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CHARACTERISTICS OF LACTATION CURVE IN DAMASCUS GOATS IN JORDAN

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ABSTRACT

Test day milk yield data on Damascus goats maintained at Walla station belonging to ministry of agriculture in Jordan were collected over the period from 2002 to 2010 and included 7700 test days (1540 records). Wood model parameters were estimated using non-linear regression and individual curves were fitted. The characteristics of lactation curve were computed. The initial yield (a), rate of increase (b) and rate of decline (c) parameters in Wood's model for Damascus goats were 1.12±0.002, 0.35±0.0003 and 0.08±0.00, respectively. The values of peak milk yield (PMY), peak week (PW) and persistency (PS) were 1.29±0.007 kg, 3.93±0.008 and 0.86±0.07, respectively. Heritability estimates were found to be low, being 0.09 ±0.01, 0.07 ±0.01, 0.08±0.01, 0.04 ±0.001 and 0.07±0.01 for a, b, c, PMY and PS, respectively. Repeatability estimates were 0.30, 0.21, 0.25, 0.13 and 0.21 for a, b, c, PMY and PS, respectively. Positive genetic correlation between the parameter a and parameter b and c were 0.99 and 0.99, respectively. The genetic and phenotypic correlations between b and c were high significant (0.99 and 0.91, respectively). Negative genetic and phenotypic correlation between the parameter a and PS were -0.99 and -0.81, respectively. It is concluded that incomplete gamma function of Wood to Damascus goats milk yields was sufficient in describing lactation curve in Damascus goats.

Keywords: Lactation curve, peak milk yield, persistency, Damascus goats

INTRODUCTION

The term lactation curve is defined as graph between milk yield and length of time since kidding. Knowledge of the main characteristics of the lactation curves is of great help for farmers and technicians of the dairy goat industry for management and breeding decisions (Gipson and Grossman, 1989). The objective of modeling the lactation curve, generally, is to predict the production on each day of lactation with maximum precision, so as to understand the underlying pattern of milk production in the presence of varying environment.

Milk production in dairy goats typically inclines to a peak 4-8 the week postpartum and declines thereafter Waheed (2011). Knowledge of this helps in prediction of total lactation milk yield from a single test day or from several test days in the beginning of lactation and is a valuable tool for decision making in selection procedures.

If the aim of the breeder is to manipulate characteristics of the lactation curve genetically, estimate of genetic parameters for individual curve would be needed. Thus, it is important to determine whether or not these are genetic differences among shapes of the curves. It might be necessary to consider those differences into account for genetic evaluation and selection (Takma *et al.,* 2009). On the other hand, improvement of the genetic models

for evaluation of milk yield has produced new characteristics describe shape of the lactation curve (Pala and Savas, 2005) and can be used as selection criteria (Togashi and Lin, 2004), and are becoming of interest for genetic evaluations based on test day models (Andonov *et al.,* 2007). For this purpose a number of different empirical models have been developed to explain lactation curve (Wood, 1967; Dhanoa, 1981; Wilmink, 1987; Gipson and Grossman, 1989; Cappio *et al.,* 1995 and Ruiz *et al*., 2000). Particularly, most of the studies reported that Wood model adequately described the lactation milk yields of various dairy goats (Ruvuna *et al*., 1995; Montaldo *et al*., 1997; Fernandez *et al*., 2002 and Rosa *et al.,* 2006). However, little research has been done on fitting lactation curve model in goats as compared with dairy cows. The objectives of this study were to estimate characteristics of lactation curve in Damascus goats using non-linear regression models, to evaluate the environmental factors affecting lactation curve parameters in Damascus goats and to estimate of genetic parameters of lactation curve parameters.

MATERIALS AND METHODS

Data

Data used for lactation curve were collected over the period from 2002 to 2010 and included 7700 test days (1540 records). Milk production data were recorded. Pedigrees data was obtained from the birth registers maintained, Data on date of birth, date of kidding, type of birth and sex of kids born were obtained from the registers maintained for management purposes at Walla agriculture research station belongs to Ministry of Agriculture in Jordan.

