Net Journal of Agricultural Science
Vol. 2(2), pp. 74-78, May 2014
ISSN: 2315-9766
Full Length Research Paper

Dhofari cow's potentiality of milk production and lactation curve

Salim Bahashwan* and Salim Alfadli

Salalah Livestock Research Station, P.O Box 1286, Postal code 211, Salalah, Sultanate of Oman.

Accepted 12 May, 2014

ABSTRACT

The objective of this study was to evaluate the potentiality of Dhofari cow's milk production and characterizing its lactation curve and its parameters together with finding out the effect of cow's parity and season of calving on their daily milk production and lactation curve parameters. Data of 644 lactations from 64 Dhofari cows were used in this study. Nonlinear regression analysis of data used Woods model incomplete gamma function to estimate lactation parameters showed peak yield (PY), peak time (PT) and persistency percentage (PR) of 9.11 kg, 70.77 day in milk (DIM) and 75.92%, respectively. Analysis of variance t- test showed no significance ($p > 0.05$) between actual milk yield lactation curve and predicted yield as the estimated lactation curve goodness of fit coefficient of determination R^2 was 98%. Estimated lactation curve parameters a, b, and c in Woods function for the Dhofari cows breed found to be 0.454, 0.92, and 0.013, respectively. Statistical analysis confirmed the significant ($p < 0.05$) effect of parity on average daily milk production. Results revealed that highest means of daily milk yield were shown in 1st (7.23 ± 0.96 kg) and 8th (7.23 ± 0.96 kg) parity. Results showed significant ($p < 0.05$) effect of parity on lactation curve parameters (a, b and c), PY and PT. There was significant ($p < 0.05$) effect of season of calving on daily milk yield. The highest means were found in autumn and summer with 7.55 ± 0.27 and 7.18 ±0.61 kg/day, respectively.

Keywords: Dhofari cows, Woods model, lactation curve, peak yield, peak time, parity, season.

*Corresponding author. E-mail: saleminiom@gmail.com. Tel: +968-23225475. Fax: +968-23225798.

INTRODUCTION

Animal milk production in Sultanate of Oman is a fast increasing business to meet the growing demand by the public. There are 33278 cows in Oman with almost 60% of them located in Dhofar governorate (Anonymous, 2010). Dhofari cow breed is an indigenous breed domesticated by Omanis for meat and milk production. There are scanty data available about their milk production ability and characterization. Lactation curves of various cattle breeds had been studied in literature but Dhofari breed never been studiedor published.Lactation curve was defined as being the graphical representation of the relationship between milk yield and lactation length (Fadlelmoula et al., 2007). It is vital to find out and study the lactation curve of a certain cattle breed as this would depict different management, breeding, and feeding problems of that breed (Epaphras et al., 2004). The shape of the lactation curve gives important data for identifying elements that best describe superior lactation potential (McGill et al., 2006). The information provided from the lactation curve would be important for selection programs and research regarding improving a certain native breeds. Although, the effect of parity and season of calving on milk yield and lactation curve has been published in several breeds (Ruvuna et al., 1995), no information is available on Dhofari cows. Hence, this study was conducted to investigate the potentiality of Dhofari cow's milk production and characterizing its lactation curve and its parameters together with finding out the effect of cow's parity and season of calving on their average milk production and lactation curve parameters.

MATERIALS AND METHODS

Data

Data of 664 lactation records from 64 Dhofari cows native breed were collected at Salalah Livestock Research Station in the south region of Sultanate of Oman during the year of 2012. Cows were milked twice per day in the morning and evening from the 5th day of parturition till the end of the lactation period just before their dry period. Cows were hand milked and milk quantity was recorded plus the milk consumed by their relative calves.Data were classified according to cow's days in milk (DIM) and also parity.Cows were fed commercial concentrate of 16% crude protein according to their weight and milk production. Rhodes grass hay (*Chloris gayana*), water and mineral blocks were given *ad libitum*.

