Turkish Journal of Agriculture - Food Science and Technology, 7(6): 871-876, 2019
DOI: https://doi.org/10.24925/turjaf.v7i6.871-876.2450

Turkish Journal of Agriculture - Food Science and Technology

Available online, ISSN: 2148-127X | www.agrifoodscience.com | Turkish Science and Technology

The Comparison of Milk and Reproductive Performance of Saanen and Saanen × Hair Goat Crossbreds (F_1, B_1 & B_2) and Growth Performance of their Kids in Semi-Intensive Production System

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ARTICLE INFO

Research Article

Received : 30/01/2019
Accepted : 25/04/2019

Keywords:
Fertility
Goat
Growth
Milk nutrient
Milk yield

ABSTRACT

The aims of this study were to evaluate the traits of reproductive, milking and growth performance of Saanen and Saanen × Hair crossbreds (F_1, B_1 and B_2) raised at the Bandırma Sheep Research Institute. The data were collected from 868 goats for reproductive performance and milk yield and from 1077 kids for survival performance between 2009-2012. Milk components (fat, protein, lactose and non-fat dry matter) of goats (n=162) and body weight changes of kid's (n=64) were evaluated for one year in 2012. Estrus rates and survival rates were similar among all genotypes. Kidding rate was significantly higher in F_1 goats than Saanen goats. Saanen goat had the lowest average mean daily milk yield compared with other genotypes. The effect of year and age were significant on milk yield. Goats in F_1 and B_1 genotypes had higher milk protein percentage and non-fat dry matter content in comparison with Saanen and B_2 genotype. Milk fat and lactose contents were similar among genotypes. Birth weight and monthly live weight were similar between genotypes while weaning weight, six month live weight and yearling live weight were higher in B_1 kids in comparison with Saanen kids. The effect of dam age and birth type were significant on birth weight, monthly live weight and weaning weight. The findings related to performance characteristics in goat genotypes investigated show that B_1 genotype could be recommend for semi-intensive production system in the Western Anatolia.

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Introduction

Goat production, with the steadily increasing numbers around 10.92 million heads (TSI, 2018), has important role in Turkey. In order to improve milk yield, Saanen goat is an important genetic resource and has been used to increase native Hair goats for the last 50 years (Sönmez, 1974). Because of the appropriate environmental conditions Southeast, Mediterranean and Aegean regions are the center for the traditional goat breeding, and more than 70% of goat production is carried out in these regions (Tuncel, 2000).

Milk yields and milk components can be affected by genotype and environmental factors (e.g. production system, feeding and management condition, birth type, age, season, milking type and milking frequency) in dairy animals. Hair goat is known for low milking performance around 160-190 d of lactation period (Şimşek et al, 2006b; Atay, 2016), 70-150 kg of milk yield (Dellal, 2000; Erten and Yılmaz, 2013; Atay, 2016). But, the rate of milk fat of Hair goat is reported quite high 4.7-5.5% (Şengoca, 1974; Tuncel, 2000).

The leading countries (e.g., France, Norway) reach 400-700 l milk production for per lactation with high milk quality by using dairy goat selection in good management condition (Danchin-Burge et al., 2012; Escareño et al., 2012; Adnoy, 2014). In the traditional goat breeding system grazing period last more than 6 months in a year (Yalçın, 1986; Gürsoy, 2006). Farmers may give priority to resistance environment than high performance (i.e. reproductive, milk yield) of goats in extensive production system (Yıldırır et al., 2017). In Turkey, selection and crossbreeding with Saanen goat both have been implemented by mainly universities, research institutions

of governments and the breeder organizations and milk yield reported around 500 l for per lactation (Tölü et al., 2010; Uzabacı et al., 2014).

Reproductive performance is an important trait for successful animal production and an indicator of environmental compatibility. Traditional Hair goat recorded 95% pregnancy and 1.2 litter size (Erten and Yılmaz, 2013). Şimşek et al. (2006b), reported the best litter size as 1.46 for Hair goat. The traits of the growth performance of Hair goat were also low in comparison with Saanen crossbreeds (Şengoca et al., 2003).

