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Genetic evaluation of milk yield and milk composition of Saudi Aradi and Damascus goats

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Abstract

The aim of the present study was to evaluate the effects of various non-genetic factors on milk production traits and to estimates its' heritability and variance component in milk production trait among Saudi Aradi and Damascus goats. A total number of 213 (98 Aradi and 115 Damascus goats) was classified according to breed, season, year, and type of birth. Data were analyzed statistically. The variation in milk yield (MY) were moderate (32.80 %), while variations in fat (F %) and protein (P %) were low (fat 17.67 % and protein 19.75 %). The genetic groups had a significant ($P \leq 0.05$) effect on milk yield and highly significant on (F % and P %, ($P \leq 0.01$)). Damascus goats had higher than Aradi in milk yield, fat and protein. Milk yield and fat% during seasons were not significant differ. Milk protein% during Summer/Spring season (S_2) had a significant higher ($P \leq 0.01$) than at during Winter/Autumn (S_1). The highest fat% ($P \leq 0.05$) found in year 2009. Triplets had higher ($P \leq 0.01$) effect on milk yield than twins or single. However, there were no significant differences between type of births for protein% and fat%. Damascus had higher heritability estimates (0.45) than Aradi goats (0.29) for milk yield. Also, for protein%, the heritability estimates of Damascus had higher heritability estimates (0.69) than Aradi goats (0.37). But the heritability for fat % in Aradi (0.23) was similar to that in Damascus goats (0.22). In conclusions, the percentage of genetic variance component in Aradi goats is low so that the best programs for the genetic improvement in the Aradi goats could be upgraded through crossing with Damascus goats.

Keywords: genetic traits, milk yield, milk composition, Aradi goats, Damascus goats.

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1. Introduction

Breeding programs depend on selecting does that have superior genetic to improve performances in dairy goats. The estimation of genetic and non-genetic factors affecting economically important traits is basics to select breeders for a certain traits. So, estimates the heritability of genetic and phenotypic traits are essential in developing efficient breeding schemes as well as in predicting breeding values accurately. Kendall *et al*. (2009) indicated that the breed affecting on level of milk production and there is variation in milk yield among different breeds and within the breed. The economic value of goat milk depends to a great extent on fat and protein contents as well as total milk yield (Montaldo and Manfredi, 2002). Several researchers have reported on the effects of breed on milk production and have also investigated milk yield traits in different breeds of goat. However milk production significantly varied in different breeds of goat and attributed it to the difference in genetic potentials of the animals (Zahraddeen *et al*., 2009). The exotic breeds like the Swiss breeds have much higher milk yields but lower milk composition than Indigenous goat breeds like the West African Dwarf and Red Sokoto (Park and Haenlein ., 2010). Scarcely, published estimates of genetic parameters for milk yield and content traits in goats, few multi-trait animal model-REML estimates of (co)variance matrices are available for milk yield and content traits (Analla *et al*., 1996; Gonçalves *et al*., 2002; Valencia *et al*., 2007). The present study was undertaken to evaluate the effects of various non-genetic factors on milk production traits (milk yield, fat % and protein %) and to estimates heritability and variance component for the same traits in Aradi and Damascus goats.

2. Materials and methods

2.1 Location of study and animal management

Saudi goats (Aradi, A) was a native breed of Saudi Arabia and Syrian goats (Damascus, D) was carried out at Camel and Range Research Center (Al-Jouf province, Northern region of Saudi Arabia located at latitude of 29.97 °N and longitude of 40.21 °W and at 684 meters above sea level). All animals were raised under similar environmental, nutritional, and management conditions. The animals were housed in semi-shaded/open front barn and fed on a commercial concentrate and alfalfa hay. The amount of concentrate and hay were calculated according to the nutritional requirements for goats (NRC, 1981), which were dependent on animal ages and production status. Water, straw, salt and minerals supplemented in blocks were freely available to all animals.

2.2 Breeding plan of the genetic groups

This study used total number of 213 (98 Aradi and 115 Damascus goats) during the time period from 2008 to 2010 of the study. The measurement of milk production began after the 3rd day *post-*

partum to allow kids consuming colostrum. Milk yield was recorded by the ICAR (International Committee for Animal Recording) A4 method at 28-day intervals during the 240 days of lactation ICRPMA (1990). All goats were milked after weaning by an automatic milking system that can measure the milk yield automatically. Milk yields of the dams were measured using the alternate day system until weaning. In this system, goats were milked at 6 AM on the recording day. Then, kids were fed with dams' milk with the assistance of the stock person and suckled their dams until 6 AM the following day. Kids were isolated from their dams until the 6 PM milk recording. Sampling was started after weaning. Every 28 days, 200 ml milk samples were collected from the morning milk and immediately taken to the laboratory in an icebox. The samples were analyzed for fat by the Gerber method, and total protein was determined by the phenol titration method as described by James (1988).

