

LACTATION CURVE AND MILK PRODUCTION TRAITS OF SYRIAN DAMASCUS GOATS

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SUMMARY

This study aimed to describe the lactation curve using the Wood's function, estimate the milk production traits and investigate the non-genetic factors affecting both, the lactation curve and milk production traits of Syrian Damascus goats. A total number of 334 weekly test-day milk records were collected during the year 2019 on 98 Damascus goats at Karhta station, Syria. The least squares means of the studied lactation curve traits were 2.6 ± 0.05 kg for the initial milk yield after kidding (parameter a), 0.45 ± 0.011 kg/week for the rate of rise in milk production to peak lactation (parameter b), 0.09 ± 0.001 kg/week for the rate of decrease in milk production from peak to the end of lactation period (parameter c), 3.40 ± 0.05 kg for peak milk yield (PMY), 5.09 ± 0.08 weeks for peak week (PW) and 55.71 ± 0.54 % for persistency of lactation (P%). The estimates for milk production traits were 413 ± 5.98 kg, 199 ± 1.23 days, and 2.1 ± 0.02 kg/day for total milk yield (TMY), lactation period (LP), and daily milk yield (DMY), respectively.

The results showed that parity exerted a highly significant ($P < 0.01$) effect on all the studied traits except PW and P%. Also, the month of kidding had a significant effect on all the studied parameters except P%. However, the type of birth had no significant effect on all the studied traits. It could be concluded that Wood's function is a convenient tool to describe the lactation curve of Syrian Damascus goats. Also, Damascus goats showed a higher potentiality for milk production and a long lactation period under subtropical environmental conditions.

Keywords: Damascus goats, Lactation curve, Milk production traits, Persistency

INTRODUCTION

Goats (*Capra hircus*) are the earliest domesticated livestock for their benefits derived from their milk, meat, fibre, and skin. Goats play a fundamental role in revenues for livestock-holders, especially for families with minimum land resources and for landless people (Patel *et al.*, 2019). Additionally, goats are considered as eco-friendly animals due to their lower methane production compared to the other ruminants (Hidayat *et al.*, 2021).

Lactating goats are characterized by their milk persistency that can be continuous up to 2-3 years without kidding, which means that goat can provide winter milk without mating season and can be milked once a day with the same milk yield (Raynal-Ljutovac *et al.*, 2007). As well as, goat's milk contains high levels of calcium and important biological composition such as lactoferrin and lysozyme (Raynal-Ljutovac *et al.*, 2008).

Damascus goats (also, called Shami goats) are considered the most locally important genetic resources in Syria, due to their higher productivity and reproductive ability under harsh environmental conditions. Therefore, many countries in the world have imported the Shami goats to genetically improve their local breeds (Guney *et al.*, 2006).

Description of the lactation curve provides crucial information concerning the way of milk production of lactating animals and to improve their productive performance to reach the ideal benefits of the breed (Shrestha and Fahmy, 2007). In the same time, knowledge of the lactation curve helps to predict the milk production in the subsequent lactations which supports the early determination of superior animals which leads to taking the culling decision early and enables farmers to recognize the appropriate diet and health situation for their animals (Marete *et al.*, 2014). Likewise, Persistency of lactation is considered a critical economic trait in breeding programs, however, it has been omitted for a long time, and there are few studies on goat's persistency of lactation (Abdallah and McDaniel, 2000).

Generally, the lactation curve and milk production traits of goats are affected strongly by many genetic and non-genetic factors such as breed, parity, season and year of kidding, nutrition, and type of birth (Gaddour *et al.*, 2009). Few previous studies were found related to the lactation curve as well as the milk production traits of Damascus goats in Syria.

Therefore, the objectives of the current study were to describe the lactation curve using the Wood's function, estimate the milk production traits and investigate the non-genetic factors affecting the lactation curve and milk production traits of Syrian Damascus goats.

MATERIALS AND METHODS

Ethics approval:

Not necessary for this study because the study was performed with a dataset provided by the General Commission for Scientific Agricultural Research, Syria, thus the study did not include any procedures on animals.

Source of data:

Data used in this study were collected from 334 weekly test-day milk records relevant to 98 multiparous Syrian Damascus goats during the year 2019, from Karahta station, belonging to the General Commission for Scientific Agricultural Research, Syria. Data included doe number, kidding date, month of kidding, type of birth, parity number, and weekly test-day milk yield.

Herd management practices :

Animals were kept under a free housing system of semi-closed sheds with concrete floors. Goats were fed once a day on concentrate feed mixture (formulated in the station), and twice a day on roughages (straw and cotton seed hulls), in addition to hay (vetch, barley, and alfalfa) and green fodder, if available.

Goats were allowed to drink water all day round. Does were machine milked twice a day at 06.00 a.m. and 6.00 p.m. The newborn kids suckled their dams till weaning age at 60 days. Milk yield was recorded once a week to calculate the monthly milk yield for each goat.

Studied traits:

A. Lactation curve traits :

1. Parameter (a): the initial milk yield (kg) after kidding.
2. Parameter (b): the rate of rise in milk production to peak lactation (kg/week).
3. Parameter (c): the rate of decrease in milk production from peak to the end of lactation (kg/week).
4. Peak milk yield (PMY, kg).
5. Peak week (PW, weeks): the number of weeks to attain the peak milk yield, and
6. Persistency of lactation (P, %): goat's ability to maintain milk yield at a high level after the peak.

