RESEARCH ARTICLE

Influence of Rumen Protected Fat Supplementation on Nutrient Intake and Feed Conversion Efficiency in Buffaloes

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Abstract

This study was carried out to assess the effects of supplementation of bypass fat for one month prepartum and three months postpartum on nutrient intake and feed conversion efficiency for milk production in buffaloes. Advanced pregnant buffaloes (n=32, 2-3 parity) were selected at farmers' doorstep, and were divided into two equal groups, each of 16 animals, on the basis of previous lactation milk production and fat %. Animals in T1 group (n=16, control) received farmers' feeding schedule, and those in T2 group were additionally supplemented with bypass fat @ 100 g/head/d during prepartum and 20 g/kg of milk yield during early lactation. Average daily DM and DCP intake did not differ significantly in control and treatment group, whereas average daily TDN intake was found significantly higher in treatment group during postpartum phase. Whole milk yield (kg/head/d) of buffaloes in T2 group was significantly ($p<0.05$) higher than T1 (5.43±0.07 vs. 4.50+0.04). Feed conversion efficiency (kg intake/kg whole milk) of DM (2.40±0.04 vs. 1.99±0.02), DCP (133.50±1.84 vs. 111.56±01.20) and TDN (1.53±0.02 vs. 1.31±0.01) was superior ($p<0.05$) in bypass fat group, and similar was the trend for 6% FCM yield. 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 higher ($p<0.05$) in T2 group over control. The findings indicated that the bypass fat supplement @ 100 g/head/day one month before parturition and 20 g/kg milk yield during early lactation to buffaloes was economically advantageous in terms of increased milk yield and better feed conversion efficiency.

Keywords: Bypass fat, Feed conversion efficiency, Milk yield, Nutrient intake, Transition buffalo.

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Introduction

The demand for energy is very high during early lactation in dairy animals but supply does not commensurate with demand thus adversely affecting their energy status and production potential. Therefore energy density of diet and productivity of lactating animals can be enhanced by strategic supplementation of bypass fat in the diet (Sirohi *et al*., 2010). Inclusion of unprotected fat in dairy ration is limited to 3% of dry matter (DM) intake, beyond which digestibility of DM and fibre are reduced (NRC, 2001). By protecting the fats from ruminal degradation, the fat content of the ration can be increased up to 6-7% of the DM intake. It is stated that supplementing ration of early lactating animals with bypass fat enhances energy intake in early lactation which reduces deleterious effect of acute negative energy balance on lactation (Barley and Baghel, 2009; Tyagi *et al*., 2009; Prajapati *et al.,* 2022). Fat supplementation increases energy density of the diet, but high dietary fat can lead to a reduction in fiber digestion in the rumen and a decline in milk fat percentage.

Variable results on nutrient intake and feed conversion efficiency in terms of DMI, DCPI and TDNI (kg/kg whole milk and kg/kg FCM) in dairy animals supplemented with bypass fat has been documented depending upon the pregnancy or stage of lactation, species and level of production, nature of bypass fat, quantity and duration of supplement, etc (Sarwar *et al*., 2003; Moallem *et al*., 2007; Shankhpal *et al*., 2009[a]; Tyagi *et al*., 2009; Shelke *et al*., 2012). In Jaffarabadi buffaloes, Savsani *et al.* (2015) showed non-significant effect on the DMI and TDNI per kg milk production, however DCP intake increased significantly ($p<0.05$) with bypass fat supplementation. Statistically similar DMI during prepartum and postpartum phase and higher ($p<0.01$) TDNI during both, with higher ($p<0.01$) DCPI only during prepartum in bypass fat supplemented than control group of buffaloes has also been reported by Ramteke *et al*. (2014). Similarly, Sharma *et al*. (2016) showed that buffaloes of fat supplemented group consumed more DMI ($p<0.01$) than the control during pre-partum period, however post-partum DMI was same, but TDNI was more ($p<0.05$), and CPI was numerically less in supplemented than control group. Therefore, this study

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was designed to evaluate the effects of feeding bypass fat (calcium salt of palm oil) on feed intake, milk yield and feed conversion efficiency for milk yield of transition buffaloes under field conditions.

