Effect of Feeding Different Levels of Bypass Fat/Protein Supplement on the Milk Yield and Composition in Crossbred Cows

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Cows (12, multiparous, crossbred, 2-3 weeks of lactation), yielding 11-14 kg milk/ animal/ day, were divided into three groups (I, II and III) of four each, based on milk yield, fat% and stage of lactation. Animals in all the three groups were fed basal ration, comprising 12 kg green maize fodder and 6 kg paddy straw per day. Cattle feed was given according to level of milk production. In addition to basal ration, animals in groups II and III were fed 0.5 and 1.0 kg bypass fat/ protein supplement (Fat 33%, CP 28%, ADIN 1.14%, NDIN 1.82 %), respectively, by replacing 1.0 kg cattle feed. Degree of fat protection was 71% of the total fat in the supplement, whereas, protein protection was 76% of total CP in the supplement. Average increase in milk yield (kg), as compared to control (group I), was 0.82 ($P<0.05$) and 1.55 ($P<0.01$) in groups II and III, respectively. Average fat percent increased by 0.20 and 0.48 ($P<0.05$) in groups II and III, respectively. However, no significant effect was observed on protein content of milk at both the levels of feeding bypass fat/ protein supplement. Saturated fatty acids reduced by 5.34 and 8.98% and unsaturated fatty acids increased by 4.23 and 11.58% in milk fat in groups II and III, respectively. On feeding 1.0 kg bypass fat/ protein supplement, significant reduction was observed in $C_{16:0}$ (12.26%), whereas, $C_{18:2}$ (59.57%) and $C_{18:3}$ (23.43%) increased significantly ($P<0.05$) in milk fat. Increase in level of oleic acid ($C_{18:1}$) was @ 9.29% in group III as compared to control group. Average net daily income increased by Rs. 6.87 and 14.76 on feeding 0.5 and 1.0 kg bypass fat/ protein supplement in lactating cows. This study demonstrated that feeding of 1.0 kg bypass fat/ protein supplement in the ration of lactating crossbred cows yielding 11-14 kg milk daily was economical.

Keywords: Rumen bypass fat/ protein, milk yield, milk composition, crossbred cow

INTRODUCTION

Due to limited availability and poor quality of feed resources, most of the dairy animals are not able to get sufficient energy from their diets as per the requirement, resulting in lower yields. Inclusion of fat in the diet of ruminants can increase the energy density of the diet. But inclusion of higher level of unprotected fat in the ration of ruminants is not recommended, as these fats depress fibre digestibility in the rumen, resulting in lower DM intake and consequently lower milk production. This problem can however, be easily overcome by feeding protected fat/ protein supplement to ruminants.

It has been reported that the development of a process for encapsulation of lipids in a formaldehyde treated protein allows the feeding of large quantities of lipids to ruminants without adversely affecting the rumen fermentation functions (Scott *et al.* 1995). Through the supplementation of bypass fat, not only energy intake is increased but is also possible to increase unsaturated fatty acid contents in milk fat. These unsaturated fatty acids are required for safer milk for human consumption, especially for heart patients. To study the economics of bypass fat and bypass protein feeding, a study was undertaken in which lactating animals were fed the bypass fat supplement at different levels to see the effect on quality and quantity of milk.

MATERIALS AND METHODS

Animals and Diets

A feeding trial was conducted on 12 multiparous crossbred (HF x Jersey) cows, yielding 11-14 kg milk per animal per day for five months. Feeding trial was conducted at Sarsa dairy farm, near Anand. Animals were divided into three groups

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(I, II and III) of four each, based on milk yield (12.29kg), fat per cent (4.32%) and stage of lactation (2-3 weeks of lactation). Animals in all groups were fed basal ration, comprising 12 kg green maize fodder and 6 kg paddy straw per day. Cattle feed having CP 20.12%; EE 2.54%; CF 12.00% and AIA 3.90%, was given according to level of milk production, to meet the maintenance and milk production requirements (NRC, 2001). Feeding was done twice daily in the morning and evening and animals were offered *ad libitum* clean drinking water thrice a day. In addition to basal ration, animals in groups II and III were fed 0.5 and 1.0 kg bypass fat/ protein supplement (Fat-33%; CP-28%; ADIN-1.14%; NDIN-1.82%), respectively, by replacing 1.0 kg cattle feed. Bypass fat/ protein supplement was prepared with formaldehyde treatment of a lipid-protein matrix (Scott and Ashes, 1993). Degree of fat protection was 71% of the total fat in the supplement, whereas, protein protection was 76% of total CP in the supplement.

