz and Aygün 2002; Karakuş and Cengiz 2007).

Table 2. Coefficient of determination (R^2) and regression equation for scrotal circumference in Karakaş male lambs

	Regression Equation	R^2	MSE	VIF
Scrotal Circumference	SC = -1.18 + 0.041 age*** +0.341 body weight***	0.6507	4.75	1.34$^{\Omega}$

***P<0.001 Ω : VIF values of age and body weight

In a similar study carried out by Salhab *et al.* (2001), determination coefficient (R^2) for scrotal circumference was found as 0.90 (R^2) higher than 0.6507 (R^2) in the present study. The difference between two studies may be due to different management and environmental factors.

Conclusion

As a result, it was found that the most appropriate model for describing growth of scrotal circumference in Karakaş male lambs was Richard's non-linear model. It was determined that 65.07 % of total variation in scrotal circumference was explained by age ($P<0.001$) and body weight ($P<0.001$) factors in multiple regression analysis.

References

Anonymous, 2001. NCSS and PASS Number cruncher statistical systems. Kaysville, Utah.

Aral, F. ve Tekin, N., 1996. Koçlarda Sperma Kalitesi Üzerine Mevsimin Etkisi. *Hayvancılık Araştırma Derg.*, 6(1-2): 15-20.

Aygün, T., Karaca, O., Altın, T., Demirel, M. ve Bingöl, M., 1999. Farklı Büyütme ve Yemleme Koşullarında Yetiştirilen Karakaş ve Karakaşx Hamdani (G1) Melezi Toklularda Testis Gelişimi. *Y.Y.Ü. Fen Bil. Enst. Derg.*, 6(1): 53-60.

Bilgin, O. C., Emsen, E. and Davis, M.H., 2004. Comparison of non-linear models for describing the growth of scrotal circumference in Awassi male lambs. *Small Rum. Res.*, 52: 155-160.

Gündoğan, M., Uçar, M. ve Tekerli, M., 2002. Afyon koşullarında yetiştirilen koçlarda testislerin morfometrik ölçüleri ve spermatolojik özellikleri üzerinde araştırmalar. *Vet. Bil. Derg.*, 18(1-2): 63-67.

Karakuş, K., Cengiz, F., 2007. Ergin Norduz ve Karakaş Koçlarında Spermatolojik Özelliklerin Döl Verimine Etkisi. *Yüzüncü Yıl Üniversitesi, Ziraat Fakültesi, Tarım Bilimleri Dergisi (J. Agri. Sci.)*, 17(1): 7-15

Ley, W. B., Sprecher, D.J., Thatcher, Lessard, P., C.D., Pelzer, K. D. and Umberger, S. H., 1990 . Scrotal Circumference Measurements in Purebreed Dorset, Hampshire and Suffolk Lamb and Yearling Rams. *Theriogenology*, 34(4): 734-747.

Özdemir, Z. ve Altın, T., 2002. Kıvırcık Erkek Kuzularında Testis Özellikleri. *Y.Y.Ü. Ziraat Fak. Tarım Bil. Derg.*, 12(1): 13-20.

Öztürk, A., Dağ, B. ve Zülkadir, U., 1996. Akkaraman ve İvesi Koçlarının Bazı Testis Özelliklerinin Döl Verimine Etkisi. *Tr. J. Vet. Anim. Sci.*, 20: 127-130.

Quirino, C.R., Bergmann, J.A.G., Vale Filho, V.R., Andrade, V.J., Pereira, J.C.C., 1999. Evaluation of four mathematical functions to describe scrotal circumference maturation in Nellora Bulls. *Theriogenology* 52: 25-34.

Rege, J. E. O., Toe, F., Mukasa-Mugerwa, E., Tembely, S., Anindo, D., BAker, R. L. ve Lahlou-Kassi, A., 2000. Reproductive Characteristics of Ethiopian Highland Sheep: II. Genetic Parameters of Semen Characteristics and Their Relationships with Testicular Measurements in Ram Lambs. *Small Rum. Res.*, 37: 173-187.

Salhab, S. A., Zarkawi, M., Wardeh, M. F., Al-Masri, M. R., Kassem, R., 2001. Development of Testicular Dimensions and Size, and Their Relationship to Age, Body Weight and Parental Size in Growing Awassi Ram Lambs. *Small Rum. Res.*, 40: 187-191.

SAS, 1998. *SAS/STAT Software: hangen and enhanced.* SAS, Inst. Cary., NC.USA.

Sönmez, R. ve M. Kaymakçı, 1987. *Koyunlarda Döl Verimi.* Ege Üniv., Ziraat Fak. Yay., Yay. No: 404, İzmir. 350 s.

Terewaki, Y., Sueda, E., Matuzaki, S., Akami, Y., Fukui, Y., 1994. Relationships between testicular growth and body measurements in Holstein bulls. *Anim. Sci. Techol.* 65: 1044-1050.

Yılmaz, A. ve Aygün, T., 2002. Norduz Erkek Kuzularının Bazı Testis Özellikleri. *Y.Y.Ü. Tarım Bil. Derg.*, 12(1): 21-26.