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Research Article

Adaptation of Reproductive and Growth Traits of Primiparous Kilis Goats to High-Altitude Mountain Areas

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Abstract

Kilis goat is an important local gene source in terms of fertility and milk yield and its original breeding area is Kilis, Adana, Gaziantep and Hatay provinces in Türkiye. This study was carried out to determine the reproductive and growth characteristics of primiparous Kilis goats and their adaptation to high-altitude mountainous areas (altitude 1550 m). A total of 120 Kilis goats from four different farms in Konya province were used in the study in 2019. Among the reproductive traits of Kilis goats, birth rate, litter size at birth, litter size at weaning, twinning rate and survival rate were found to be 92.5%, 1.25, 1.11, 25.1% and 88.2%, respectively, and the difference between the flocks were not statistically significant (P>0.05). Most of the births occurred between 06:00 and 09:00 during the day (P<0.05). The effects of flock, gender, type of birth and month of birth on the growth characteristics of goats were found to be significant (P<0.05). Birth weight, 1-month, 2-month, 3-month, 6-month and yearling live weights of Kilis kids were 2.91 kg, 6.6 kg, 10.9 kg, 14.2 kg, 19.3 kg and 22.8 kg, respectively. The effect of birth type and month of birth (P<0.01) on the live weight gain of Kilis goats from postpartum to the mating period was found to be significant and the average increase was 4.1 kg. In conclusion, although some of the reproductive and growth performances of the Kilis goat in mountainous areas are somewhat lower than in the original area, relatively good values were still observed, which shows that this breed is well adapted to mountainous areas. It should also be noted that the goats in the study were primiparous goats.

Keywords: Adaptation, birth time, birth month, growth traits, Kilis goat, reproduction.

İlkine doğum yapan Kilis Keçilerinin Üreme ve Büyüme Özelliklerinin Yüksek Rakımlı Dağlık Alanlara Adaptasyonu

Özet

Türkiye'de, Kilis keçisi döl ve süt verimi bakımından önemli bir yerel gen kaynağı olup, orijinal yetiştirme alanı Kilis, Adana, Gaziantep ve Hatay illeridir. Bu çalışma, İlkine doğum yapan Kilis keçilerinin üreme ve büyüme özelliklerinin yüksek rakımlı dağlık alanlara (rakım 1550 m) adaptasyonlarını belirlemek amacıyla yapılmıştır. Çalışmada 2019 yılında Konya ilindeki dört farklı çiftlikten toplam 120 baş Kilis keçisi kullanılmıştır. Kilis keçilerinin üreme özelliklerinden doğum oranı, doğumda yavru sayısı, sütten kesimde yavru sayısı, ikizlik oranı ve yaşama gücü sırasıyla %92,5, 1,25, 1,11, %25,1 ve %88,2 olarak bulunmuş olup, sürüler arasındaki fark istatistiksel olarak önemli değildir (P>0,05). Doğumların çoğu gün içinde 06:00 ile 09:00 saatleri arasında gerçekleşmiştir (P<0.05). Sürü, cinsiyet, doğum tipi ve doğum ayının oğlakların büyüme özellikleri üzerindeki etkileri önemli bulunmuştur (P<0.05). Kilis oğlaklarının doğum ağırlığı, 1. ay, 2. ay, 3. ay, 6. ay ve 1 yaş ağırlıkları sırasıyla 2.91 kg, 6.6 kg, 10.9 kg, 14.2 kg, 19.3 kg ve 22.8 kg'dır. Kilis keçilerin doğum sonrası dönemden çiftleşme dönemine kadar canlı ağırlık artışı üzerine doğum tipi ve doğum ayının (P<0.01) etkisi önemli bulunmuş ve ortalama artış 4.1 kg olmuştur. Sonuç olarak, Kilis keçisinin dağlık alanlardaki bazı üreme ve büyüme performansları orijinal alana göre biraz daha düşük olsa da, yine de nispeten iyi değerler gözlemlenmiştir, bu da bu ırkın dağlık alanlara iyi adapte olduğunu göstermektedir. Çalışmadaki keçilerin ilkine doğum yapan keçiler olduğu da unutulmamalıdır.

Anahtar Kelimeler: Adaptasyon, doğum zamanı, doğum ayı, büyüme özellikleri, Kilis keçisi, üreme.