The flock was reared under semi-intensive system. The doses were allowed to graze four hours in the morning and three hours in the afternoon. Breeding season at the station starts in July and ends in October, therefore, kidding started in October and lasted till March every year. The kidding pattern in was observed to be divided into distinct season (January-February and October –December).

After kidding kids were ear tagged, weighed and recorded after birth. Kids suckled their dams until weaning at age of 75-90 days. After weaning, kids were grouped according to sex and weight and were provided with 0.25-0.35 kg of ration daily.

Statistical Analysis

Parameters and characteristics of lactation curve

Non linear regression was used for the estimation of parameters of lactation curves. For this purpose Wood's model (Wood, 1967) was as follows:

$$Yn = an^{b}e^{-cn}$$

Where:

Yn the total milk yield (kg) in the n^{th} week of lactation;

a the initial milk yield (kg);

b the rate of milk yield increase to peak during the ascending phase (kg/week);
c the rate of milk yield decrease during the descending phase
n the time (week)and
e the base of natural logarithms.

The constant a, b and c were calculated for each lactation by the least squares method.

The other characteristics of lactation curve such as: the peak milk yield (kg) were computed using following formulas Ali Schaffer (1987): ($PMY= a (b/c)^b e^{-b}$), the week of peak yield (PW) was calculated as (PW=b/c), and persistency of lactation (PS=-(b+1) loge c) were also estimated for each lactation period groups according to Wood (1967).

Data were analyzed using general linear model (GLM) procedure of Statistical Analysis System (SAS, 2009) to estimate fixed effects of parity, season and year of kidding, month of kidding, kidding type and the interaction between parity and month of kidding on lactation curve parameters were studied. The statistical model used as following:

$Yijklm = \mu + Ai + Lj + Mk + Pl + PMik + eijklm$

Where,

Yijklm	the observation on the m^{th} record of the i^{th} year of kidding, j^{th} kidding type, k^{th} month of kidding and l^{th} parity;
μ	is the overall mean,
Ai	the effect of i^{th} year of kidding, i = 2002, 2003,…….2010;
Lj	the effect of j^{th} kidding type, j = 1, 2 and 3 for single, twice and triplet;
Mk	the effect of k^{th} month of kidding, k = 1 …., 5 for January, February, October, November and December.
Pl	the effect of l^{th} parity, 1, 2 …, ≥5;
PMlk	the interaction between parity and month of kidding;
eijklm	the effect of random error associated with the m^{th}

Genetic parameters

Variance and covariance components for lactation curve traits were estimated with a multi-trait analysis using restricted maximum likelihood method as implemented in VCE (Groeneveld *et al*., 2008). The assumed model was:

$Y= X\beta + Za\ a + Zc\ c + e,$

Where,

Y the vector of observations;
X the incidence matrix that relates data to the vector of fixed effects;
β the vector of an overall means and fixed effects of year of kidding, parity, month of kidding and kidding type;
Z the incidence matrix of random effects;
a the vector of random effect (animals additive genetic effect) associated with the incidence matrix Z;
c the vector of permanent environmental effect and

e the vector of random effect errors normally and independently distributed with (0, σ²e).

RESULTS AND DISCUSSION

Environmental factors affecting parameters and characteristics of lactation curve

Least squares means and their standard errors for parameters and characteristics of lactation curve in Damascus goats are presented in table 1. The overall means of initial milk yield measured on 1540 records for all goats together was 1.12±0.002 kg, the value higher to that of 0.70 ±0.04 obtained by Kamel Fatal (2008) in Shami goats.

The analysis of mean square of initial milk yield (Table 2) revealed that parity had a highly significant effect on initial milk yield ($p<0.01$). Initial milk yield did not increase with advancing parity from first to the fourth parity (Figure 1). The lowest value of "a" in second parity (1.06±0.002 kg) and the highest value of "a" in fifth parity (1.21±0.002 kg).this result didn't agree with Kamel Fatal (2008) in Shami goats who found no significant influence of parity on initial milk yield. Significant influence of parity on initial milk yield was also detected by Hamed (2010) on Zaraibi goats and Akpa *et al*., (2001) on Red Sokoto goat. This result reflects the relatively moderate initial milk yield for Damascus goat breed.

