

FACTORS INFLUENCING MILK YIELD DURING LACTATION OF D'MAN EWES IN ITS CRADLE IN ALGERIA

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Abstract

A study was conducted at the National Institute of Agricultural Research (Adrar station) between 2017 and 2019 to assess the milk yield potential of prolific D'man ewes. A total of 210 daily milk production records from (of) 21 D'man ewes were collected during three successive lambings with the weighing method before and after feeding followed by manual milking. In addition, the effects of birth type, lambing rank, birth season and weight of ewes to the struggle (at breeding) on milk production were analyzed. The least-squares averages of daily and total milk production of D'man ewes were 0.85 ± 0.03 kg and 59.1 ± 0.96 kg, respectively, and the highest daily milk yield was observed in the second week of lactation. Ewes suckling more than two lambs had the highest milk yield. Indeed, ewes with triplets or more (+57.3%) and twins (+22.1%) have a significantly higher milk yield ($P < 0.01$) than ewes nursing single lambs. The effect of the other factors was not significant on milk production of D'man ewes. It can be concluded that increasing the quantity of milk produced per ewe according to the number of lambs suckled will help to make the most of multiple lambings thanks to a low mortality rate and improved growth, especially during the first month of lactation.

Keywords: D'man ewes, lactation curve, milk yield, oases, prolificacy

1. INTRODUCTION

Sheep breeding constitutes an activity adapted to practically all agroecological zones of Algeria. Its total headcount is around 22 million heads (MADR 2023 [1]). The importance of this breeding in Algeria lies in the richness of its genetic resources.

Currently, this herd consists of at least 9 breeds presenting various characteristics of resistance, prolificacy, productivity as well as good adaptability in arid environments; steppe and Saharan (Djaout et al. 2017 [2]). The D'man is the local breed of the oases of southern Morocco and southwestern Algeria, it is exploited in the palm groves of Touat, Tidikelt and Gourara (Foley and Meslin 1924 [3]; Bouix and Kadiri 1975 [4]).

This breed has considerable adaptability to Saharan conditions (Chellig 1992 [5]). The D'man ewe has an average adult body weight of 33.6 kg (Boubekur et al. 2015 [6]), and is renowned for its interesting reproduction performance, including its high prolificacy with an average of 190% and the possibility of its exploitation in an accelerated lambing system (Boubekur et al. 2019 [7]). It is a non-seasonal breed, the ewe can accept the male all year round (Derqaoui 2003 [8]).

This remarkable numerical productivity requires a good knowledge of the quantity of milk supplied by the ewe to its lambs insofar as it makes it possible to provide lactating ewes with a food ration according to their production needs and to carry out a selection of ewes by elimination of mothers who do not feed their lambs sufficiently.

With this in mind, the study aims to provide more information on the milk yield of D'man ewes reared in the oases production system in the region of Adrar and to determine the main factors that influence this production, using the double weighing method and manual milking.

2. MATERIALS AND METHODS

The study was carried out at the experimental station of the National Institute of Agronomic Research in Adrar in the southwest of Algeria. The station is located approximately 5 km southwest of the capital of the wilaya of Adrar at latitude $27^{\circ} 49' N$ and longitude $00^{\circ} 11' E$, and an altitude of 279 m above sea level. It is located in the hyperarid bioclimatic stage with negligible rainfall of less than 25 mm per year. The average temperature fluctuates between $0^{\circ}C$ in winter to more than $45^{\circ}C$ in summer.

Animal conduct

A total of 210 daily milk production records of 21 D'man ewes were collected during 3 successive lambings (autumn 2017, summer 2018 and spring 2019).

These females were on average 30 months old and have an average weight of 36 kg and were on their 1st, 2nd, 3rd or 4th lambing (Figure 1). The ewes were farmed in an accelerated lambing system with three farrowings every 24 months and were constantly kept in permanent housing.

The feeding behavior of the animals was adapted to the Oasian breeding system, which is based on the

valorization of the by-products of the palm grove (Boubekeur & Benyoucef 2014 [9]).

The ewes received a daily ration based on the number of lambs suckled (Table 1). For the lambs, the diet was exclusively milk during the first month. From the 2nd month, they received, ad libitum, a mixture of concentrate composed of barley, bran, dates and vitamin-mineral supplement. Weaning was done at 70 days of age. At all times, local salt stones and water were provided to the animals.

