Characteristics, Curve and Persistency of Lactation in Jaffarabadi (*Bubalus bubalis*) Buffaloes

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ABSTRACT

Lactation milk yield in dairy bovines is closely related with, and therefore a function of, peak yield, persistency and lactation length. Therefore, characteristics, curve, and persistency of lactation were studied in Jaffarabadi (*Bubalus bubalis*) buffaloes. A total of 1,15,339 daily morning and evening milk production performance records in 176 lactations of 1st to 6th parity of 30 Jaffarabadi buffaloes lactating at the Cattle Breeding Farm, JAU, Junagadh, Gujarat over a period of 28 years (1991-2018) were used for the study. Overall lactation length (LL), total lactation milk yield (TLMY), and standard lactation milk yield (SLMY) of the Jaffarabadi buffalo averaged 325.90 ± 5.53 days, 2009.31 ± 42.13 lit and 1872.61 ± 32.88 lit, respectively. Overall daily peak yield (DPY) was 11.27 ± 0.20 lit/day, attained at 102.00 ± 4.68 days postpartum. Overall weekly peak yield (WPY) and weeks to attain WPY averaged 64.79 ± 1.09 lit/week and 13.72 ± 0.64 weeks, respectively. Weekly milk yield could be predicted using linear function [($\hat{y}$ = 59.149 + (−0.6634) × X)] and logarithmic function [($\hat{y}$ = 1.80 × (−0.0008)^X)] with an accuracy of 66 to 73%. In contrast, monthly milk yield could be predicted using linear function [($\hat{y}$ = 261.64 + (−13.229) × X)] and logarithmic function [($\hat{y}$ = 2.45 × (−0.035)^X)] with comparatively more precision, R^2 value being 79.7 to 81.2 %. Overall persistency in terms of weekly and monthly milk yield was estimated to be 98.03±0.24% and 91.24±0.59%, respectively.

Keywords: Characteristics, Jaffarabadi (*Bubalus bubalis*) buffalo, Lactation curve, Linear regression, Peak yield, Persistency.

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INTRODUCTION

An economically important trait, milk production is influenced principally by maximum initial production, the persistency with which such yields are maintained, and the length of the production period. The total milk production of an animal is closely correlated with peak yield and persistency. Persistency of milk production is the ability of animals to maintain milk production at a high level after peak production or usually refers to the rate of decline in daily yield after the peak of lactation (Togashi and Lin, 2004). Jaffarabadi breed is one of the country's superior buffalo breed known for higher milk production and perhaps maximum milk fat content. The breeding tract of these buffalo lies in the Saurashtra region of Gujarat, especially areas in and around the Gir forest.

Several workers studied persistency in buffalo breeds mainly in Murrah (Geetha, 2006; Pareek and Narang, 2015), Nili-Ravi (Chaudhry *et al.,* 2000), and Swamp buffalo (Das *et al.,* 2007). There is a dearth of such studies in Jaffarabadi buffalo (Savaliya and Ahlawat, 2016). Therefore, the characteristics, curve, and persistency of lactation in Jaffarabadi buffalo were studied.

MATERIALS AND METHODS

A total of 1,15,339 daily morning and evening milk production performance records in 176 lactations of 1st to 6th parity of 30 Jaffarabadi buffaloes lactating at the Cattle Breeding Farm, JAU, Junagadh, Gujarat over a period of 28 years (1991-2018)

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were utilized for the study. Averages along with standard error were worked out for various lactation characteristics, and means were compared using Duncan's multiple range test in SPSS Statistics for Windows, Version 17.0 (SPSS Inc., 2008).

Total milk production was partitioned into 44 weekly and 11 monthly milk yields, and persistency was calculated using the ratio method below.

$$\text{Persistency (\%) of milk yield of X}^{th} \text{ week or month}$$
$$= \frac{\text{Milk yield of X}^{th} \text{ week or month}}{\text{Milk yield of (X}-1)^{th} \text{ week or month}} \times 100$$

(Ludwick and Peterson, 1943)

Prediction equations were evolved for monthly and weekly milk yield of Jaffarabadi buffalo using simple linear and logarithmic regression functions as follows:

$\hat{Y} = a + b\,X$ (simple linear regression)

$\hat{Y} = a + b \log X$ (logarithmic regression)

Where

$\hat{Y}$ predicted weekly or monthly milk yield,

a, intercept value,

b, the regression coefficient of milk yield (Y) on the independent variable (X), and

X, independent variables (week or month).

