Influence of Dietary Butyrate on Growth Rate, Efficiency of Nutrient Utilization and Cost of Unit Gain in Murrah Buffalo (*Bubalus bubalis*) Male Calves

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ABSTRACT : Eighteen Murrah male buffalo calves were allotted into three groups of six each. The calves in group I (control) were fed with whole milk, skim milk, calf starter and green maize fodder. The calves in group II (high butyric acid) and group III (low butyric acid) were fed with the same diet as control along with 24 ml and 12 ml of butyric acid/calf/day for 120 days, respectively for 120 days. Dry matter intake was higher in group II and III as compared with group I. Digestibility of dry matter, organic matter, crude protein, crude fibre, ether extract, neutral detergent fibre, acid detergent fibre, cellulose and hemicellulose was the highest in group II followed by group III and the control group. Body weight gain and conversion efficiency of dry matter, digestible crude protein and total digestible nutrients were better in group II. Cost of feed for per unit of live weight gain was the lowest in group II. It was concluded that dietary addition of butyric acid (24 ml/day) was economical and had positive effect on the performance of Murrah buffalo calves. (*Asian-Aust. J. Anim. Sci. 2001. Vol. 14, No. 4 : 474-478*)

Key Words : Butyrate, Efficiency, Nutrient, Buffali Calves, Growth

INTRODUCTION

Volatile fatty acids are the part of ruminal content. Addition of salt of volatile fatty acid in the rumen had been established to result in early development of functional rumen (Phillipson and McAnalhy, 1942; Flatt et al., 1958; Harrison et al., 1960; Vidyarthi and Kurar, 1994 and 1995), which enhanced body weight gain (Hibbs et al., 1956). It had been observed that the calves fed only milk or in addition to different additives like sponges or purified diet or salts of volatile fatty acids had no substantial differences on the body weight gain (Flatt et al., 1958) or body weight increased in the calves over only milk fed calves (Morrill et al., 1981; Anderson et al., 1982; Anderson et al., 1988) or it decreased over milk fed calves (Martin et al., 1959). Effects of addition of pure volatile fatty acid on performance and nutrient utilization in buffalo calves had not been studied besides a few conflicting results on body weight gain had been reported. Therefore, the present experiment was conducted to study the effect of feeding pure butyric acid at different levels with scheduled diet on nutrient utilization, growth performance and cost of per unit gain in buffalo calves.

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MATERIAL AND METHODS

Animals and experimental diets

Eighteen Murrah male buffalo calves at the age of 11 days were randomly distributed into three groups of six each. They were individually fed with whole milk, skim milk, calf starter and green maize fodder following the schedule for feeding of buffalo calves at National Dairy Research Institute, Karnal, India (table 1). The calves of group II and III received 24 ml butyric acid daily (12 ml/calf/feeding time) and 12 ml daily (6 ml/calf/feeding time), respectively. The calf starter was prepared by mixing 40 percentage of crushed maize, 16 parts of wheat bran, 40 parts of ground nut cake and 2 parts of each of mineral mixtures and common salt. The chemical composition of whole milk, skim milk, calf starter and green maize fodder is given in table 2. The quantity of whole milk and/or skim milk equally divided into two with a view of two times feeding was taken into plastic bucket; half quantity of calf starter was mixed into milk and provided to calf feeding. Simultaneously, the quantity of butyric acid to each treatmental groups was slowly incorporated into milk to avoid a sudden change in the taste. The quantity of butyric acid to a higher level of 24 ml/calf/day (12 ml/calf/feeding time) was stabilized by a preliminary trial on the basis of calf acceptability. 24 ml was the highest level of butyric acid that calves could accept. The higher level was adjusted within 5 days of onset of experiment. Green maize fodder and water was offered *ad libitum* and any fodder residue was also weighed

Table 1. Feeding schedule for feeding of buffalo calves at NDRI, Karnal

Age of calves (days)	Milk as proportion of body wt. (kg/day)	Skim milk as proportion of body wt. (kg/day)	Calf starter (kg/day)	Green fodder
0- 5	Colostrum - 1/10th	Nil	Nil	Nil
6- 30	Whole milk - 1/10th	Nil	0.050	*ad lib.*
31- 60	Whole milk - 1/15th	Skim milk - 1/25th	0.120	- do -
61- 90	Whole milk - 1/25th	Skim milk - 1/15th	0.250	- do -
91-120	Nil	6.50	0.650	- do -
121-150	Nil	6.50	1.000	- do -
151-180	Nil	5.00	1.500	- do -

Table 2. Chemical composition of diets (% DM basis)

