RESEARCH ARTICLE

Effect of Feeding Rumen Bypass Fat on Productive and Reproductive Performance of Buffaloes under Field Conditions

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Abstract

The present study was conducted to evaluate the effects of supplementation of bypass fat one month pre-parturition and three months of early lactation on milk production and reproductive performance of buffaloes. Thirty two multiparous pregnant buffaloes (2-3 lactation) were selected at farmers' doorstep in Dahod District, Gujarat, and were divided into two equal groups, each of 16 animals, on the basis of their milk production and fat % during previous lactation. Animals in T1 group (n=16, control) were fed as per farmers' feeding schedule, and those in T2 group were additionally supplemented with bypass fat @ 100 g/h/d during prepartum and 20 g/kg of milk yield during postpartum phase. The overall average whole milk yield (kg/head/d) of buffaloes was significantly ($p<0.05$) higher in bypass fat group T2 than control T1 (5.43±0.07 vs. 4.50+0.04). The fat percentage was significantly ($p<0.05$) higher (6.77±0.09 vs. 5.84±0.04) and SNF was lower (10.68±0.18 vs. 11.32±0.16) in bypass fat supplemented group. The average daily yields (kg/head/d) and cumulative yields (kg/head) of whole experimental period of fat, SNF, 6% FCM, SCM and ECM were significantly ($P<0.05$) higher in bypass fat group. However, average milk constituents, *viz.,* total solids, protein, calcium and phosphorus were statistically similar in T1 and T2 groups. Daily feed cost (Rs. 101.66±0.45 vs. 92.98±0.64) and average realizable receipt from sale of milk (Rs. 231.12±1.46 vs. 165.88±1.39/head) were ($p<0.05$) higher in T2 group over control, and thus average daily profit increased per buffalo was Rs. 56.56 over control. Postpartum first heat was earlier by 14 days with significantly ($p<0.05$) reduced number of AIs per conception (1.63±0.13 vs. 3.88±0.20) and service period (129.46±9.61 vs 187.70±11.89 days) in bypass fat group compared to control group. The findings indicated that supplementing bypass fat to buffaloes @ 100 g/head/day one month before parturition and 20 g/kg milk yield during early lactation is advantageous in terms of increased milk yield, 6% FCM yield, with improved postpartum fertility and higher daily profit per buffalo.

Keywords: Bypass fat, Milk composition, Milk yield, Reproductive performance, Transition buffalo,

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Introduction

High producing cows and buffaloes in early lactation are not able to consume sufficient dry matter to support maximal production of milk. High energy requirement at the onset of lactation results in a negative energy balance that begins a few days prepartum and reaches maximum up to few weeks postpartum, thus forcing mobilization of body fat to satisfy energy requirement (Barley and Baghel, 2009). This may adversely affect postpartum health, fertility and overall reduction in milk yield. Therefore, minimizing the extent and duration of negative energy balance during this period could be beneficial for better productive and reproductive performance of dairy animals.

Bypass fat technology involves coating of fat by chemical or physical treatment to protect it from ruminal hydrolysis and bio-hydrogenation and making more availability in lower gastro-intestinal tract. Calcium salts of long chain fatty acids (LCFAs) are more effective as bypass fat for transition animals as extra-energy source. The problem of negative energy balance during early lactation can be easily overcome by feeding rumen protected/bypass fat to ruminants (Tyagi *et al.*, 2010) and in expressing their milk production potential to the fullest extent (Krishna Mohan and Reddy, 2009). The improvement from added fat includes higher milk yield & milk fat (Parnerkar *et al.*, (2011), steroidogenesis (Staples *et al.*, 1998), higher conception/pregnancy rate, reduced service period and economic viability (Shankhpal *et al.*, 2009;

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Parnerkar *et al*., 2011). Therefore, this study was planned to study the effects of feeding bypass fat (calcium salt of palm oil) on milk yield and gross milk composition and the cost of milk production including postpartum reproductive performance in transition buffaloes under field conditions.