Table 1. Feed rations for ewes D'man based on breastfed lambs (in kg/animal/day)

Ration distributed		Breastfeeding type		
		Simple	Double	Multiple
Coarse foods	Alfalfa (autumn)	02	02	02
	Oats (spring)	02	02	02
	Millet (Summer)	02	02	02
	Crushed palm fronds	0,25	0,25	0,25
Concentrate foods	Barley	0,50	0,60	0,70
	Wheat bran	0,20	0,25	0,30
	Crushed dates	0,20	0,30	0,40
	vitamin-mineral supplement	0,10	0,10	0,10

the advantage of determining the quantity of milk naturally available to lamb (Boujenane et al 1996 [12]). Milk recording was carried out once a week over a period of 70 days, with the first taking place 3 to 7 days after lambing. The day before the check-up day (5 p.m.), the babies are separated from their mothers.

The next day, at 8 a.m., a first milk check using the weighing method before and after feeding the lambs, supplemented by manual milking.

After the first check, the lambs remain separated from their mothers and a second check was carried out on the same day at 5 p.m. Daily milk production is determined by the sum of the quantities of milk fed and milked during successive morning and evening checks (Figure 2).



Figure 1. Ewes of the breed D'man

Controls carried out

To estimate the milk production of ewes, the method chosen was the weighing of lambs before and after feeding described by Ricordeau et al. 1960 [10], because it gives a precise idea of the quantity of milk consumed by the lambs (Ünal et al 2007 [11]). This method also has



Figure 2. Method of weighing before and after feeding

The total quantities of milk produced were estimated using the Fleishmann method (Boujenane et al 1996 [12]). The average of the estimation of two successive controls (C_i and C_{i+1}) was considered characteristic of the interval separating the two controls and the milk production per interval was obtained by the following formula:

$$[(C_i + C_{i+1})/2] \times 7 \text{ (days)} \quad (1)$$

C_i is the estimated milk production from the previous control and C_{i+1} is the next control milk quantity.

Milk production at the first control was calculated by multiplying the quantity of milk obtained during this control by the number of days separating lambing from the first control. The persistence coefficient (milk production of the n^{th} week/milk production of $(n-1)^{\text{th}}$ week, from the week of appearance of the maximum production) was calculated.

The variables studied were the average daily milk production (DMP) and weekly milk production from the 1st to the 10th week in kg per day and per week respectively, the milk production of the 1st (MPM1) and 2nd month (MPM 2) of lactation in kg per month, as well as the total milk production (TMP) obtained during the 70 days of lactation.

Statistical analysis

All statistical analyses were carried out using SPSS/PASW 20 statistical software. Descriptive statistics for the variables studied were calculated and the means were presented with their Standard Errors (mean $\pm$ SE). An analysis of variance of fixed effects includes the effect of lambing season; the effect of lambing rank (parity), the effect of ewe weight and the effect of the number of lambs suckled per ewe was made by univariate analysis of the general linear model of SPSS (Table 2). The statistical difference was reported at $p < 0.05$.

Table 2. Modalities of the factors tested in the analysis of variance for milk control

Factor tested	Level	modality	Number	Percentage
Lambing season	1	Autumn	11	27,5
	2	Summer	12	30,0
	3	Spring	17	42,5
lambing rank (parity)	1	primiparous	13	32,5
	2	2 nd lambing	15	37,5
	3	Multiparous (3 and more)	12	30,0
Weight of the ewe in wrestling	1	Weight $\leq$ 33 kg	17	42,5
	2	33 < weight $\leq$ 40 kg	15	37,5
	3	Weight > 40 kg	08	20,0
Number of lambs suckled	1	A single lamb	19	47,5
	2	Two lambs	18	45,0
	3	Three lambs and more	03	7,50

3. RESULTS AND DISCUSSION

Quantities of milk produced

The levels of average milk production of D'man ewes quantified per day, per week, at one month (28 days), at two months (56 days) and total production at 70 days, according to the method weighed before and after suckling of lambs, are presented in Table 3. The D'man ewes achieved an average daily production of 0.85 ± 0.03 kg per day with values ranging from 0.50 to 1.24 kg per day. Thus, the total milk production achieved after 10 weeks of lactation in this study was 59.1 ± 1.96 kg. The coefficients of variation were large with values above 20%, indicating a wide dispersion of values around the mean. Of these, D'man ewes produced an average of 26.5 kg and 23.8 kg in the first and second month of lactation, respectively.

