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Milk yield, udder, and growth traits of Hair goats and their crossbreeds managed under extensive conditions

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Abstract

This study was carried out to compare some production traits of Alpine × Hair-crossbred, Saanen × Hair-crossbred, and Hair goats in rural conditions. In the first year of the study, a total of 45 animals were used to determine the milk yield characteristics of the three genotypes. In the second year, a total of 56 does and 62 goat kids were used to determine the characteristics of the animals. The ICAR AT method was used to calculate the lactation milk yield of the goats. The average lactation lengths, the average lactation milk yields, and the daily average milk yields of Alpine × Hair-crossbred, Saanen × Hair-crossbred, and Hair goats were 242, 232, and 229 days; 182, 201, and 164 kg; and 0.754, 0.873, and 0.716 kg, respectively. The effect of genotype on lactation milk yield and daily average milk yield was statistically significant. Live weights of the kids were recorded at monthly intervals and live weights of the kids for days 30, 60, 90, and 120 were calculated by linear interpolation. The effect of genotype on the 90- and 120-day weights were similar. Measurements of udder characteristics were determined twice, at the beginning (30 d) and at the end (180 d) of the lactation period. It was determined that crossbreeding had no effect on udder characteristics except the distance between teats and udder depth. The main result of this study is that crossbreeding substantially increased milk yield in goats, even at the F1 level, under extensive conditions.

Keywords: crossbreed**,** extensive conditions**,** goat, lactation, kid

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Introduction

Milk and meat are essential foods that will never lose their importance as long as humanity exists. In developing countries, the main source of milk and meat production is goats. Therefore, goat breeding is a branch of livestock production that maintains its importance, especially under extensive conditions. In developing countries, goats continue to make a substantial contribution to poor people, especially in rural areas. However, for some reasons, goats and goat breeding are underestimated and their contribution to the livelihood of rural people is not well understood. Compared to cattle and sheep breeding, the contribution of goats is often overlooked. A consequence of this neglect is the fact that many goat breeds in developing countries have not been adequately researched in terms of genetics. Goats will be an important source of livelihood for many more people over the coming years and therefore deserve more attention at both the micro and macro level (Madelena *et al*., 2002; Argüello, 2011; Leroy *et al*., 2015).

Goats have advantages over other farm animals (e.g., cattle and poultry) in some respects, such as less investment, low input requirement, ease of herd management, resistance to diseases, higher productivity, early

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sexual maturity, and ease of marketing of products. In addition, changing consumer preferences with increasing human population, urbanisation, and increasing income create extra demand for these animals and their products. For these reasons, well-planned improvement programs are needed to increase and maintain goat productivity. The development of successful goat genetic improvement programmes requires the conduct of many studies to reveal the breeding and yield performance of local goat breeds. Goats are tolerant to diseases and parasites, have good flock instinct, can walk long distances, are highly tolerant to adverse climatic conditions, and are resistant to drought (Madelena *et al*., 2002; Argüello, 2011)

In breeding, genetic selection is a prerequisite for genetic gains. Inbreeding and crossbreeding are the conventional methods used for genetic improvement. The success of crossbreeding as a method depends on revealing the genetic characteristics of the native breed, defining the environment well, and choosing the right breed to be crossed. The success of crossbreeding is highly variable and depends on local environmental conditions. In developing countries, crossbreeding studies have been carried out to create new goat breeds since the end of the 19th century and the beginning of the 20th century (Madalena *et al*., 2002).

Adaptation of crossbreeds to adverse environmental conditions and insufficient complementary socioeconomic support have cast doubts on the sustainability of crossbreeding in some regions or some breeding systems. When local conditions allow crossbreeding to be successful, crossbreeding results in substantial increases in animal yield, and hence breeder income (Roschinsky *et al*., 2015).

Taking into account the difference between the yields of high-yielding breeds bred in developed countries and low-yielding native breeds in developing countries, crossbreeding seems to be a logical and attractive solution, as it can rapidly improve the performance of native animal populations. In this context, the countries' reports presented as part of the 'Second Report' on the state of animal genetic resources for world food and agriculture (SoW2) in 2014 have given interesting insights into how crossbreeding is evaluated in developing countries (FAO, 2015). According to these reports, developing countries tend to import animals or cross-breed to increase the yield of animals from developed countries. Imported breeds or semen are used for crossbreeding, but the approach to benefits from high-yielding breeds within the country is low. Therefore, in a sense, genetic materials are continuously imported rather than produced domestically. Country reports also point to random crossbreeding as the main cause of 'genetic erosion', particularly in Africa, Asia, and the Middle East. Irregular crossbreeding in the world also has a reducing effect on genetic diversity. Consequently, deciding on crossbreeding requires serious preliminary studies.