Materials and Methods

This study was undertaken on thirty two advanced pregnant buffaloes in 2nd to 4th parity at farmers' doorstep from four villages of Limkheda and Devgadh Baria talukas of Dahod District in Gujarat (India). Buffaloes were selected on the basis of their average daily milk yield and fat % in previous lactation and were randomly allotted to two equal dietary treatment groups, *i.e.,* T1 (Control) and T2 (Bypass fat). Animals in T1 (control) group were fed as per farmers' feeding schedule (home-made concentrate mixture, maize straw, green bajra, shedha grass, paddy straw and ground nut gotar) and those in T2 group were supplemented with bypass fat (S.A. Pharmachem Pvt Ltd, Mujpur, Padara, Vadodara, India) @ 100 g/h/d during one month prepartum and 20 g/kg of milk yield during first three months of lactation in addition to farmers' feeding schedule. The conventional practice of feeding concentrates in two equal portions at the time of hand milking in the morning and evening was followed. Clean, fresh and wholesome water was made available to all the experimental animals in the morning and afternoon. The average body weight of buffaloes was considered as 450 kg.

Milk Yield and Milk Composition

The buffaloes were hand milked twice daily (5.30 and 18.00 h) and yields were recorded. The milk samples were collected at fortnightly intervals from individual animals during both times of milking. After through mixing, composite milk sample (100-150 mL) from each buffalo was taken by means of a dipper and transferred to a sample bottle with rounded corners, corked tightly, labelled and dispatched to laboratory for analysis of fat, total solids, SNF, protein and mineral contents on the same day as per BIS (1981).

The fat content of milk samples was estimated by digital electronic Milk-o-tester (REMI made) machine. The per cent total solids, *i.e.*, dry matter content of milk samples was estimated by evaporation method. Solids-not-fat (SNF %) was estimated by deducting fat from total solids. To assess milk protein, the nitrogen content in milk samples was estimated by Kjeldahl's method (BIS, 1981), and was multiplied by factor 6.38 to get the protein content of milk. The calcium and phosphorus contents of milk samples were analysed as per the AOAC (2005).

Fat/Solid/Energy-Corrected-Milk (FCM, SCM, ECM) Yield

The 6% FCM of whole milk was determined as per the formula: 6% FCM (kg) = [(0.4 M + 15 F)/1.3], Where, M = Milk yield in kg, and F = Weight of fat contained in it. SCM yield was determined as per the formula, SCM (kg) = [12.3 (F) + 6.556 (SNF) – 0.0752 (M)], Where, M = Milk yield in kg, F = Weight of fat contained in it, and SNF= Solids-not-fat yield in kg, and ECM (kg) = [(milk yield * 0.3246) + (fat yield * 12.86) + (protein yield * 7.04)], Where, fat yield = (fat % * milk yield)/100, and protein yield = (protein % * milk yield)/100.

Reproductive Performance

The period for occurrence of first estrus postpartum and number of AI/conception was recorded for all the buffaloes. Approximately 90 days after AI, pregnancy diagnosis was carried out by rectal palpation, and the service period was calculated.

Cost of Feeding and Return Over Feed Cost

The cost of feeding per animal was calculated from the data of feed intake and prevailing procurement price of individual feed ingredients. The realizable receipt was calculated based on the milk purchase price declared by The Panchmahal District Cooperative Milk Producers' Union Ltd, Godhra (The Panchamrut Dairy, Rs. 630 per kg fat).

The data generated on milk yield and milk composition was analyzed using two way ANOVA following factorial completely randomized design and those on reproduction parameters by one way ANOVA (Snedecor and Cochran, 1994).

Results and Discussion

The findings of the study in two groups of buffaloes including cost-benefit ratio of feeding bypass fat are presented in Tables 1 to 4.

Whole Milk Yield and Milk Composition

The buffaloes in T1 and T2 groups on an average produced 4.50±0.04 and 5.43±0.07 kg/head/d whole milk, which was significantly (P<0.01) higher in bypass fat group (Table 1). This improvement in whole milk yield was attributed to higher ME intake through fortification of the diet with rumen protected fat (Shelke *et al*., 2012). Many earlier researchers (Shelke and Thakur, 2010; Parnerkar *et al*., 2011; Ramteke *et al*., 2014; Desai *et al*., 2017; Atkare *et al*., 2018) have also reported a significant increase in whole milk yield in dairy animals fed bypass fat, which is in agreement with present findings. On the contrary, Sarwar *et al*. (2003), Ranjan *et al.* (2012) and Savsani *et al*. (2017) reported no significant difference in milk yield of dairy animals due to supplementation of bypass fat. However, Sarwar *et al*. (2003), Tyagi and Thakur (2007), Ranjan *et al*. (2012), found a significant increase in FCM yield in dairy animals fed bypass fat.