B. Milk Production traits:

1. Total milk yield (TMY, kg): the cumulative milk yield during the lactation period.
2. Lactation period (LP, days): number of days in milk.
3. Daily milk yield (DMY, kg): total milk yield divided by lactation period.

Statistical analysis:

The lactation curve traits (a, b, and c) were estimated according to the Wood's function (1967) as follows:

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

Where: Y_n is the total milk yield (kg) in the n^{th} week of lactation, a: the initial milk yield (kg), b: the rate of rise in milk production to peak lactation (kg/week), c: the rate of decrease in milk production

from peak to the end of lactation (kg/week), and e is the base of natural logarithms.

PMY was calculated as $PMY, kg = a (b/c)^b e^{-b}$, and PW, weeks was calculated as $PW = b/c$. Persistency of lactation (P, %) was calculated as $P \% = \text{Milk L} / \text{Milk F} * 100$, where Milk L is milk production after peak and Milk F is milk production before the peak (Waheed and Khan, 2013).

The least squares of General Linear Model (GLM) procedures as described by (XLSTAT 2020.1.2.56963) were utilized to estimate the least squares means of the studied traits and test the significance of the fixed effects of parity, month of kidding, and type of birth on the studied traits according to the following model:

$$Y_{ijkl} = \mu + P_i + M_j + T_k + e_{ijkl}$$

Where: Y_{ijkl} = the observation of the studied traits,

μ = the overall mean,

P_i = the fixed effect of i^{th} parity, where (i=1, 2, 3, 4),

M_j = the fixed effect of j^{th} month of kidding (j= 1, 2, 3), where 1= January, 2= February, and 3= March,

T_k = the fixed effect of k^{th} type of birth (k= 1, 2), where 1=single kidding, 2= twin kidding, and

e_{ijkl} = the random error assumed N I D (0, σ^2). The significant differences among means of the studied traits were tested using Duncan's multiple range test.

RESULTS AND DISCUSSION

Lactation curve traits :

The least-squares means and standard errors (LSM±SE) of the lactation curve traits for Syrian Damascus goats are presented in Table (1).

The overall mean of the parameter (a) was 2.6 ± 0.05 kg which is higher than those of 1.12 kg, 0.9 kg, and 2.08 kg that reported by Ayasrah *et al.* (2013), Mousa *et al.* (2016), and Siqueira *et al.* (2017) of Damascus goats in Jordan, Aradi goats in Saudi Arabia, and Saanen goats in Brazil, respectively. However, Takma *et al.* (2009), and Abosaq *et al.* (2012) found higher estimates of 5.8 kg and 3.1 kg of Bornova goats in Turkey and Cyprus Damascus goats in Libya, respectively.

In the same context, the overall mean of the parameter (b) was 0.45 ± 0.011 kg/week. This estimate is higher than the estimates of 0.35 kg/week, 0.13 kg/week, and 0.20 kg/week observed by Ayasrah *et al.* (2013), Mousa *et al.* (2016), and Siqueira *et al.* (2017) of Damascus goats in Jordan, Aradi goats in Saudi Arabia, and Saanen goats in Brazil, respectively. However, this estimate is lower than that reported by El-Wakil and Foda (2013) of Defray goats in the Sultanate Oman (0.83 kg/week).

The overall mean of parameter (c) was 0.09 ± 0.001 kg/week. This estimate is higher than the means of 0.08 kg/week and 0.005 kg/week that demonstrated by Ayasrah *et al.* (2013) and Siqueira *et al.* (2017) of Damascus goats in Jordan and of dairy goats in Brazil, respectively. Conversely, the obtained estimate is lower than that of 0.12 kg/week reported by Takma *et al.* (2009) and Waheed and Khan (2013) of Bornova goats in Turkey and Beetal goats in Pakistan, respectively.

Table 1. Least squares means (LSM) and standard errors (SE) of factors affecting the lactation curve traits (a, b, c, peak milk yield, peak week and persistency of lactation) for Syrian Damascus goats