Introduction

Goats are one of the most widely farmed livestock species in many different regions of the world due to their ability to adapt to different climatic and environmental conditions (Erduran, 2021; Álvarez et al., 2023). Reproductive, viability and yield traits are the determining factors in the adaptation of animals to different regions (Boztepe, 2015 Erduran, 2017; Castillo-Zuñiga et al., 2022). Genotype, geographical structure, climate change, production system, direction of yield, care and feeding are among the most important factors influencing the adaptability of animals (Tölü, 2010; Erduran and Dag, 2021; Akbaş et al., 2023; Koluman, 2023).

Dairy goat breeding has become an economically significant animal production sector in recent years due to its diverse range of features, such as human health benefits, and its contribution to cheese and ice cream production (Álvarez et al., 2023; Erduran, 2023b). The first scientific researches on the development of dairy goat breeding in Türkiye mainly focused on the Aegean, Mediterranean and Marmara regions (Şengonca et al., 2003; Tölü, 2010; Erduran, 2017; Keskin et al., 2017). However, in recent decades, it has also been intensified in Central Anatolia and Central Black Sea regions (Çelik and Olfaz, 2018; Erduran, 2022, 2023a). In these studies, Alpine and Saanen breeds, which are exotic dairy breeds, and Kilis and Malta breeds, which are domestic dairy breeds, have been used primarily. In addition, in recent decades, selection studies have been carried out by the Ministry of Agriculture and Forestry for the breeding of Hair goat, Ankara goat, Turkish Saanen goat and Kilis goat (Erduran, 2017). As a result of these studies, dairy goat breeding is becoming more widespread in Türkiye and provides significant contributions to both the national economy and producer income.

Goat breeding is carried out in accordance with the climatic and geographical conditions of the country, generally based on pastures in and around forests in Türkiye (Ocak, 2016; Erduran, 2017). There are approximately 12 million goats in Türkiye, and 90 percent of these goats are Hair goats (TURKSTAT, 2022). However, milk and fertility yields are not at the desired level in the pasture-based breeding system (Çelik and Olfaz, 2015; Atay and Gokdal, 2016; Erduran, 2021). Kilis goat is an indigenous goat breed adapted to warm climatic conditions that is known for its fertility and milk yield in the southeast of Türkiye, generally in Kilis, Gaziantep, Hatay, and Şanlıurfa provinces (Daşkıran and Yılmaz, 2018; Özdemir and Keskin, 2018). Interest in dairy goat breeding is increasing day by day in parallel with the increase in demand for processing goat milk and dairy products in the Central Anatolia Region (Erduran, 2017).

In this study, phenotypic parameters of some yield and adaptation criteria of primiparous Kilis goats brought from Kilis province to Doğanhisar district of Konya province were investigated under breeder conditions. In this context, the effects of some environmental factors on the fertility and live weight changes of Kilis goats, birth time and growth characteristics of kids in a pasture-based breeding system in a high-altitude mountainous region were investigated.

Material and Method

No animals were used in laboratory studies for this work. No animal rights were violated. Data collection and animal husbandry procedures were carried out in accordance with the provisions of Article 9 of Law No. 5996 on Animal Welfare.

Animal material was obtained from the breeding project "Kilis Goat National Breeding sub-project" carried out in Kilis province within the scope of "Sheep and Goat National Breeding Project" in 2018. This study was carried out in four different goat farms in Konya province, Doğanhisar district, Fırınlı village, on a total of primiparous 120 Kilis goats in 2019. The research was conducted within a region comprised of mountainous, forested, and maquis areas, alongside herbaceous plants, including both annual and perennial pasture species. According to 2019 meteorological data, the average annual rainfall of Doğanhisar district is 614 mm and the temperature is 11.4 °C. The altitude of the grazing area varies between 1500 m and 2000 m. The average annual precipitation in Kilis is 500 mm, the average temperature is 17.2 °C and the altitude is 660 m (Anonymus, 2019) . Goats were grazed on natural pasture for an average of 6-8 hours a day throughout the year, except for snowy and adverse weather conditions. In addition to the pasture, between December and May, a daily average of 500 g of concentrate feed and barley crumb mixture as well as about 1 kg of alfalfa and straw mixture roughage were given.

Births occurred between February and April, with registration information recorded after goats and kids received colostrum milk. To overcome the weaning shock, the kids were allowed to suckle

their mother until they were on average 2 months old, then weaned at an average age of 3 months after being allowed to suckle the milk remaining after milking (Erduran, 2021). The reproductive characteristics were determined using the method described by Boztepe (2015). Goat births typically take place during the daylight (Erduran and Yaman, 2014), so the four daylight periods and two dark periods (evening and night) were analyzed to determine birth times. The time of birth was determined by intervals: 24:01-06:00, 06:01-09:00, 09:01-12:00, 12:01-15:00, 15:01-18:00 and 18:01-24:00. In addition to the birth weight, live weights of the kids were recorded at one month, two months, three months, six months and yearling of age. The live weights of goats were weighed at birth and after mating.

