

## MILK YIELD AND HORMONAL RESPONSE OF JAFFRABADI BUFFALOES TO EXTENDED PHOTOPERIOD AND SHOWERING

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**Abstract:** An experiment was conducted to study the effect of long day photoperiod and showering on milk production and associative endocrine changes in lactating Jaffrabadi buffaloes between November, 2013 and May, 2014 at Cattle Breeding Farm, Junagadh Agricultural University, Junagadh (India) on twenty-four recently calved Jaffrabadi buffaloes for a total duration of 182 days. The treatment groups were T<sub>1</sub> (control-Natural day photoperiod-NDPP), T<sub>2</sub> (NDPP + showering twice a day), T<sub>3</sub> (long day photoperiod of 18 h-LDPP) and T<sub>4</sub> (LDPP + showering twice a day). The buffaloes were fed as per ICAR (2010) feeding standards to meet the nutritional demands of lactation. Supplemental lighting of 20 foot candle at eye level of buffaloes in T<sub>3</sub> and T<sub>4</sub> was provided by fluorescent lamps, controlled by automatic timer. Plasma was assayed for Insulin like Growth Factor-1 (IGF-1) and Prolactin (PRL) hormones by using ELISA kit. Buffaloes in T<sub>4</sub> produced 27.68% (1.55 lit) more milk than control group of buffaloes, followed by T<sub>3</sub> group of buffaloes producing 24.0% (1.35 lit) and T<sub>2</sub> group of animals producing 8.93% (0.5 lit) more milk per day. Buffaloes exposed to LDPP showed greater concentrations of IGF-1 and prolactin than buffaloes exposed to NDPP and revealed physiological basis for possible endocrine mechanism for the galactopoietic response of both the hormones. LDPP along with showering twice a day produce dsynergetic effect on milk yield in Jaffrabadi buffaloes. These practices are simple to implement, easy to manage, profitable, cost effective and does not require any technological insertion and thus provide another management tool for dairy buffalo producers to enhance productivity and profitability

**Keywords:** Jaffrabadi buffalo, milk yield, Insulin like Growth Factor-1, prolactin, photoperiod, showering.

### INTRODUCTION

First reported by Peters *et al.* (1978), the galactopoietic response of cows to a long daily (24-h) photoperiod (16 to 18 h of light to 6 to 8 h of darkness) has subsequently been confirmed by a number of investigators (Stanisiewski, *et al.* 1985; Bilodeau *et al.*, 1989; Evans and Hacker, 1989). Insulin like growth factor-1 (IGF-I) is associated with increased milk yield in cows following treatment with exogenous somatotropin (ST) (Dahl *et al.* 1991; Bauman and Vernon, 1993). Long day photoperiods stimulate IGF-I secretion in a number of species, including cattle, and these increases can be independent of ST (Suttie *et al.*, 1991; Spicer *et*

*al.*, 1994). Close arterial infusion of IGF-I in the mammary gland stimulates milk yield in goats, suggesting that the galactopoietic action of IGF-I is direct (Prosser *et al.*, 1990). Dahl *et al.* (1997) reported that a long daily photoperiod increases circulating concentrations of IGF-I and milk yield in lactating cows. The light stimulus inhibits the secretion of melatonin by the pineal gland such that melatonin is high at night and low during the day (Stanisiewski *et al.*, 1988). In lactating dairy cows, exposure to a long-day photoperiod of 16 h of light and 8 h of dark (16L:8D) is associated consistently with an increase in prolactin (PRL) concentration and milk production (Dahl and Petitclerc, 2003).

The effect of photoperiod on circulating concentration of IGF-1 and prolactin is of particular interest, because both the hormones influence on the function of mammary glands of dairy animals.

Sharma and Gangwar (1981) revealed that the showers and the evaporative cooling were responsible for increasing the galactopoietic responses in Murrah buffaloes. Verma *et al.* (1988) studied the effect of showering and observed significant increase in FCM yield in lactating buffaloes. Ahmad and Tariq (2010) opined that showering of buffaloes twice a day, wallowing and cooled drinking water can increase conception rate from 21 to 30 percent and there is a definite increase in milk yield of about 20 to 25%. Ambulkar *et al.* (2011) concluded that the high pressure fogger system (HPFF) was beneficial in terms of the body comfort of the animals and the milk yield in Murrah buffaloes.

Hence, considering the importance of photoperiod and thermal cooling in enhancing milk production and paucity of such studies in Jaffrabadi buffaloes, the present investigation was undertaken to investigate the production and endocrine responses to long day photoperiod and thermal cooling in Jaffrabadi buffaloes.