"Hair goat", a common breed in western Asia and especially in the Middle East and Turkey, is a primitive breed with low productivity that has adapted to adverse environmental conditions. Although there are studies on the individual productivity of this breed, scientific studies that compare the performances of crosses with dairy goats in different regions are scarce.

The present study aims to compare Alpine × Hair F1, (AHF1), Saanen × Hair F1 (SHF1) and Hair goats (H) in terms of their lactation period, lactation milk yield, average daily milk yield, udder characteristics, and growth characteristics of kids under breeder conditions. The findings are expected to contribute to the production of basic data for possible crossbreeding programs.

Materials and Methods

All animal studies were approved by the Animal Ethics Committee of the HADYEK (Aydın Adnan Menderes University Animal Experiments Local Ethics Committee) No: 64583101/2022/98.

The study was carried out on a rural farm in Kavsit Village (latitude 37° 65' E, longitude 28° 13' N). It is a forest-side village (altitude 700 m) approximately 10 km from the Çine district of Aydın city, in the southern Aegean Region of Türkiye.

The goats were kept in an extensive system in open housing and had year-round access to rangelands. The goats were grazed with natural vegetation and set to graze at two different times of the lactation period; intensively, plant vegetation was grazed from January to July, and then the goats were grazed on woody vegetation until the end of the lactation period.

In the first year of the study (2021), a total of 45 animals (2 years old) were used to determine the milk yield characteristics of the three genotypes. In the second year (2022), a total of 56 does (3 years old) and 62 goat kids were used to determine the investigated characteristics of the animals. The ICAR AT method was used to calculate the lactation milk yield of the goats (Basdagianni *et al*., 2005).

The kids were weighed 24 h after birth and numbered with ear tags. Subsequently, live weights of the kids were recorded monthly intervals, and live weights of the kids for days 30, 60, 90, and 120 were calculated by linear interpolation.

Fifty goats at the beginning of the lactation and 56 goats at the end of the lactation were used to evaluate udder characteristics. Measurements of udder characteristics were determined twice, at the beginning (day 30) and at the end (day 180) of the lactation period. The udder measurements were taken one hour before milking. Measuring tape was used for udder circumference (UC), udder height (UH), udder depth (UD), udder lateral circumference (ULC), and distance between teats (DBT); a calliper was used for teat lengths (TL) (left–right) and diameters (TD) (left–right) (Mavrogenis *et al*., 1988). Udder volume (UV) was calculated using the method reported by Emediato *et al*. (2007). Udder conformation (UC) was determined in the middle of lactation (day 90) (Mavrogenis *et al*., 1988).

Analyses of variance were conducted using generalised linear models (GLM). Phenotypic correlations of udder and milk yield characteristics were calculated using the PROC CORR procedure (SAS, 1998). Duncan's multiple range test was used to determine the differences between means.

The mathematical models included the following fixed effects; the age of doe, year, birth type, and random effect due to residual error for lactation length, lactation milk yield, and daily milk yield of the goats; the age of dam, sex, birth type, and random effect due to residual error for growth traits of the kids; and the age of doe, lactation period, birth type, and random effect due to residual error for udder characteristics.

Results and Discussion

In this study, the averages of lactation length (LL), lactation milk yield (LMY), and daily milk yield (DMY) are given in Table 1. The differences among genotypes for LMY and DMY and differences between years for LMY were statistically significant (P <0.05). The Saanen and Alpine crossbreeds had higher milk yield performance than the Hair goats, as expected (P <0.05).

In studies carried out in the Alpine breed, LMY was reported as 452 kg and 685 kg; LL was reported as 149 and 253 days, and DMY was reported to be 2.31 kg and 2.84 kg, in the first and second lactations, respectively (Boichard, 1989; Mourad, 2001; Memişi *et al*., 2011; Lotric *et al*., 2017; Sramek *et al*., 2018; Agradi *et al*., 2020). In the Saanen breed, LMY was reported to be 450 and 725 kg; LL was 240–291 d, and DMY was 0.84 and 2.70 kg, in first and second lactations, respectively (Boichard, 1989; Şengonca *et al*., 2003; Bolacalı & Küçük, 2012; Kandemir *et al*., 2018).