Classification	a (kg)	b (kg/week)	c (kg/week)	Peak milk yield (PMY, kg)	Peak week (PW, weeks)	Persistency (P, %)
	LSM ±SE	LSM ±SE	LSM ±SE	LSM ±SE	LSM ±SE	LSM ±SE
Overall mean	2.6±0.05	0.45±0.011	0.09±0.001	3.40±0.05	5.09±0.08	55.71±0.54
Parity	**	**	**	**	NS	NS
1	2.3 ^a ±0.12	0.48 ^b ±0.027	0.09 ^b ±0.003	3.01 ^a ±0.11	5.03±0.19	54.8±1.27
2	2.8 ^b ±0.13	0.41 ^a ±0.031	0.08 ^a ±0.003	3.56 ^{cb} ±0.13	4.81±0.22	54.6±1.46
3	2.9 ^b ±0.13	0.41 ^a ±0.031	0.08 ^a ±0.003	3.67 ^c ±0.13	5.02±0.22	57.2±1.47
4	2.4 ^a ±0.14	0.52 ^b ±0.033	0.09 ^b ±0.004	3.34 ^b ±0.14	5.50±0.24	56.3±1.58
Month of kidding	**	**	**	**	**	NS
January	2.2 ^a ±0.06	0.53 ^b ±0.01	0.08 ^a ±0.001	3.37 ^b ±0.05	6.40 ^b ±0.09	54.5±0.62
February	3.4 ^b ±0.16	0.34 ^a ±0.04	0.08 ^a ±0.004	3.89 ^c ±0.15	4.05 ^a ±0.26	53.7±1.72
March	2.2 ^a ±0.23	0.50 ^b ±0.05	0.10 ^b ±0.006	2.93 ^a ±0.22	4.82 ^a ±0.38	59.0±2.55
Type of birth	NS	NS	NS	NS	NS	NS
Single	2.6±0.11	0.4±0.026	0.09±0.003	3.33±0.11	5.12±0.19	55.7±1.24
Twin	2.7±0.10	0.45±0.024	0.09±0.003	3.47±0.10	5.06±0.17	55.7±1.15

Within each classification in the same column, means followed by different superscript letters differ significantly; ** (P<0.01); NS: not significant; Parameter (a): the initial milk yield (kg) after kidding; Parameter (b): the rate of rise in milk production to peak lactation (kg/week); Parameter (c): the rate of decrease in milk production from peak to the end of lactation (kg/week).

In the current study, the overall mean of PMY of Syrian Damascus goats was 3.40±0.05 kg (Table 1). This estimate is greater than those of 1.29 kg, 2.4 kg, and 1.1 kg that reported by Ayasrah *et al.* (2013), Miranda-Alejo *et al.* (2019), and Suranindyah *et al.* (2020) of Damascus goats in Jordan, Murciano-Granadina goats in Spain and Etawah crossed goats in Indonesia, respectively. In the contrary, this estimate is less than 4.08 kg reported by Abosaq *et al.* (2012) of Damascus Cyprus goats in Libya.

The PW was attained at the fifth week (5.09±0.08 weeks, Table 1), which is higher than 3.9 weeks and 3.1 weeks reported by Ayasrah *et al.* (2013) and Mousa *et al.* (2016) in Damascus goats in Jordan and Aradi goats in Saudi Arabia, respectively. On the other hand, higher estimate of 7.14 weeks was observed by Miranda-Alejo *et al.* (2019) in Murciano-Granadina goats in Spain.

The overall mean of persistency of lactation (P %) was 55.71±0.54 % (Table 1), which is lower than those estimates of 86 %, 84 %, and 66.4 % that obtained by Ayasrah *et al.* (2013), Mousa *et al.* (2016), and Suranindyah *et al.* (2020) of Damascus goats in Jordan, Aradi goats in Saudi Arabia and Etawah crossed goats in Indonesia, respectively. Meanwhile, the current estimate is higher than the persistency of lactation that observed by Takma *et al.* (2009) in Bornova goats (29.76 %) and Saanen goats (25.05 %) in Turkey.

Non-genetic factors affecting lactation curve traits

Parity:

Table (1) showed a highly significant effect (P<0.01) of parity on parameter (a). The highest value of parameter (a) was observed in the second and third parities (2.8 kg and 2.9 kg, respectively) compared to first and fourth parities of 2.3 kg and 2.4 kg, respectively, as shown in Figure (1). This result may be due to the growth and maturation of the mammary glands as well as, the increase of body weight with increasing parities. This result is in agreement with León *et al.* (2012) in Murciano-Granadina dairy goats in Spain, and Arnal *et al.* (2018) in French goats. While, Waheed and Khan (2013) found non-significant effect of parity on parameter (a) in Beetal goats in Pakistan.

The parameter (b) was significantly affected by parity (Table 1). A higher estimate was observed at the first and fourth parities (0.48 kg/week and 0.52 kg/week, respectively) compared to 0.41 kg/week in the second and third parities. This may be due to that; parameter (a) was the lowest in the first and fourth parities, therefore, milk production increased to reach the peak milk yield. The same result was reported by Ayasrah *et al.* (2013) in Damascus goats in Jordan, and Marete *et al.* (2014) in Kenyan Alpine dairy goats. On the contrary, León *et al.* (2012) found the lowest value of (b) which was (0.0184 kg/week) in the first parity compared to 0.0312 kg/week in the fourth parity of Murciano-Granadina dairy goats in Spain. Whereas, Waheed and Khan (2013) and Ben Abdelkrim *et al.* (2021) found no significant effect of parity on the parameter (b) of Beetal goats in Pakistan and French dairy goats, respectively.