Analytical Methods

The chemical composition of feeds and fodder was carried out as per AOAC (2005). Feeds and fodder were also analysed for NDF, NDIN, ADF, ADIN, cellulose, hemi-cellulose and acid detergent lignin as per Van Soest (1991). The degree of fat and protein protection was measured as per procedures of Gulati *et al.* (1993). The data were analyzed statistically (Snedecor and Cochran, 1989). The milk yield of individual cows was recorded in the morning and evening. The milk samples were drawn weekly and were analyzed for fat and protein contents as per IS: 1479. (1961, reaffirmed in 2003). Fatty acid analysis (Ashes *et al.* 1992) was carried out by Gas Chromatography (Perkin-Elmer, auto system XL). Following conditions were used to separate the fatty acids in methyl esters: BPX70 capillary column (50 m x 0.32 mm ID x 0.25 μm, SGE), split-splitless injection with column temperature programmed at 150 ^{0}C for 40 min. having helium as carrier gas.

RESULTS AND DISCUSSION

Chemical Composition

Analysis of feeds and fodder (Table 1) revealed that the NDIN and ADIN contents were very low. Thus, cell wall bound nitrogen level was non-significant in all the feeds and fodder offered to the animals during trial period. Bypass fat/ protein supplement contained 33% fat and 28% crude protein (CP) contents. Degree of fat protection was 71% of the total fat in the supplement, whereas, protein protection was 76% of total CP in the supplement. Level of essential fatty acids e.g. $C_{18:1}$, $C_{18:2}$ and $C_{18:3}$ were 52.34, 28.12 and 7.45% in protected fat supplement.

Effect on Milk Parameters

On feeding 0.5 (group II) and 1.0 kg (group III) bypass fat/ protein supplement to dairy cows, average increase in milk yield (kg), as compared to control, was 0.82 ($P<0.05$) and 1.55 ($P<0.01$) in groups II and III, respectively (Table 2). Average fat percent increased by 0.20 and 0.48 ($P<0.05$) in groups II and III, respectively. However, there was no effect on protein percent in milk at both the levels of feeding bypass fat/ protein supplement. Significant effect of supplementing bypass fat on milk production and daily fat yield in Holstein Friesian cows has been reported earlier (Carlos, *et al.* 2009; Garg *et al.* 2002a; 2002b).

The significant improvement in milk production could be due to the increased supply of amino acids at the tissue level. There are reports by several workers that, formaldehyde treatment caused an increased supply of amino acids at the lower tract (Xu *et al.* 1998; Antoniewicz *et al.* 1992). Chalupa and Sniffen (1996) also reported that the increased supply of essential amino acids in protected form causes an increase in milk production. Methionine in particular, plays a significant role as a methyl donor during milk fat synthesis, and is also the precursor for phospholipids component i.e. choline synthesis. The improved supply of amino acids in the presence of sufficient metabolizable energy might have also improved the protein-energy balance and created a better balance of precursors for milk synthesis, resulting in increased milk production.

Effect on Fatty Acid Composition

On feeding bypass fat/ protein supplement, level of oleic acid ($C_{18:1}$), linoleic acid ($C_{18:2}$) and linolenic acid ($C_{18:3}$) were higher in group III, as compared to groups I and II (Garg *et al.* 2008; Luna *et al.* 2008; Goodridge *et al.* 2001; Gulati *et al.* 2000). Manipulation of composition of milk fat is possible through feeding practices (Mahecha *et al.* 2008; Petit *et al.* 2002). Feeding fat rich in 18 carbon fatty acid increases $C_{18:0}$ and $C_{18:1}$ content of milk fat and reduces the short chain fatty acids

Table 1: Chemical Composition (% on DM basis) of Feeds and Fodder Fed During Trial Period