Least square means of months of kidding are shown in Table 1and (Figure 2). Initial milk yield was highest for February month and the lowest value of "a" was observed in November month. Month of kidding had no significant effect on Initial milk yield ($p>0.05$) (Table 1). A significant effect of month of kidding on the initial milk yield was observed by Kamel Fatal (2008) in Shami goats and Hamed (2010) in Zaraibi goats.

Year of kidding had a highly significant ($p<0.0001$) effect on Initial milk yield (Table 2). A significant effect of year of kidding on the initial milk yield was observed by Kamel Fatal (2008) in Shami goats, Hamed (2010) in Zaraibi goats and Ruiz *et al.,* (2000).

individual
assumed NID with (0, σ²e)

Does produced single and twins had higher initial milk yield than those produced triplets kids (Table 1). A non significant influence of kidding type was observed on initial milk yield. These results are in agreement with those reported by Kamel Fatal (2008) in Shami goats, Hamed (2010) in Zaraibi goats and Akpa *et al.,* (2001) on Red Sokoto goats. The effect of interaction between parity and month of kidding on initial milk yield was high significant ($p<0.01$).

The overall mean of the rate of milk production increased during the ascending stage (parameter b) is 0.35±0.0003 kg (Table 1). This estimate is lower than the value (0.70±0.03) obtained by Kamel Fatal (2008) on Shami goats. The results in Table (1) and Figure(1) showed that a gradual decrease was observed in the rate of increase by advancing parity. This means that does of older needed longer periods to reach the peak as compared with those of younger ages.

The analysis of mean square (Table 2) showed that parity had a significant effect on the rate of ascending to peak. the highest value of "a" in first parity (0.38±0.0001) and the lowest value of "a" in fifth parity (0.33±0.0003). These results agree with Kamel Fatal (2008) in Shami goats who found significant influence of parity on the rate of ascending to peak. The rate of ascending to peak was slower for does kidded in November and December month than in October and February month (Table1 and Figure 2). The effect of month of kidding no significant effect on the rate of ascending to peak. These results were similar to that reported by Hamed (2010) in Zaraibi goats but not agree with Kamel Fatal (2008) in Shami goats who reported month of kidding had significant effect on the rate of ascending to peak.

Year of kidding had a significant effect on the rate of ascending to peak (Table 2). The rate of ascending to peak increased with litter size increasing. The influence of kidding type was also non-significant on the rate of ascending to peak (Table 2). These results are in agreement with those reported by Hamed (2010) in Zaraibi goats, Akpa *et al.,* (2001) on Red Sokoto goats and Portolano *et al*. (1997) on Comisana breed; but does not agree with Kamel Fatal (2008) in Shami goats who reported year of kidding and kidding type had significant effect on the rate of ascending to peak.

The overall mean of the rate of decline of milk yield during the descending phase after peak (parameter c) is 0.08±0.00 (Table 1). However, it is lower than 0.21 ±0.01 obtained by Kamel Fatal (2008) on Shami goats. This estimate is higher than the range (0.0003-0.01) reported by Chang *et al*., 2001 for different dairy goats and it is lower than that 0.186 reported by Gipson and Grossman (1990). This result indicates that the rate of decline decreased with advancing lactation. The rate of decline was higher in the fourth and fifth parity than other parity.

The analysis of mean square (Table 2) showed high significant effect of parity on the rate of decline. Similar results were also reported by Kamel Fatal (2008) in Shami goats. Non significant effect of month of kidding ($p>0.05$) on the rate of decline was detected (Table 2). Year of kidding had a highly significant effect. Similar results were also reported by Kamel Fatal (2008) in Shami goats and Hamed (2010) in Zaraibi goats, Differences among years of kidding could be due to variation in feed availability (Figure 3).

Although a general trend of increasing the rate decline by increasing kidding type was observed (Table 1). The analysis of mean square (Table 2) showed that no significant differences of kidding type on the rate of decline.

