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The Effect of Birth Types on Growth Curve Parameters of Karayaka Lamb

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Abstract: This study focused on the comparison of the growth characteristics of single and twin birth lambs in Karayaka sheep which is an indigenous breed of the northern part of Turkey. Gompertz growth function was fitted to body weight age data of 81 lambs (39 males and 42 females) from birth to 10 months of age. Single birth lamb of both sexes showed lower asymptotic weight than the twin birth ones. There were a noticeable difference in the absolute growth rate between birth types before inflection point but decline after the inflection point was slower for twins than that for singles. Similarly, the decrease in relative growth rate was higher for singles than that for twins. The Gompertz model parameters showed similar trends for birth types in both sexes. The results indicated that the type of the birth should be taken into account besides the sex of the individuals, while working on biological modelling of sheep growth and subsequent genetic evaluations of the related traits.

Key words: Growth curve, gompertz function, nonlinear model parameter, birth type, indigenous breed, karayaka lamb, Turkey

INTRODUCTION

Growth described as the changes in volume, size or shape of an organism over time is very important characteristic of living organisms. The long series of weights recorded during the entire lifespan of animal are difficult to interpret unless summarized in some form. The use of growth equations provides a good way of summarising the information contained in such data into a few parameters with biological meaning (Fitzhugh, 1976). Biologically interpretable growth parameters can allow studying differences between the lines having diverse genetic background and groups subjected different environmental factors.

Information on not only live weights but also relationship between the degree of maturity and growth rate during all phases of growth are of important for selection purposes given their association with other traits and economy of production. Most studies on the growth of sheep have concentrated on live weights over an economic time period (e.g., birth weight, weaning weight and yearling weight). Hence, relationship between weight and age through the economic life of animal has become major interest area of scientists and producers (Beltran *et al*., 1992; Bathaei and Leroy, 1998). To utilize the parameters related with growth for selection purposes needs to be estimated early and to establish their association with other traits. Such information is essential in planning breeding programs to improve the amount of meat production and carcase quality of concerned breeds. Sheep are an important component of the farming systems in Turkey and have important cultural and financial roles for the rural population. Karayaka sheep, numbering about 1,300,000 is one of the indigenous breed of sheep reared in the middle and east Black Sea region of Turkey. The breed is mainly kept for its delicious meat. Preliminary studies showed that Karayaka has got high quality meat due to mosaic dispersion pattern of fat in among muscle fiber. Being a non-fat tailed sheep in a harsh environment makes the breed more interesting. These special characters also bring a positive advantage for carcass grading system in terms of dressing percentage. Additionally, its wool is widely used for weaving traditional quilt, mattress and carpet.

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Live weight of mature Karayaka rams and ewes are ranged 65-90 and 40-60 kg, respectively. Weights at birth, 56 and 140 days of age of Karayaka lambs were reported as 4.16, 16.47 and 30.63 kg, respectively (Ulutas *et al*., 2009). Ratio of twins to singles, milk yield of lactation, lactation period and total greasy wool yield were 8-29%, 60-90 kg, 100-160 days and 2-3.5 kg, respectively (Ulutas *et al*., 2009; Atasoy *et al*., 2003; Ünal *et al*., 2003). Optimum slaughter weight for male Karayaka lambs was suggested as 40 kg (Balci and Karakas, 2007). These results showed that there is wide variation of Karayaka sheep characteristics. Therefore, Karayaka sheep needs to be taken under breeding programs in order to improve growth and carcasses characteristics.

The Gompertz growth function provides a useful description of growth in a quite simple and single equation when the environment (e.g., food, housing) is nonlimiting (Lewis *et al*., 2002). Hence, this study is aimed to define the effect of the sex and birth type of lambs on growth curve of Karayaka lambs using Gompertz function.

MATERIALS AND METHODS

The weight-age data for this study were obtained from 81 lambs (39 males and 42 females) held in Gaziosmanpasa University Agricultural Research Farm. The lambs weights were taken at birth and weekly afterwards upto approximately 8 months of age with 50 g sensitivity scale.

The breeding season mostly occurs between July and September and lambing occurs between November and March in each year. Lambs were kept with their mother approximately 3-4 months of age, whereupon they were weaned and placed in semi-intensive feeding system. The amounts of concentrate feed available to each lamb were maximum 200 g day^{-1}. Supplementary vicia straw was given *ad-libutum* up to the grazing period which starts from mid April-November. Animals had free access to water.

The animals were regularly vaccinated and dosed against diseases and internal parasites. Routing dipping was carried out to kill ectoparasites.