Lactation curve

Woods (1967) incomplete gamma function method was used to describe the lactation curve according to the following equation:

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

Where:

Y_n = milk Yield at n time of lactation day.
a = initial yield
b = increasing slope of yield
c = decreasing slope of yield

Parameters a, b and c were obtained after the logarithmic transformation of Woods equation: ln Y_n = ln (a) + b * ln (n) –cn

After fitting the curve the peak yield (PY), time at peak (PT) and persistency percentage were computed using the following Woods (1967) equations:

$$PY = a\left(\frac{b}{c}\right)^b exp^{-b}$$

PT = b/c

$$PR\% = \left[1 - \frac{(milk\ kg\ in\ earlier\ test - milk\ kg\ in\ later\ test) \times \frac{30\ days}{days\ between\ tests}}{milk\ kg\ in\ earlier\ test}\right] \times 100$$

Statistical analysis

All data were analyzed using SPSS software version 19 (2010). The lactation curve data parameters and curve goodness of fit were analyzed using nonlinear regression of Woods (1967) model. Analysis of variance for parity and season of calving effect as independent factor on the milk yield, lactation curve parameters, PY and PT as dependant factors were analyzed using GLM procedure. Duncan test was performed to test the significant differences among means at alpha 5%.

RESULTS AND DISCUSSION

Table 1 shows that estimated lactation curve parameters (a, b and c) of Dhofari cows were 0.454, 0.920 and 0.013 respectively with coefficient of determination of R^2 = 98%. Estimated lactation peak yield (PY) was 9.11 kg at PT day (70.77 day) of lactation period with persistency of 75.92% (Table 1). Similar results were found in other breeds such as Iranian Holsteins (Torshizi et al., 2011) whereas, another study (Ural and Koskan, 2014) found different results for Holstein-Friesian cows. Conflicting results could be attributed to breed, management, environment, and temperate zones (Orman and Ertugrul, 1999).

Table 2 shows that the average actual daily milk yield and Woods predicted average daily milk yield were 5.29 ± 0.18 and 5.56 ± 0.01 kg, respectively. There was no significant ($p > 0.05$) difference between the actual and predicted daily milk yield. This insignificance was due to the high goodness of fit with coefficient determination of R^2 = 98%. Results in Table 2 shows that initial and total milk yield for actual and predicted lactation of Dhofari cows was 7.44 ± 0.35, 7.02 ± 0.03, 1852.16 and 1946.29 kg respectively with no significant ($p > 0.05$) difference. This was higher than 1827 kg found by others (Cervantes et al., 1997) but lower than 3106 reported by Diaz et al. (2004) for Holstein × Zebu cross. In Figure 1, Dhofari cow's actual and Woods predicted lactation curve, showed excellent fit for the predicted curve. It gave clear graphical idea of the shape of milk production through time from initial lactation till the end. As shown Figure 1, cows began lactation with a high production of around 7 to 8 kg per day during the first 30 days (parameter a) and increased to a maximum (PY) production of about 9 kg per day during the 70th day (PT) of lactation (parameter b) then slow decrease (parameter c) till it reached minimum production of around 2 kg per day at the last days of lactation with persistency percentage of 75.92%. Results showed significant ($p < 0.05$) effect of parity on milk yield (Table 3) with greatest effect of the 1st and 8th parities that gave out milk yields of 7.23 ± 0.96 and 7.18 ± 0.96 kg. There was no significant ($p > 0.05$) difference between parities 2, 3, 4, 5, 6 and 7 effect on milk yield (Table 3). Similar results of effect of parity on milk yield were found by (Rekik et al., 2003). Results in Table 4 showed significant ($p < 0.05$) effect of parity on lactation curve parameters (a, b and c), PY and PT. Lactation parameter (a) was highest for the 9th parity with value of 0.620 and lowest for the 4th parity with value of 0.079. Lactation parameter (b) was highest for the 4th parity with value of 1.420 and lowest for the 9th parity with value of 0.833. Lactation parameter (c) was highest for the 4th parity with value of 0.019 and lowest for the 8th parity with value of 0.010. PY was highest for the 1st parity with value of 12.63 kg/d at PT of 71.08 day. PY was lowest for the 9st parity with value of 8.11 kg/d at PT of 59.50 day.