The objective of this study was to compare the traits of reproductive, milk performance, milk contents, and kid's growth characteristics of Saanen and Saanen x Hair crossbreds (F_1, B_1 and B_2) raised in semi intensive production conditions.

Materials and methods

Animal Material and Management

The animals used in this study were consisted of Saanen and Saanen x Hair crossbred goats (F_1, B_1 and B_2) and their kids born in 2009-2012 in Bandırma Sheep Research Institute (BSRI). In total of 868 does for reproductive and milk yields and 1077 kids were used for survival characteristics. Milk components (fat, protein, lactose and non-fat dry matter) of goats (n=162) and body weight changes of kid's (n=64) were recorded for one year in 2012. The Saanen and crossbreeds flock at the BSRI originated from different research farms since 2004. Saanen buck introduced from research farms, were mated with Hair goats and F_1 and B_1 goats.

BSRI is located in Balıkesir province (40°21 N; 27°52 E) at altitude of 65 m. The mean ambient temperature and annual rainfall in this region respectively 14-31°C and 500-700 mm, indicating that these climatic parameters show throughout the year (TSMS, 2019). The flock grazed on pastures composed of native grass and wheat stubble when the weather conditions suitable and kept indoors during winter months. Before mating and parturition season, animals feed with 400-600 g/d/head of concentrated feed produced at the institute. Content of the concentrate feed was composed of 74% barley, 24% sunflower oilcake, 1.4% marble powder, 0.5% salt and vitamin + mineral premix. Kids were kept alone with their dams in stalls for 3 days after kidding. When kids were 15 days old, they fed as ad-libitum a creep-feed concentrate and, alfalfa hay and water. The kids were permitted to suckle for 1 h twice a day. The suckling period of kids was about three months at the average. After weaning (90 day) male and female kids were separated and were fed with 200-400 g/d of concentrate feed for the first 6 months. Then kids managed similar with their dams.

Reproductive Performance and Kids' Survival Rate

Reproductive data collected from main goat herds (n=868) of BSRI from 2009 to 2012. Does were assigned to sexually active around 8 months old. Estrous detection was performed daily by using teaser bucks and does were mated with selected buck at the mating season. Does were exposed to bucks for 45 days around September first to October 15 days. Parameters of reproductive performance analyzed included: estrus rate (does estrus / does mated × 100), kidding rate (does kidding / does mated × 100), fecundity (kids born / does mated), litter size (kids born / does kidding), single kidding (single born kid / kid born × 100), twin kidding (twin born kids / kids born × 100), triple kidding (triple born / kids born × 100) and survival rate (kids weaning / kids born × 100).

Milk Yield and Components

Goats were machine milked twice a day at 06.00h and 16.00h. Daily milk yield was weighed with an electronic weighing instrument sensitive to 2 g monthly interval. The basic method for estimating daily milk yield of goat was used Holland method according to Kaymakçı (2006). In every control milking, 50 ml milk sample was taken from each goat, and milk samples were analyzed for fat, protein, lactose and non-fat dry matter (NFDM) concentration using infrared analysis (MIRIS dairy milk analyser). Milking was terminated, when daily milk yield of the goats fell below 100 g.

Growth Traits

Growth traits were collected total of the 64 kids at the last year of the study in the year of the 2012. Saanen (n=32) and Saanen x Hair goat kids B_1 (n=16) and B_2 (n=16) live weights at birth (BW), weaning (WW; 90 day), 6th month (SMLW) and yearling (YLW) were recorded. Kids were selected from main flock that close to kidding and BW.

Statistical Analysis

Chi-square test was conducted to analyses of reproductive performance of goats and kids survival rates. The effects of year, dam age, birth type and sex on the growth characteristic of the kids were determined by least squares analysis of variance. The differences between the means of the sub-groups were tested by Tukey test. All statistical analysis was performed with the SPSS software for windows (SPSS, 1999). The model used to analyze the growth characteristics was:

$$Y_{ijkl} = \mu + A_i + B_j + C_k + D_l + e_{ijkl.}$$

For kids growth characteristics,

Y = traits,
μ = overall mean,
A_i = year where
i = 2009, 2010, 2011, 2012 years,
B_j = age of dam where
j = 2-5,
C_k = birth type where
k = single, twin, triple,
D_l = sex where
l = male, female
e_{ijkl} = was the random residual error.