The total milk production (TMP) achieved by D'man ewes was significantly lower than the values reported by Boujenane and Lairini (1992) [13] of 78 kg over 10 weeks of lactation and by Boujenane and Kerfal (1992) [14] who reported a total of 81.2 kg after 12 weeks of lactation in the same breed in Morocco. However, this average total milk production was higher than previous reports in some prolific breeds by 63.5 and 48.4 kg in ewes Avishaan and GMM (Garole x Malpura) respectively after 90 days of lactation Prakash et al. (2019) [15] and 43.6 kg in Priangan ewes (Tiesnamurti et al. 2012 [16]). This difference compared to prolific breeds may be related to the driving conditions of the animals, the average age and weight of the sample studied, and the duration of milk recording in each study.

However, among local Algerian breeds, the total milk production obtained was slightly higher compared to the average estimated in Rembi ewes (55.3 kg) at 112 days of lactation, according to Benchohra et al. (2014a) [17] and the total obtained by Benyoucef and Ayachi (1991) [18] of 56 kg in Hamra ewes during 42 days of lactation by the hormonal method (oxytocin). Likewise, the milk production of the 1st month estimated in this study (26.5 kg) was very low compared to the value given by Belkheir et al. (2021) [19] in the Tazegzawt breed (31.6 kg) but higher than the average estimated by Benchohra et al. (2014b) [20] in the Rembi breed, with milk production of 21.5 kg after 28 days of lactation.

Table 3. Average milk production ($\pm$ SE) daily, weekly, monthly and total of D'man ewes (kg)

Variables	Mean $\pm$ SE	Minimum	Maximum
MP daily	0.85 ± 0.03	0,50	1,24
MP week 1	1.00 ± 0.05	0,53	1,74
MP week 2	1.06 ± 0.04	0,66	1,70
MP week 3	0.98 ± 0.04	0,51	1,56
MP week 4	0.96 ± 0.03	0,41	1,37
MP week 5	0.93 ± 0.04	0,38	1,45
MP week 6	0.86 ± 0.04	0,33	1,54

MP week 7	0,79 ± 0,04	0,37	1,61
MP week 8	0,69 ± 0,03	0,30	1,14
MP week 9	0,63 ± 0,03	0,21	1,02
MP week 10	0,59 ± 0,03	0,28	0,97
MP 1 st month	26,5 ± 0,92	16,3	38,3
MP 2 nd month	23,8 ± 0,88	13,8	37,7
MP total	59,1 ± 1,96	35,3	87,9

MP : Milk production

Lactation curve

The initial mean milk production of D'man ewes was 1.00 kg/d and reached a maximum value of 1.06 kg in the 2nd week, then it decreased to 0.59 kg in the 10th week of lactation (Table 3). This peak obtained in this study seems very low compared to the values reported by Boujenane and Kerfal (1992) [14] and by Boujenane and Lairini (1992) [13] of 1.45 kg/d and 1.48 kg/d respectively in D'man ewes in southern Morocco. However, it is slightly higher than the peaks achieved by the Sardi breed ewes (0.88 kg/d), Timahdite (0.87 kg/d) and Beni Guil (0.91 kg/d) according to (Boujenane et al. 1996 [12]) and in the prolific ewes Avishaan (0.91 kg/d) and GMM (0.72 kg/d) according to Prakash et al (2019) [15]. In comparison with local Algerian breeds, this maximum production appears to be similar to the value obtained by Benchohra et al. (2014a) [17] of 1.07 kg/d in Rembi ewes but lower than the peak recorded by Tazegzawt ewes of 1.22 kg/d (Belkheir et al 2021 [19]).

The highest milk yield was observed during the second week of lactation in D'man ewes in this study (Figure 3). The same period of appearance of maximum production was recorded in the same breed in Morocco (Boujenane and Kerfal 1992 [14]), at Rembi ewes (Benchohra et al. 2014b [20]), at the Sardi, Timahdite and Beni Guil breeds (Boujenane et al 1996 [12]), at the prolific Avichan breed (Prakash et al. 2019 [15]) and in Pelibuey ewes (Rodríguez-Álvarez et al. 2021 [21]).