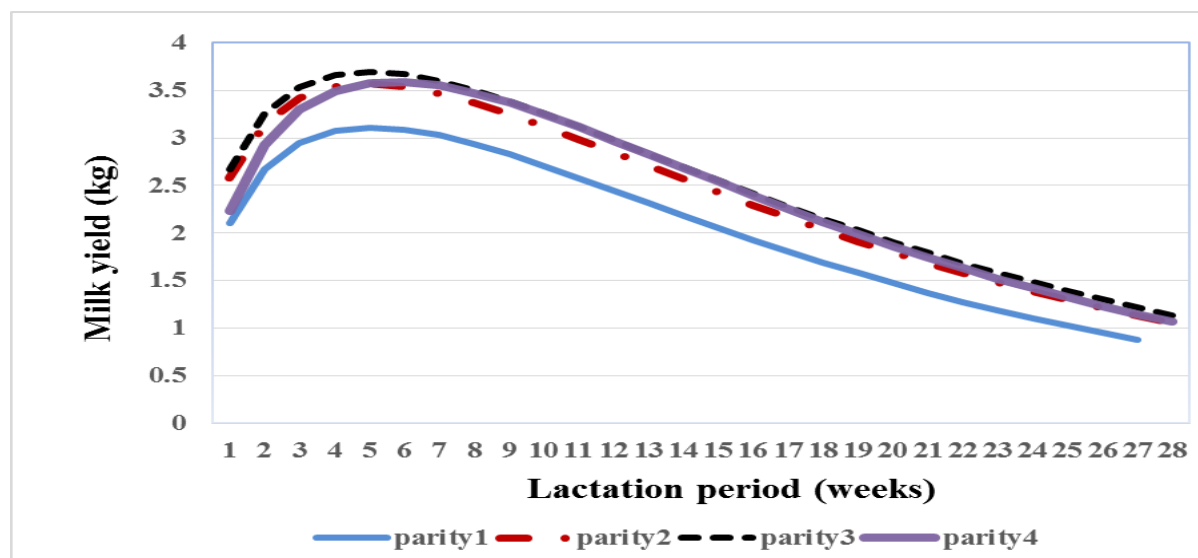


Figure 1. Lactation curve of Syrian Damascus goats as affected by parity

The obtained results revealed that parity had a highly significant ($P < 0.01$) effect on the parameter (c) as shown in Table (1). The estimate of the parameter (c) was 0.09 kg/week in the first and fourth parities compared to 0.08 kg/week in the second and third parities. This is due to the association between the first and fourth parities with the higher values of (b). Therefore, milk production decreased sharply after the peak compared to those in the second and third parities (0.08 kg/week). This result is in agreement with the results of Ayasrah *et al.* (2013) in Damascus goats in Jordan and Marete *et al.* (2014) in Kenyan Alpine dairy goats. Otherwise, Waheed and Khan (2013) mentioned no significant effect of parity on this parameter for Beetal goats in Pakistan.

The analysis of variance showed that PMY increased significantly ($P < 0.01$) from the first parity till the third parity. It scored 3.01 kg in the first parity and reached 3.67 kg in the third one (Table 1). This could be due to the increase in feed utilization, udder capacity, and the development of the epithelial cells with increasing parity. While the decline in PMY after the third parity may be due to a reduced number of secretory cells with the advancing of age. A similar finding was reported by Miranda-Alejo *et al.* (2019) who mentioned that the PMY was the lowest (1.98 kg) in the first parity and increased by progress parities till the fourth in Murciano-Granadina goats in Spain. On the other hand, Ayasrah *et al.* (2013) and Marete *et al.* (2014) revealed no significant effect of parity on PMY in different goat breeds.

Parity had no significant effect on PW (Table 1). Similar result was reported by Ayasrah *et al.* (2013) in Damascus goats in Jordan. Otherwise, León *et al.* (2012) found that, goats in the first parity attained the PMY lately (55 days) compared to other ones in Murciano-Granadina goats in Spain.

Also, the P % revealed no significant differences among parities, and ranged between 54.59 % in the second parity and 57.18 % in the third one (Table 1). On the other hand, Arnal *et al.* (2018) and Miranda-

Alejo *et al.* (2019) indicated that the P % decreased with progress parities.

Month of kidding:

The effect of month of kidding on all the lactation curve parameters was highly significant (Table 1). February kidding had the highest initial milk yield (3.4 kg) compared to the January and March ones. The lowest estimate of (b) was 0.34 kg/week during February kidding compared to 0.53 kg/week and 0.50 kg/week during January and March, respectively. The lactation curve of Syrian Damascus goats as affected by month of kidding is shown in Figure (2). This may be due to the differences in the feed quality and climatic conditions among months of kidding. This result is in accordance with that of Hamed *et al.* (2009) of Zaraibi goats in Egypt. Also, León *et al.* (2012) found that the initial milk yield was the highest (2.1 kg) in spring and the lowest (1.77 kg) in summer kidding, whereas, the (b) value was higher (0.063 kg/week) in summer kidding compared to other seasons. The authors concluded that, this may be due to the availability of body reserves accumulated with the appropriate feeding in spring of Murciano-Granadina goats in Spain. Conversely, Ayasrah *et al.* (2013) demonstrated that, the effect of month of kidding on all the lactation curve parameters was not significant of Damascus goats in Jordan. While, Marete *et al.* (2014) indicated that, month of kidding had a significant effect on the parameter (b), and had no significant effect on parameter (c) of Kenyan Alpine dairy goats.