Items	Whole milk	Skim milk	Calf starter	Green maize
Dry matter	12.25	9.90	90.40	25.00
Organic matter	11.45	9.02	81.00	22.32
Crude protein	28.80	36.80	20.20	8.35
Crude fibre	-	-	6.42	30.15
Ether extract	30.90	1.00	4.45	2.05
Total ash	6.50	8.90	10.40	10.70
Nitrogen free extract	33.80	53.30	58.53	48.75
NDF	-	-	41.41	69.30
ADF	-	-	11.39	42.63
Cellulose	-	-	6.05	29.50
Hemicellulose	-	-	30.02	26.67

in order to record the daily intake of feed. All calves were weighed for two consecutive days at weekly intervals. The experiment lasted for 120 days. The records of intake of whole milk, skim milk, calf starter and green fodder were maintained carefully and precisely in order to calculate cost of feed per unit of live weight gain. The market rates of all items of feeds fed to the calves in all the groups were procured and the total cost for each calf in 120 days was calculated. Then, on the basis of gain, cost per unit gain of each calf was calculated and was subjected to statistical analsis. At the end of experiment, a digestion trial of 7 days collection was conducted as described by Crampton (1969).

Chemical analysis

Calf starter and green fodder offered, residue left and faeces voided were analysed for proximate principles (Association of Official Analytical Chemists, 1984). Whole milk and skim milk samples were analysed by the procedure of Indian Standard Institution (1961). Neutral detergent fibre (NDF), acid detergent fibre (ADF), acid detergent lignin (ADL) cellulose and hemicellulose were estimated by Goering and Van Soest (1970) method. Gross energy of feeds, faeces and milk was estimated by the method described by Anon (1981).

Statistical analysis

Data were analysed to test the significance of differences among means using ANOVA in a randomized block design as described by Snedecor and Cochran (1967).

RESULTS AND DISCUSSION

Digestibility

Butyric acid showed positive effects on performance in group II as compared with the other two groups. The average intake of dry matter during the 120 days of growth experiment was significantly ($p<0.01$) higher in group II compared with group I and III (table 3). The higher intake of dry matter in higher level of butyric acid fed calves may be due to its beneficial effect on structural development of rumen wall (Pennington and Pfander, 1957; Vidyarthi and Kurar, 1995), increased rate of volatile fatty acid absorption from the rumen (Sutton et al., 1963b) and sufficient amount of butyric acid for effective stimulation (Tamate et al., 1962) which could probably increase feed intake (Godfrey, 1961b). The calves of all groups were equal in ages, but the calves in group II showed significantly higher body weight, which might attribute to higher intake of dry matter as compared to other two groups.

The digestibility coefficients (table 3) of dry matter, organic matter, crude protein, crude fibre, ether extract, neutral detergent fibre, acid detergent fibre, cellulose and hemicellulose were the highest ($p<0.01$) in higher butyric acid fed calves followed by lower butyric acid and the lowest in control group calves. The digestibility coefficient of nitrogen free extract was similar among all groups. Higher digestibility of grains and fibre with a view of other components of feeds being constant in either high or low butyric acid fed calves as compared to control calves was in agreement with the results of Conrad and Hibbs (1956) and Pres and Kroliczek (1971). The increase

Table 3. Intake of DM and digestibility of nutrients (%) in buffalo calves

Items	Control (Group I)	High butyric acid (Group II)	Low butyric acid (Group III)	Level of significance
Body weight at 120 days (kg)	78.73[a]	113.57[c]	90.27[b]	**
Metabolic body weight (kg $W^{0.75}$)	26.43[a]	34.79[c]	29.29[b]	**
Dry matter intake (kg/day)	1.121[a] ±0.10	1.561[b] ±0.06	1.490[b] ± 0.05	**
Whole milk	0.473 ±0.03	0.556 ±0.02	0.491 ± 0.02	NS
Skim milk	0.311 ±0.04	0.353 ±0.04	0.433 ± 0.01	NS
Calf starter	0.127[a] ±0.02	0.227[c] ±0.06	0.183[b] ± 0.00	**
Green maize	0.210[a] ±0.04	0.425[c] ±0.07	0.383[b] ± 0.02	**
Dry matter intake (g/kg$W^{0.75}$)	45.82[a]	44.87[a]	50.87[b]	**
Digestibility of nutrients				
Dry matter	61.55[a] ±1.80	68.57[c] ±1.95	64.64[b] ± 1.85	**
Organic matter	65.50[a] ±1.07	72.57[c] ±1.09	68.60[b] ± 1.19	**
Crude protein	67.10[a] ±1.40	74.26[c] ±1.65	70.81[b] ± 1.55	**
Crude fibre	50.50[a] ±1.10	59.21[c] ±1.21	56.77[b] ± 1.15	**
Ether extract	60.45[a] ±1.10	72.10[c] ±1.40	66.72[b] ± 1.38	**
NFE	71.77 ±1.69	74.42 ±1.60	73.05 ± 1.57	NS
NDF	60.11[a] ±1.03	67.42[c] ±1.14	64.44[b] ± 1.09	**
ADF	55.84[a] ±1.63	67.47[c] ±1.43	61.33[b] ± 1.53	**
Cellulose	41.09[a] ±1.55	49.33[c] ±1.41	45.88[b] ± 1.47	**
Hemcellulose	66.18[a] ±1.33	75.58[c] ±1.38	70.22[b] ± 1.27	**

[a,b,c] Different superscript in a row differ significantly ($p<0.01$).
** Significant at probability ($p<0.01$).
NS Non-significant at probability ($p>0.05$).

could be attributed to better structural development of rumen, early establishment of rumen functions (Phillipson and McAnally, 1942), effectiveness on stimulating rumen mucosal growth in order as butyrate>propionate>acetate (Sander et al., 1959; Gilliland et al., 1962; Sakata and Tamate, 1978 and 1979) and sufficient amount of butyric acid for effective stimulation (Tamate et al., 1962).