The overall mean of peak milk yield was 1.29±0.007 kg (Table 1). This estimate is lower than that 1.8 kg obtained in Zaraibi goats by Hamed (2010). However, Ruvuna *et al.* (1995) on Galla and East African goats found lower estimate (0.347 kg). Second parity had lower peak milk yield as compared with other parity (1.20±0.006 kg). The same trend was observed by Hamed (2010) in Zaraibi goats, Groenewald and Viljoen (2003) and Gipson and Grossman (1989).

The analysis of mean square (Table 3) revealed that peak milk yield was not affected significantly ($p<0.166$) affected by parity.

The effect of month of kidding on peak milk yield was non- significant. Hamed (2010) found also that peak milk yield was not affected by season of kidding in Zaraibi goats. However, Montaldo *et al.* (1997) found also that peak milk yield was not affected by season of kidding in Mexico goats. However, Portolano *et al.* (1997) and Akpa *et al*. (2001) in Red Sokoto goats obtained significant influence of season of kidding on peak yield. Year of kidding had a highly significant influence on peak yield (Table 3). Similar significant effect was also found for year of kidding on peak milk yield by Hamed (2010) in Zaraibi goats and Lombaard (2006) in different goat breeds.

Peak milk yield was found to be similar with increasing kidding type. The differences in peak milk yield due to kidding type were non-significant ($p>0.05$).The interaction between year and month of kidding had no significant effect on peak milk yield.

Table1. Least squares means and their standard errors (SE) for parameters and characteristics of lactation curve in Damascus goats.

Effects	N	a	b	c	PMY	PS	PW
		Mean ± S.E	Mean ± S.E	Mean ±S.E	Mean ± S.E	Mean ± S.E	Mean ± S.E
Overall mean	1540	1.12±0.002	0.35±0.0003	0.08±0.000	1.29±0.007	0.86±0.0003	3.93±0.008
Parity		**	*	*	ns	*	ns
1	769	1.10±0.001^{bc}	0.38±0.0001^{a}	0.08±0.000^{a}	1.29±0.004^{ab}	0.87±0.0002^{a}	3.94±0.004^{a}
2	325	1.06±0.002^{c}	0.35±0.0002^{a}	0.08±0.000^{a}	1.20±0.006^{b}	0.87±0.0003^{a}	3.94±0.007^{a}
3	171	1.08±0.002^{bc}	0.34±0.0003^{a}	0.08±0.000^{a}	1.24±0.008^{ab}	0.87±0.0004^{a}	3.93±0.009^{a}
4	129	1.14±0.002^{ab}	0.33±0.0004^{ab}	0.09±0.000^{ab}	1.32±0.009^{ab}	0.85±0.0004^{ab}	3.91±0.010^{a}
≥5	146	1.21±0.002^{a}	0.33±0.0003^{b}	0.09±0.000^{b}	1.40±0.009^{a}	0.82±0.0004^{b}	3.93±0.010^{a}
Year of kidding		**	*	*	**	ns	**
2002	107	1.38±0.003^{a}	0.41±0.0004^{a}	0.10±0.000^{a}	1.63±0.001^{a}	0.79±0.0005	3.59±0.010^{a}
2003	178	1.12±0.002^{b}	0.36±0.0003^{b}	0.09±0.000^{b}	1.31±0.008^{ab}	0.84±0.0004	4.09±0.009^{b}
2004	116	0.99±0.003^{c}	0.33±0.0004^{bc}	0.08±0.000^{bc}	1.14±0.001^{b}	0.87±0.0005	4.32±0.010^{c}
2005	212	1.00±0.002^{c}	0.33±0.0003^{bc}	0.08±0.000^{bc}	1.15±0.007^{b}	0.87±0.0003	4.30±0.008^{c}
2006	125	1.09±0.002^{bc}	0.34±0.0004^{bc}	0.09±0.000^{bc}	1.26±0.009^{b}	0.86±0.0005	4.13±0.010^{bc}
2007	260	1.11±0.002^{b}	0.33±0.0003^{c}	0.08±0.000^{c}	1.28±0.006^{b}	0.87±0.0003	3.81±0.007^{b}
2008	282	1.14±0.002^{b}	0.33±0.0002^{bc}	0.08±0.000^{c}	1.31±0.006^{ab}	0.87±0.0003	3.67±0.007^{b}
2009	90	1.13±0.003^{b}	0.33±0.0004^{c}	0.08±0.000^{c}	1.30±0.011^{ab}	0.87±0.0005	3.58±0.010^{b}
2010	170	1.10±0.002^{bc}	0.32±0.0003^{c}	0.08±0.000^{c}	1.26±0.008^{b}	0.88±0.0004	3.91±0.009^{bc}
Month of kidding		ns	ns	ns	ns	ns	**
January	248	1.14±0.002	0.35±0.0003	0.09±0.000	1.31±0.007	0.85±0.0003	3.96±0.008^{b}
February	321	1.17±0.002	0.36±0.0002	0.09±0.000	1.35±0.006	0.84±0.0003	3.79±0.007^{d}
October	328	1.16±0.002	0.36±0.0002	0.09±0.000	1.36±0.006	0.84±0.0003	3.90±0.007^{c}
November	347	1.04±0.001	0.32±0.0002	0.08±0.000	1.18±0.006	0.88±0.0003	4.08±0.006^{a}
December	296	1.08±0.002	0.33±0.0002	0.08±0.000	1.26±0.006	0.87±0.0003	3.93±0.007^{bc}
Kidding type		ns	ns	ns	ns	ns	*
Single	678	1.13±0.001	0.35±0.0002	0.09±0.000	1.31±0.004	0.86±0.0002	3.90±0.005^{b}
Twins	811	1.27±0.001	0.35±0.0001	0.09±0.000	1.30±0.004	0.85±0.0002	3.93±0.004^{a}
Triplets	51	1.09±0.004	0.34±0.0006	0.08±0.000	1.26±0.014	0.86±0.0007	3.97±0.02^{a}

