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Effect of supplementing bypass fat prepared from soybean acid oil on milk yield and nutrient utilization in Murrah buffaloes

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ABSTRACT

This experiment was conducted to study the effect of supplementing Ca salts of soya acid oil fatty acids on milk production, its composition and nutrient utilization in lactating buffaloes. Lactating Murrah buffaloes (16) were divided in 2 groups (milk yield 7.08, 6.92 kg/d; 30 and 25 days in milk, 2–4 lactation) of 6 animals in each group, and the animals in control group were fed with wheat straw, green maize fodder and concentrate mixture as per requirements and the animals in experimental group were fed with the same ration as that of control group along with 4% Ca salts of soya acid oil fatty acids of total DMI for 90 days. The average milk yield in experimental group was higher by 12.43% over that of control group. Similarly, the 4% FCM yield was higher by 13.40% in experimental group over that of control group. There was no difference in milk protein, total solids and solid not fat in both groups except milk fat content which was higher in experimental group than that of control group. The total LCFA and MUFA content in milk fat was higher in experimental group compared to control group. The DMI and CPI were similar in both groups, whereas TDNI was higher in experimental group than that of control group. The digestibility coefficient of DM, CP, CF, NDF and ADF were similar in both groups except EE which was higher in experimental group than that of control group. It could be concluded that supplementation of Ca salts of soya acid oil fatty acids at 4% of DMI improved milk yield and proportion of unsaturated FA and LCFA in milk fat in Murrah buffaloes.

Key words: Buffalo, Bypass fat, Ca salts of soya fatty acids, Milk yield, Nutrient utilization

Feeding Ca soaps of fatty acids, which are inert in rumen, to high producing lactating cows, can enhance dietary energy density and therefore, energy intake in early lactation without compromising the activity of rumen microflora (Jenkins and Palmquist1984). Thus, the deleterious effect of acute negative energy balance on lactation performance in animals can be alleviated. Rumen inert fat provides partial resistance from ruminal biohydrogenation and hence enhances beneficial fatty acid profile of milk and body tissues from human health point of view (Mishra *et al.* 2004, Tyagi *et al.* 2009). Such quality milk can be used as a nutraceutical for prevention of various life style diseases.

Considering the above points, a feeding trial was conducted to investigate the effect of bypass fat supplementation on milk production, fatty acid profile of milk and nutrient utilization in Murrah buffaloes.

MATERIALS AND METHODS

Lactating Murrah buffaloes (12) were divided in 2 groups (milk yield 7.08, 6.92 kg/d; 30 and 25 days in milk, 2–4 lactation) of 6 animals in each group. The animals in control group were fed with wheat straw, green maize fodder and concentrate mixture as per requirements (Kearl 1982) and the animals in experimental group were fed with the same ration as that of control group along with 4% Ca salts of soya acid oil fatty acids of total DMI for 90 days. The concentrate mixture contained maize 33, groundnut cake 21, mustard cake 12, wheat bran 20, deoiled rice bran 11, mineral mixture 2 and common salt 1 part. The lactating buffaloes were housed in a well ventilated paddock having individual feeding mangers and space for separate tying of individual animal and provided with fresh and clean tap water three times daily at 8.00 h, 12.00 h and 18.30 h. These buffaloes were hand milked twice a day, in the morning and in the evening. Digestibility trial was conducted under the same housing management conditions at the end of trial.

Calcium salts of soya acid oil fatty acids were prepared using double decomposition method (Deuel 1951). Soybean acid oil was heated in a metal container; an aqueous solution of sodium hydroxide was added and again heated to cause saponification, sodium salts so formed were dissolved in

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excess boiling water. Calcium chloride dissolved in water was then added slowly to the water soluble sodium soaps with stirring causing immediate precipitation of calcium salts. Excess water was removed by squeezing soaps through cheese cloth. The soap was allowed to air dry and then lumps were broken before being mixed with other concentrate ingredients (Jenkins and Palmquist 1984). The level of protection of the rumen inert fat was judged by estimating the degree of saponification of the Ca soaps (Garg and Mehta 1998). From the pooled milk samples of individual animal, the fatty acid analysis of milk and feed samples, viz. green fodder, concentrate and rumen protected fat was done using saponification method (Gulati and Ashes 2000). The analysis was carried out on GLC fitted with flame ionization detector and 50 m length of capillary column. Initial temperature of the column was 140ºC. The RAMP rate was 2 ºC/min. Identification of peaks was made through retention time of the reference standards.

DM, CP, EE, CF and total ash of feed and faecal samples were analyzed (AOAC 2005), and NDF and ADF were estimated (Goering and Van Soest 1970). Milk samples were analyzed for total solids, protein and SNF as per AOAC (2005), whereas, milk fat by REIL, electronic milk fat tester. Statistical analyses of the data were carried out using Students't' test as per Snedecor and Cochran (1980).

RESULTS AND DISCUSSION

The total fat content (Table 1) in the supplemented rumen protected fat was 85.35% and the protection level from rumen hydrolysis (saponifiable portion) was 58.5%. The predominant fatty acids in protected fat supplement (Table 2) were palmitic, stearic, elaidic, oleic, linoleic and linolenic acids.

