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FACTORS AFFECTING MILK PRODUCTION TRAITS OF SAANEN GOAT RAISED UNDER SUDAN - SEMI ARID CONDITIONS

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ABSTRACT: *The aim of this study is to investigate the genetic and environmental factors affecting milk production characteristics of Saanen goats raised under Sudan conditions. It also aims at estimating heritabilities, phenotypic, genetic and environmental correlations among milk production traits. Means for total milk yield, lactation length and daily milk were 340.78±11.35 kg, 203.99±7.66 days and 1.50±0.05 kg, respectively. The season, year of calving and parity number had significant influence on total milk yield and daily milk yield. The lactation length was significantly (P<0.05) affected by season, year of kidding and origin of birth, and was insignificantly (P>0.05) influenced by parity number. The origin of birth insignificantly affected total milk yield and daily milk yield. The study concludes that the Saanen breed can effectively raise milk production in the state.*

ORIGINAL ARTICLE

Key words: *Milk yield, Lactation length, Heritability, Daily milk yield, Goats.*

INTRODUCTION

Goat genetic resources play an important socio-economic role in many rural parts of the world in contributing to food and nutrition security (Ogola and Kosgey, 2012). In the developing countries, research and development investments to improve the relatively low level of goat productivity do not match their potential importance, resulting in many goat breeds that are not genetically explored (Abdel Aziz, 2010). Saanen is probably the most developed dairy breed. Among goat breeds it occupies the place that the Holstein-Friesian has among cattle breeds (Weppert, 1998). The present paper aims to identify the main factors influencing milk production and to estimate genetic parameters such as heritability, genetic and environmental correlations among production traits.

MATERIAL AND METHODS

Farm location and History of foundation herd

Data utilized in this study were extracted from the Goat Improvement Project records, a governmental farm belonging to the Ministry of Agriculture, Animal Wealth and Irrigation, Khartoum state. The farm is located in Khartoum North (Hilat Kuku), Khartoum state, Sudan. The latitude, longitude and altitude are 15° 36´ N, 32° 33´ and E 382 m (1253 ft). A total number of 404 performance records of Saanen goats were used; covering the period from 2004 to 2011. Saanen goats were imported from the Netherlands in three batches (the first was in 2004; 15 pregnant females and 20 males, second; 20 pregnant females and 80 males and the last batch was in June 2006; 80 pregnant females and 20 males). The main objectives of the project were genetic improvement of the local goats and in consequence improve the nutritional status of poor families, increase their incomes, create job opportunities for post graduates, increase milk supply in Khartoum state, provide training and extension for goat breeders and collect data for research.

The annual precipitation in Khartoum State is 164 mm; average temperature is 29.8° C with maximum high temperature of 42° C and minimum low temperature of 16° C. The average relative humidity during the year is 21.8% ranging from 13% in March and April to 42% in August. On average there are 3664 sunshine hours annually (*2008-2012 climatetemp.info*).

Management system

Goats were kept in groups in a metal frame building. The roof is made of iron sheets and is 2.95 m high the floor is of concrete; the fencing is made of metal bars about 1.5 cm high. Feeders and water troughs were placed in the shaded area. Milking was carried out twice daily (6:00 AM and 2:00 PM) using portable milking machines for goats. Daily milk yield was recoded for each animal. Artificial insemination (A.I) was adopted in the farm; selected bucks were used for collection of semen to inseminate goats using fresh semen. The favored breeding season is

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wet summer (July – Oct.) in order that the does give birth in the winter season. Heat was detected by using teaser bucks every day at early morning. Forty days after insemination pregnancy was diagnosed using an ultra sound machine. The goats are raised in a confined system receiving green forages such as Alfalfa (*Medicago Sativa*) and Rhodes grass offered twice a day about 3% of body weight. Also dairy goat concentrate ration was given to the animals according to their physiological status and milk yield. The concentrate contains on average 15-17% crude protein and 11.2MJ/Kg metabolizable energy. Water and mineral salt are given *ad libitum.* Pregnant does were dried 45 to 60 days before the next kidding. Pregnant females received a concentrate diet 2 weeks before delivery as steaming up. Bucks were given 1 kg / day of concentrates during the breeding season. All animals in the farm were regularly vaccinated against the major epidemic diseases in the Sudan *vis*: *Pese des Petits Ruminants* (P.P.R), anthrax, sheep pox and haemorrhagic septicemia. Drenching pendazole and spraying with thypermethrin were used to control internal and external parasites. The pen floor was disinfected periodically with phonic acid.