Result

Reproductive Traits and Kid's Survival Rate

Some reproductive performance obtained in goats is given at Table 1. Estrus rates, triple kidding rates and survival rates were similar among all genotypes ($P > 0.05$). Kidding rate was significantly higher in F_1 goats than Saanen goats and similar kidding rate were observed B_1 and F_1 genotypes while Saanen, B_1 and B_2 genotype had similar kidding rate.

Table 1 Some reproductive performance of goats according to genotype

Traits	Saanen	F1	B1	B2	Total
Goats mated	395	137	210	126	868
Estrus showing goats	359	129	193	118	799
Goats kidding	297	117	168	95	677
Goats single kidding	127	37	71	59	294
Goats twin kidding	163	76	92	35	366
Goats triple kidding	7	4	5	1	17
Kids live born	474	201	270	132	1077
Kids number dead	35	11	27	10	83
Estrus rate, %	90.89	94.16	91.90	93.65	92.05^{NS}
Kidding rate, %	75.19^{b}	85.40^{a}	80.00^{ab}	75.40^{b}	78.00^{*}
Single, %	42.76^{b}	31.62^{b}	42.26^{b}	62.11^{a}	43.43^{**}
Twin, %	54.88^{a}	64.96^{a}	54.76^{a}	36.84^{b}	54.06^{**}
Triple, %	2.36	3.42	2.98	1.05	2.51^{NS}
Survival rate, %	92.62	94.53	90.00	92.42	92.29^{NS}
Litter size	1.60^{a}	1.72^{a}	1.61^{a}	1.39^{b}	1.59**
Fecundity	1.20^{a}	1.47^{a}	1.29^{a}	1.05^{b}	1.24**

abc: different letters indicate significant differences among genotypes (: P≤0.05; **: P≤0.01).

Table 2 Least square means and standard errors of mean daily milk yields (g/d; 2009-2012) of goats according to genotype and age

FI	2009		2010		2011		2012		Average	
	n	$\bar{X}\pm S_{\bar{x}}$	n	$\bar{X}\pm S_{\bar{x}}$	n	$\bar{X}\pm S_{\bar{x}}$	n	$\bar{X}\pm S_{\bar{x}}$	n	$\bar{X}\pm S_{\bar{x}}$
Genotype *										
F_1	51	1668 ± 66.00^{ab}	23	1349 ± 91.88	15	1599 ± 141.92	9	1517 ± 156.89^{ab}	98	1529 ± 54.45^{a}
B_1	33	1527 ± 160.73^{ab}	37	1294 ± 99.87	37	1627 ± 138.70	30	1596 ± 91.92^{ab}	137	1526 ± 61.89^{a}
B_2	6	1968 ± 183.93^{a}	17	1376 ± 115.15	28	1733 ± 133.68	49	1656 ± 92.20^{a}	100	1629 ± 61.89^{a}
Saanen	61	1464 ± 125.21^{b}	55	1186 ± 74.26	75	1446 ± 63.14	75	1382 ± 64.35^{b}	266	1370 ± 43.91^{b}
P	0.045		0.409		0.111		0.014		<0.001	
Age*										
1	2	980 ± 318.56^{c}	7	940 ± 144.99^{b}	19	1083 ± 179.35^{b}	26	1044 ± 97.53^{c}	54	1014 ± 91.18^{c}
2-3	83	1598 ± 61.41^{bc}	57	1365 ± 67.82^{a}	71	1734 ± 61.09^{a}	69	1443 ± 80.62^{b}	280	1527 ± 35.61^{b}
4-5	48	1738 ± 68.84^{ab}	52	1484 ± 65.77^{a}	36	1821 ± 114.38^{a}	35	1697 ± 86.80^{a}	171	1680 ± 44.29^{a}
>6	18	1923 ± 108.92^{a}	16	1294 ± 101.59^{a}	29	1652 ± 94.61^{a}	33	1875 ± 96.87^{a}	96	1717 ± 50.94^{a}
P	<0.001		0.009		0.004		<0.001		<0.001	
Year**	151	1583 ± 67.89^{a}	132	1292 ± 56.27^{b}	155	1591 ± 55.88^{a}	163	1542 ± 44.36^{a}	601	0.001

*abc: different letters indicate significant differences among genotypes and ages (P≤0.01), FI: Factors investigated

Table 3 Average milk components (%) of goats according to genotype and age in 2012.