Average daily milk production (Table 3) ranged from 7.08 to 10.43 kg/d in control group and 6.92 to 11.17 kg/d in experimental group in different fortnights. Average milk was 9.49 kg/d in control group and it was 12.43% higher ($P<0.05$) in experimental group (10.67 kg/d) than that of control group. Fortnightly average 4% FCM yield (Table 3) ranged from 8.35 to 12.71 in control group and 8.08 to 14.24 kg/d in experimental group. Average 4% FCM yield was 11.86 kg/d in control group, and it was enhanced ($P<0.05$) by 13.40% in experimental group (13.45 kg) over that of experimental group. Control group reached the peak yield in second fortnight and experimental group at third fortnight but the average peak production was also better ($P<0.05$) in experimental group. Higher peak yield and milk production observed in experimental group may be attributed to enrichment of ration with Ca salts of soya acid oil fatty acids that increased the energy density of the ration. The present results are in line with the findings of Fahey *et al.* (2002); McNamara *et al.* (2003); Mishra *et al.* (2004) and Tyagi *et al.* (2009) who observed improvement in milk yield on supplementation of bypass fat to cows.

Milk fat ranged from 5.29 to 6.00% in control group and 5.15 to 6.20% in experimental group during different fortnights. The overall average milk fat% was higher ($P<0.05$) in experimental group (6.16) than that of control (5.94). There was no effect on protein, total solids and SNF contents of milk in the 2 groups (Table 3). Our results are in agreement with those of previous researchers who reported improvement in milk fat but no effect on protein, Total solids and SNF contents on addition of bypass fat (Sklan *et al*. 1994, McNamara *et al.* 2003).

The contents of myristoleic acid (C14: 1), palmitoleic acid (C16: 1), elaidic acid (C18: 1t9), oleic acid (C18: 1c9), linoleic acid (C18: 2), linolenic acid (C18: 3) and arachidic acid (C20: 0) in the milk fat of experimental group were higher as compared to that of control group (Table 2). Total unsaturated fatty acids increased by 21.76% in experimental group over control group, saturated fatty acid content showed a decrease of 14.14 whereas, that of monounsaturated fatty acids (MUFA) also elevated in experimental group by 9.39% than control group, respectively. The total long chain fatty acids (LCFA) content was also higher in experimental group. Dietary bypass fat alters fatty acid profile of the milk towards the fatty acid content of the supplemental fat. The results obtained with polyunsaturated fatty acids (PUFA) rich protected fat feeding (Sampelayo *et al.* 2004), with Ca salts of FA (Fahey *et al.* 2002) and with dietary supplementation of progressively more unsaturated fatty acids of Canola, Soybean, and Linseed oil (Chouinard *et al.* 1998) to cows are substantiated by the present findings, wherein the PUFA and unsaturated fatty acid contents were elevated on feeding of bypass fat made from soya acid oil. Tyagi *et al.* (2009) also reported increased MUFA and unsaturated fatty acids content in milk fat in crossbred cows on supplementing dietary bypass fat

The DMI ranged from 10.59 to 11.95 kg/d in control group and 11.28 to 12.72 kg/d in experimental group during six fortnights. The overall DMI recorded was 11.38 kg and 12.05 kg/d (Table 4) in control and experimental groups, respectively. The overall DMI/100 kg BW was 2.34 and 2.29 kg/d in control and experimental group, respectively. The

Table 1. Chemical composition of feed ingredients offered (% DM basis)

Particulars	Green fodder	Wheat straw	Concentrate	Ca salts of soya acid oil
DM	22.00	92.00	92.00	96.64
OM	89.00	89.82	90.99	
CP	7.77	3.05	20.18	
EE	1.72	1.26	3.38	85.35
CF	35.75	38.87	7.99	
NFE	43.97	46.64	59.46	
NDF	70.72	77.81	38.12	
ADF	30.72	35.55	25.14	
Total Ash	10.79	10.18	9.01	14.58

Table 2. Fatty acid profile (% of total fatty acids) of feed ingredients and milk

Fatty acids (% of total fatty acids)	Feeds			Milk		
	Green fodder	Wheat straw	Concentrate feed	Bypass fat	Control group	Experimental group
Caprylic acid (C8: 0)	0.51	ND	0.32	0.51	1.06	0.92
Capric acid (C10: 0)	0.78	ND	0.55	0.42	3.04	2.46
Lauric acid (C12: 0)	3.4	7.03	2.48	0.78	3.42	3.08
Myristic acid (C14: 0)	2	1.01	1.41	0.27	11.85	8.50
Myristoleic acid (C14: 1)	0.48	ND	ND	0.54	0.85	1.18
Palmitic acid (C16: 0)	20.77	20.25	12.83	8.96	28.65	25.96
Palmitoleic acid (C16: 1)	0.63	ND	1.48	0.78	1.47	1.62
Margaric acid (C17: 0)	ND	4.32	ND	ND	0.51	0.24
Stearic acid (C18: 0)	3.32	42.00	34.83	3.81	14.65	12.93
Elaidic acid (C18: 1t9)	2.45	ND	2.65	1.45	2.30	2.77
Oleic acid (C18: 1c9)	4.31	13.62	20.93	21.31	25.21	28.06
Linoleic acid (C18: 2)	16.25	ND	2.73	51.57	1.41	4.45
Linolenic acid (C18: 3)	40.59	ND	16.26	5.90	0.79	0.92
Arachidic acid (C20: 0)	0.69	5.63	0.33	0.56	0.41	0.51
Total	95.67	93.86	96.48	96.86	95.62	93.6
Total unsaturated					32.03	39.00
Total saturated					63.59	54.60
Total LCFA					75.40	76.46
Total MUFA					29.83	32.63