Parameter	Paddy straw	Green maize	Cattle feed
Organic matter	81.15 ± 0.18	92.21 ± 0.11	82.80 ± 0.15
Crude protein	2.11 ± 0.02	4.38 ± 0.05	20.12 ± 0.11
Ether extract	0.21 ± 0.00	0.31 ± 0.00	2.54 ± 0.03
Acid detergent fibre	51.24 ± 0.62	41.18 ± 0.28	12.20 ± 0.15
Neutral detergent fibre	76.32 ± 0.81	62.55 ± 0.30	21.26 ± 0.30
Acid detergent lignin	4.30 ± 0.10	6.82 ± 0.16	1.67 ± 0.03
Cellulose	40.59 ± 0.72	31.16 ± 0.24	6.63 ± 0.24
Hemi-cellulose	25.08 ± 0.40	21.37 ± 0.20	9.06 ± 0.15
Silica	6.35 ± 0.11	3.20 ± 0.14	3.90 ± 0.12
Acid detergent insoluble nitrogen	1.22 ± 0.02	1.89 ± 0.03	1.38 ± 0.00
Neutral detergent insoluble nitrogen	2.14 ± 0.02	3.28 ± 0.06	2.18 ± 0.01

Table 2: Quantitative and Qualitative Changes in Milk on Feeding Bypass Fat/ Protein Supplement in Crossbred Cows

Parameter	Group-I (Control)	Group-II (0.5 kg BPF)	Group-III (1.0 kg BPF)
Average milk yield (kg)	12.38 ± 0.34	13.20* ± 0.41	13.93** ± 0.31
Average milk fat (%)	4.32 ± 0.11	4.52 ± 0.06	4.80* ± 0.10
Average milk protein (%)	3.21 ± 0.05	3.36 ± 0.08	3.38 ± 0.06
Average fatty acid composition in milk fat (%)			
$C_{8:0}$	1.26	1.14	1.12
$C_{10:0}$	3.12	2.96	2.94
$C_{12:0}$	2.72	2.63	2.62
$C_{14:0}$	11.63	11.22	10.88
$C_{16:0}$	31.47	29.37	27.61*
$C_{16:1}$	1.10	1.11	1.10
$C_{18:0}$	10.24	9.88	9.83
$C_{18:1}$	27.33	28.45	29.87
$C_{18:2}$	1.41	1.54	2.25*
$C_{18:3}$	0.64	0.67	0.79*
$C_{20:0}$	0.22	0.22	0.21
Total saturated fatty acids	60.66	57.42	55.21
Total unsaturated fatty acids	30.48	31.77	34.01
BPF = Bypass fat/ protein supplement	* P<0.05; **P<0.01		

(SCFA) content of milk via reduction of *de novo* fatty acid synthesis. Oleic acid ($C_{18:1}$) content of milk can be increased substantially if the cow is fed high levels of substrate ($C_{18:0}$) for stearonyl-CoA desaturse (Bickerstaffe *et al.* 1972).

Economic Advantage

Feeding 0.5 kg bypass fat/ protein supplement:

Average values of 12.38 kg milk in control group (group-I) with 4.3% fat (@ Rs.13.18/kg) = Rs. 163.17

Average values of 13.20 kg milk in experimental group (group-II) with 4.5% fat (@ Rs. 13.45/kg) = Rs. 177.54

Increase in gross income per animal per day = Rs. 14.37

Cost of 0.5 kg bypass fat/ protein supplement = Rs. 7.50

Increase in net daily income = Rs. 6.87

Feeding 1.0 kg bypass fat/ protein supplement:
Average values of 12.38 kg milk in control group (group-I) with 4.3% fat (@ Rs. 13.18/kg)

= Rs. 163.17

Average values of 13.93 kg milk in experimental group (group-III) with 4.8% fat (@ Rs. 13.85/kg)

= Rs. 192.93

Increase in gross income per animal per day

= Rs. 29.76

Cost of 1.0 kg bypass fat/ protein supplement

= Rs. 15.00

Increase in net daily income = Rs. 14.76

It was observed that the net daily income was Rs. 6.87 and Rs. 14.76 on feeding 0.5 and 1.0 kg bypass fat/ protein supplement in lactating crossbred cows, respectively. This study demonstrated that feeding of 1.0 kg bypass fat/ protein supplement in the ration of lactating crossbred cows yielding 11-14 kg milk per animal per day, was more economical.

CONCLUSIONS

The study on lactating crossbred cows conclude that feeding of byepass fat/protein improved milk yield, milk fat (%) and protein.

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