The average percentage of milk fat was significantly higher (6.77±0.09 vs. 5.84±0.04 p<0.05), whereas the SNF was lower (10.68±0.18 vs. 11.32±0.16 P<0.05) in group T2 buffaloes fed bypass fat than control T1 group (Table 1). Significantly (p<0.05) higher milk fat percent found in bypass fat supplemented group was attributed to more availability of fatty acids for absorption in intestine due to protection of fat and these absorbed fatty acids are directly incorporated in milk fat leading to increase in milk fat (Shelke *et al*., 2012). These findings on fat content were in agreement with the results reported in dairy animals by Sarwar *et al*. (2003), Shankhpal *et al*. (2009), Shelke and Thakur (2010), Parnerkar *et al*. (2011), Ramteke *et al*. (2014), Sharma *et al*. (2016), Desai *et al*. (2017) and Atkare *et al*. (2018). However, no effects of bypass fat supplementation was observed on milk fat by Moallem *et al*. (2007), Tyagi *et al*. (2009). Similarly, significantly (p<0.01) lower SNF percent in bypass fat supplemented cows was also observed by Desai *et al*. (2017). However, others (Shankhpal *et al*., 2009; Shelke and Thakur, 2010; Sharma *et al*., 2016; Mobeen *et al*., 2017) observed that the SNF content of milk was not influenced by feeding of bypass fat.

In the present study, the overall average per cent total solids in milk of T1 and T2 groups was 17.16±0.16 and 17.45±0.22, protein 3.61±0.05 and 3.53±0.04, calcium 0.16±0.00 and 0.17±0.00 and phosphorus 0.08±0.00 and 0.08±0.00, respectively, which however did not differ statistically from each other (Table 1). The fortnightly average values of all these parameters are given in Table 2. The observations on protein percent and total solids in the milk was in accordance with the findings of Tyagi *et al*. (2009), Shelke *et al*. (2012), Sharma *et al*. (2016) and Mobeen *et al*. (2017). However, Moallem *et al*. (2007) found significant increase in milk protein and total solids due to supplementation of bypass fat.

Milk Constituents Yield

The average values of daily yield (kg/head) based on fortnightly interval and overall of entire experiment of fat, total solid, SNF, 6% FCM, SCM and ECM are presented in Table 2. The overall average daily yields (kg/head) of fat, total solids, SNF, 6% FCM, SCM and ECM in T1 and T2 groups were 0.26±0.00 and 0.37±0.00; 0.77±0.01 and 0.94±0.02; 0.51±0.01 and 0.58±0.01; 4.42±0.04 and 5.87±0.07; 6.23±0.08 and 7.86±0.12; 5.99±0.05 and 7.78±0.09, respectively. All the values were significantly (p<0.05) higher in bypass fat supplemented group. Further, the cumulative yield (kg/head/105 d) of whole milk (570.44±6.85 vs. 473.19±4.27), fat (38.52±0.48 vs. 27.65±0.30), SNF (60.68±1.29 vs. 53.40±0.94) and 6% FCM (615.98±7.24 vs. 464.27±4.48) of entire experiment was significantly (p<0.05) higher in bypass far supplemented group than the control (Table 4). These findings corroborated well with the reports of Garg *et al*. (2008), Parnerkar *et al*., (2011), Desai *et al*., (2017) in dairy animals.

Reproductive Performance

The time required for occurrence of first postpartum heat in T1 and T2 group was 74.44±0.95 and 60.19±1.08 days, the number of AI required per conception 3.88±0.20 and 1.63±0.13, and service period 187.70±11.89 and 129.46±9.61 days, respectively, which were significantly (p<0.05) shorter/lower in bypass fat supplemented group T2. The commencement of cyclicity is related with the process of involution of uterus, as the duration for uterine involution was reduced on account of bypass fat supplementation, it might be responsible for relatively early commencement of cyclicity. These results concurred well with the reports of Tyagi *et al*. (2010), Gowda *et al*. (2013), Savsani *et al*. (2013) and Ramteke *et al*. (2014). According to Shelke *et al*. (2012) the reproductive performance is strongly associated with energy status. Dietary fats can provide fatty acids precursors for cholesterol and prostaglandin production, which have an effect on ovarian function, uterine function, and conception rates. Bypass fat typically increases concentrations of circulating cholesterol, the precursor of progesterone and thereby the blood progesterone concentration (Staples *et al*., 1998). Progesterone, secreted by the corpus luteum prepares the uterus for implantation of the embryo and helps maintain pregnancy by providing nourishment for the conceptus via induction of heterotrophic proteins from the endometrium.