Statistical analysis

Data were extracted from farm records and were classified according to season of kidding into three seasons; dry summer from March to June; wet summer from July to Oct. and winter from Nov. to December. The data were also classified according to year of kidding (from 2004 to 2011) into eight groups. According to parity number the data were classified into six parities. The data of total and daily milk yield were classified into three groups according to lactation length. The data were analyzed using Harvey's (1990) Least Squares computer programme. The analysis of variance was completed according to the following statistical model:

$Yijklmnp = \mu + B_i + S_j + Y_k + P_m + L_n + e_{ijklmnp}$

Where:

$Y_{ijklmnp}$ = observation; μ = overall mean; B_i = the fixed effect of the ith origin of birth (i= 1 and 2); S_j= the fixed effect of the jth season of kidding (j= 1, 2 and 3); Y_k= the fixed effect of the kth year of Kidding (k= 1, 2, ...7); P_m= the fixed effect of the mth parity number (m= 1, 2, ...6); L_n= the fixed effect of the nth lactation length group (1, 2 and 3); $e_{ijklmnp}$ = the random error term

All fixed effects were used for the total and daily milk yield, but the effect of lactation length group was removed from model of lactation length. The genetic parameters (heritabilities, phenotypic, genetic and environmental correlations) were estimated by paternal half sibs and full sibs' methods according to the following model:

$Y_{ij} = S_i + D_j : S_i + e_{ij}$

Where:

Y_{ij} = observation; S_i = the random effect of the ith sire; D_j:S_i= the random effect of the jth dam nested to the ith sire; e_{ij} = the random error term

RESULTS

The least squares means and standard errors of total milk yield (kg) are shown in Table 1. The overall mean of total milk yield was 340.78±11.35 kg / lactation. Analysis of variance results revealed that the origin of birth had insignificant (P>0.05) influence on total milk yield, while the season and year of kidding, parity number and lactation length significantly affected (P<0.05) total milk yield. The goats that kidded in winter yielded significantly higher milk (377.47 kg), followed by those which kidded in the dry summer (340.41 kg); while those kidded in wet summer gave significantly lower milk yield per lactation (304.47 kg). The results showed a significantly decreasing trend of milk yield with advancing year of kidding. The total milk yield increased with increasing parity number and the highest milk yield was recorded in the fourth and fifth lactations and after that it decreased slightly. Also the results revealed that the milk yield increased with increasing lactation length with the third group (>300 days) having a significantly higher milk yield, followed by the second group (180-300 days), and the first group (<180 days).

The overall mean of daily milk yield was 1.50±0.05 kg. Analysis of variance results revealed that the origin of birth and lactation length had an insignificant (P>0.05) influence on daily milk yield, while season of kidding, year of kidding and parity number had a significant (P<0.05) effect on daily milk yield. The results also showed that the imported and locally born does had similar daily milk yield. On the other hand; the does which kidded in winter had the highest yield (1.31 kg), followed by those which kidded in dry summer (1.52 kg), while those kidded in wet summer gave the lowest milk yield (1.68 kg). The does during the early years of the project recorded significantly (P<0.05) higher daily milk yield compared to those raised during the middle years while does during the late years yielded the lowest daily milk. The least daily milk yield was in the first parity (1.29 kg) and it increased with advancing parity and the highest daily milk yield was recorded in the fifth and sixth parities.