Statistical analysis

In the study, the Chi-square test was used to determine the effects of the flock, gender, type of birth and month of birth on the birth times of kids as well as the effects of flock on the reproductive traits of goats. Live weight and growth traits were analysed using the General Linear Model (GLM) procedure. Significant differences between factor levels were analysed using Tukey multiple comparison tests (Kesici and Kocabaş, 2021).

$$y_{ijklm} = \mu + a_i + b_j + c_k + d_l + e_{ijklm} \quad (1)$$

where y_{ijklm} is the observation, μ the overall mean, a_i the flock effect (i=1, 2, 3, 4), b_j the gender effect (j=male, female), c_k the birth type effect (k=single, twin), d_l the birth month effect (l=february, march, april), e_{ijklm} the random error.

Results and Discussion

In this study, Table 1 shows that the flock factor had no significant effect on the fertility traits of primiparous Kilis does. The average birth rate, number of kids at birth, number of kids at weaning, twinning rate and survival rate of kids were 92.5%, 1.25, 1.11, 25% and 88.2%, respectively. These values were similar to the values obtained from Kilis goats in the original breeding area (Keskin et al., 2017; Özdemir and Keskin, 2018; Keskin et al., 2022) and slightly higher than the previous studies with pure and crossbred Hair goats in the mountainous area (Çelik and Olfaz, 2015; Erduran, 2021).

Table 1. Effect of flock on reproductive in goats

Flock	Birth rate (%)	Litter size at birth	Litter size at weaning	Survival rate (%)	Twining rate
1	96.7	1.31	1.24	94.7	31.0
2	93.3	1.29	1.14	88.9	28.6
3	93.3	1.21	1.04	85.3	21.4
4	86.7	1.19	1.00	83.9	19.2
Chi-square	0.090	0.093	0.424	0.148	0.835
P	0.933	0.993	0.935	0.985	0.841
Total	**92.5**	**1.25**	**1.11**	**88.2**	**25.1**

The results indicate that Kilis goats display satisfactory levels of fertility, twinning, and kid yield, reflecting their healthy and productive nature. In addition, this demonstrates that the fertility characteristics of Kilis goats can generally adapted to high-altitude mountainous regions.

The effects of flock, gender, type of birth and month of birth factors on the birth times of kids distributed at different times of the day were found to be significant ($P<0.05$) and given in Table 2. The average distribution of the births according to the hours of the day, the lowest rate was 3.6% in the evening hours (18:01-24:00) and the highest rate was 41.7% in the first hours of the morning (06:01-09:00). 92.5% of the male kids and 90.3% of the female kids were born during the daytime.

The most intensive births took place in March and then in February. While the birth time of the goats was observed mostly in the first hours of the morning in March and February, it was observed in the afternoon and daytime in April. In this study, although the findings related to the time of birth are similar to the previous studies conducted in different regions in goats and sheep (Erduran and Yaman, 2014; Şahin, 2023), there are differences in the distribution of births during the day. However, births usually occur at night in mammals with daytime activity under natural conditions

(Erduran, 2022). Therefore, it suggests that there are intrinsic and extrinsic mechanisms such as circadian rhythm and the instinct to protect the offspring from predators and evolution that regulate the time of birth (Erduran, 2022, 2023a).

Table 2. Distribution of birth times of Kilis kids according to some environmental factors