However, a peak in production was obtained in the third week of lactation in D'man ewes in Tunisia by Dhaoui et al. (2018) [22] and in the prolific Priangan breed (Tiesnamurti et al. 2012 [16]). According to Belkheir et al. (2021) [19], the maximum production value was achieved during the fourth week of lactation in Tazegzawt ewes in Algeria. The variations concerning the maximum production and the week of onset are mainly related to the effects of the genotype of the breed exploited and the experimental conditions in each study (Aboul-Naga et al. 1981 [23]).

The persistence coefficient in D'man ewes in this study was 0.94. This value seems similar to the value reported by Boujenane and Kerfal (1992) [14] and (Boujenane et al. 1996 [12]), in the D'man, Sardi, Timahdite and Beni Guil breeds, but slightly higher than the coefficient obtained by Benkobra et al (2014b) in Rembi ewes of 0.90. This high coefficient does not support the conclusion of Louda and Doney (1976) [24] that milk

production decreases rapidly when the number of suckled lambs is high.

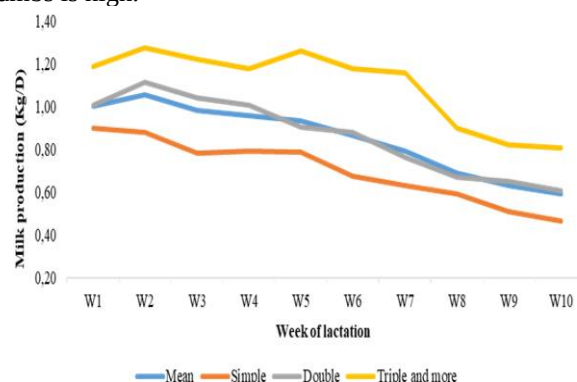


Figure 3. Lactation curve of D'man ewes as a function of number of lambs suckled

Factors of variation in milk production of D'man ewes

The analysis of variance showed that lambing rank (parity) had no significant influence on the milk production of D'man ewes (Table 4). This conclusion is consistent with the results reported by Arbouche (2010) [25] in Ouled Djellal ewes, and by Benchohra et al. (2014a) [17] who concluded that the age of the Rembi ewe has no significant effect on its milk production. However, a significant effect of parity on average daily production and total milk production was also reported by Boujenane and Kerfal (1992) [14] and (Boujenane et al. 1996 [12]) in D'man ewes in Morocco, and by Belkheir et al. (2021) [19] in Tazegzawt ewes. This factor was also significant on average daily milk production in prolific Avishaan and GMM ewes (Prakash et al. 2019 [15]).

A non-significant effect of the mother's wrestling weight on average daily, monthly and total milk production was observed in the D'man herd studied. Similarly, Prakash et al. (2019) [15] for the prolific breeds Avishaan and GMM also reported similar performance in ewes for different weight categories. However, Ángeles Hernández et al. (2018) [26] in the East Friesian breed, and Rodríguez-Álvarez et al. (2021) [21] in the Pelibuey breed reported the effect of body weight of ewes at mating, in mid-gestation, at lambing and during lactation on the milk yield of ewes. The absence of the weight effect can be justified by the mobilization of the ewe's body reserves to ensure sufficient milk production for the lambs. Therefore, good nutrition during breastfeeding is essential.

The effect of lambing season on average daily milk production and milk yield of D'man ewes during lactation was non-significant. Boujenane and Kerfal (1992) [14] deduced the same conclusion for this breed in Morocco. However, Dhaoui et al. (2018) [22] reported a significant effect of the birth season on the average daily milk yield of D'man ewes in the first, fourth, sixth and last (10) weeks of lactation. The absence of difference in the milk yield of ewes lambing at different seasons of the year confirms the high adaptability of D'man ewes to the study region's Saharan conditions, as already reported by Chellig (1992) [5].

The number of lambs suckled has a very highly significant effect ($P < 0.01$) on the milk production of mothers for the different stages of lactation (Table 4).

During the monitoring period, ewes lactating triples or more achieved a higher daily and total milk yield than those suckling double and single, as a result of greater udder stimulation. The superiority of ewes with several lambs was around 57.2% compared to ewes with single births and 28.8% compared to ewes suckling twins.