## **MATERIALS AND METHODS**

The experiment was conducted between November 2013 and May 2014 at Cattle Breeding Farm, Junagadh Agricultural University, Junagadh (India). Twenty-four recently calved Jaffrabadi buffaloes after attaining their peak yield in their 1-5 lactations were balanced for uniformity according to average daily milk yield and body weight. The buffaloes were maintained under standard feeding conditions as per ICAR (2010) feeding standards to meet the nutritional demands. The buffaloes were housed in a barn under stall fed conditions. Buffaloes were randomly assigned to one of to four treatments, each group consisting of 6 lactating buffaloes in a completely randomized design. This study consisted of 13 fortnights (182 days) measurement periods. The treatment groups were T<sub>1</sub> (control-Natural day

photoperiod-NDPP), T<sub>2</sub> (NDPP + showering twice a day), T<sub>3</sub> (long day photoperiod of 18 h-LDPP) and T<sub>4</sub> (LDPP + showering twice a day). Supplemental lighting of 20 foot candle at eye level of buffaloes was provided by fluorescent lamps, controlled by automatic timer. Lights were turn on at 17:30 h and off at 24 h for group T<sub>3</sub> and T<sub>4</sub>. showering was offered twice in a day at 10:30 h and at 16:00 h. (each for 15 minutes)for T<sub>2</sub> and T<sub>4</sub> groups. Buffaloes were milked daily at 4:30 h and at 16:30 h by hand milking. Blood samples were collected in 10 ml tubes (BD Vacutainer, K2E 18.0 mg) containing EDTA anticoagulant by puncture of a jugular vein of buffaloes at 30, 60, 120 and 180 day of the experiment. Plasma was harvested after centrifugation for 10 minutes at 3000 rpm and frozen at -20°C until concentrations of Insulin like Growth Factor-1(IGF-1) and Prolactin (PRL) were determined by using ELISA kit (My BioSource, California, USA).

### Statistical analysis

Data generated during the experiment were analyzed as per Completely Randomized Design (CRD) (Snedecor and Cochran, 1994) and results are presented as average  $\pm$  standard error of mean.

## RESULTS AND DISCUSSION

### Milk yield

Mean daily milk yield during entire experimental period was  $5.60 \pm 0.55$ ,  $6.10 \pm 0.63$ ,  $6.95 \pm 0.62$  and  $7.15 \pm 0.44$  litres in T<sub>1</sub>, T<sub>2</sub>, T<sub>3</sub> and T<sub>4</sub> respectively (Table 1).

Differences in milk production during different periods were non-significant. In all the treatments mean daily milk yield increased linearly from P1 to P3 in T<sub>1</sub> and T<sub>2</sub> and thereafter declined gradually. However, in T<sub>3</sub> and T<sub>4</sub> peak milk yield was recorded in P4 and thereafter declined in linear fashion. Though differences were non-significant, buffaloes in T<sub>4</sub> produced 27.68% (1.55 lit) more milk than control group of buffaloes, followed by T<sub>3</sub> group of buffaloes producing 24.0% (1.35 lit) and T<sub>3</sub> group of animals producing 8.93% (0.50 lit) more milk per day than control group.

Total whole milk produced during entire experimental period of 182 days was  $1098.30 \pm 108.56$ ,  $1195.02 \pm 124.35$ ,  $1362.55 \pm 121.47$  and  $1402.32 \pm 86.27$  liters in T<sub>1</sub>, T<sub>2</sub>, T<sub>3</sub> and T<sub>4</sub> respectively

Increase in milk yield due to extended photoperiod was observed by number of researchers (Peters *et al.*, 1978; Stanisiewski, *et al.*, 1985; Bilodeau *et al.*, 1989; Evans and Hacker, 1989; Dahl *et al.*, 2000; Vanbaale *et al.*, 2005; Gavan and Motorga, 2009) in exotic cows.

### **Insulin-like growth factor-1(IGF-1)**

Concentration of IGF-1 did not increase significantly in plasma at 30, 60, 120 and 180 days of the experiment. IGF-1 concentration ranged from  $7.37 \pm 2.44$  ng/ml in T<sub>2</sub> at 30-day to  $43.46 \pm 22.69$  ng/ml at 60-day in T<sub>4</sub>. Extension of photoperiod under T<sub>3</sub> and T<sub>4</sub> from 12 h to 18 h /day increased plasma concentration of IGF1. Though levels decreased simultaneously afterward but remained higher than control and T<sub>2</sub> group of buffaloes. Increase in IGF-1 level was associated with increased milk production in T<sub>3</sub> and T<sub>4</sub> compared to other groups (Table 2).