Table 1. Dhofari cows estimated Woods lactation curve parameters, peak yield, peak time, persistency, and coefficient of determination of R^2.

Lactation curve parameters			PY (kg/d)	PT (day)	PR%	R^2
a	b	c				
0.454	0.92	0.013	9.11	70.77	75.92	0.98

PY = peak yield. PT = peak time. PR = persistency. R^2 = coefficient of determination.

Table 2. Mean and standard error (M ± SE) of actual yield (AY), and predicted Woods yield (PY).

DIM	AY	SE	PY	SE
30	7.44	0.35	7.02	0.03
60	8.03	0.36	8.99	0.02
90	8.07	0.34	8.85	0.02
120	7.53	0.35	7.81	0.06
150	7.17	0.35	6.49	0.04
180	5.24	0.36	5.20	0.05
210	3.97	0.36	4.05	0.01
240	2.79	0.34	3.10	0.02
270	1.71	0.35	2.34	0.02
300	0.97	0.35	1.75	0.03
Total yield (kg)	1852.16		1946.29	

Values of AY and PY are not significant ($p > 0.05$). AY = actual yield. PY = predicted yield.

Table 3. Mean (M ± SE) of daily milk yield (MY) by cows parity.

Parity effect on (MY) production		
Par	Mean	SE
1	7.23^a	0.96
2	5.11^b	0.79
3	5.08^b	0.41
4	4.91^b	0.51
5	4.67^b	0.96
6	5.40^b	0.68
7	5.70^b	0.96
8	7.18^a	0.96
9	4.25^c	0.96

*Means with different subscripts (^{a}, ^{b} and ^{c}) are significant at $p<0.05$. MY= milk yield.

Table 4. Effect of parity on lactation parameters, peak yield and peak time.

Parity	Lactation curve parameters			Peak yield (kg)	Peak time (days)
	a	b	c		
1	0.619^a	0.924^a	0.013^a	12.63^a	71.08^a
2	0.199^b	1.176^b	0.016^b	9.61^b	73.50^b
3	0.219^c	1.158^c	0.017^b	9.13^c	68.12^c
4	0.079^d	1.420^c	0.019^c	8.74^d	74.74^d
5	0.227^e	1.159^c	0.018^c	8.89^e	64.39^e
6	0.302^f	1.101^b	0.017^b	9.91^f	64.76^f
7	0.154^g	1.272^c	0.017^b	10.44^g	74.82^d

Table 4. Continues.

8	0.089[h]	1.227[c]	0.010[c]	9.54[h]	122.70[g]
9	0.620[a]	0.833[a]	0.014[a]	8.11[i]	59.50[h]

*values in columns with different subscripts ([a], [b], [c], [d], [e], [f], [g], [h], and [i]) are significant at $p < 0.05$.

Table 5. Effect of Season of calving on daily milk yield.

Season	Mean	Std. error	95% Confidence interval	
			Lower bound	Upper bound
Summer	7.18[a]	0.61	5.97	8.40
Autumn	7.55[a]	0.27	7.03	8.08
Spring	5.94[a]	0.29	5.37	6.52
Winter	3.3[b]	1.10	1.14	5.46

*values in columns with different subscript ([a] and [b]) are significant at $p<0.05$.