The number of lambs suckled had a very highly significant effect ($P < 0.01$) on maternal milk production for the different stages of lactation (Table 4). During the follow-up period, ewes lactating triples or more achieved a higher daily and total milk yield than those suckling double and single, as a result of greater udder stimulation. The superiority of ewes followed by several lambs was 57.2% higher than single-born ewes and 28.8% higher than ewes suckling twins. Several authors (Boujenane and Lairini 1992 [13], Boujenane and Kerfal 1992 [14], Dhaoui et al. 2018 [22]) have reported the significant effect of this factor on the milk production of D'man ewes. Similarly, Prakash et al. (2019) [15] and Belkheir et al. (2021) [19] also reported higher milk production in twin ewes.

Suckling two or more lambs increases the milk extraction capacity of the udder, which leads to an increase in milk production (Peart et al. 1972 [27]). According to Boujenane and Kerfal (1992) [14], the greater milk production of ewes suckling several lambs can be explained by the more frequent emptying of the udder, and also by the high hormonal secretions at the time of gestation which could have a positive effect on mammogenesis and lactogenesis.

Table 4. Least-squares means ($\pm$ SE) of D'man ewes' milk production

Source of Variation	N	Daily milk production	Milk production of the 1 st month (28j)	2 nd month milk production (56j)	Total milk production (70j)
Lambing rank		ns	ns	Ns	ns
1	13	0,88 $\pm$ 0,05	27,3 $\pm$ 1,61	25,0 $\pm$ 1,66	61,4 $\pm$ 3,52
2	12	0,81 $\pm$ 0,05	24,7 $\pm$ 1,93	23,2 $\pm$ 1,69	57,0 $\pm$ 3,94
3 and more	15	0,84 $\pm$ 0,04	27,1 $\pm$ 1,35	23,1 $\pm$ 1,34	58,8 $\pm$ 3,00
Weight of the ewe		ns	ns	Ns	ns
Live Weight $\leq$ 33 kg	17	0,85 $\pm$ 0,05	26,3 $\pm$ 1,35	24,3 $\pm$ 1,66	59,0 $\pm$ 3,34
33 < Live Weight $\leq$ 40 kg	15	0,84 $\pm$ 0,04	26,8 $\pm$ 1,41	23,3 $\pm$ 1,09	59,0 $\pm$ 2,64
Live Weight > 40 kg	8	0,85 $\pm$ 0,07	26,1 $\pm$ 2,74	23,7 $\pm$ 1,94	59,4 $\pm$ 5,16
Suckling lambs		**	**	**	**

1	19	0,70 $\pm$ 0,03	22,3 $\pm$ 1,19	19,4 $\pm$ 0,83	48,9 $\pm$ 2,14
2	18	0,86 $\pm$ 0,02	27,1 $\pm$ 1,03	23,6 $\pm$ 0,59	59,7 $\pm$ 1,59
3 and more	03	1,10 $\pm$ 0,03	32,9 $\pm$ 1,63	32,4 $\pm$ 1,29	76,9 $\pm$ 2,00
Lambing season		ns	ns	Ns	ns
Autumn	11	0,88 $\pm$ 0,05	27,2 $\pm$ 1,82	25,2 $\pm$ 1,64	61,6 $\pm$ 3,50
Summer	12	0,82 $\pm$ 0,05	25,3 $\pm$ 1,99	23,4 $\pm$ 1,78	57,7 $\pm$ 4,01
Spring	17	0,85 $\pm$ 0,04	26,8 $\pm$ 1,24	23,1 $\pm$ 1,31	58,5 $\pm$ 2,99
** significant to $p < 0,01$; * significant to $p < 0,05$; ns : non-significant correlation					

4. CONCLUSION

The results of this study suggest that milk production achieved by the prolific D'man ewes exploited in the oasis production system in Adrar can sufficiently meet the lactation needs of reared lambs. Quantified milk yield was significantly affected by litter size at birth. Indeed, ewes that suckled several lambs produced a higher quantity of milk than those that suckled a single lamb. This production will help to make the most of multiple lambs through low mortality and improved lamb pre-weaning growth performance. However, ewes suckling multiple lambs must be carefully assessed at lambing to eliminate mothers with low milk production.

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