a= Initial milk yield; b= Rate of increase up to peak; c= Rate of decline after peak; PMY= Peak milk yield; PS= Persistency. PW= Peak Week. Subclass with different superscripts are significantly different.

Table 2. Means squares (MS) of initial milk yield (the coefficient "a" of the lactation curve), increase to peak (the coefficient "b" of the lactation curve) and rate of decline (the coefficient "c" of the lactation curve)in Damascus goats.

Source of variation	df	a		b		c	
		MS	P value	MS	P value	MS	P value
Parity	4	0.01	0.007	0.012	0.017	0.001	0.006
Year of kidding	8	0.24	0.0001	0.011	0.003	0.001	0.001
Month of kidding	4	0.06	0.088	0.004	0.350	0.000	0.220
Kidding type	2	0.02	0.552	0.001	0.778	0.000	0.704
Parity* Month of kidding	16	0.07	0.001	0.006	0.058	0.000	0.030
R^2		0.21		0.127		0.136	

Table 3.Means square (MS) of peak milk yield, Peak week and persistency in Damascus goats.

Source of variation	df	PMY		PW		PS	
		MS	P value	MS	P value	MS	P value
Parity	4	0.167	0.166	0.294	0.777	0.016	0.008
Year of kidding	8	0.366	0.0001	104.212	0.0001	0.011	0.018
Month of kidding	4	0.076	0.570	8.150	0.0001	0.006	0.271
Kidding type	2	0.032	0.734	4.154	0.002	0.002	0.631
Parity* Month of kidding	16	0.162	0.069	5.809	0.0001	0.007	0.100
R^2		0.117		0.822		0.114	

PMY= Peak milk yield; PW= Peak week, PS= Persistency.

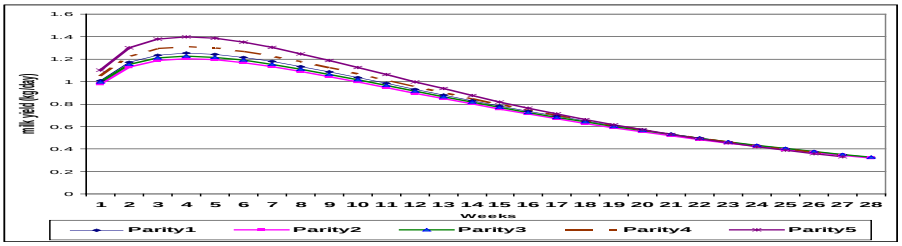

Figure 1.Lactation curve for does of different parities in Damascus goats.