2.3 Data collection for statistical analysis

Data were recorded for all animals during season 1 (winter / Autumn), season 2 (spring / summer), and years from 2008 to 2010.They were classified according to breed, season, year, and type of birth. Data were analyzed using PROC GLM procedure (SAS, 2008) for the least-squares means and standard errors of the fixed factors. Heritability and genetic parameters were estimated with derivative-free restricted maximum likelihood (REML) procedures using the MTDFREML program of Boldman *et al*. (1995).

2.4 Statistical model used for data analysis

The following statistical model was used for data analysis:

$$Y_{ijklm} = \mu + B_i + S_j + Y_k + T_l + e_{ijklm}$$

Where; Y_{ijklm}: The record of MY, F % or P % measured on does had milked at k^{th} year, i^{th} breed, j^{th} season and l^{th} type of birth; μ: Overall mean when equal subclass numbers exists; Bi: effect of i^{th} breed (i = 1 and 2); S_j: Fixed effect of j^{th} season (j = 1 and 2); Y_k: Fixed effect of k^{th} year (k = 1, 2and 3); T_l: Fixed effect of l^{th} type of birth (l = 1, 2, and 3); e_{ijklm}: Random error particular to the $ijklm^{th}$ observation assumed to be independently and normally distributed with mean zero and variance of δ^2e. The assumed model for heritability, genetic correlations and breeding values was:

$$y = Xb + Zu + e$$

Where; y: a vector of observations, b: a vector of fixed effects with an incidence matrix X; u: a vector of random animal effects with incidence matrix Z; e: a vector of random residual effects with mean equals zero.

3. Results and Discussion

The obtained results articulated wide phenotypic variations in all traits of the milk yield, fat and protein %. The percentages of variation for milk yield were moderate (32.80 %) but the difference between minimum and maximum were high ranged from 54.24 to 479.00, while these variations for fat and protein % were low (fat 17.67 % and protein 19.75 %) but the difference between minimum and maximum were high ranged from 2.16 to 6.34 for fat % and from 1.46 to 5.64 for protein % (Table 1). The genetic groups had a significant (P≤0.05) effect on milk yield and highly significant on fat and protein % (P≤0.01). Damascus goats had higher than Aradi in milk yield, fat and protein (Table 2). The importance of the various environmental effects on milk yield, fat% and protein% has been also examined in other studies. Rabasco *et al*. (1993) in the Spanish Verata goats found that birth type and production year were significant effects for milk yield. It was recorded that milk yield significantly affected by season of kidding, litter size and year (Valencia *et al*., 2002; 2007).

Table (1): Actual means standard error (SE), standard deviations (SD) and ranges for milk yield, fat and protein %.

Variable	Mean	SD	CV%	SE	Minimum	Maximum
Milk Yield	203.011	66.596	32.80	4.563	54.245	479.00
Fat	4.155	0.734	17.67	0.050	2.155	6.34
Protein	3.375	0.666	19.75	0.045	1.455	5.64

Table (2): Least squares means ± S.E for milk yield, fat and protein %.

Items / Breed	No	Milk yield	Fat (%)	Protein (%)
		*	**	**
Aradi	98	199.518 ± 10.379	3.901 ± 0.116	3.259 ± 0.104
Damascus	115	216.793 ± 9.677	4.252 ± 0.108	3.600 ± 0.097
Season		NS	NS	**
Winter and Autumn	184	209.753 ± 7.940	4.091 ± 0.089	3.247 ± 0.079
Summer and Spring	29	206.558 ± 13.999	4.062 ± 0.157	3.612 ± 0.140
Year		**	*	*
2008	35	230.691 ± 13.491	3.906 ± 0.151	3.524 ± 0.135
2009	57	180.261 ± 10.905	4.279 ± 0.122	3.237 ± 0.109
2010	121	213.515 ± 10.010	4.044 ± 0.112	3.527 ± 0.100
Type of birth		*	NS	NS
Single	101	188.941 ± 7.460	4.240 ± 0.083	3.581 ± 0.074
Twins	101	212.529 ± 8.821	4.022 ± 0.099	3.385 ± 0.088
Triplets	11	222.996 ± 20.332	3.968 ± 0.228	3.323 ± 0.204

* = P ≤ 0.05; ** = P ≤ 0.01; NS= non-significant.