Cost of Feeding and ROFC of Experimental Buffaloes

The feed cost, realizable receipt from sale of milk and return over feed cost (ROFC) overall and fortnightly interval have been depicted in Table 3 and 4. The daily feed cost (Rs/head) during prepartum phase was 64.64±0.62 and 72.75±1.11, which was significantly (p<0.05) higher in bypass fat supplemented group. Daily feed cost (Rs./head) during postpartum period was 92.98±0.64 and 101.66±0.45, respectively, which was also statistically (p<0.05) higher in bypass fat group. Similarly, Savsani *et al*. (2017) reported higher feed cost on account of bypass fat feeding. The average daily realizable receipt from sale of milk (Rs./head) in T1 and T2 groups was 165.88±1.39 and 231.12±1.46, respectively, which was significantly (p<0.05) higher in bypass fat supplemented group. The cumulative cost of feeding (Rs/head/105 d) was 9762.90±67.2 and 10674.30±47.25 and total realizable receipt (Rs/head/105 d) was 17417.40±186.90 and 24267.60±302.4 in T1 and T2 groups, respectively. Thus the average daily profit per buffalo (Rs) was 56.56 per day in

Table 1: Average daily gross milk yield (kg) and milk composition (%) of experimental buffaloes

Whole milk		Fat		SNF		TS		Protein		Calcium		Phosphorus	
T1	T2	T1	T2	T1	T2	T1	T2	T1	T2	T1	T2	T1	T2
4.50[a] ±0.04	5.43[b] ±0.07	5.84[a] ±0.04	6.77[b] ±0.09	11.32[b] ±0.16	10.68[a] ±0.18	17.16 ±0.16	17.45 ±0.22	3.61 ±0.05	3.53 ±0.04	0.16 ±0.00	0.17 ±0.00	0.08 ±0.00	0.08 ±0.00

Means with different superscripts for a particular milk parameter differ significantly (p<0.05).

Table 2: Average daily whole milk, fat, TS and SNF yield (kg/head) as well as fat (6%), solid and energy corrected milk yield (kg/head) of experimental buffaloes at fortnightly intervals and overall of early lactation

Component	Fortnight I		II		III		IV		V		VI		VII		Overall	
	T_1	T_2	T_1	T_2	T_1	T_2	T_1	T_2	T_1	T_2	T_1	T_2	T1	T2	T_1	T_2
Whole milk	4.41 ±0.08	5.29 ±0.10	4.40 ±0.13	5.38 ±0.11	4.45 ±0.08	5.34 ±0.10	4.62 ±0.11	5.58 ±0.10	4.55 ±0.11	5.45 ±0.11	4.41 ±0.09	5.46 ±0.09	4.69 ±0.07	5.52 ±0.25	4.50[a] ±0.04	5.43[b] ±0.07
Fat	0.26 ±0.01	0.35 ±0.01	0.25 ±0.01	0.35 ±0.01	0.26 ±0.01	0.38 ±0.01	0.28 ±0.01	0.38 ±0.01	0.26 ±0.01	0.37 ±0.01	0.26 ±0.01	0.38 ±0.01	0.28 ±0.01	0.36 ±0.01	0.26[a] ±0.00	0.37[b] ±0.00
TS	0.76 ±0.03	0.96 ±0.03	0.76 ±0.03	0.90 ±0.02	0.73 ±0.02	0.89 ±0.04	0.81 ±0.03	1.00 ±0.03	0.78 ±0.03	0.93 ±0.02	0.76 ±0.02	0.99 ±0.04	0.80 ±0.02	0.94 ±0.05	0.77[a] ±0.01	0.94[b] ±0.02
SNF	0.50 ±0.02	0.62 ±0.02	0.51 ±0.02	0.54 ±0.02	0.47 ±0.02	0.53 ±0.03	0.53 ±0.03	0.62 ±0.02	0.52 ±0.02	0.56 ±0.02	0.50 ±0.02	0.60 ±0.04	0.53 ±0.02	0.58 ±0.04	0.51[a] ±0.01	0.58[b] ±0.01
6% FCM	4.35 ±0.11	5.60 ±0.15	4.23 ±0.13	5.68 ±0.11	4.42 ±0.10	5.77 ±0.16	4.61 ±0.19	6.06 ±0.17	4.34 ±0.14	5.95 ±0.19	4.36 ±0.09	6.12 ±0.11	4.64 ±0.10	5.89 ±0.21	4.42[a] ±0.04	5.87[b] ±0.07
SCM	6.15 ±0.19	7.88 ±0.23	6.08 ±0.22	7.46 ±0.12	5.97 ±0.15	7.52 ±0.29	6.54 ±0.21	8.27 ±0.25	6.22 ±0.19	7.83 ±0.22	6.17 ±0.15	8.26 ±0.25	6.51 ±0.13	7.83 ±0.36	6.23[a] ±0.08	7.86[b] ±0.12
ECM	5.92 ±0.14	7.47 ±0.18	5.74 ±0.16	7.53 ±0.14	6.03 ±0.15	7.67 ±0.18	6.19 ±0.23	8.02 ±0.20	5.96 ±0.19	7.88 ±0.22	5.87 ±0.11	8.06 ±0.11	6.21 ±0.12	7.83 ±0.27	5.99[a] ±0.05	7.78[b] ±0.09