Animal performance

The mean body weight gain and conversion efficiency of different nutrients were significantly ($p<0.01$) higher in high butyric acid fed calves followed by low butyric acid fed calves and the lowest in control groups (table 4). This supports the findings of Hibbs et al. (1956), Morrill et al. (1981) and Anderson et al. (1988); however, contradicts those of Flatt et al. (1958), Martin et al. (1959) and Singh et al. (1973). The reasons for these differences in results are not clear. It could, however, be explained that additional amount of butyric acid in either group II or group III probably played synergetic role in better structural development of rumen wall, early establishment of ruminal functions, effective stimulatory activity, and higher digestibility coefficients and intake of nutrients, and the responses varied in the species

The average intake of different feedstuffs and butyric acid (table 5) and their cost during the period of experiment showed that overall expenditure were 76.22, 60.73 and 74.69 rupees/kg body weight gain in the control, high butyric acid and low butyric acid fed calves, respectively. The cost per unit gain in group II was the lowest compared with those in group I and III. The finding was in agreement with the results of Razdan et al. (1965), Khoury et al. (1967) and Arora et al. (1979) who had reported higher cost per unit gain in calves fed only milk than fed milk substitute. Better performance in calves fed the higher butyric acid probably caused the lower cost of unit gain. However, higher cost per unit gain in the present study compared with the past experiments might be due to relatively higher prices of different items of feeds, in the present experiment.

It is concluded from the results that butyric acid feeding at the level of 24 ml/calf/day increase the intake and digestibility of nutrients, growth performance, and conversion efficiency of nutrients and reduces the cost per unit of gain of Murrah buffalo calves.

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Table 4. Growth rate and conversion efficiency of nutrients in buffalo calves

Items	Control (Group I)	High butyric acid (Group II)	Low butyric acid (Group III)	Level of significance
Initial body weight (kg)	36.980	43.230	38.330	NS
Total weight gain in 120 days (kg)	41.75[a]	70.340[c]	51.940[b]	**
Average daily gain (kg)	0.348[a]	0.586[c]	0.433[b]	**
Dry matter intake (kg/day)	1.121[a]	1.561[b]	1.490[b]	**
DMI (kg/kg gain)	3.480[c]	2.664[a]	3.441[b]	**
Crude protein intake (kg/day)	0.294	0.371	0.370	NS
DCP intake (kg/day)	0.197	0.276	0.262	NS
DCP intake (kg/kg gain)	0.566[b]	0.471[a]	0.605[b]	**
TDN intake (kg/day)	1.055[a]	1.541[c]	1.173[b]	**
TDN intake (kg/kg gain)	3.032[c]	2.630[a]	2.709[b]	**
GE intake (Mcal/day)	4.642[a]	6.780[c]	5.161[b]	**
DE intake (Mcal/day)	3.041[a]	4.920[c]	3.540[b]	**
ME intake (Mcal/day)	2.494[a]	4.034[c]	2.903[b]	**
ME intake (Mcal/kg gain)	7.167[b]	6.884[a]	6.704[a]	**

[a,b,c] Different superscript in a row differ significantly ($p<0.01$).
** Significant at probability ($p<0.01$).
NS Non-significant at probability ($p>0.05$).

Table 5. Cost of feed per live weight gain (Rs./kg)

Items	Control (Group I)	High butyric acid (Group II)	Low butyric acid (Group III)	Level of significance
Average daily gain (kg)	0.348[a]	0.586[c]	0.433[b]	**
Whole milk consumed (kg)	11.095	7.745	9.257	--
Cost of whole milk (Rs.)	55.480	38.730	46.290	--
Skim milk consumed (kg)	9.027	6.085	10.101	--
Cost of skim milk (RS.)	18.050	12.170	20.200	--
Calf starter consumed (kg)	0.404	0.429	0.468	--
Cost of calf starter (Rs.)	1.240	1.320	1.440	--
Green maize consumed (kg)	2.414	2.901	3.538	--
Cost of green maize (Rs.)	1.450	1.740	2.210	--
Butyric acid consumed (ml)	0.000	39.800	27.298	--
Cost of butyric acid (Rs.)	0.000	6.770	4.640	--
Total cost of feed (Rs.)	76.220[b]	60.730[a]	74.690[b]	**

[a,b,c] Different superscript in a row differ significantly ($p<0.01$).
** Significant at probability ($p<0.01$).
NS Non-significant at probability ($p>0.05$).

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