	Time period						**Total**
	06:01-09:00	**09:01-12:00**	**12:01-15:00**	**15:01-18:00**	**18:01-24:00**	**24:01-06:00**	
	n (%)	**n (%)**	**n (%)**	**n (%)**	**n (%)**	**n (%)**	**n (%)**
Flock							
1	16 (27.6)	8 (47.1)	4 (18.2)	7 (23.3)	0 (0.0)	3 (42.9)	38 (27.3)
2	18 (31.0)	0 (0.0)	5 (22.7)	12 (40)	1 (20.0)	0 (0.0)	36 (25.9)
3	11 (19.0)	3 (17.6)	10 (45.5)	6 (20)	3 (60.0)	1 (14.3)	34 (24.5)
4	13 (22.4)	6 (35.3)	3 (13.6)	5 (16.7)	1 (20.0)	3 (42.9)	31 (22.3)
$\chi 2$: 26.434; DF: 15; *P-value*: 0.034							
Gender							
Male	23 (39.7)	10 (58.8)	17 (77.3)	12 (40.0)	3 (60..0)	2 (28.6)	67 (48.2)
Female	35 (60.3)	7 (41.2)	5 (22.7)	18 (60.0)	2 (40.0)	5 (71.4)	72 (51.8)
$\chi 2$: 12.079; DF: 5; *P-value*: 0.034							
Birth Type							
Single	34 (58.6)	9 (52.9)	18 (81.8)	14 (46.7)	5 (100)	3 (42.9)	83 (59.7)
Twin	24 (41.4)	8 (47.1)	4 (18.2)	16 (53.3)	0 (0.0)	4 (57.1)	56 (40.3)
$\chi 2$: 11.144; DF: 5; *P-value*: 0.049							
Birth month							
February	15 (25.9)	10 (58.8)	6 (27.3)	9 (30.0)	3 (60.0)	1 (14.3)	44 (59.7)
March	38 (65.5)	5(29.4)	9 (40.9)	19 (63.3)	1 (20.0)	4 (57.1)	76 (40.3)
April	5 (8.6)	2 (11.8)	7 (31.8)	2 (6.7)	1 (20.0)	2 (28.6)	19 (13.7)
$\chi 2$: 19.291; DF: 10; *P-value*: 0.037							
Total	**58 (41.7)**	**17 (12.2)**	**22 (15.8)**	**30 (21.6)**	**5 (3.6)**	**7 (5.0)**	**139 (100)**

$\chi 2$: Chi-square Result; DF: Degree of Freedom; n: Number of Animals; P: Significance Level

The study indicates that the live weight and growth traits of Kilis kids were influenced by flock, gender, type of birth (excluding yearling weight), and months of birth (excluding in the 1 and 2 month weights) factors ($P<0.01$ and $P<0.05$) and were presented in Table 3.

In the current study, male kids had higher body weight and faster growth than female kids. The difference in body weight between singletons and twins had a significant effect until six months of age, but this difference lost its effect by one year of age. Kids born in February (winter) had lower birth weights than those born in March and April (spring). However, kids born in winter had higher live weight and faster growth from weaning to one year of age. Kids born earlier grew faster and reached a higher body weight than those born later. This is probably due to the fact that early-born kids had more opportunities to feed on the abundant and high quality grasses in the pasture during spring and summer, which led to faster growth and development. They may also have developed an adaptation mechanism to make winter-born kids more resistant to cold weather conditions (Sing et al., 2022; Das et al., 2023).

Table 3. Least squares and standard errors for growth trait of Kilis kids (kg)

Traits	n	Birth weight	One-month weight	Two-month weight	Weaning weight	Six-month weight	Yearling weight
Flock		**	**	**	**	**	**
1	35	3.15±0.06^{a}	7.2±0.18^{a}	12.3±0.27^{a}	15.2±0.33^{a}	20.9±0.50^{a}	25.0±0.63^{a}
2	29	2.93±0.07^{b}	6.4±0.23^{b}	10.2±0.34^{b}	14.1±0.41^{ab}	18.5±0.62^{b}	21.5±0.78^{b}
3	22	2.79±0.08^{b}	6.5±0.25^{ab}	10.6±0.36^{b}	13.7±0.44^{b}	18.6±0.67^{b}	21.9±0.84^{b}
4	26	2.78±0.07^{b}	6.4±0.22^{b}	10.7±0.33^{b}	13.7±0.40^{b}	18.9±0.60^{b}	22.9±0.76^{ab}
Gender		**	*	*	*	*	**
Male	54	3.03±0.05	6.8±0.17	11.2±0.25	14.6±0.30	20.1±0.46	24.0±0.57
Female	58	2.80±0.05	6.4±0.16	10.6±0.24	13.7±0.30	18.4±0.45	21.7±0.56
Birth type		**	**	**	*	**	
Single	72	3.13±0.05	7.0±0.15	11.6±0.23	14.6±0.27	20.0±0.42	23.3±0.52
Twin	40	2.69±0.06	6.2±0.18	10.3±0.27	13.8±0.33	18.5±0.50	22.4±0.63
Birth month		*			*	*	*
February	38	2.79±0.05^{B}	6.7±0.18	11.4±0.26	15.0±0.32^{A}	20.3±0.48^{A}	24.4±0.60^{A}
March	62	2.97±0.04^{A}	6.7±0.14	11.1±0.21	14.1±0.26^{AB}	19.7±0.39^{AB}	23.3±0.49^{AB}
April	12	2.99±0.10^{A}	6.4±0.32	10.3±0.47	13.4±0.57^{B}	17.8±0.86^{AB}	20.8±1.08^{B}
Overall	**112**	**2.91±0.04**	**6.6±0.13**	**10.9±0.19**	**14.2±0.23**	**19.3±0.35**	**22.8±0.44**

a, b, c. Means within an inside-class of a column with different superscripts differ significantly at capital letters – (*P<0.05), small letters – (**P<0.01).