Factors investigated	n	Fat	Protein	Lactose	NFDM**
		$\bar{X}\pm S_{\bar{x}}$	$\bar{X}\pm S_{\bar{x}}$	$\bar{X}\pm S_{\bar{x}}$	$\bar{X}\pm S_{\bar{x}}$
Genotype*					
F_1	11	3.12 ± 0.25	3.21 ± 0.15^{a}	3.24 ± 0.07	7.67 ± 0.16^{a}
B_1	28	3.04 ± 0.17	3.00 ± 0.09^{a}	3.34 ± 0.05	7.52 ± 0.10^{a}
B_2	48	2.90 ± 0.17	2.75 ± 0.09^{b}	3.35 ± 0.05	7.17 ± 0.10^{b}
Saanen	75	3.13 ± 0.11	2.76 ± 0.06^{b}	3.37 ± 0.03	7.18 ± 0.07^{b}
P	0.622		0.009	0.504	0.002
Age*					
1	29	3.22 ± 0.16	2.97 ± 0.09	3.43 ± 0.05	7.54 ± 0.10
2-3	65	3.07 ± 0.15	2.81 ± 0.09	3.34 ± 0.04	7.24 ± 0.09
4-5	32	2.96 ± 0.15	2.83 ± 0.09	3.28 ± 0.04	7.24 ± 0.10
>6	36	2.89 ± 0.17	2.86 ± 0.10	3.33 ± 0.05	7.28 ± 0.11
P	0.436		0.436	0.104	0.054
Average	162	3.03 ± 0.08	2.86 ± 0.05	3.35 ± 0.02	7.32 ± 0.05

*abc: different letters indicate significant differences among genotypes and ages (P≤0.01), **NFDM; non-fat dry matter.

Daily Milk Yield and Milk Components

Saanen goats had the lowest (P≤0.001; 1370±43.91 g/d) mean DMY compared to F_1, B_1 and B_2 goats (Table 2). The effect of year and age were significant on milk yield (P=0.001). Yearling goats had the lowest mean DMY, 2-3 years was moderate, and older ages were higher mean daily milk yield (P≤0.001).

Milk fat content and lactose content were similar among all genotypes (Table 3). However, milk protein content and NFDM content were lower in Saanen and B_2 goats compared to F_1 and B_1 goats (Table 3). Goat age had no effects on milk components (P>0.05).

Table 4 The least square means (LSM) and standard errors (SE) of the live weights of kids at different control days in 2012

Factors Investigated	BW		MLW		WW		SMLW		YLW	
	n	LSM	n	LSM	n	LSM	n	LSM	n	LSM
Genotype										
B_1	16	3.43±0.14	16	10.01±0.42	16	22.34±0.90^{a}	11	31.20±1.66^{a}	10	39.59±1.75^{a}
B_2	16	3.31±0.12	16	8.98±0.37	16	20.51±0.79^{a}	13	28.69±1.44^{ab}	13	38.63±1.52^{ab}
Saanen	32	3.30±0.08	32	8.88±0.25	31	18.49±0.53^{b}	28	26.92±0.97^{b}	28	35.99±1.02^{b}
P		0.177		0.178		<0.001		0.033		0.040
Sex										
Male	32	3.42±0.09	32	9.90±0.28^{a}	32	22.11±0.61^{a}	24	31.43±1.12^{a}	23	39.05±1.18
Female	32	3.26±0.08	32	8.62±0.25^{b}	31	18.50±0.55^{b}	28	26.27±1.00^{b}	28	36.69±1.05
P		0.496		0.005		0.001		0.001		0.060
Birth type										
Single	32	3.56±0.08^{a}	32	9.78±0.25^{a}	32	21.16±0.55^{a}	29	29.24±1.00	28	38.43±1.05
Twin	32	3.04±0.09^{b}	32	8.39±0.28^{b}	31	18.63±.061^{b}	23	27.54±1.12	23	36.77±1.18
P		0.001		0.001		0.003		0.246		0.062
Dam age										
2	11	3.02±0.14^{b}	11	8.08±0.42^{b}	11	18.86±0.89^{b}	10	28.38±1.64	10	38.45±1.72
3	17	3.41±0.12^{ab}	17	9.57±0.37^{a}	16	20.98±0.80^{ab}	14	27.69±1.47	13	37.48±1.55
4	15	3.45±0.12^{a}	15	9.85±0.37^{a}	15	21.14±0.80^{a}	13	29.82±1.47	13	38.09±1.55
≥5	21	3.47±0.11^{a}	21	9.33±0.35^{a}	21	19.52±0.74^{ab}	15	28.20±1.36	15	36.85±1.43
P		0.001		0.017		0.026		0.471		0.992