The coefficient of determination (R^2) was calculated based on the following formula:

$$R^2 = \frac{\text{Regression sum of square}}{\text{Total sum of square}} \times 100$$

(Snedecor and Cochran, 1994)

Results and Discussion

Lactation Characteristics

Information on the production performance of Jaffarabadi buffaloes in terms of lactation length (LL), total lactation milk yield (TLMY), and standard lactation milk yield (SLMY) are presented in Table 1. Overall, LL, TLMY, and SLMY of the Jaffarabadi buffalo averaged 325.90 ± 5.53 days, 2009.31 ± 42.13 lit, and 1872.61 ± 32.88 lit, respectively. Dangar et al. (2011) reported LL and SLMY in Jaffarabadi buffaloes as 337.81 ± 7.08 days and 1742.50 ± 43.38 lit, respectively. Gadariya et al. (2017) estimated LL, TLMY, and SLMY as 291.87 ± 4.96 days, 1800.46 ± 32.21 lit, and 1681.64 ± 27.23 lit, respectively in Jaffarabadi buffaloes. The superior performance of Jaffrabadi buffaloes observed in the present study could be attributed to the large sample size (lactation record, 177) and the buffaloes produced and retained in the herd for six or more normal lactations with a minimum of 210 lactation days constituted the base of the investigation. In the present study, the effect of parity was significant only on the SLMY of Jaffarabadi buffalo, being significantly ($p < 0.01$) lower in first lactation and 6th lactation. SLMY and TLMY were observed highest in 5th lactation.

Overall daily peak milk yield (DPY) in the Jaffarabadi buffalo was 11.27 ± 0.20 lit/day, attained at 102.00 ± 4.68 days postpartum. Overall weekly peak yield (WPY) and weeks to attain WPY of the Jaffarabadi buffalo averaged 64.79 ± 1.09 lit/week and 13.72 ± 0.64 weeks, respectively. The parity of buffaloes significantly ($p < 0.01$) affected the peak yield, being lowest in the first lactation. Dangar et al. (2011) reported DPY in Jaffarabadi buffalo as 9.42 ± 0.22 lit, which was lower than that found in the present study.

Lactation Curve

The correlation coefficients of milk yield were -0.819 to -0.911 ($p < 0.01$) for both week and month. Hence, prediction equations were evolved for the lactation yield of Jaffarabadi buffalo using linear and logarithmic functions. The regression coefficients and coefficients of determination for milk yield have been furnished in Table 2. Weekly milk yield could be predicted using linear function [$\hat{y} = 59.149 + (-0.6634) \times X$] and logarithmic function [$\hat{y} = 1.80 \times (-0.0008)^X$] with an accuracy of 66 to 73%. Monthly milk yield could be predicted using linear function [$\hat{y} = 261.64 + (-13.229) \times X$] and logarithmic function [$\hat{y} = 2.45 \times (-0.035)^X$] with comparatively more precision, R^2 value being 79.7 to 81.2%. The graphical illustrations of actual and predicted weekly and monthly milk production curves are presented in Figs. 1 and 2, respectively. Pandya et al. (2021) studied the lactation curve

Table 1: Parity wise daily and weekly peak yield and lactation milk yield along with lactation days of Jaffarabadi buffalo