Materials and Methods

Advanced pregnant buffaloes (n=32) in their 2nd to 4th parity were selected at farmers' doorstep from four villages of Dahod District in Gujarat (India) on the basis of their average daily milk yield and fat % in previous lactation. They were randomly allotted to two equal dietary treatment groups, *i.e.,* T1 (Control) and T2 (Bypass fat). Animals in T'1 (control) group received farmers' feeding (home-made concentrate mixture, maize straw, green bajra, shedha grass, paddy straw and ground nut gotar) and those in T2 group were supplemented, in addition to farmers' feeding schedule, with bypass fat (S.A. Pharmachem Pvt Ltd, Mujpur, Padara, Vadodara, India) @ 100 g/head/d during one month prepartum and 20 g/kg of milk yield during first three months of lactation. The conventional practice of feeding concentrates at the time of milking in the morning and evening was followed. Free access to clean, fresh and wholesome water was made available to all the experimental animals.

Feed and Nutrient Intake

The intake of DM, DCP and TDN of experimental buffaloes was compared with respective requirement for maintenance and milk production as per ICAR (1998). The amount of daily DM, DCP and TDN intake per head in dairy buffaloes was calculated from the records of intake of feeds and fodder, and its digestibility coefficients/nutritive values (Ranjhan, 1991; Anonymous, 2005). The average body weight of buffaloes was considered as 450 kg (calculated by body measurements). Composite samples of feed and fodder were analysed for proximate constituents by the methods of AOAC (2005). The chemical composition of home-made compound concentrate mixtures, dry, green roughages and bypass fat used in the experiment is as given in Table 1.

Milk Yield and 6% FCM Yield

The buffaloes were hand milked twice daily (5.30 and 18.00 h) and yields were recorded. The daily, fortnightly and overall milk yield was recorded for all animals and was analysed for fat content by digital electronic machine (Milk-o-tester, REMI make) and total solids by evaporation method, and then 6% fat corrected milk yield was derived using standard formula.

Feed Conversion Efficiency for Milk Yield

The feed conversion efficiency (FCE) of buffaloes under bypass fat supplemented and control groups in terms of DM, DCP and TDN intake (kg/kg whole milk and kg/kg 6% FCM yield) was calculated using standard formulae, and was compared between two groups.

The return over feed cost was calculated by taking difference of the realizable receipt from sale of milk and the total feed cost taking into consideration the market rates prevailed at the time of experiment. The data generated on nutrient intake and FCE for milk yield was analyzed using two-way ANOVA following completely randomized design (Snedecor and Cochran, 1994).

Table 1: Chemical composition of feeds (% on DM basis)

Ingredients	DM %	CP %	EE %	CF %	NFE %	Ash %	Silica %	P %	Ca %
Cotton seed cake	90.45±0.47	23.4 ±0.65	6.70±0.32	24.46±0.68	39.35±1.37	6.08±0.35	1.21±0.10	0.53±0.05	0.35±0.02
Panchamrut dan	90.97±0.12	18.11±0.21	2.61±0.11	13.04±0.16	59.25±0.44	6.99±0.12	1.32±0.09	0.68±0.05	1.25±0.04
Maize bhardo	91.75±0.57	10.61±0.30	4.00±0.15	2.65±0.13	80.13±0.29	2.59±0.13	0.10±0.01	0.33±0.02	0.34±0.01
Wheat bhardo	91.56±0.30	10.67±0.19	2.44±0.14	4.27±0.12	79.91±0.35	2.69±0.12	0.55±0.07	0.33±0.03	0.41±0.02
Mixed grain bhardo	91.33±0.45	10.10±0.22	4.65±0.20	2.90±0.19	79.31±0.37	3.02±0.17	0.08±0.00	0.40±0.02	0.4±0.01
Bajra fodder	25.70±0.44	6.62±0.34	2.86±0.20	33.23±0.73	49.15±0.83	8.12±0.25	2.84±0.21	0.26±0.01	0.53±0.03
Shedha grass	23.96±0.54	7.58±0.34	2.06±0.12	29.72±0.41	47.05±0.76	13.58±0.19	5.70±0.23	0.20±0.01	1.04±0.07
Paddy straw	91.37±0.22	3.07±0.19	2.85±0.21	31.32±0.34	45.44±0.48	17.3±0.34	10.84±0.28	0.0972±0.00	0.38±0.04
Maize straw	91.1±0.17	4.41±0.24	3.08±0.15	31.80±0.56	50.44±0.37	10.28±0.28	3.57±0.14	0.23±0.02	0.80±0.04
GN gotar	89.26±0.37	8.18±0.57	4.02±0.25	26.02±0.50	50.53±0.80	11.24±0.55	2.98±0.17	0.46±0.06	2.25±0.12
Bypass fat		-	99.71±0.05	-	-	-	-	-	-