The highest estimate of PMY (3.89 kg and 3.37 kg) was observed in February and January kidding, respectively. While the lowest one (2.93 kg) was scored in March kidding (Table 1). This is due to the differences in climatic conditions and nutrition practices over months of kidding. Similar results were observed by Zamuner *et al.* (2020) who reported that goats kidded in November had the highest PMY (2.8 kg) compared to those kidded in March (2.4 kg) in Australian dairy goats. Conversely, Ayasrah *et al.* (2013) and Miranda-Alejo *et al.* (2019)

demonstrated that the effect of month of kidding on PMY was not significant in Damascus goats in

Jordan and Murciano-Granadina goats in Spain, respectively.

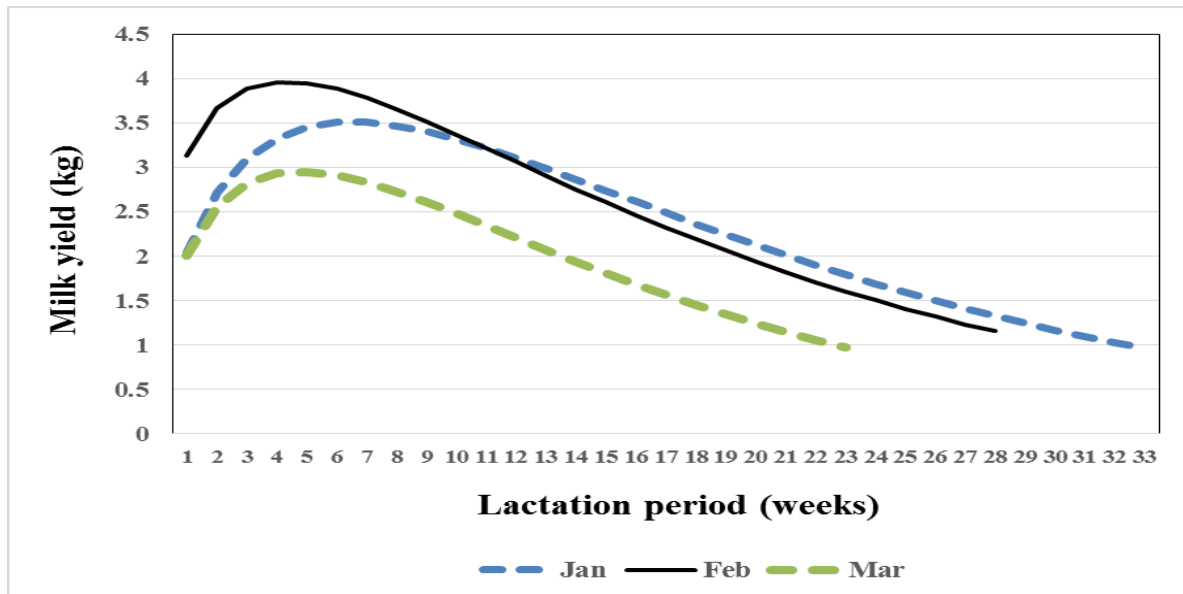


Figure 2. Lactation curve of Syrian Damascus goats as affected by month of kidding

It could be noticed that month of kidding exerted a significant effect on PW as shown in Table (1). Does that kidded in February and March reached PW (4.05 weeks and 4.82 weeks, respectively) faster than those kidded in January (6.40 weeks). This is due to that goat does kidded in January produced the highest total milk yield with the longest lactation period, due to the presence of convenient temperature for a long time before the summer months (June, July, and August). Therefore, does spend a long time to attain PMY compared to the others kidded in February and March. This result is in agreement with Ayasrah *et al.* (2013) who found that does kidded in November reached PMY lately (4.08 weeks) compared to those kidded in February (3.79 weeks) in Damascus goats in Jordan. Miranda-Alejo *et al.* (2019) mentioned that the PW was achieved at 40 days and 45 days in summer and autumn, respectively compared to 63 and 56 days in winter and spring, respectively in Murciano-Granadina goats in Spain.

The attained results showed that the month of kidding had no significant effect on the persistency trait (P %). It ranged between 53.7 % in February and 59.0 % in March (Table 1). A similar finding was observed by Ayasrah *et al.* (2013). Conversely, León *et al.* (2012) found that P % was higher for goats kidded in winter compared to those kidded during the spring season in Murciano-Granadina dairy goats in Spain. They attributed that, does kidded in winter had a lower milk production at starting lactation, therefore, they could maintain milk yield for a longer time compared to those kidded in spring. Miranda-Alejo *et al.* (2019) mentioned that the P % was the lowest in spring and the highest in fall in Murciano-Granadina goats in Spain. While Bermejo *et al.* (2020) found that the P % was highest in autumn kidding in Murciano-Granadina goats in Spain.

Type of Birth:

Results in Table (1) showed that the effect of type of birth on all the lactation curve traits wasn't significant. The lactation curve of Syrian Damascus goats as affected by birth type is presented in Figure (3). A similar result was observed by Ayasrah *et al.* (2013) in Damascus goats in Jordan. On the contrary, Rojo-Rubioa *et al.* (2016) and Bermejo *et al.* (2020) reported that the highest values of the lactation curve parameters were in twin kidding compared to single kidding of Mexican goats and Murciano-Granadina goats in Spain. They attributed that to an increase in both hormonal activity and the suckling effect with the increasing number of kids born.