The results presented in table 1 show that the average lactation period was 203.99±7.66 day. Analysis of variance results revealed that the origin of birth, year and season of kidding had significant influence on lactation length. However, parity number had insignificant (P>0.05) influence on lactation length. The results also indicate that the imported does had short lactation length in comparison with the locally born does. The does which kidded in winter had the highest lactation length (235.37 day), followed by those which kidded in dry summer (204.0 day), while those kidded in wet summer had the east lactation length (172.6 day). The parity order had no significant effect (P>0.05) on lactation length.

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Table 2 shows the heritability of milk yield, daily milk yield and lactation length (0.443, 0.822 and 0.337 respectively). The genetic correlation of milk yield with daily milk yield was high and positive (0.74) and the genetic correlation of milk yield with lactation length was positive, but low (0.216). The genetic correlation between daily milk yield and lactation length was negative (-0.446). Milk yield had a positive phenotypic correlation with daily milk yield (0.589). The phenotypic correlation of milk yield with lactation length was moderately high and positive (0.639). However; the correlation of daily milk yield with lactation length was low and negative (-0.169).

Table 1 - Factors affecting total milk yield (kg), daily milk yield (kg) and lactation length (days) of Saanen goats raised under Sudan conditions

Item		Milk yield	Daily milk yield	Lactation length
	N	LS Mean ±SE	LS Mean ±se	LS Mean ±se
Origin		NS	NS	*
Imported	211	329.98^{a}±11.01	1.50^{a}±0.04	188.82^{b}±7.17
Locally born	193	351.58^{a}±15.15	1.50^{a}±0.06	219.16^{a}±10.54
Season of kidding:		**	**	**
Dry summer	139	340.41^{b}±13.15	1.52^{b}±0.05	204.00^{b}±8.74
Wet summer	46	304.47^{c}±20.64	1.31^{c}±0.08	172.60^{c}±13.99
Winter	219	377.47^{a}±10.31	1.68^{a}±0.04	235.37^{a}±7.14
Year of kidding:		**	**	**
2004	6	407.00^{a}±45.57	2.26^{a}±0.18	116.52^{b}±31.37
2005	32	460.83^{a}±24.13	1.90^{b}±0.10	209.15^{a}±16.78
2006	80	424.79^{a}±18.76	1.74^{b}±0.07	210.15^{a}±13.04
2007	60	323.68^{b}±15.93	1.45^{c}±0.06	195.21^{a}±10.99
2008	69	297.36^{bc}±14.78	1.29^{c}±0.06	196.30^{a}±9.86
2009	82	286.13^{bc}±13.08	1.20^{d}±0.06	239.21^{a}±9.12
2010	55	262.49^{c}±15.41	1.07^{d}±0.06	239.29^{a}±10.78
2011	20	263.99^{bc}±24.27	1.08^{d}±0.10	225.93^{a}±16.55
Parity:		**	*	NS
1st	155	278.97^{b}±11.28	1.29^{c}±0.04	206.12^{a}±7.67
2nd	94	342.34^{a}±13.88	1.48^{ab}±0.06	209.41^{a}±9.42
3rd	63	328.24^{a}±16.33	1.40^{bc}±0.06	207.79^{a}±11.22
4th	44	368.30^{a}±19.16	1.57^{ab}±0.08	212.23^{a}±13.24
5th	25	368.58^{a}±23.63	1.64^{a}±0.09	194.41^{a}±16.49
6th	23	358.27^{a}±25.18	1.61^{a}±0.10	193.97^{a}±17.58
Lactation length group:		**	NS	-
1st < 180 days	108	208.26^{c}±13.17	1.53^{a}±0.05	-
2nd 181 – 300 days	227	348.06^{b}±12.54	1.51^{a}±0.05	-
3rd > 300 days	69	466.02^{a}±17.09	1.46^{a}±0.07	-
Overall mean	404	340.78±11.35	1.50±0.05	203.99±7.66
CV (%)		31.17	27.84	30.32