An interesting observation in present experiment is that photoperiod combined with showering effect appeared to have associative positive (additive) effect on IGF-1 concentration than photoperiod alone. Present study conformed galactopoietic effect of IGF-1 due to extended photoperiod.

The observation that buffaloes exposed to the long photoperiod had increased milk yield relative to buffaloes exposed to the natural photoperiod confirmed previous reports that long days are galactopoietic in cows (Peters *et al.*, 1978; Stanisiewski, *et al.*, 1985; Bilodeau *et al.*, 1989; Evans and Hacker, 1989; Dahl *et al.*, 1997).

The effect of a long photoperiod on IGF-I in Jaffrabadi buffaloes must also be considered in the context of the biological outcome, that is, increased milk yield. Bauman and Vernon (1993) have suggested that the galactopoietic effects of ST in ruminants are mediated by the concomitant increases in circulating concentrations of IGF-I. Indeed, there is evidence that IGF-I has a direct galactopoietic action at the mammary gland (Prosser *et al.*, 1990), even in the absence of elevated concentrations of ST. The results of the present study support the concept that net increase in circulating concentration of IGF-1 is galactopoietics.

### **Prolactin**

Concentration of Prolactin hormone increased significantly in plasma at 30, 120 and 180 days of the experiment. Prolactin concentration ranged from  $17.26 \pm 1.51$  ng/ml in T<sub>1</sub> at 30-day to  $36.41 \pm 1.75$  ng/ml at 30-day in T<sub>4</sub>. Prolactin concentration increased linearly in plasma in T<sub>1</sub> to T<sub>4</sub> at 30 days. Significantly ( $P < 0.05$ ) higher concentration of prolactin was recorded in buffaloes subjected to photoperiod treatment (T<sub>3</sub>) and photoperiod and showering (T<sub>4</sub>) in comparison to T<sub>1</sub> and T<sub>2</sub> (Table 3). In T<sub>1</sub>, concentration of Prolactin increased up to 60 days and declined thereafter at 120 and 180 days. T<sub>2</sub> group of buffaloes followed the same pattern. Prolactin concentration did not differ significantly among treatments at 60-day sampling. However, at 120-day and 180-day sampling, differences among prolactin concentration were

significant ( $P < 0.05$ ). Extension of photoperiod under  $T_3$  and  $T_4$  from 12 h to 18 h /day increased plasma concentration of Prolactin. Increase in Prolactin level was associated with increased milk production in  $T_3$  and  $T_4$  compared to other groups and revealed a physiological basis for possible endocrine mechanism for the galactopoietic response of Prolactin hormone.

Prolactin emerged as the initial candidate responsible for the galactopoietic effects of photoperiod. According to Tucker *et al.* (1984), long day photoperiod increase circulating concentrations of PRL in a number of species, including cattle Short days, and melatonin replacement to mimic short days, decrease circulating PRL (Buchanan *et al.*, 1993). Because of the galactopoietic role of PRL in a number of species, it would appear to be a logical mediator of the photoperiodic effect on lactation in Jaffrabadi buffalo.

### **Showering**

From point of view of dark skinned. Buffaloes due to their dark skin and very less number of sweat glands/square inch (Marai and Haebe, 2010) require a mechanism to dissipate body heat, showering was main option available. During the experimental periods maximum daily temperature recorded was 40.1°C in May, 2014. Showering in combination to LDPP ( $T_4$ ) seems to have synergetic effect on milk production. Increased milk yield was noticed by providing thermal cooling in buffaloes by number of workers (Sharma and Gangwar, 1981; Verma *et al.*, 1988; Ahmad and Tariq, 2010; Ambulkar *et al.*, 2011).

### **Conclusions**

IGF-I and prolactin (PRL) are galactopoietic in dairy buffaloes and revealed physiological basis for possible endocrine mechanism for the galactopoietic response of both the hormones. Long day photoperiod and showering twice a day are effective managerial practices that can be used to improve milk production of lactating Jaffrabadi buffaloes. These practices are simple to implement, easy to manage, profitable, cost effective and does not require any technological insertion in dairy buffalo management and thus provide another management tool for dairy producers to enhance productivity and profitability.