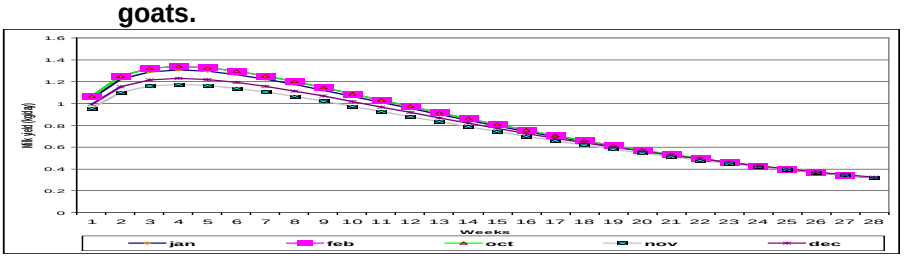

Figure 2. Lactation curve for does of different months of kidding in Damascus goats

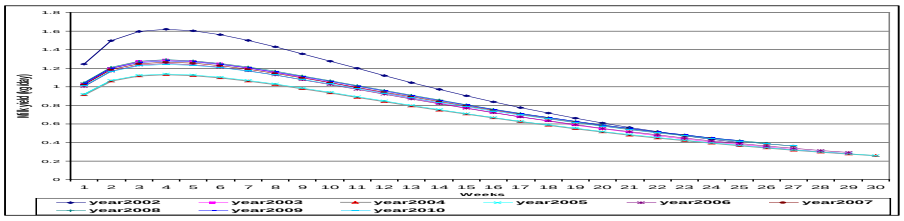

Figure 3.Lactation curve for does of different years of kidding in Damascus goats.

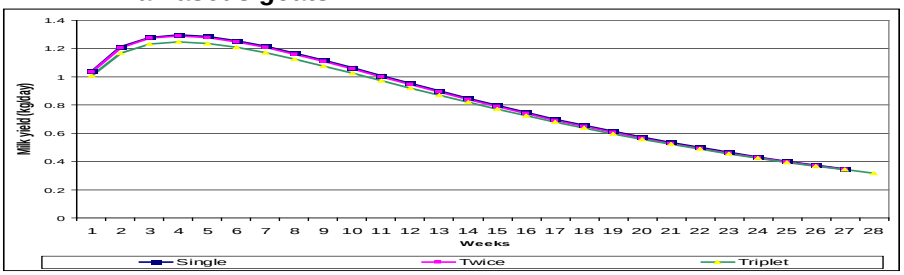

Figure 4.Lactation curve for does of different type of kidding in Damascus goats.

Least squares means and their standard errors of peek week (the time in weeks, required to reach peak milk yield) are presented in Table 1. The overall means of peak week was 3.93±0.008 weeks. This estimate was close to that reported by Hamed (2010) in Zaraibi goats (3.94±0.08) week.

Peak week in the first and second parity was occurred later as compared with the subsequent parities, indicating that the time not required to reach maximum weekly milk yield decreased with parity. This finding is in agreement with that reported Hamed (2010) and Groenewald and Viljoen (2003), where peak yield of first parity was attained later as compared with those of the other parity.

The analysis of mean square (Table 3)showed that parity had no significant on peak week. Significant influence of parity on the time required to attain peak was observed by Montaldo *et al.* (1997) on crossed goat in Mexico.

Month of kidding had Significant influence on the time to reach peak, where November month required longer time to reach peak yield compared to those kidding February month.

Kidding type had significant effect on peak week. Where does produced triplet kids required longer time to reach peak time compared to those produced twin and single. Hamed (2010) observed that peak week was significantly influenced by kidding type.

Effect of year of kidding on peak week had highly significant effect. Similar results were obtained by Hamed (2010 on Zaraibi goats. The influence of interaction between parity and month of kidding was significant on peak week.