*ab: different letters indicate significant differences among genotypes and ages (P≤0.01), **BW: birth weight, MLW; monthly live weight, WW; weaning weight at 3 months, SMLW; six month live weight, YLW; yearling live weight.

Growth Traits

The least square means (LSM) and standard errors (SE) of the live weights of kids have been presented in Table 4. Birth weight (BW) and MLW were similar between genotypes. Weaning weight was higher (P=0.001) in B_1 and B_2 kids in comparison with Saanen kids, and the difference between B_1 and Saanen kids continued at SMLW and at the YLW. Male kids had higher (P<0.005) MLW, WW and SMLW than female kids, but WW and YLW were similar (P=0.060) between male and female kids. BW, MLW and WW were higher (P≤0.003) in single born kids than twin kids; however, SMLW and YLW were similar (P>0.05) between single and twin kids. Dam age were significant (P≤0.026) on BW, MLW and WW, whereas SMLW and YLW were similar (P>0.05) among kids from different dam ages. Higher WW were found in kids from 4 older dams compared to kids from 2 years older does, and BW was also higher in kids from 4 and ≥5 older dams than 2 years older dams.

Discussion

In animal production, good reproductive performance is essential for whole production. Reproductive performance of the goats depends on genetic and environmental factors, and particularly sensitive to the latter (Song et al., 2006). Therefore, it would be helpful to compare of the various systems of goat production, and the importance of reproductive efficiency in attaining them. The reproductive success of goats and survival performance of kids were evaluated from four years data of goat population at BSRI between 2009 and 2012. Several researchers reported that Saanen crossbreed's reproductive performance is quite high with 96% of estrus rate (Ceyhan and Karadağ, 2009; Tölü et al., 2010; Bolacalı and Küçük, 2012) and 90% pregnancy rate (Bolacalı and Küçük, 2012). Kidding rate was found 64% by Tölü et al. (2010) and 82% by Ceyhan and Karadağ (2009) and Bolacalı and Küçük (2012) for Saanen goats. Fecundity and litter size were reported between 1.2-1.6 and 1.6-1.9 respectively in Saanen goats (Ceyhan and Karadağ, 2009; Tölü et al., 2010; Ulutaş et al., 2010; Bolacalı and Küçük, 2012). Twin kidding rate was reported around 58% by Bolacalı and Küçük (2012) and Ulutaş et al. (2010) for Saanen and their crossbreeds. In this study, the overall litter size and fecundity were found 1.59 and 1.24 respectively. Our results for reproductive performance (i.e. estrus rate, kidding rate and litter size) are correlated with a review of the literature. However, B_2 genotype had significantly lower (P≤0.01) litter size and fecundity in comparison with all genotypes. Similarly, kidding rate was lower in Saanen and B_2 genotypes in comparison with F_1 and B_1 genotypes.