### **Acknowledgement**

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**Table-1** Average daily milk yield (l) of experimental Jaffrabadi buffaloes during different periods

Treatment	P0	P1	P2	P3	P4	P5	P6	P7	P8	P9	P10	P11	P12	P13	Overall
T <sub>1</sub>	6.68	6.90	7.11	7.13	7.11	6.82	6.91	6.40	6.29	5.65	5.13	4.70	4.25	4.04	5.60
	±	±	±	±	±	±	±	±	±	±	±	±	±	±	±
	0.51	0.78	0.84	0.74	0.70	0.68	0.85	0.77	0.69	0.62	0.48	0.52	0.61	0.63	0.55
T <sub>2</sub>	6.68	7.34	7.58	7.69	7.61	7.22	7.10	6.36	6.75	6.22	5.88	5.78	5.09	4.73	6.10
	±	±	±	±	±	±	±	±	±	±	±	±	±	±	±
	0.43	0.28	0.54	0.61	0.63	0.72	0.86	0.76	0.93	0.88	0.83	0.87	0.80	0.79	0.63
T <sub>3</sub>	6.70	7.72	8.53	8.81	9.16	8.62	8.29	7.83	7.48	6.76	6.61	6.33	5.80	5.38	6.95
	±	±	±	±	±	±	±	±	±	±	±	±	±	±	±
	0.36	0.37	0.63	0.75	0.87	0.81	0.80	0.74	0.85	0.71	0.80	0.88	0.82	0.78	0.62
T <sub>4</sub>	6.63	7.80	8.88	9.10	9.49	8.91	8.54	7.97	7.92	7.20	6.80	6.37	5.82	5.39	7.15
	±	±	±	±	±	±	±	±	±	±	±	±	±	±	±
	0.48	0.39	0.40	0.47	0.36	0.52	0.52	0.41	0.74	0.63	0.64	0.61	0.63	0.52	0.44
<b>S.Em.±</b>	0.45	0.49	0.63	0.65	0.67	0.69	0.77	0.69	0.81	0.72	0.70	0.74	0.72	0.69	0.57
<b>C.D. at 5%</b>	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
<b>C.V. %</b>	16.5	16.21	19.11	19.05	19.61	21.28	24.49	23.61	27.79	27.21	28.22	31.19	33.76	34.54	21.54

Values are Mean±SE, T<sub>1</sub>:control-Natural day photoperiod-NDPP, T<sub>2</sub>:NDPP + showering twice a day, T<sub>3</sub>:long day photoperiod of 18 h-LDPP, T<sub>4</sub>:LDPP + showering twice a day, C.D.: Critical Difference, C.V.: Coefficient of variance, S.Em: Standard error mean, P:Measurement Period, NS: Non-significant



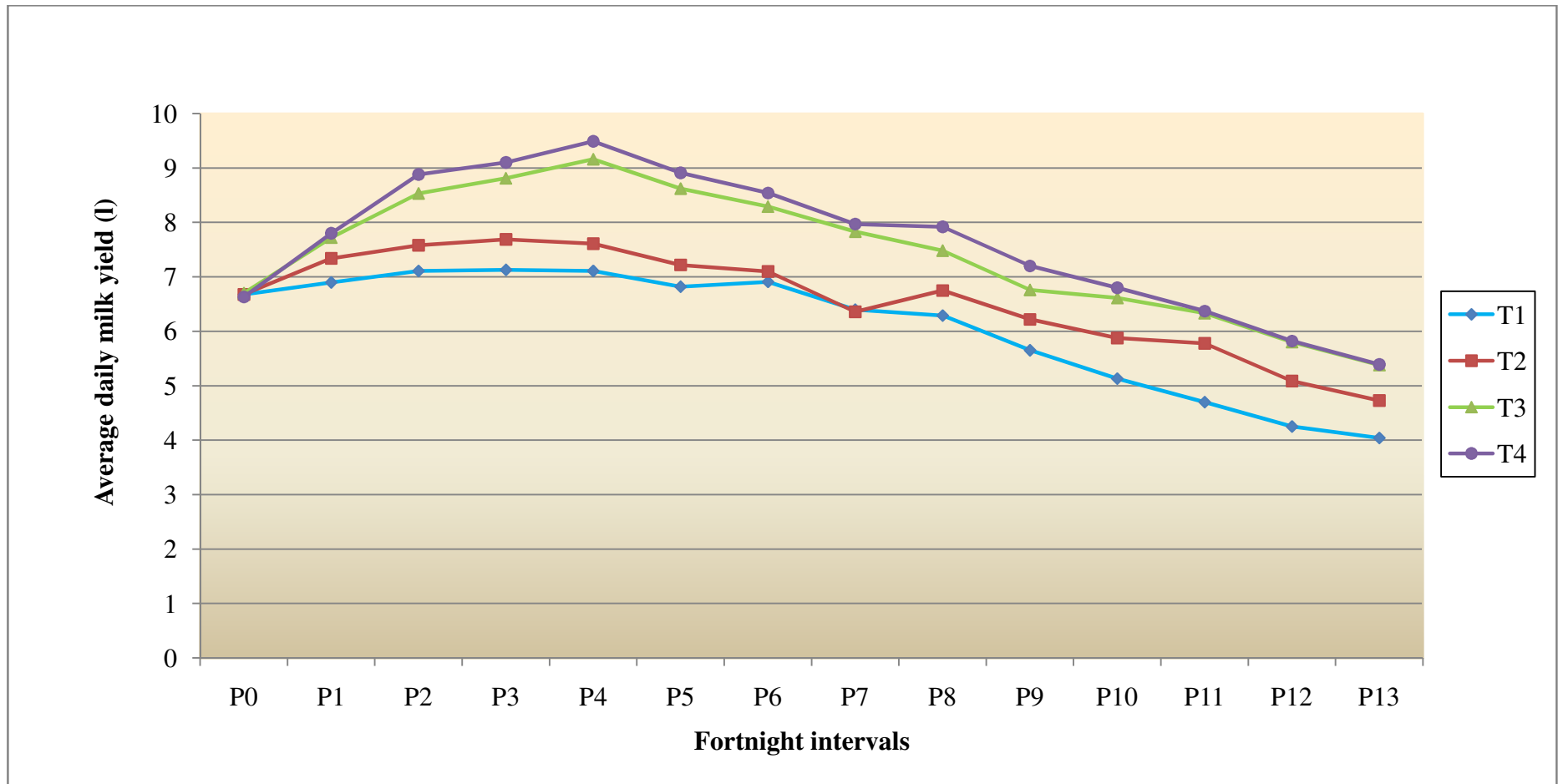
**Table -2** Average Insulin like growth factor-1 (IGF-1) (ng/ml) levels in Jaffrabadi buffaloes during different phases of experiment