LS Mean ± se: least squares means and standard errors. ^{a,b} Means with same superscripts within each item were not significantly (P<0.05) different. *, ** and NS: significant at P<0.01, P<0.001 and not significant at P>0.05

Table 2 - Heritabilities, genetic and phenotypic correlations for milk production traits estimated from the full sibs' and half sibs' methods (n=172)

Method	Traits	Milk yield	Daily milk	Lactation length
Full sibs	Milk yield	0.44±0.17	0.74	0.22
	Daily milk	0.59	0.82±0.18	- 0.45
	Lactation length	0.64	- 0.17	0.34±0.17
Paternal half-sibs	Milk yield	0.73±0.34	0.07	0.21
	Daily milk	0.59	1.40±0.38	- 0.60
	Lactation length	0.64	- 0.17	0.68±0.34

♀Parameters estimated by full sibs' method, heritabilities were presented in diagonal, genetic and phenotypic correlations were presented above and below diagonal respectively.

Table 3 presents the environmental correlations among the three traits. The results show that the environmental correlation between milk yield and daily milk yield was positive (0.454) and that between milk yield with lactation length was however, high and positive (0.914) the environmental correlation between daily milk yield with lactation length was low and positive (0.192).

Table 3 - Environmental correlations♀ among milk production traits (n=172)

Traits	Milk yield	Daily milk	Lactation length
Milk yield		0.454	0.914
Daily milk	0.259		0.192
Lactation length	0.164	NE	

♀ Correlations which estimated by full sibs' method above diagonal; while those estimated by paternal half sibs' method below diagonal; NE: not estimated

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DISCUSSION

The mean of milk yield obtained in this study (340.78±11.35 kg) is lower than that obtained by Ali et al. (1983) (787 kg) in the United States, Bolacali and Kucuk (2012) (383.05 kg) in Eastern Anatolia region, turkey and Boichard et al. (1989) (490 kg) in France. On the other hand it is close to the estimate that mentioned by Pesce Delfino et al. (2011). The average lactation length (203.99±7.66day) is less than the finding of Pesce Delfino et al. (2011) who estimated that the average lactation length was 230 days. It is also less than the estimate of Bolacali and Kucuk (2012) (273.12 days), Ali et al. (1983) (231days) and Boichard et al. (1989) (238 days). Daily milk yield in the present study was 1.5±0.05kg which was higher than that of Bolacali and Kucuk (2012) (1.37 kg) and higher than the estimate of Saanen goats in South Africa noted by Norris et al. (2010) (1.45 ±0.27 kg). Boro et al. (2009) in Croatia gave a higher value (2.63 kg/day) than that obtained in the present study.

The effect of year and season of kidding on milk yield traits was significant. This may be due to the variability in climatic conditions, fluctuations in the availability of nutrients and flock composition over the years. The increased milk production during winter might be to the lower ambient temperatures, availability of feeds and lower incidence of diseases, while the lower milk production during wet summer may have resulted from the stress of high temperature and humidity, prevalence of external and internal parasites and scarcity of feedstuffs. The increasing trend of milk production with increasing parity order may be result of better udder development and growth in size of the animal. It should be emphasized that although the milk production of the temperate breed observed in this study is lower than that in its home country, the yield is still much higher than the milk production of the indigenous goat.

The heritability estimates of milk yield traits in this study are higher than those found by Pesce Delfino et al. (2011). They reported that the estimates of heritability were 0.21 and 0.15 for milk yield and lactation length respectively. Also, the heritability of milk yield is higher than the findings of Belichon et al. (1999) who reported that heritability of milk yield was 0.32±0.17. Tholon et al. (2001) estimated that the heritability of milk yield was 0.37. The high values of heritability in the present study may be due to the small size of the data set.

In conclusion, the milk production data obtained in the current study from Saanen goats raised in Khartoum state, Sudan have revealed that Saanen goats can be used for goat milk production in the region. The milk production performance of the Saanen goat breed was superior to that of crossbred and local goat.

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