Growth model: Gompertz function (Laird *et al*., 1965) shown in Eq. 1 was used to describe the growth pattern of Karayaka sheep.

$$W_t = W_0.\exp\left[L.\frac{\left(1-e^{-k\,t}\right)}{k}\right] \quad (1)$$

Where:

W_t = Body Weight (BW) of sheep at age t (day)

W_0 = Predicted BW at birth

k = Maturation index which is the rate of exponential decay of the initial specific growth rate

L = Instantaneous growth rate (per day) which measures the rate of decline in the growth rate

Then, weight (W_i) and age (T_i) at the inflection point and predicted average final weight or asymptotic weight (W_f) were calculated using estimated curve parameters as follows:

$$W_i = \frac{W_f}{e} \quad (2)$$

$$W_f = W_0.e^{L/k} \quad (3)$$

$$T_i = \frac{1}{k}.\ln\left(\frac{L}{k}\right) \quad (4)$$

Absolute Growth Rate (GR) and Relative Growth Rate (RGR) were calculated as follows:

$$GR = \frac{k.W_t.(W_f^m - W_t^m)}{m.W_f^m} \quad (5)$$

$$RGR = \frac{GR}{W_t} \quad (6)$$

Body weight data were classified into groups in terms of sex and birth type. Gompertz model was fitted to the experimental data belonging to each group (not for individual lamb).

RESULTS AND DISCUSSION

Means and standard deviations of the weights at birth, 56 and 140 days of age were shown in Table 1. In the present study, measured birth weights of the males and females were 3.72 and 3.58, respectively. Unal *et al*. (2003) were reported the birth weight over the sex higher than that reported in this study. On the other hand, weight at 56 and 140 days of age were quite similar to the

Table 1: Means and (±) standard deviations of the birth, 56 and 140 days of age weight for single and twin birth lambs for both sexes

	Weight (kg) at the age		
Sex	0 (Birth)	56th day	140th day
Male			
Single	3.81±0.623	17.73±3.63	30.54±4.89
Twin	3.41±0.424	13.98±2.41	28.62±4.57
Overall	3.72±0.604	16.87±3.72	30.08±4.77
Female			
Single	3.61±0.56	17.07±2.82	28.75±3.43
Twin	3.47±0.37	14.27±1.35	27.25±3.11
Overall	3.58±0.52	16.47±2.82	28.38±3.36

Table 2: Estimated growth curve parameters (±SE) of Gompertz model, final weight, age and weight at inflection point for Karayaka sheep

	Male			Female		
Parameters	Overall	Single	Twin	Overall	Single	Twin
W_0	4.58±0.246	4.535±0.281	4.420±0.328	4.165±0.178	4.172±0.204	4.110±0.247
k	0.036±0.0021	0.040±0.003	0.028±0.002	0.039±0.002	0.042±0.002	0.032±0.002
L	0.017±0.0008	0.019±0.001	0.012±0.001	0.019±0.001	0.020±0.001	0.014±0.001
W_f*	36.68	35.84	44.23	33.32	32.89	38.05
W_i*	13.49	13.19	16.27	12.26	12.10	14.00
T_i*	42.10	37.63	68.39	38.73	36.07	56.33

*Since these parameters were calculated using respective model parameters, standard errors were not available

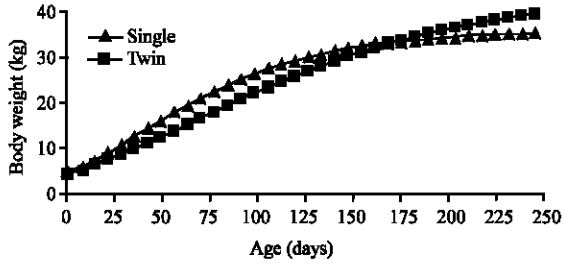

Fig. 1: Growth curves of single and twin birth male Karayaka sheep

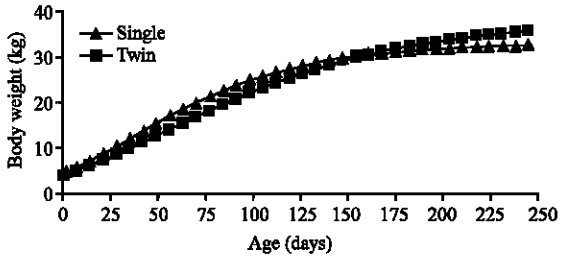

Fig. 2: Growth curves of single and twin birth female Karayaka sheep

results obtained by Ulutas *et al.* (2009). Although, there were no differences in weights at birth and 140 days of age between single and twin birth lambs ($p>0.05$), birth type affected the weight at 56th day of age within both sexes ($p<0.05$). This could be result of limited capacity of ewes to provide more milk for lambs (Rajab *et al.*, 1992). Estimated model parameters and their Standard Errors (SE) and predicted final Weight (W_f), age (T_i) and Weight (W_i) at the inflection point were shown in Table 2.