Results and Discussion

Dry Matter and Nutrient Intake

Average daily DMI (kg/head), DCPI (g/head) and TDNI (kg/head) in T1 and T2 groups during prepartum period were 10.27±0.11 and 10.17±0.14; 600.95±5.86 and 600.76±9.25; 6.34±0.07 and 6.45±0.09, respectively. The corresponding values during postpartum period were 10.73±0.02 and 10.75±0.6; 596.74±4.10 and 601.28±3.23; 6.83±0.06 and 7.06±0.05, respectively. The DMI and DCPI did not differ in control and treatment groups during prepartum and postpartum phase, whereas TDNI was found statistically higher in treatment group during postpartum phase (Table 2). Similar results on DM, DCP and TDN intake were reported by Shankhpal *et al*. (2009[a]), Ramteke *et al*. (2014) and Sharma *et al*. (2016). However, Shelke and Thakur (2010) and Mane *et al*. (2016) observed higher average DCPI in the group fed rumen protected fat as compared to control, while Shankhpal *et al*. (2009[a]) found non-significant difference in TDNI, and Shelke and Thakur (2010) found significantly higher DCPI in bypass fat supplemented groups.

The cumulative intake of DM, DCP and TDN (kg/head/105 d) was 1127.06±11.33 and 1129.16±11.20, 62.66±0.43 and 63.14±0.34, and 716.73±6.43 and 740.85±5.73 in T1 and T2 groups, respectively (Table 2), which was statistically similar in both groups. The average daily DCP and TDN intake of buffaloes as per cent of requirement (ICAR, 1998) in control and bypass fat groups have been presented in Table 3. The average daily DCP intake as per cent of requirement of buffaloes was 109.63±1.18 and 96.06±0.75 and TDN intake 126.28±1.67 and 117.36±0.89 in T1 and T2 groups, respectively, which were statistically nearer in both groups and indicates that animals were adequately fed to support the production performance.

Feed Conversion Efficiency

The data on the feed conversion efficiency of DM, DCP and TDN for whole milk and 6% FCM yield are shown in Table 4. The overall feed conversion efficiency for whole milk (kg intake/kg whole milk) of DM, DCP and TDN in T1 and T2 groups was 2.40±0.04 and 1.99±0.02; 133.50±1.84 and 111.56±01.20; 1.53±0.02 and 1.31±0.01 respectively, being superior ($p<0.05$) in bypass fat group. The conversion efficiency for 6% FCM of DM (kg/kg FCM) was 2.46±0.04 and 1.85±0.02; DCPI (g/kg FCM) 136.95±1.97 and 105.88±1.03 and TDNI (kg/kg FCM) was 1.57±0.02 and 1.24±0.01 in T1 and T2 groups, respectively, indicating better ($P<0.05$) FCE in bypass fat group. Almost same trend of observation was noted at each fortnightly interval postpartum also (Table 4). Similar results for FCE were also reported by Tyagi *et al*. (2009), Shankhpal *et al*. (2009[a]), Ranjan *et al*. (2012), Savsani *et al*. (2015) and Sharma *et al*. (2016) in cattle and buffaloes.