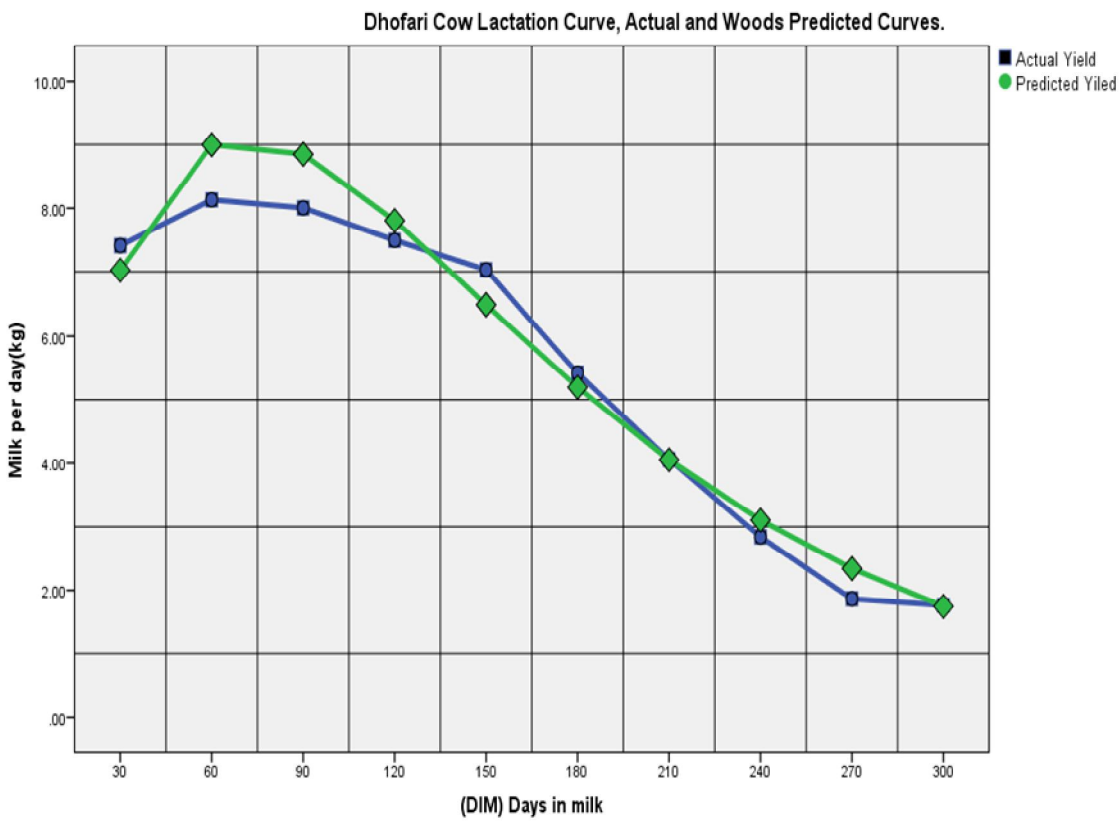

Figure 1. Dhofari cows actual and predicted Wood lactation curve shape.

Similar results were obtained by (Horan et al., 2005). Results in Table 5 showed significant ($p < 0.05$) effect of season of calving on milk yield with highest effect for autumn and summer seasons of 7.55 ± 0.27 and 7.18 ±0.61 kg/day, these results are in accordance with (Fadlelmoula et al., 2007) who found similar results for Fresian-Ayrshire crossbred cows.

CONCLUSION

Dhofari cows breed potentiality of milk production as a native breed is promising and will respond well to improvement. The lactation curve shape of this breed followed typical shapes of other breeds. Selection of cows based on persistency should be recommended for

better milk yield. Management (feeding, breeding, and health care) will play important roles for lactation yield. Season and parity effects should be monitored for more economical production. This research would give an insight for researchers on Dhofari cows breed for further researches especially in terms of genetic selection and improvement programs.

ACKNOWLEDGEMENTS

This work was supported by Salalah Livestock Research Station, Salalah, Oman. Thanks to Dr. Ahmed Alshanfri, Dr. Hamood Alhasani, Dr. Ahmed Albakry, Mr. Abdulla Alrawas and Mr. Mohammed Khadim.

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