In a study conducted by Erduran (2017), the first and second LMYs of the Alpine × Hair crossbred (F1) goats were 264.5 ± 4.47 kg; mean LL, 220.5 ± 1.23 days; and DMY was 1.197 ± 0.018 kg. In the same study, first and second LMYs in Saanen × Hair crossbred F1s were 207.6 ± 11.27 to 287.27 ± 5.17 kg. LL of 195.9 ± 10.05 d to 221.6 ± 1.43 d, and DMY of 1.06 ± 0.09 to 1.293 ± 0.021 kg have been reported (Şengonca *et al*., 2003; Çelik & Oflaz, 2015; Erduran, 2017)

In studies carried out on Hair goats, LMYs of 80.15 ± 2.07 and 223.00 ± 8.88 kg; LLs of 130.55 ± 22.18 and 242.18 ± 5.75 d; and DMYs of 0.560 ± 0.08 and 1.039 ± 0.017 kg have been reported in the first and second lactations, respectively (Şengonca *et al*., 2003; Şimşek *et al*., 2006; Toplu & Altınel, 2008; Çelik & Oflaz, 2015; Atay & Gökdal, 2016; Erduran, 2017; Bolacalı *et al*., 2019). In the current study, the LMY and DMY of the Saanen and Alpine crosses were higher than that of the Hair goats, and the LL and LMY values calculated for the Hair goats were much higher than the values found in other studies related to the Hair goats.

The averages of birth weight, 30-, 60-, 90-, and 120-day weights of the kids are presented in Table 2. The live weight gain of the Hair goat kids on the days 90 and 120 was higher than that of the other two genotypes. In some studies, Hair goat kids have been shown to perform better than Saanen × Hair (F1) kids in terms of growth characteristics (Şimşek and Bayraktar, 2006; Gökdal *et al*., 2013). Some studies did not find statistical differences in the growth characteristics of Saanen × Hair and Hair goats (Ekiz *et al*., 2014; Atay, 2016; Çelik & Olfaz, 2018). The study of Şengonca *et al*. (2002) reported that crossbred kids performed better than Hair kids. In other studies comparing the growth characteristics of Hair goat kids and Alpine × Hair goat (F1) crosses, Gökdal *et al*. (2013) reported that Alpine crossbreed kids had better growth performance than Hair goat kids, while Atay (2016) reported that there were no statistical differences between these two genotypes.

Table 1 Least squares means (± S.E.) of lactation length (LL), lactation milk yield (LMY), and daily milk yield (DMY) of Alpine × Hair crossbred goats (AHF1), Saanen × Hair crossbred goats (SHF1), and Hair (h) goats in rural conditions.

	Traits	n	LL (day)	LMY (kg)	DMY (kg)
Genotype		101			
	AHF1	48	242.91±5.27	182.01±10.19[ab]	0.754 ± 0.03[ab]
	SHF1	27	232.96 ± 6.56	201.95 ± 12.68[a]	0.873 ± 0.04[a]
	H	26	229.64 ± 7.48	164.34 ± 14.46[b]	0.716 ± 0.05[b]
Lactation					
	1	74	226.82 ± 6.68	182.79 ± 12.92	0.812 ± 0.04
	2	27	243.52 ± 6.20	182.74 ± 11.98	0.751 ± 0.04
Year					
	1	45	247.18 ± 6.57	187.19 ± 9.93[a]	0.786 ± 0.03
	2	56	223.16 ± 4.92	178.34 ± 9.51[b]	0.776 ± 0.03
Birth Type					
	Single	76	230.08 ± 4.37	187.22 ± 8.46	0.811 ± 0.03
	Twice	25	240.26 ± 6.07	178.32 ± 11.74	0.751 ± 0.04
Overall		101	235.17 ± 5.06	182.77 ± 7.54	0.781 ± 0.02

a, b; Differences among groups with different letters in the same column are statistically significant (*P* <0.05)