<b>Treatment</b>	<b>30 Day</b>	<b>60 Day</b>	<b>120 Day</b>	<b>180 Day</b>
<b>T<sub>1</sub></b>	9.48 ± 3.34	15.78 ± 5.93	16.27 ± 10.22	17.63 ± 4. 20
<b>T<sub>2</sub></b>	7.37 ± 2.44	17.95 ± 6.14	18.44 ± 11.29	17.37 ± 4.37
<b>T<sub>3</sub></b>	23.18 ± 11.87	29.38 ± 13.07	27.53 ± 11.82	23.30 ± 10.17
<b>T<sub>4</sub></b>	239.58 ± 21.57	43.46 ± 22.69	37.17 ± 16.86	37.37 ± 17.87
<b>S.Em.±</b>	12.42	13.62	14.18	10.71
<b>C.D. at 5%</b>	NS	NS	NS	NS
<b>C.V. %</b>	23.29	28.65	32.52	42.56

**Table -3** Average bovine Prolactin (ng/ml) levels in Jaffrabadi buffaloes during different phases of experiment

<b>Treatment</b>	<b>30 Day</b>	<b>60 Day</b>	<b>120 Day</b>	<b>180 Day</b>
<b>T<sub>1</sub></b>	17.26 ± 1.51 <sup>b</sup>	28.55 ± 1.80	23.51 ± 0.22 <sup>b</sup>	18.17 ± 1.82 <sup>b</sup>
<b>T<sub>2</sub></b>	18.40 ± 1.53 <sup>b</sup>	27.10 ± 2.21	25.81 ± 1.55 <sup>b</sup>	22.19 ± 1.75 <sup>b</sup>
<b>T<sub>3</sub></b>	35.62 ± 1.43 <sup>a</sup>	33.52 ± 2.29	30.63 ± 1.36 <sup>a</sup>	28.36 ± 1.72 <sup>a</sup>
<b>T<sub>4</sub></b>	36.41 ± 1.75 <sup>a</sup>	31.81 ± 1.93	30.35 ± 1.35 <sup>a</sup>	26.28 ± 2.81 <sup>a</sup>
<b>S.Em.±</b>	1.56	2.07	1.24	2.08
<b>C.D. at 5%</b>	4.68	NS	3.7	6.23
<b>C.V. %</b>	12.96	15.28	10.04	19.58

Means in a column with different superscripts differ significantly (P<0.05)



**Figure-1** Average daily milk yield (lit) of Jaffrabadi buffaloes during different phages of experiment