In this context, PMY recorded 3.33 kg in single kidding and 3.47 kg in twin kidding, while PW was 5.12 weeks and 5.06 weeks in single and twin kidding, respectively, and P % scored 55.70 % and 55.72 % for single and twin kidding, respectively (Table 1). Similar results were also reported by Abosaq *et al.* (2012) who found that the effect of type of birth on PMY and PW wasn't significant in local and crossbred goats in Libya. Also, Ayasrah *et al.* (2013) reported that no significant effect of type of birth on PMY and P %, however, they found a significant effect of type of birth on PW, which is the lowest (3.90 weeks) in the single kidding compared to 3.93 weeks and 3.97 weeks in the twin and triplet kidding, respectively in Damascus goats in Jordan.

Conversely, Bermejo *et al.* (2020) found that goats kidded triple or more kids had the highest PMY and lowest PW compared to goats kidded with single or twin kids in Murciano-Granadina goats in Spain. Miranda-Alejo *et al.* (2019) found that goats with twin kids reached PMY early (46 days) compared to goats with single and triple kids (54 days and 53 days, respectively), with no significant effect of type

of birth on PMY in Murciano-Granadina goats in Spain.

Rojo-Rubio *et al.* (2016) in Mexican goats, and Bermejo *et al.*, (2020) in Murciano-Granadina goats

in Spain indicated that the P % was higher in goats with single kids compared to those with twin kids.

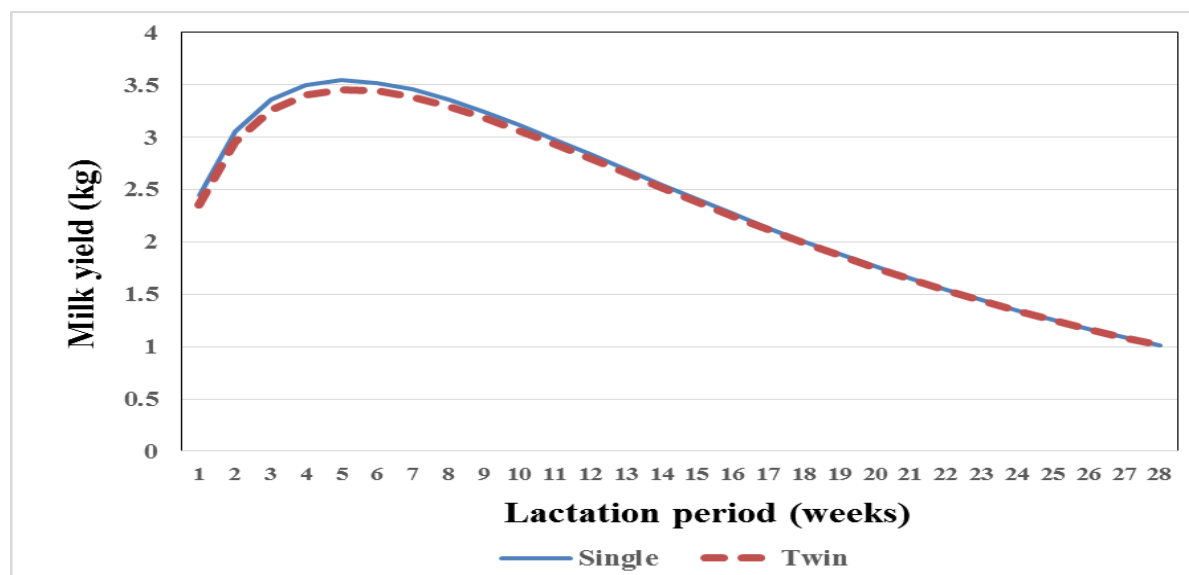


Figure 3. Lactation curve of Syrian Damascus goats as affected by type of birth

Milk production traits:

The overall mean for TMY of Syrian Damascus goats in the current study was 413 ± 5.98 kg (Table 2). This result is higher than that reported by Al-Azzawi (2017), Yakan *et al.* (2019), Akbaş *et al.* (2021), and Praharani *et al.* (2021) in Shami goats in Iraq, Damascus goats in Turkey, Honamlı goats in Turkey, and F2 (Anglo Nubian \times Etawah grade) goats in Indonesia, respectively. This estimate is less than 436 kg and 519 kg reported by Miranda-Alejo *et al.* (2019), and Zamuner *et al.* (2020) in Murciano-Granadina goats in Spain and dairy goats in Australia, respectively.

In the same context, the overall mean of the LP was estimated as 199 ± 1.23 days (Table 2). This estimate is lower than that demonstrated by Yakan *et al.* (2019), Zamuner *et al.* (2020), and Praharani *et al.* (2021) in Damascus goats in Turkey, Australian dairy goats, and F2 (Anglo Nubian \times Etawah grade) goats in Indonesian (210 days, 233 days, and 212 days, respectively). However, the current estimate is higher than those estimates reported by Kunbhar *et al.* (2016) in Kamori goats in Pakistan of 113 days, Al-Azzawi (2017) in Shami goats in Iraq of 175 days and Suranindyah *et al.* (2020) in Etawah crossed goats in Indonesia of 157 days.