Whole Milk, Fat and 6% FCM Yield and Economics

The buffaloes supplemented with bypass fat in group T2 produced overall significantly ($p<0.01$) higher whole milk (5.43±0.07 vs. 4.50±0.04 kg/head/d), fat content in milk (6.77±0.09 vs. 5.84±0.04 %), and 6% FCM yield (5.87±0.07 vs, 4.42±0.04 kg/head/d) as compared to T1 control group (Table 5), which may be due to higher ME intake through fortification of the diet with rumen protected fat (Shelke *et al*., 2012). Many earlier researchers (Barley and Baghel 2009; Parnerkar *et al*., 2011; Ramteke *et al*., 2014; Sharma *et al*., 2016; Desai *et al*., 2017; Atkare *et al*., 2018) have also reported a significant increase in whole milk yield and FCM in dairy animals fed bypass fat. On the contrary, Saxena *et al*. (2009) and Savsani *et al*. (2017) reported no difference in milk yield of dairy animals due to supplementation of bypass fat, while Sarwar *et al*. (2003), Tyagi and Thakur (2007), and Ranjan *et al*. (2012) found a significant increase in FCM yield in dairy animals fed bypass fat.

The cumulative yields of whole milk, fat and 6% FCM (kg/head/105 d) of the experimental period in control and bypass fat groups were 473.19±4.27 and 570.44±6.85, 27.65±0.30 and 38.52±0.48, and 464.27±4.48 and 615.98±7.24, respectively

Table 2: Average daily and cumulative (105 days) intake of DM, DCP and TDN in buffaloes of control T1 and bypass fat supplemented T2 groups during pre- and postpartum phases

	Average daily intake prepartum			Average daily intake postpartum			Cumulative intake in 105 days of lactation		
Group	DM (kg/head)	DCP (g/head)	TDN (kg/head)	DM (kg/head)	DCP (g/head)	TDN (kg/head)	DM (kg/head)	DCP (g/head)	TDN (kg/head)
T1	10.27±0.11	600.95±5.86	6.34±0.07	10.73±0.11	596.74±4.10	6.83[a] ±0.06	1127.06±11.33	62.66±0.43	716.73±6.43
T2	10.17±0.14	600.76±9.25	6.45±0.09	10.75±0.11	601.28±3.23	7.06[b] ±0.05	1129.16±11.20	63.14±0.34	740.85±5.73

Means with different superscripts within the row differ significantly between groups (P<0.05).

Table 3: Average daily DCP and TDN intake (as % of requirement) control (T1) and bypass fat supplemented (T2) buffaloes

DCPI (g/d)		TDNI (kg/d)		DCPR (g)		TDNR (kg)		DCPI % of R		TDNI % of R	
T_1	T_2	T_1	T_2	T_1	T_2	T_1	T_2	T_1	T_2	T_1	T_2
596.74 ±4.10	601.28 ±3.23	6.83 ±0.06	7.06 ±0.05	544.87[a] ±4.15	626.43[b] ±5.24	5.41[a] ±0.06	6.01[b] ±0.05	109.63[b] ±1.18	96.06[a] ±0.75	126.28[b] ±1.67	117.36[a] ±0.89

Means with different superscripts in a row for a parameter differ significantly, (p<0.05), R= Recommended.

Table 4: Average conversion efficiency of DM, DCP and TDN to whole milk (kg/kg milk) and to 6% FCM (kg/kg FCM) control (T1) and bypass fat supplemented (T2) buffaloes during early lactation of 105 days