Estimated birth weights from Gompertz model were higher than observed ones. Differences between predicted and observed birth weights for female and male female were 0.86 (3.72-4.58) and 0.58 kg (3.58-4.16), respectively. These differences between predicted and measured initial weights are common in Gompertz model in literature (Aggrey, 2002; Sezer and Tarhan, 2005).

Maturation index, k and instantaneous growth rates (the parameter L) were estimated high for females than that for males as the previous reports (Bathaei and Leroy, 1996, 1998; Gbangboche *et al.*, 2006). Hence, these parameters provide the information on the pattern of growth and they are direct responses of the genetic constitution of the examined breed.

Bathaei and Leroy (1996) estimated higher k values (0.1034 for males and 0.1305 for females) for the Mehraban Iranian fat tailed sheep than the values obtained in this study, when applying the body growth function. On the other hand, Gbangboche *et al.* (2006) reported much lower k values (0.00527 for males and 0.00514 for females) for Karagouniko dairy sheep breed of Greece. In a model comparison study, Topal *et al.* (2004) reported similar k values (ranged between 0.006 and 0.018 depending on the examined model) for Morkaraman, a fat tailed bred and Avassi, a dairy sheep breed. Differences in k and L parameters between single and twin birth lambs for both sexes were remarkable. Overall, females reached the estimated age at maximum growth (T_i) slightly faster than the males.

The differences in T_i between single and twin birth lambs were 30.76 and 20.26 days for males and females, respectively. This extension of the acceleration time may also result in a higher estimated average mature Weight (W_f) of the twins than singles. Estimated average mature body weight in twins was higher by about 23 and 16% for male and females, respectively. This could be explained by compensation growth when taking into account the natural feed restriction during the weaning period because of the limitation in the sucked milk by twins.

Because of the differences in weighting date of the lambs, the graphs were drawn using predicted weights and shown in Fig. 1 and 2. The growth patterns of single and twin birth lambs were markedly different from each other for both sexes.

Although, twin birth lambs shows poor growth up to 5.5-6 months of age, they continued to grow constantly, while singles reached to their final weight. The influence of litter type on lamb's growth curve over the sexes is also reported by Gbangboche *et al.* (2006). They were unable to report the consequent steady growth of the twins and decreased growth of the singles because their

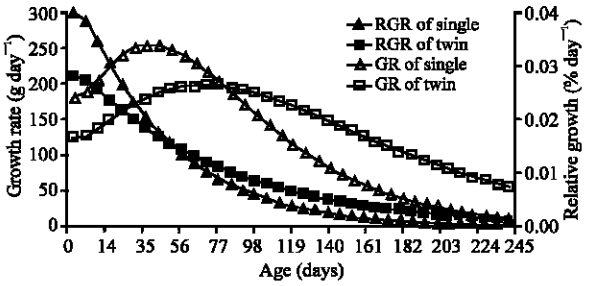

Fig. 3: Absolute (GR) and Rrelative Growth (RGR) rates of single and twin birth male Karayaka sheep

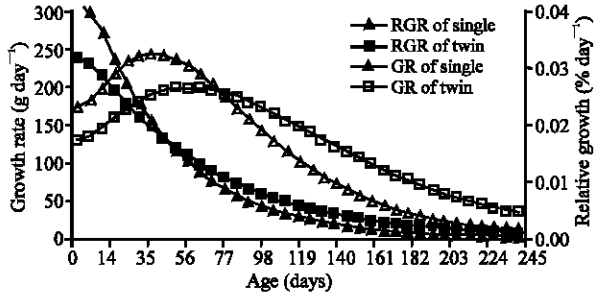

Fig. 4: Absolute (GR) and Relative Growth (RGR) rates of single and twin birth female Karayaka sheep

live-weight data were available up to the age of 119 days. Figure 3 and 4 show the absolute (GR) and Relative Growth Rates (RGR) of the single and twin birth males and females, respectively.

Daily weight gain of the single and twin birth lambs showed similar trends for males and females. Although, GR and RGR were better for single birth lambs up to the age of 70-80 day (Fig. 1 and 2), GR and RGR decreased more slowly for twin birth lamb than that for single birth lamb through the rest of study. Daily weight gain of the Karayaka used in this study is lower than the breed Romanov (Maria *et al*., 1993) but higher than the Karagouniko (Gbangboche *et al*., 2006).

CONCLUSION

Body weight and growth rate are economically important features, requiring particular attention in breeding programs. The present study provides the initial information on growth potential of Karayaka sheep.

It was also determined that birth type has an effective factor on weight and growth parameters of Karayaka sheep and so this factor should be taken into account in subsequent genetic evaluation. Producing heavier carcasses (18-20 kg) at <140 days of age may increase the productivity and efficiency of the farming system.

Hence, incorporating the parameters of Gompertz equation in breeding programs would help to achieve fast responses to the remarked aims for Karayaka sheep.

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