The overall means of persistency for animals was0.86±0.0003. First to third parity had higher persistency values as compared with the

subsequent lactations (Table 1). Moreover, the increase in the rate of decline by advancing parity explain the increase of persistency of lactation with advancing parity. Hamed (2010) in Zaraibi goats, Montaldo *et al*., (1997) and Gipson and Grossman (1989) reported the same trend in dairy goats. However, Ruvuna *et al*., (1995) in East African and Galla goats found an opposite trend where, the persistency of lactation of young does was lower than those in the old does.

The analysis of the mean square (Table 3) showed that The effect of parity had significant effects on the persistency. The effect of year of kidding had no significant effects on the persistency of lactation. However, the month of kidding had no significant effect on the persistency of lactation.

The influence of kidding type on the persistency of lactation was non-significant effect. The interaction between month of kidding and parity had non- significant effect on the persistency of lactation.

Genetic parameters for lactation curve

Heritability estimates

Heritability estimates of lactation curve parameters (a, b and c) and related traits as well as peak milk yield and peak week are presented in the table (4). Heritability for parameter "a" was 0.09. This estimate is lower than that reported by Kamel Fatal (2008) in Shami goats (0.58) and by Chang *et al*., (2002, 0.23) on dairy sheep and higher than those reported by Hamed (2010, 0.04) on Zaraibi goats. Heritability of parameter "b" was 0.07; this estimate is close to that reported by Chang *et al*., (2002) on dairy sheep and Rekaya *et al*. (2000) and higher than those reported by Hamed (2010, 0.02) on Zaraibi goats and lower than 0.35 reported by Kamel Fatal (2008) in Shami goats. The heritability estimate of parameter "c" was 0.08. This estimate is close to that reported by Varona *et al*., (1998) and higher than those reported by Hamed (2010) on Zaraibi goats (0.02) and lower than 0.31 reported by Kamel Fatal (2008) in Shami goats. Heritability estimate of persistency was 0.07 and it close to that reported by Macciotta *et al*., (2006) and Rekaya *et al.,* (2000). Heritability estimate of peak yield was 0.04 which is lower than the estimates reported by Rekaya *et al*., (2000). The low heritability estimates obtained in the present study could be due the differences between models used, breed and also environmental and genetic variation affecting different measurements.

Repeatability

Repeatability estimates for lactation curve parameters and the related traits are shown in table (4). Repeatability estimate for parameter "a" and "b" were 0.30 and 0.21 respectively. This estimate is higher than that reported by Wood (1967), Tekerli *et al*., (2000) and Hamed (2010). Estimate of the repeatability of the parameters "c" is 0.25. This estimate is higher than that reported by Tekerli *et al*., (2000) and Hamed (2010). Repeatability estimate of persistency was and peak yield were 0.21and 0.13, respectively. These estimates are higher than reported by Tekerli *et al*., (2000) and Hamed (2010). In general, estimates of repeatability of the curve parameters are higher estimates than the range of such estimates in the literature due to the

permanent environmental which was high and also genetic variances for these traits.

Table 4. Heritability and repeatability estimates of lactation curve parameters in Damascus goats.

Repeatability	Heritability	Trait
0.30	0.09 ±0.01	**a**
0.21	0.07 ±0.01	**b**
0.25	0.08±0.01	**c**
0.13	0.04±0.001	**PMY**
0.21	0.07±0.01	**PS**

a= Initial milk yield; b= Rate of increase up to peak; c= Rate of decline after peak; PMY= Peak milk yield; PS= Persistency.

Genetic correlation

Estimates of genetic correlations are listed in table (5). Estimate of genetic correlation between each of "a" and "b", "a" and "c" was0.99.High positive genetic correlation was found between a and PMY (0.99). Similar results reported by Rekaya *et al.,* (2000). Peak yield was negative correlated with persistency (-0.99). These results agree with results by Kamel Fatal (2008) in Shami goats. The results of Rekaya *et al.* (2000) confirmed the positive genetic correlation between persistency and peak yield. Persistency was negatively correlated with the parameter "a" of the lactation curve. These results are don't agree with results by Abubakr (1991) for correlation between persistency and parameter "a". Selection indices could be useful in changing the shape of the lactation curve. Moreover peak yield is negative correlated with persistency. Selection for high initial yield "a" may be associated with high peak yield (genetic correlation is 0.99).