High rate of pre-weaning mortality is a major constraint in goat production. Mortality rates from the literature were also high, ranging from 14 % to 18%, averaging 16% for Saanen and their crossbreds (Şimşek and Bayraktar, 2006; Şimşek et al., 2007; Akdağ et al., 2011; Gökdal et al., 2013). The high mortality rate of kids can be explained by management, coccidiosis and weather conditions of the first week of the birth (Şimşek et al., 2007). The overall mortality rate of kid's in the present study was 7.8%. The interaction effects between genotype and environment on kid's mortality rate at weaning is important. However, we found no difference between the genotypes for the mortality rate of kid's.

The overall mean birth weight of kids obtained in the present study was 3.34 ± 0.08 kg. Mean body weights of kid's at birth and 30 d were very similar for all genotypes. But, at the weaning and at the further control days body weight changes of kid's were highly affected by genotype and sex. There are many studies described in the literature for body weight at birth (2.9 kg to 4.0 kg), at weaning (12.9 kg to 15.6 kg) and six months age (19.1 kg to 31.9 kg) for Saanen and their crossbreeds (Şimşek et al., 2007; Ceyhan

and Karadağ, 2009; Ulutaş et al., 2010; Akdağ et al., 2011; Bolacalı and Küçük, 2012; Gökdal et al., 2013; Önder et al., 2015). The weaning weight obtained in this study was higher than the literature by Şimşek et al. (2007), Bolacalı and Küçük (2012), Gökdal et al. (2013) and Akdağ et al. (2011).

Dam age and birth type had significant effect on birth weight and pre-weaning daily weight gain of kids. The significant influence of dam age and birth type on birth weight of kids were reported in previous studies (Simşek et al., 2007; Zeleke, 2007). But, the effects of birth type and dam age were not significant at the control days of six months and yearling. Akdağ et al. (2011), reported that crossbreds had higher growth performance than purebred Saanen kids in the Blacksea region. Şimşek and Bayraktar (2006) found that the growth and survival rate were similar between Hair kids and Saanen x Hair crossbreeds (F_1). In compliance with Akdağ et al. (2011), we found mean values of body weight of B_1 kids at different stages of control days (weaning, six month and yearling age) higher than Saanen kids.

The milk yield records of 601 goats were analyzed for four years data between 2009 and 2012. In this study, overall average DMY was 1.58 kg for all genotypes. In evaluating Saanen goats in the improved stock milk performance records was higher than our results (Ecareno et al., 2012; Adnoy, 2014). Mean DMY of Turkish Saanen goat was reported 1.8 kg by Şengonca et al. (2003), 1.7 kg by Tölü et al. (2010), 1.4 kg by Bolacalı and Küçük (2012) and 0.95 kg by Ulutaş et al. (2010). Hair goat can be improved by selection and optimum maintenance and feeding conditions (Şimşek and Bayraktar, 2006). The use of Saanen x Hair crossbreeds may be more productive than using purebred Saanen in certain region (Akdağ et al., 2011). Improved breed performance is effective in commercial systems, however in farming conditions especially in marginal environments or extensive production system there is a need to carry out further investigations of utilizing crossbred.

Milk fat, protein and lactose content are important nutrients and higher dry matter content is associated with better quality of milk. In this study, milk components were evaluated by using one year data in 2012. The components of milk for Saanen goat were reported as 4.04% fat, 3.09% protein, and 4.35% lactose by Adnoy (2014), and 3.24% protein and 4.01% fat by Tölü et al., (2010). The milk protein rate encountered in the present study is lower than the values reported by Tölü et al. (2010). Milk protein content and NFDM content were markedly lower in Saanen and B_2 genotypes in comparison with F_1 and B_1 genotypes.

As conclusion, some reproductive, milking and growth characteristics of B_1 genotype were superior than Saanen and B_2 genotype for production traits investigated. Environmental interactions and/or genetic factors such as inbreeding could be main reason of the performance results. However, inbreeding rate was not analyzed in this study, because of the effect of incomplete pedigrees. Saanen x Hair goat crossbred of B_1 is recommended for higher performance in semi intensive production system for Western Anatolia. On the other hand, Saanen and B_2 genotypes would be more successful in more controlled environment.

Acknowledgements

We thank the General Directorate of Agricultural Research and Policy (GDAR) for support to conduct this study.

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