In this study, the birth weight and 2nd-month live weight of Kilis kids were found to be lower than in previous studies on Kilis kids in the original breeding area (Keskin et al., 2017; Özdemir and Keskin, 2018; Gül et al., 2022; Keskin et al., 2022). However, live weights of Kilis kids from birth to 6 months of age were lower, but partly similar, than those of native gene resources, pure and crossbred Hair kid genotypes (Erduran, 2017; Çelik and Olfaz, 2018; Akbaş et al., 2023). It is seen that environmental factors significantly affect the live weight and growth characteristics of Kilis kids from birth to one year of age. Therefore, improving the management, nutrition, care and health conditions of Kilis kids in accordance with the climatic conditions, making appropriate breeding practices for gender and paying attention to birth months in breeding selection will contribute to the improvement of live weight and growth characteristics of Kilis goats.

The effect of flock, type of birth (expect for mating) and month of birth (except for flock) on the average live weight of Kilis goats in the postpartum period (38.8 kg), live weight in the mating period (42.9 kg) and live weight gain between postpartum and mating period (4.1 kg) were found significant at P<0.01 and P<0.05 levels (Table 4).

The findings suggest that the live weights of Kilis goats during the postpartum and mating periods were within the range of 36.0 kg to 58.0 kg previously reported for various goat genotypes aged 2-5 years in different regions (Erduran, 2017; Ünalan and Ceyhan, 2017; Daşkıran and Yılmaz, 2018; Özdemir and Keskin, 2018). This situation can be explained by the variability of goats depending on their genetic capacity, social rank, area conditions, feeding, care, yield direction and grazing capacity of the pasture (Ocak, 2016; Castillo-Zuñiga et al., 2022; Erduran, 2023a).

Table 4. Means and standard errors of live weights of Kilis goats at postpartum and mating period

Traits		Body weight (kg)		
	n	Postpartum	Mating	Difference
Flock		*	*	
1	29	38.3±0.54^{AB}	42.4±0.64^{AB}	4.0±0.11
2	28	37.8±0.62^{B}	41.8±0.73^{B}	3.9±0.13
3	26	39.1±0.61^{AB}	43.2±0.72^{AB}	4.1±0.12
4	28	40.0±0.56^{A}	44.2±0.66^{A}	4.2±0.11
Birth Type		*		**
Single	83	39.5±0.37	43.1±0.44	3.6±0.08
Twin	28	38.1±0.55	42.7±0.65	4.5±0.11
Birth month		*	*	**
February	36	39.9±0.49^{A}	44.5±0.58^{A}	4.6±0.10^{a}
March	63	38.2±0.38^{B}	41.7±0.45^{B}	3.8±0.08^{b}
April	12	38.4±0.83^{AB}	41.9±0.97A^{B}	3.8±0.17^{b}
Total	**111**	**38.8±0.36**	**42.9±0.43**	**4.1±0.07**

a, b, c. Means within an inside-class of a column with different superscripts differ significantly at capital letters – (*P<0.05), small letters – (**P<0.01).

The growth and development potential of goats can last up to 5 ages. However, it is highly likely that the live weight of goats will be adversely affected if they are unable to reach the food source they need, especially during the first lactation period (Tölü et al., 2009; Erduran, 2021). Therefore, a live weight gain of 4.1 kg can be considered normal in Kilis goats that both continue to grow and start milk production in the first lactation period under natural pasture conditions. In addition, the live weight gain of Kilis kids is 5.1 kg between 3-6 months of age and 3.5 kg between 6 months and 1 year of age.

Conclusion and Suggestions

As a result, Kilis goats generally showed good performance in terms of fertility traits. However, the growth and development traits of Kilis kids were acceptable for a local dairy breed. This may indicate that the fertility and growth traits of Kilis goats are adapted to high altitude mountainous areas. This study would provide important contributions to improving environmental factors as well as increasing the productivity and endurance of Kilis goats in mountainous and high-altitude regions. These findings would be important for the planning and implementation of Kilis goat breeding studies in different regions.

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Author's Contribution Rate Declaration Abstract

The entire study was designed, analysed, written and drafted by H.E. (100%). The author reviewed and approved the final version of the manuscript.

Conflict of Interest

The author declares that there is no conflict of interest.

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