Parity	N	DPY, lit	Days to attain DPY	WPY, lit	Weeks to attain WPY	SLMY, lit	TLMY, lit	Lactation Days
		Mean ± SE	Mean ± SE	Mean ± SE	Mean ± SE	Mean ± SE	Mean ± SE	Mean ± SE
1	27	09.81[a] ± 0.51	102.59 ± 11.92	57.96[a] ± 3.38	16.70 ± 2.27	1680.62[a] ± 93.12	1871.66 ± 132.84	329.59 ± 15.95
2	30	11.40[b] ± 0.47	106.93 ± 14.60	66.13[b] ± 2.43	13.07 ± 1.78	1928.89[b] ± 70.26	2070.41 ± 093.57	332.20 ± 13.59
3	30	11.40[b] ± 0.43	087.77 ± 11.36	65.90[b] ± 2.39	12.53 ± 1.13	1933.15[b] ± 70.24	2068.82 ± 091.24	324.23 ± 13.85
4	30	11.55[b] ± 0.35	114.53 ± 10.66	66.21[b] ± 2.08	14.47 ± 1.58	1918.73[b] ± 67.70	2057.81 ± 094.68	323.27 ± 13.20
5	30	11.68[b] ± 0.49	106.90 ± 10.48	67.26[b] ± 2.69	13.10 ± 1.30	1963.78[b] ± 84.77	2077.45 ± 101.12	324.33 ± 12.91
6	29	11.64[b] ± 0.58	093.03 ± 09.15	64.59[a] ± 2.90	12.72 ± 1.13	1788.49[a] ± 90.57	1892.07 ± 107.59	322.00 ± 12.92
Overall	176	11.27 ± 0.20	102.00 ± 04.68	64.79 ± 1.09	13.72 ± 0.64	1872.61 ± 32.88	2009.31 ± 042.13	325.90 ± 05.53

N = No. of lactations, DPY/WPY = daily/weekly peak yield, SLMY/TLMY = standard/total lactation milk yield.
Means with different superscripts indicate significant differences ($p < 0.01$).

Table 2: Regression coefficients and R^2 for prediction equations of milk yield in Jaffarabadi (*Bubalus bubalis*) buffalo

Trait	Function	r value	Intercept	b value	F value	R^2 %
Weekly milk yield, lit	Linear	-0.857	59.15 ± 1.59	-0.663 ± 0.06	116.12	72.80
	Logarithmic	-0.819	1.80 ± 0.02	-0.007 ± 0.00	85.42	66.25
Monthly milk yield, lit	Linear	-0.911	261.64 ± 13.52	-13.229 ± 1.99	44.04	81.20
	Logarithmic	-0.904	2.45 ± 0.04	-0.035 ± 0.01	40.37	79.70
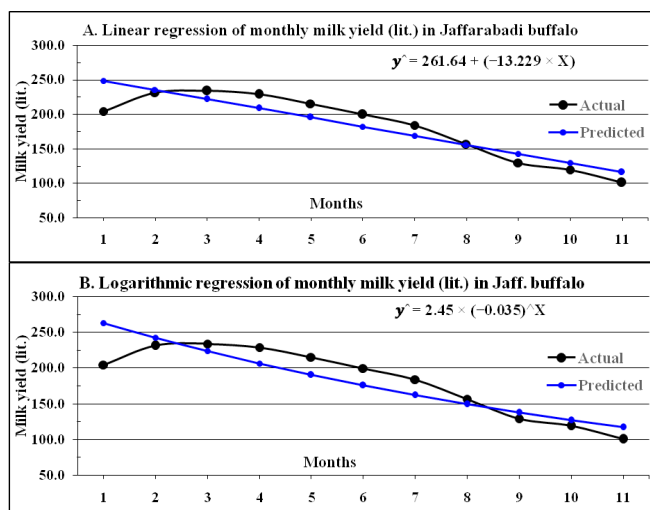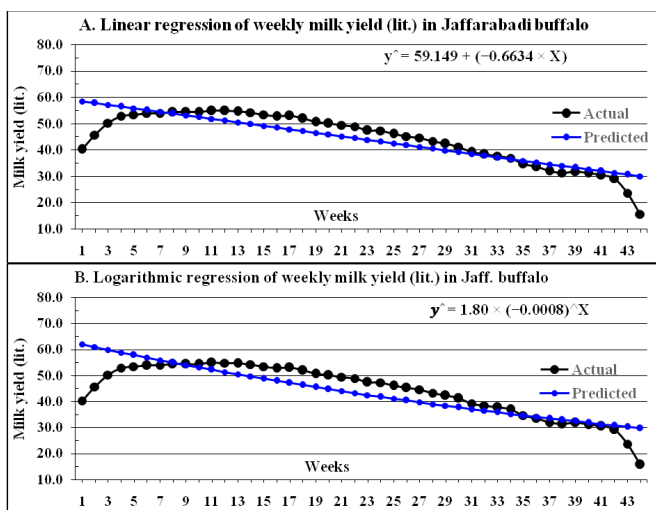
Figs. 1: Linear and logarithmic regression of lactation curve in terms of weekly milk production in Jaffarabadi (*Bubalus bubalis*) buffalo