Means with different superscripts within the row differ significantly ($P<0.05$), Effect of fortnightly interval was also significant ($p<0.05$) for TS.

Table 3: Cost of feeding, realizable receipt from sale of milk and return over feed cost (Rs/head/d) considering the cost of bypass fat supplement given during postpartum period to experimental buffaloes

Factor	Fortnight I		II		III		IV		V		VI		VII		Overall	
	T_1	T_2	T_1	T_2	T_1	T_2	T_1	T_2	T_1	T_2	T_1	T_2	T1	T2	T_1	T_2
Cost of feeding	94.56 ±1.58	100.74 ± 0.72	93.93 ±1.93	99.93 ±1.12	93.20 ±1.79	100.95 ±1.29	92.38 ±1.41	102.08 ±1.44	93.00 ±1.75	102.91 ±1.20	91.05 ±1.19	101.72 ±1.16	92.75 ±1.50	103.28 ±1.16	92.98[a] ±0.64	101.66[b] ±0.45
Receipt from sale of milk	163.41 ±5.82	217.35 ±7.21	157.50 ±5.21	219.71 ±6.24	166.16 ±4.91	238.15 ±9.21	175.22 ±8.69	237.83 ±8.26	160.65 ±6.63	233.89 ±8.89	163.80 ±3.68	242.16 ±6.14	174.43 ±4.66	228.77 ±7.22	165.88[a] ±1.78	231.12[b] ±2.88
Return over feed cost	68.84 ±6.87	116.61 ±7.06	63.58 ±5.22	119.78 ±6.38	72.96 ±5.64	137.20 ±8.73	82.84 ±9.36	135.74 ±8.07	67.65 ±7.21	130.98 ±8.95	72.75 ±3.71	140.44 ±6.23	81.68 ±5.01	125.49 ±7.76	72.90[a] ±2.18	129.46[b] ±2.71

Means with different superscripts within the row differ significantly ($p<0.05$).

Table 4: Cumulative yield of whole milk and fat; feed cost, realizable receipt and return over feed cost of experimental buffaloes

No.	Particulars	T1	T2
1	Total milk yield (kg/head/105 d)	472.50±4.20	570.15±7.35
	Daily milk yield (kg/head)	4.50±0.04	5.43±0.07
2	Total fat yield (kg/head/105 d)	27.30±0.0	38.85±0.0
	Daily fat yield (kg/head)	0.26±0.0	0.37±0.0
3	Total SNF yield (kg/head)	53.40±0.94	60.68±1.29
4	Total 6% FCM yield (kg/head)	464.27±4.48	615.98±7.24
5	Cumulative feed cost - postpartum (Rs/head/105 d)	9762.90±67.2	10674.30±47.25
6	Realizable receipt from sale of milk (Rs/head/105 d)	17417.40±186.90	24267.60±302.4
7	ROFC (Rs/head/105 d) during postpartum phase	7654.50±228.9	13593.30±284.55
8	Daily ROFC (Rs/head) during postpartum	72.90±2.18	129.46±2.71
9	Difference in ROFC over control (Rs/head/d)	-	56.56

T2 over T1 group (Table 4). Parnerkar *et al*. (2011) reported the average daily return over feed cost from sale of milk (Rs/buffalo) as 100.51 and 127.12 in farm fed and bypass fat groups, respectively, which was Rs 26.61 more in bypass fat group. Similarly, Shelke *et al*. (2011) and Savsani *et al*. (2017) also reported improvement in daily return per buffalo on account of bypass fat feeding.

Conclusions

The findings of study indicated that supplementing bypass fat to transition buffaloes @ 100 g/head/day one month before parturition and 20 g/kg milk yield during early lactation was advantageous in terms of increased milk yield, 6% FCM yield, better feed conversion, higher daily profit per animal (Rs. 56), and improved postpartum fertility.

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