Furthermore, Torres-Vázquez *et al*. (2009) found that all fixed effects were significant (P≤0.01) for milk yield, fat and protein %. For fat%: season of kidding and year had highly significant ($P \leq 0.01$), but for protein %: year only had highly significant ($P \leq 0.01$). Pesce Delfino *et al*. (2011) found that milk yield was affected by year of lactation ($P \leq 0.001$) and type of birth ($P \leq 0.05$). Analyses of variance showed that the fixed effects of season, year and type of birth were significantly different for most traits (Tables 2). Milk yield during Summer/Spring season had a higher yield than at Winter/Autumn of season but it was not significant, as well as not significant differences between seasons for fat %. Anyways, it was recorded highly significant differences between seasons for protein. However protein % during Summer/Spring had a significant higher ($P \leq 0.01$) than it during Winter/Autumn. Project years had highly significant ($P \leq 0.01$) effect on milk yield and significant ($P \leq 0.05$) on milk fat and protein % (Table 2). The highest milk yield was recorded during year 2008. Conversely, the lowest milk yield was recorded in years 2009. The highest fat% was found during year 2009, but the lowest fat % was recorded during year 2008. The highest protein % was noticed during year 2008 as well as 2010. Conversely, the lowest protein % was recorded among year 2009. Triplets had higher ($P \leq 0.01$) effect on milk yield than twins or single. However, there were no significant differences between type of birth for protein and fat % (Table 2). The estimates of variance components and heritability for milk yield, fat and protein % for Aradi goat, and Damascus goats are presented in Table (3). It could be noticed that Damascus had higher heritability estimates (0.45) than Aradi goats (0.29) for milk yield. Also, the heritability for protein% estimated in Damascus (0.69) was higher than that in Aradi goats (0.37). The heritability for fat % estimated in Aradi (0.23) was similar to that in Damascus goats (0.22).

Table (3): Estimates of Heritability (h^2) and variance component for total milk yield in different goat population (Milk yield, fat and protein %).

Breed	Milk traits	h^2	$\delta^2 p$	$\delta^2 g$	$\delta^2 e$
Aradi	MY	0.29	2920.014	835.409	2084.605
	F %	0.23	1272.569	298.244	974.324
	P %	0.37	1206.943	443.386	763.557
Damascus	MY	0.45	2683.251	1207.463	1475.788
	F %	0.22	689.362	151.661	537.701
	P %	0.69	959.789	663.646	296.143

$\delta^2 p$ = Phenotypic variance, $\delta^2 g$= Genetic variance, $\delta^2 e$ = Environmental variance

The heritability estimate for milk yield of Aradi goat (0.29) are similar to the estimates reported by Constantinou (1985) for Damascus goats (0.29 ± 0.08) and Boichard *et al*. (1989) for Alpine (0.29). It was higher than that reported by Ribeiro *et al*. (1998) for Saanen goats (0.09), Kominakis *et al*. (2000) for

Skopelos dairy goats (0.14 ± 0.04), Torres-Vázquez *et al*. (2009) for Saanen goats from Mexico (0.17 ± 0.04), Pesce Delfino *et al*. (2011) for Maltese Goat (0.21 ± 0,04), Valencia *et al*. (2007) for Saanen (0.22±0.07), Rabasco *et al.* (1993) for Verta goats (0.24). It was lower than that reported by Kala and Prakash (1990) for Jamunapari goats (0.40), and Grossman *et al.* (1986) for Toggenburg goats, Saanen goats and Nubian goats (0.41, 0.44 and 0.45 respectively). The heritability estimates for milk yield of Damascus goats (0.45) are similar to the estimate of Mavrogenis *et al*. (1989) worked with the same breed in Cyprus goats (0.46) and Hermiz *et al*. (2002) for Iraqi local goats (0.46). It was higher than that found by Constantinou (1989) for Damascus Goats (0.35) and Kala and Prakash (1990) for Barbari goats (0.36). It was lower than that reported by Voutsina *et al*. (1990) for Alpine (0.54), Thilagor *et al*. (1992) for Tellicerry goat (0.54), Other estimates were reviewed for Pinto *et al*. (1993) for Anglo-Nubian (0.55), Badamana *et al*. (1990) for British Sannen (0.68), Banda (1992) for Malawi goat (0.68) and Faiz *et al* (1994) for Beetal and Nachi (0.68). The heritability estimates in our study for fat % (0.23 & 0.22) and for protein% (0.37 and 0.69) among Aradi and Damascus goats was within the range of values estimated by other authors which ranged (from 0.14 to 0.73) for different dairy goat populations (Analla *et al*., 1996; Andonov *et al*., 2007; Bömkes *et al*., 2004; Ilahi *et al*., 1998; Torres-Vázquez *et al*., 2009). Generally, increasing the percentage of environmental variance component indicates that the trait is highly affected by environmental conditions. The moderate percentage of genotypic variance gives hope for the possibility of improving the trait through different breeding programs. In this study, the percentage of genetic variance component in Aradi goats is low so that the best programs for the genetic improvement and upgrading in the Aradi goats could be done through crossing with Damascus goats which has superior genetic characteristics.

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