The overall mean of DMY was estimated as 2.1 ± 0.02 kg (Table 2), which is greater than estimates of 0.99 kg, 0.7 kg, 1.4 kg, and 0.45 kg reported by Bermejo *et al.* (2020), Marković *et al.* (2020), Suranindyah *et al.* (2020), and Akbaş *et al.* (2021) in Murciano-Granadina goats in Spain, local Balkan goats in India, Etawah crossed goats in Indonesia, and Honamlı goats in Turkey, respectively. However, the current estimate is lower than that found by Kunbharet *et al.* (2016) of 2.7 kg in Kamori goats in Pakistan.

Non-genetic factors affecting milk production traits:

Parity:

Parity had a highly significant ($P < 0.01$) effect on TMY (Table 2). It scored the highest estimates of the second and third parities (446 kg and 445 kg, respectively) compared to the first and fourth parities of 360 kg and 402 kg, respectively. This could be due to the increase in body weight, feed intake, udder size and full development of the mammary glands with parity progress. Whereas, the reduction in TMY after the third parity may be due to advancing of age, and the enzymatic activities of the secretory cells became impaired; therefore, milk secretion was adversely affected. Similar results were reported by Al-Azzawi (2017) in Shami goats in Iraq, Zamuner *et al.* (2020) in Australian dairy goats, and Praharani *et al.* (2021) in F2 (Anglo Nubian \times Etawah grade) goats in Indonesia. However, Ralević *et al.* (2021) found that goats in the sixth parity produced more milk than those in the first parity in Saanen goats in Serbia. In contrary, Mohammed *et al.* (2012) reported that parity had no significant effect on milk production in Arsi-Bale goats in Ethiopia.

The same trend, was observed that parity significantly ($P < 0.01$) affected LP. The first parity scored the lowest estimate (191 days) compared to other parities (Table 2). This result is in agreement with that of Abraham *et al.* (2017) in Begait goats in Ethiopia and Al-Azzawi (2017) in Shami goats in Iraq. On the other hand, Zamuner *et al.* (2020) found that, Australian goats had a significantly longer LP in the first and the second parities than those in the third and the fourth ones. The estimates were 241 days and 242 days for the first and the second parities and 230 days and 217 days for the third and the fourth parities, respectively.

Table 2. Least squares means (LSM) and standard errors (SE) of factors affecting milk production traits for Syrian Damascus goats

Classification	Total milk yield (TMY, kg)	Lactation period (LP, days)	Daily milk yield (DMY, kg)
	LSM ± SE	LSM ± SE	LSM ± SE
Overall mean	413±5.98	199±1.23	2.1±0.02
Parity	**	**	**
1	360 ^a ±14.09	191 ^a ±2.89	1.9 ^a ±0.06
2	446 ^c ±16.22	203 ^b ±3.32	2.2 ^b ±0.06
3	445 ^c ±16.30	202 ^b ±3.34	2.2 ^b ±0.06
4	402 ^b ±17.56	199 ^b ±3.60	2.0 ^a ±0.07
Month of kidding	**	**	**
January	490 ^c ±6.83	233 ^c ±1.40	2.1 ^a ±0.03
February	430 ^b ±19.15	196 ^b ±3.92	2.2 ^b ±0.07
March	320 ^a ±28.32	167 ^a ±5.80	1.9 ^a ±0.11
Type of birth	NS	NS	NS
Single	405±13.78	199±2.82	2.0±0.05
Twin	421±12.78	198±2.62	2.1±0.05

Within each classification in the same column, means followed by different superscript letters differ significantly; **($P < 0.01$); NS: not significant.

DMY increased significantly ($P < 0.01$) with increasing parity till the third parity. It was 1.9 kg in the first parity compared to 2.2 kg for the second and the third parities (Table 2). Similar findings were reported by Abraham *et al.* (2017) who found that the highest DMY was recorded in the fourth parity and the lowest one was in the first parity in Begait goats in Ethiopia. Likewise, Pizarro *et al.* (2020) found that, lowest DMY was observed at the first parity and increased with increasing parity till the fourth, then decreased of Murciano-Granadina goats in Spain. Khandoker *et al.* (2018) reported that, the highest DMY in Saanen goats was recorded at 2-3 years of age in Malaysia. Also, Yakan *et al.* (2019) found that, older Damascus goats had a higher DMY than younger ones in Turkey. Conversely, Phoya *et al.* (2003) found that the DMY decreased with parity progress in local Malawi goats.

Month of kidding:

As shown in Table (2), LSM of TMY in January was the highest (490 kg) due to the increase of lactation period (233 days) compared to either February (430 kg) or March (320 kg). Regarding lactation period, March characterized by the shortest LP (167 days). This may be due to that animals were exposure to a higher ambient temperature during summer months, which is reflected on energy consumption to regulate body temperature. Additionally, feed intake is reduced during summer season. Similar findings were observed by Abraham *et al.* (2017) who confirmed that, the highest milk yield was in the wet season and the lowest one was in the dry season. Khandoker *et al.* (2018) reported that the highest milk production, was in October and September (784.58 and 720.09 ml/day, respectively) and the lowest value was in august (396.24 ml/day) in Saanen goats in Malaysia. Zamuner *et al.* (2020) found that, the highest TMY was at November (578

litres) and the lowest value was in March (455 litres) in Australian dairy goats. The authors attributed that, due to variations in photoperiod length and temperature fluctuations among months of kidding.