Table 2 Least square means (± S.E.) of the live weights of the kids of Alpine × Hair crossbred (AHF1), Saanen × Hair crossbred (SHF1), and Hair (h) goats at different periods

Genotype	Traits	n	Birth weight	30-day weight	60-day weight	90-day weight	120-day weight
	AHF_1	36	2.71 ± 0.05	7.46 ± 0.15	12.31 ± 0.29	17.20 ± 0.27**b**	22.05 ± 0.36**b**
	SHF_1	15	2.88 ± 0.08	7.98 ± 0.23	13.28 ± 0.45	17.59 ± 0.41**b**	21.72 ± 0.55**b**
	H	11	2.80 ± 0.10	8.11 ± 0.27	13.33 ± 0.53	18.85 ± 0.48**a**	24.36 ± 0.64**a**
Dam age							
	2	28	2.72 ± 0.06	7.81 ± 0.17	13.11 ± 0.34	18.23 ± 0.31	23.01 ± 0.41
	3	34	2.88 ± 0.06	7.89 ± 0.17	12.84 ± 0.33	17.53 ± 0.30	22.41 ± 0.40
Sex							
	Male	32	2.87 ± 0.06	7.82 ± 0.17	12.97 ± 0.33	18.34 ± 0.30	23.90 ± 0.40**b**
	Female	30	2.73 ± 0.06	7.88 ± 0.17	12.97 ± 0.34	17.42 ± 0.32	21.52 ± 0.42**a**
Birth Type							
	Single	34	3.06 ± 0.06a	8.02 ± 0.18	13.25 ± 0.36	18.18 ± 0.33	22.81 ± 0.44
	Twice	28	2.54 ± 0.06b	7.68 ± 0.20	12.70 ± 0.39	17.58 ± 0.35	22.61 ± 0.47
	Overall	62	2.80 ± 0.04	7.85 ± 0.12	12.97 ± 0.24	17.88 ± 0.22	22.71 ± 0.30

a, b; differences among groups with different letters in the same column are statistically significant (*P* <0.05)

The udder characteristics of the goats are given in Table 3. It was determined that crossbreeding did not have an effect on udder characteristics, except DBT and UD (*P* <0.05). All udder characteristics, except UH, were statistically different at the two lactation stages (days 30 and 180) (*P* <0.05). The difference between TL and UD was evident in goats with single or twins (*P* <0.05). Crossbreeding had no effect on UV, UC, TD, and TL traits, which were reported to be positively correlated with milk yield.

Morphological udder characteristics in dairy animals are very important determinants in terms of grazing, milk yield, ease of milking, and milking technology. The voluminous udder structure in dairy goats and a strong connection of the udder are interpreted as a high milk yield. There is a positive relationship between milk yield and some udder dimensions, such as udder circumference, udder volume, teat diameter, and teat length. As the values of the above-mentioned characteristics increase, the milk yield also increases (Labussière *et al*., 1981; Atay *et al*., 2011). However, it has often been suggested that UC is one of the most influential udder characteristics on milk yield, and that UC should be taken into account in selections based on the udder (Montalto & Martinez-Lozano, 1993; Fernandez *et al*., 1995; Merksan, 2014; Atay & Gökdal, 2016; Sam *et al*., 2017; Tilki & Keskin, 2021; Kutan & Keskin, 2022). The fact that the milk yields of the crossbreeds are low compared to the other studies may be a result of the fact that the animals used in the present study were 2–3 years old and, therefore, only the first and second lactations were evaluated. In terms of the growth performance of the kids, Hair kids reached a higher body weight in terms of the 90- and 120-day weights, compared to the other two genotypes. The goat kids in Türkiye are usually marketed for slaughter at 120–180 days of age. In particular, the 120-day weight is an important parameter in terms of marketing (Atay *et al*., 2010).

The udder characteristics were not statistically different among genotypes. This may be due to the fact that the Hair goats in the flock were selected in terms of udder characteristics, albeit superficially. In this context, it is useful to remember that the heritability of udder characteristics is medium-high (Manferdi *et al*., 2001; Biffani *et al*., 2020). It can be said that the use of young does (2 and 3 years old) in the experiment was also a factor in the result.