FCE for		Fortnight														Overall	
		I		II		III		IV		V		VI		VII			
		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	DM	2.50 ±0.10	2.03 ±0.05	2.53 ±0.09	1.94 ±0.03	2.44 ±0.06	2.01 ±0.04	2.31 ±0.08	1.94 ±0.03	2.31 ±0.07	2.01 ±0.06	2.40 ±0.06	1.99 ±0.03	2.31 ±0.06	2.04 ±0.08	2.40^{b} ±0.04	1.99^{a} ±0.02
	DCP	137.76 ±3.91	113.72 ±2.20	137.86 ±4.78	110.80 ±2.22	134.53 ±3.29	112.47 ±2.32	130.55 ±4.28	108.72 ±1.99	132.65 ±3.97	112.30 ±2.46	134.03 ±3.73	110.01 ±2.31	127.12 ±2.93	112.92 ±4.30	133.50^{b} ±1.84	111.56^{a} ±1.20
	TND	1.59 ±0.06	1.33 ±0.03	1.60 ±0.06	1.28 ±0.02	1.55 ±0.04	1.32 ±0.03	1.47 ±0.05	1.27 ±0.02	1.49 ±0.04	1.32 ±0.03	1.53 ±0.04	1.31 ±0.02	1.47 ±0.04	1.34 ±0.05	1.53^{b} ±0.02	1.31^{a} ±0.01
6% FCM	DM	2.56 ±0.12	1.92 ±0.05	2.63 ±0.09	1.84 ±0.04	2.48 ±0.08	1.87 ±0.04	2.36 ±0.13	1.79 ±0.05	2.45 ±0.09	1.86 ±0.08	2.43 ±0.06	1.78 ±0.05	2.35 ±0.07	1.90 ±0.06	2.46^{b} ±0.04	1.85^{a} ±0.02
	DCP	140.96 ±5.45	107.69 ±2.55	143.37 ±5.07	105.09 ±2.59	136.32 ±4.65	104.54 ±2.33	133.51 ±7.06	110.45 ±4.15	140.25 ±5.27	110.16 ±3.66	135.46 ±3.39	98.18 ±2.09	128.80 ±3.58	105.03 ±3.60	136.95^{b} ±1.97	105.88^{a} ±1.03
	TND	1.63 ±0.07	1.26 ±0.03	1.67 ±0.06	1.21 ±0.03	1.57 ±0.05	1.22 ±0.03	1.50 ±0.08	1.29 ±0.04	1.57 ±0.06	1.29 ±0.05	1.54 ±0.04	1.17 ±0.03	1.49 ±0.04	1.24 ±0.04	1.57^{b} ±0.02	1.24^{a} ±0.01

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

Table 5: Economics of bypass fat feeding in transition buffaloes

No.	Particulars	T1	T2
1	Daily milk yield (kg/head)	4.50±0.04	5.43±0.07**
2	Cumulative milk yield (kg/head/105 days)	473.19±4.27	570.44±6.85**
3	Fat content in milk (%)	5.84±0.04	6.77±0.09*
4	Cumulative fat yield (kg/head/105 days))	27.65±0.30	38.52±0.48**
5	Daily 6% FCM yield (kg/head)	4.42±0.04	5.87±0.07 **
6	Cumulative 6% FCM yield (kg/head/105 day)	464.27±4.48	615.98±7.24**
7	Daily feed cost - postpartum (Rs/head)	92.98±0.64	101.66±0.45*
8	Cumulative feed cost - postpartum (Rs/head/105 d)	9762.90±67.2	10674.30±47.25
9	Realizable receipt from sale of milk (Rs/head/105 d)	17417.40±186.90	24267.60±302.4
10	ROFC (Rs/head/105 d) during postpartum phase	7654.50±228.9	13593.30±284.55
11	Daily ROFC (Rs/head) during postpartum	72.90±2.18	129.46±2.71**
12	Service period / days open	187.70±11.89	129.46±9.61**

*p<0.05, **p<0.01

(Table 5, Prajapati *et al.,* 2022). Significantly ($p<0.05$) higher values of all three parameters were observed in T2 group than the T1 group. These findings corroborated well with the reports of Garg *et al*. (2008), Shankhpal *et al*. (2009[b]), and Desai *et al*. (2017) in dairy animals.

The economics of bypass fat feeding in transition buffaloes, particularly postpartum phase is given in Table 5. The daily feed cost (Rs/head) during prepartum (64.64±0.62 and 72.75±1.11), and postpartum phase (92.98±0.64 and 101.66±0.45, respectively) was statistically ($P<0.05$) higher in bypass fat group than the control, which corroborated with Savsani *et al*. (2017). The average daily realizable receipt from sale of milk (Rs./head) was also significantly ($p<0.01$) higher in bypass fat supplemented group than the control (231.12±1.46 vs. 165.88±1.39). Thereby the average daily profit per buffalo (Rs) was 56.56 per day higher in bypass fat supplemented group. Postpartum heat was reduced statistically ($p<0.05$) by 14 days in bypass fat group compared to that of control group. Parnerkar *et al*. (2011) reported the average daily return over feed cost from sale of milk as Rs 26.61 in bypass fat supplemented buffaloes. Similarly, Shelke *et al*. (2012), and Savsani *et al*. (2017) also reported higher daily return with bypass fat feeding in buffaloes.

Conclusions

The present findings 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 efficiency and higher daily profit per head (Rs. 56), hence may be recommended to the farmers for economic benefits.

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