The present result showed that month of kidding affected significantly ($P < 0.01$) LP, and scored the lowest estimate (167 days) during March and the highest estimate (233 days and 196 days) during January and February months, respectively (Table 2). This is due to that, TMY was the highest in January (490 kg) and February (430 kg) compared to 320 kg in March. Similar findings were observed by Abraham *et al.* (2017) who found that the longest LP was observed in wet season and the lowest one was in dry season of Begait goats in Ethiopia. Zamuner *et al.* (2020) reported the lowest value of lactation period was 216 days in March and the highest values were 241 days and 236 days in June and November, respectively. The authors explained that, by the differences in daylight period and temperature fluctuations among months of kidding.

The effect of month of kidding on DMY was also significant (Table 2). The highest estimate of DMY was 2.2 kg and 2.1 kg for does kidded in February and January, respectively. However, the lowest one was 1.9 kg of does kidded in March. This result is in agreement with Abraham *et al.* (2017) who demonstrated that the highest DMY was in the wet season and the lowest one was in the dry season. Likewise, Zamuner *et al.* (2020) found the highest DMY was 2.4 litres in February and the lowest was 1.8 litres in June in dairy goats in Australia. Pizarro *et al.* (2020) found that goats kidded in January and March had DMY of 2.815 kg to 2.820 kg which is higher than those kidded in June to October (2.717 kg and 1.699 kg, respectively of Murciano-Granadina goats in Spain.

Type of Birth:

The effect of type of birth on milk production traits was not significant (Table 2). This result is in agreement with Al-Azzawi (2017) and Yakan et al. (2019) of Shami goats in Iraq and Turkey, respectively. On the other hand, Khandoker et al. (2018), Zamuner et al. (2020), and Ralević et al. (2021) reported that goats delivered multi kids produced milk production more than those delivered single kids. They attributed that to the increase in the hormonal activity such as progesterone, placental lactogen, and prolactin which increases the stimulus for mammary gland to develop during gestation period. Pizarro et al. (2020) found that, DMY increased significantly by increasing the number of kids born of Murciano-Granadina goats in Spain. Bermejo et al. (2020) on Murciano-Granadina goats in Spain found that, TMY, LP, and DMY increased by the increasing the number of kids born. While, Ralević et al. (2021) indicated that type of birth had no significant effect on LP of Saanen goats in Serbia.

CONCLUSIONS

The results of our study showed that Wood's function is appropriate tool to fit the lactation curve of Syrian Damascus goats, which provides the essential information about the milk production efficiency of Syrian Damascus goats. It is of interest to notice that, the results of this study demonstrated that, Syrian Damascus goats have higher potential for milk production and a long lactation period. These findings could be the basis for better determination of the sustainable strategy for selection and management of Syrian Damascus goats under subtropical regions to preserve them as a distinct genetic resource.

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CONFLICT OF INTEREST

The authors have declared no conflict of interest.

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صفات منحني الحليب وإنتاج اللبن للماعز الدمشقي السوري

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الغرض من هذه الدراسة هو وصف منحني الحليب باستخدام دالة Wood وتقدير صفات إنتاج اللبن وبحث تأثير العوامل الغير وراثية علي صفات منحني الحليب وإنتاج اللبن للماعز الدمشقي السوري. في هذه الدراسة تم جمع ٣٣٤ سجلاً إسبوعياً لكمية اللبن خلال العام ٢٠١٩ لعدد ٩٨ ماعز دمشقي من محطة قرحتا في سوريا. كان متوسط صفات منحني الحليب هو 2.6 ± 0.05 كجم لإنتاج اللبن في بداية مرحلة الحليب بعد الولادة (a)، 0.11 ± 0.45 كجم/إسبوع لمعدل ارتفاع إنتاج اللبن حتى أقصى حد (b)، 0.01 ± 0.09 كجم/إسبوع لمعدل إنخفاض اللبن حتى نهاية مرحلة الحليب (c)، 3.40 ± 0.05 كجم لأقصى إنتاج لبن (PMY)، 0.08 ± 0.09 أسابيع لأقصى إسبوع إنتاجاً (PW) و 55.71 ± 0.54 % للمثابرة (P %). كانت متوسطات صفات إنتاج اللبن هي 413 ± 5.98 كجم، 199 ± 1.23 يوم و 2.1 ± 0.02 كجم/يوم لإنتاج اللبن الكلي (TMY)، فترة الحليب (LP) وإنتاج اللبن اليومي (DMY) علي التوالي. أظهرت النتائج أن تأثير ترتيب موسم الولادة كان معنوياً ($P < 0.01$) علي جميع الصفات ماعدا أقصى إسبوع إنتاجاً (PW) والمثابرة (P %). كذلك فإن شهر الولادة كان له تأثير معنوي علي جميع الصفات ماعدا المثابرة (P %) بينما كان تأثير نوع الولادة (فردية أو توأمية) غير معنوي علي جميع الصفات تحت الدراسة. أوضحت الدراسة أن دالة Wood كانت ملائمة لوصف منحني الحليب في الماعز الدمشقي السوري وأن الماعز الدمشقي السوري يتميز بالمقدرة العالية علي إنتاج الحليب وطول فترة الحليب تحت الظروف البيئية شبه الاستوائية.