Table 3 Least squares means (± S.E.) of the udder characters of Alpine × Hair crossbred (AHF1), Saanen × Hair crossbred (SHF1), and Hair (h) goats at different periods

	n	**ULC (cm)**	**TD (cm)**	**TL (cm)**	**DBT (cm)**	**UD (cm)**	**UH (cm)**	**UC (cm)**	**UV (cm^3)**
Genotype									
AHF_1	51	21.79 ± 0.61	1.77 ± 0.14	3.63 ± 0.20	7.57 ± 0.39**b**	17.32 ± 0.69b	38.60 ± 0.51	30.83 ± 0.81	1422.50 ± 102.78
SHF_1	30	23.21 ± 0.76	1.92 ± 0.18	4.07 ± 0.25	7.23 ± 0.49**b**	18.04 ± 0.86a	37.42 ± 0.64	31.84 ± 1.01	1630.27 ± 127.86
H	25	21.31 ± 0.87	2.21 ± 0.20	4.07 ± 0.28	6.15 ± 0.55**a**	17.64 ± 0.98b	38.25 ± 0.73	29.03 ± 1.15	1324.64 ± 145.80
Lactation Period									
Day 30	50	25.42 0.59**a**	2.19 ± 0.14**a**	4.45 ± 0.19**a**	6.53 ± 0.38**a**	19.34 ± 0.67**a**	38.11 ± 0.50	34.82 ± 0.79**a**	1961.21 ± 100.17**a**
Day 180	56	18.78 ± 0.57**b**	1.74 ± 0.13**b**	3.40 ± 0.18**b**	7.43 ± 0.36**b**	15.99 ± 0.64**b**	38.07 ± 0.48	26.32 ± 0.75**b**	957.05 ± 95.89**b**
Age									
2	52	22.60 ± 0.77	1.89 ± 0.18	3.78 ± 0.25	6.16 ± 0.49**a**	18.47 ± 0.88	38.56 ± 0.65	29.30 ± 1.03	1390.26 ± 130.27
3	54	21.59 ± 0.72	2.047 ± 0.17	4.07 ± 0.23	7.80 ± 0.46**b**	16.86 ± 0.81	37.61 ± 0.61	31.86 ± 0.95	1528.00 ± 120.85
Birth Type									
Single	72	21.97 ± 0.51	2.13 ± 0.12	4.29 ± 0.16**a**	6.91 ± 0.32	16.57 ± 0.57**a**	38.32 ± 0.43	29.96 ± 0.67	1341.85 ± 85.29
Twin	34	22.23 ± 0.70	1.80 ± 0.16	3.56 ± 0.23**b**	7.06 ± 0.45	18.77 ± 0.80**b**	37.86 ± 0.59	31.17 ± 0.93	1576.42 ± 118.37
Overall									
	101	22.10 ± 0.34	1.97 ± 0.8	3.93 ± 0.14	6.98 ± 0.27	17.67 ± 0.33	38.09 ± 0.29	30.58 ± 0.45	1459 ± 68.41

a, b: differences among age groups with different letters in the same column are statistically significant ($P < 0.05$)
ULC: udder lateral circumference, TD: teat diameter, TL: teat length, DBT: distance between teats, UD: udder depth, UH: udder height, UC: udder circumference, UV: udder volume

Conclusions

In this study, Alpine × Hair F1 (AHF1), Saanen × Hair F1 (SHF1), and Hair goats were compared in terms of lactation period, lactation milk yield, daily average milk yield, udder, and growth characteristics. The crossing provided an important increase in lactation milk yield under extensive conditions (in poor pasture). The growth characteristics of the Hair goat kids were better than those of the crossbreds. Crossbreeding had no positive effect on udder characteristics. Although positive effects of crossbreeding have been detected in terms of milk, more studies are needed to form the basis of improvement programs. These proposed studies should be carried out under rural conditions and in different regions. In this study, the positive effects of crossbreeding in terms of milk yield were determined at the F1 level. However, it is very clear that there is a need for studies to compare the performances of Hair goat and dairy breed crosses at different crossing rates (such as F1, G1, G2) and age groups in different regions and breeder conditions in order to form a basis for breeding programs.

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Author Contributions

Both authors contributed to the study conception, design, data collection, and analysis. The first draft of the manuscript was written by Okan Atay; Özdal Gökdal, who commented on previous versions of the manuscript, read and approved the final manuscript.

Conflict of Interest Declaration

The authors do not have any conflicts of interest to declare.

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