Phenotypic correlation

Phenotypic correlations are presented in table (6). The parameter "a" of the lactation curve was highly positive correlated with parameter "b" (0.92) and positively with "c". These results indicate that high initial milk yield is associated with high rate of ascending to peak and high rate of descending after peak yield. Positive phenotypic correlation was found between parameter "a" and peak milk yield (0.81). The parameter "b" was negatively correlated with persistency (-0.80). The parameter "c" had also negative phenotypic correlation with persistency (-0.86). These results reflects the fact that low rate of declining after peak is associated with higher persistent does. These results in agreement with those of Abubakr (1991) and Hamed (2010).

Table5. Estimates of genetic correlation of lactation curve parameters in Damascus goats.

Traits	b	c	PMY	PS
a	0.99	0.99	0.99	-0.99
b		0.99	1.00	-0.99
c			0.99	-0.99
PMY				-0.99

a=Initial milk yield; b=Rate of increase up to peak; c=Rate of decline after peak; PMY= peak milk yield; PS= persistency.

Table6. Estimates of phenotypic correlations of lactation curve parameters in Damascus goats.

Traits	b	c	PMY	PS
a	0.92	0.92	0.81	-0.81
b		0.91	0.80	-0.80
c			0.88	-0.86
PMY				-0.96

a=Initial milk yield; b=Rate of increase up to peak; c=Rate of decline after peak; PMY= Peak milk yield; PS= Persistency.

Conclusion

The results in the present study concluded that: Incomplete gamma function of Wood was sufficient in describing lactation curve for Damascus goats. The Wood's model explained the variation quite accurately and described the shapes of lactation curves. The results can be used as a strategy tool to find out optimum lactation length, milk production and peak milk yield, taking into account different number of parities. Better the understanding of lactation curve in Damascus goats, more efficient the application of test day models for genetic evaluation and management decisions about milk production. An understanding of lactation curve should enable more efficient selection and management decisions, because a standard curve can provide a criterion for comparison of individual doe's milk production.

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خصائص معادلة منحنى إنتاج اللبن في الماعز الدمشقي في الأردن

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جمعت بيانات اختبار اللبن اليومي للماعز الشامي في محطة الوالة الزراعية التابعة لوزارة الزراعة الأردنية خلال الفترة من سنة 2002 إلى 2010م، وأجريت هذه الدراسة على 1540 سجل إنتاج حليب تضمنت إجراء 7700 اختبار إنتاج اللبن اليومي ، تمت دراسة السجلات وتحليلها باستخدام معادلة وود 1967 وتم حساب ثوابت منحنيات اللبن باستخدام طريقة الانحدار الغير خطي.

بلغ قيمة للثابت a، b و c 1.12± 0.002 ، 0.35 ± 0.0003 و0.08 ±0.00 كغم على التوالي. بلغ قمة إنتاج الحليب، متوسط الفترة للوصول إلى قمة الإنتاج و للمثابرة 1.29± 0.007 كغم ،3.93± 0.008 أسبوعا و0.86 ±0.07 كغم، على التوالي.

قدر المكافئ الوراثي للثابت a ، b ، c ، قمة إنتاج الحليب والمثابرة فبلغت 0.07,±0.01 0.09±0.01و 0.08±0.01 و0.04 ±0.01 و 0.07 ±0.01 على التوالي. قدر المعامل التكراري للثابت a ، b ، c ، قمة إنتاج الحليب والمثابرة فبلغت 0.30 ، 0.21 ، 0.25 ، 0.13 ، و 0.21 ، على التوالى . الارتباط الوراثي موجبا بين الثابت a وكلا من الثابت b و c بلغ 0.99 ، 0.99 ، على التوالي وكانت عالية المعنوية. الارتباط المظهري والوراثي بين الثابت a والثابت c كان 0.92 و 0.91 على التوالي. ارتباط وراثي ومظهري سالب بين الثابت a والمثابرة -0.99 و -0.81 على التوالي. وتبين نتائج هذه الدراسة أن معادلة جاما الغير خطية ل وود كافية لوصف منحنى إنتاج اللبن في الماعز الدمشقي.

قام بتحكيم البحث

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