Figs. 2: Linear and logarithmic regression of lactation curve in terms of monthly milk production in Jaffarabadi (*Bubalus bubalis*) buffalo

Table 3: Persistency (%) of milk yield based on weekly and monthly milk production of Jaffarabadi (*Bubalus bubalis*) buffalo

Week	N	Persistency(%)	Week	N	Persistency(%)	Month	N	Persistency(%)
2	176	116.14 ± 1.40	24	174	99.38 ± 0.83	2	176	114.75 ± 1.33
3	176	111.35 ± 1.12	25	174	97.55 ± 0.81	3	176	102.34 ± 0.97
4	176	106.45 ± 1.04	26	174	98.24 ± 0.82	4	176	99.16 ± 0.96
5	176	100.99 ± 0.80	27	174	98.88 ± 1.00	5	176	94.97 ± 1.01
6	176	101.80 ± 1.02	28	174	98.38 ± 1.22	6	176	92.43 ± 1.14
7	176	101.36 ± 0.92	29	174	98.14 ± 0.83	7	174	91.01 ± 1.07
8	176	101.28 ± 0.88	30	173	96.98 ± 0.89	8	172	83.63 ± 1.64
9	176	100.92 ± 1.06	31	172	94.41 ± 1.15	9	158	74.51 ± 2.15
10	176	100.64 ± 0.72	32	169	95.78 ± 1.17	10	125	75.25 ± 2.64
11	176	101.73 ± 0.88	33	164	95.48 ± 1.04	11	97	66.92 ± 3.37
12	176	100.78 ± 0.74	34	161	96.40 ± 1.15	Overall	1606	91.24 ± 0.59
13	176	99.77 ± 0.78	35	159	91.29 ± 1.45			
14	176	100.01 ± 0.71	36	153	100.09 ± 7.19			
15	176	99.32 ± 0.82	37	148	90.63 ± 1.71			
16	176	99.41 ± 0.72	38	138	89.11 ± 1.98			
17	176	100.96 ± 0.70	39	128	93.00 ± 1.60			
18	176	98.39 ± 0.80	40	123	92.20 ± 1.82			
19	176	97.86 ± 0.88	41	118	92.38 ± 2.10			
20	176	99.50 ± 1.14	42	112	88.85 ± 1.85			
21	176	100.32 ± 1.25	43	106	74.65 ± 2.10			
22	176	98.92 ± 0.71	44	103	62.87 ± 1.00			
23	176	96.51 ± 0.91						
Overall				7043	98.03 ± 0.24			

N = No. of lactations.

in Surti buffalo using gamma function and inverse polynomial function and reported the R^2 value 74.90% to 96.78%.

Persistency of Lactation

In terms of weekly milk yield, overall persistency was estimated to be 98.03±0.24%. Thus, the overall rate of decline in milk yield was 1.97 % per week. Weekly milk production was above 100 % until the 12th week and further maintained above 95% up to the 30th week (Table 3). Overall persistency in terms of monthly milk yield was estimated to be 91.24±0.59%, overall rate of decline in milk yield being 8.76 % per month. Monthly milk production was found to persist above 90 %

till 7th month postpartum (Table 3). The effect of parity on lactation persistency was non-significant (p > 0.05). Savaliya and Ahlawat (2016) reported overall persistency in Jaffarabadi buffalo as 0.82±0.02, *i.e.*, 82 %, which is somewhat lower than the present findings. Das *et al.* (2007) studied and reported the persistency of first lactation of Swamp buffaloes of Assam as 96.99 % and average persistency of five lactations as 97.40%. Pandya *et al.* (2021) reported the persistency of Surti buffalo ranging from 97.94 to 98.56%.

CONCLUSIONS

The present findings tended to indicate that Jaffarabadi buffalo is a high and persistent milk producer animal with quite a long lactation length. Linear regression function has been found more accurate than Logarithmic regression function for prediction of weekly and monthly milk production of this buffalo.

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