results of the present study indicated that there was no adverse effect of bypass fat supplementation on DMI of lactating buffaloes. Similar observations were made by Salfer *et al.* (1995) and Elliot *et al.* (1995) on feeding Ca salts of rapeseed fatty acids at the rate of 500 g/d in lactating cows, Garg *et al.* (2002) on supplementing bypass nutrients (fats encapsulated in a formaldehyde treated protein) @ 1000 g/d to lactating cows and buffaloes.

There was no difference in the CP intake between two groups (Table 4). Average TDNI was 9.13 kg/d in control group and it was higher ($P<0.05$) by 8.43% in experimental group (9.90 kg/d) over that of control group (Table 4). Average TDN intake/100 kg BW was 2.01 kg/d in experimental group which was higher ($P<0.05$) by 5.78% over that of control group (1.90 kg/d). In the present

Table 3. Milk yield and its composition in lactating buffaloes fed experimental diets

Particular	Control group	Treatment group
Milk yield (kg/d)	$9.49^{a}\pm0.27$	$10.68^{b}\pm0.16$
FCM yield (kg/d)	$11.86^{a}\pm0.79$	$13.45^{b}\pm0.63$
Milk composition (%)		
Fat	$5.94^{a}\pm0.07$	$6.16^{b}\pm0.21$
Total solid (TS)	15.26±0.04	15.40±0.07
Solids not fat (SNF)	9.32±0.061	9.35±0.175
Protein	5.59±0.048	3.72±0.075

[ab]Means having different superscripts in the same row differ significantly ($P<0.05$).

Table 4. Nutrient intake, digestibility coefficient (%) and efficiency of utilization of nutrients in lactating buffaloes fed experimental diets

Attributes	Control group	Treatment group
DMI (kg/day)	11.38±0.65	12.05±0.69
CPI (kg/day)	1.59±0.09	1.54±0.08
TDNI (kg/day d)	$9.13^{a}\pm0.16$	$9.90^{b}\pm0.22$
DMI (kg/100 kg BW)	2.34±0.051	2.29±0.049
CPI (kg/100 kg BW)	0.32 ±.007	0.30 ±.005
TDNI (kg/100 kg BW)	$1.90^{a}\pm0.29$	$2.01^{b}\pm0.21$
Digestibility of nutrients		
DM	65.83±1.34	66.59±1.80
CP	60.80±2.69	61.56±1.96
EE	$70.68^{a}\pm2.29$	$82.05^{b}\pm1.32$
CF	52.87±1.79	53.60±2.58
NFE	59.07±3.45	60.87±2.47
NDF	50.07±1.65	51.32±2.62
ADF	42.40±2.97	43.49±3.20
Efficiency of utilization of nutrients		
DMI (kg/kg) milk yield	1.22±0.019	1.15±0.038
DMI (kg/kg) FCM yield	0.97±0.017	0.90±0.036
CPI (g/kg) milk yield	170.09±3.59	157.85±6.09
CPI (g/kg) FCM yield	137.81± 4.35	126.98±8.93
TDNI (g/kg) milk yield	960.56±35.56	926.65± 15.87
TDNI (g/kg) FCM yield	766.54±22.34	737.86±19.55

[a b]- Means having different superscripts in the same row differ significantly ($P<0.05$).

experiment, since the DMI was not adversely affected by supplementing protected fat, it led to significantly higher TDNI in experimental group.

There was no effect on the digestibility of DM, CP, CF, NFE, ADF and NDF (Table 4). However, EE digestibility was higher ($P<0.05$) in experimental group than the control group. In the present study, higher EE digestibility in experimental group supplemented with Ca salts of soya acid oil fatty acids is in agreement with the findings of Chouinard *et al.* (1998) and Tyagi *et al.* (2009). Calcium soaps of fatty acids remain in intact form in the rumen and unlike direct fat supplementation, do not lead to any toxic effect on rumen microflora thus not altering the fibre digestion (Schauff and Clark 1989, Harrison *et al.* 1995). In the present investigation, digestibility of fibre fractions was not adversely affected on supplementation of Ca salts of soya acid oil fatty acids.

There was no effect on the efficiency of conversion of DMI, CPI and TDNI to milk and 4% FCM in the 2 groups (Table 4).

Our results indicated that bypass fat prepared from soybean acid oil supplemented at 4% of DMI, increased milk production, FCM yield and proportion of unsaturated FA and LCFA in milk fat of Murrah buffaloes.

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