Indian Journal of Animal Sciences **84** (4): 442–446, April 2014/Article

Effect of nutrients level and source on feed intake, nutrients digestibility, rumen profile, blood metabolites and growth in Bhadawari buffalo female calves

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Received: 29 September 2013; Accepted: 12 December 2013

ABSTRACT

In a nutritional experiment 15 Bhadawari female calves (77.47±6.92 kg; 11.0 months age) divided equally into 3 dietary groups (G_1, G_2 and G_3) were fed wheat straw- berseem- concentrate mixture (CM) based diets to evaluate the response of dietary protein and energy concentrations on intake, nutrients digestibility, rumen metabolites and growth. Calves in G_1 were offered were offered wheat straw, berseem and concentrate mixture to meet protein and energy requirements (ICAR 1985), while in G_2 and G_3 calves were given 25% less nutrients than G_1. In G_2 50% of CM was replaced with green berseem, while in G_3 100% of CM was replaced with berseem and given 500 g maize grain as energy source. In G_1, G_2 and G_3 protein was met through CM: berseem (75: 25), CM: berseem (50: 50) and berseem (100%), respectively. DMI (g/kg w $^{0.75}$) was 86.97, 77.47 and 79.18 in G_1, G_2 and G_3, respectively. DM, CP, NDF, ADF and cellulose digestibility of calves on different diets was similar. Nitrogen metabolites concentration in rumen liquor of calves was higher in G_1 than G_2 and G_3, while TVFA concentration was 100.0, 110.0 and 90.0 meq/l in G_1, G_2 and G_3, respectively. Total protozoa counts were comparable, while sporangia counts in rumen liquor of buffalo calves were higher in G_1 than G_3. Blood glucose, protein and urea were similar in calves of all the groups. Calves growth rate was higher in G_1 than G_2 and G_3. Dietary DCP and ME contents were similar, while feed and nutrients conversion ratio for body weight gain was relatively lower for G_1 than other dietary groups. Study showed that there was no significant effect of levels and sources of nutrients from the present diets on calves' intake, nutrients digestibility and growth rate, however rumen liquor N contents and, sporangia counts - were higher in G_1 than G_2 and G_3 groups.

Key words: Berseem, Bhadawari buffalo calves, Energy level,Intake, Nutrients digestibility, Protein level, Rumen profile, Weight gain

India has nearly 50% of the global buffalo population consisting of 13 defined breeds located in different agro ecological regions of country to fulfill the socio economic needs of rural farming community (http://www.nbagr.res.in/regbuf, Kundu *et al*. 2004). Bhadawari a buffalo breed known for high milk fat content is found in central part of Uttar Pradesh and adjoining districts of Madhya Pradesh state covering the ravines of Chambal River. Buffalo breeds differ in their genetic makeup, size, adaptation to climate and feeds and production level and thus have different nutritional requirement. Within the breed the requirement for different nutrients and their utilization efficiency from a diet also varies with the physiological stage, chemical and physical nature and nutritive value of feed and fodder. For growing calves proteins and energy are the most critical nutrients along with minerals and vitamins for their normal growth. Nutritional studies with NRC requirements had been carried out with varying levels of energy and protein in buffalo calves (Basra *et al*. 2003, Paul and Patil 2007). Feeding high levels of protein was found to be effective in promoting rapid live-weight gains, especially in growing buffalo (Basra *et al*. 2003a). Level and source of dietary energy and protein influence the balanced supply of these nutrients to rumen microbes required to maximize the microbial growth and efficiency. Therefore, efficient synthesis of rumen microbial protein to enhance buffalo performance needs synchronization in fermentation of nitrogen sources and energy in the diets and such studies are inadequate for Bhadawari buffaloes. So the present study was planned to assess the effect of nutrients (CP and energy) sources and their level in diets on Bhadawari buffalo calves nutrients utilization, rumen metabolites and performance.

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MATERIALS AND METHODS

Calves, diets and management

Bhadawari female calves (15; average body weight 77.47±6.92 kg and age 11.03 months) were distributed into dietary groups G_1, G_2 and G_3, with 5 animals in each group. Animals were offered wheat straw (WS) and berseem as

roughage source. Calves in G_1 were offered concentrate mixture, berseem and wheat straw to meet protein and energy requirements (ICAR, 1985) for 450 g/d growth rate, while in G_2 and G_3 calves were given 25% less nutrients (protein and energy) than G_1. In G_2 50% of concentrate mixture (CM) protein was replaced with green berseem, while in G_3 100% of CM was replaced with berseem and given additional 500 g wheat bran as energy source. In G_1, G_2 and G_3 protein was met by offering berseem: concentrate in 25: 75, 50: 50 and 100: 0 proportions, respectively. Concentrate mixture consists of 60% maize grain, 37% CSC, 2% mineral mixture and 1% common salt, respectively. Calves were offered WS, chaffed berseem and concentrate mixture between 09.00 –10.00 h. The chemical composition of dietary ingredients (fodders, feeds and concentrate mixture) fed to calves during study is given in Table 1. Animals were offered water twice daily at 11.30 h and 16.00 h. Feeding of experimental calves was started in last week of February 2011 and continued up to end of May 2011.

Table 1. Chemical composition of fodder feeds and concentrate mixture (% DM basis)

Parameters	WS	MG	CSC	Berseem	CM
CP	3.70	12.1	27.9	17.2	17.2
OM	89.95	92.73	94.87	86.34	94.78
NDF	76.97	29.34	49.25	57.88	44.72
ADF	50.72	9.6	36.27	44.83	15.14
Cellulose	42.03	8.28	24.60	33.61	11.23
Hemicellulose	26.25	15.9	12.98	13.05	29.58
Lignin	6.12	1.27	11.51	10.04	4.34

OM organic matter, CP crude protein, NDF neutral detergent fiber, ADF acid detergent fiber, WS wheat straw, MG maize grain, CSC cotton seed cake, CM concentrate mixture.

Digestion-cum –metabolism trial

After 72 days of feeding a digestion cum metabolism trial was conducted for 7 days and faeces of individual animal was collected for 24 h and pooled in plastic buckets covered with lid, while urine was collected manually for 3 consecutive days for 24 h and polled in plastic canes, respectively. A fixed aliquot of faeces sample for DM (1/ 50) and N (1/500 preserved in 20% H_2SO_4) estimation were collected from individual animal daily during the trial. Samples of feed offered (WS, berseem, concentrate mixture and maize grain) and refusals were also collected daily and representative samples were kept for DM estimation. Dried samples of faeces, feeds offered and refusals were ground through a 1 mm sieve using an electrically operated grinding mill. Ground samples were stored in plastic containers and used for further chemical and biochemical estimations.

Rumen liquor and blood collection

At the end of the experimental feeding, rumen liquor was sampled from 3 animals in each group using stomach tube before feeding (0 h). About 150 ml of representative sample of rumen liquor was drawn from each calf from all parts of the rumen. Rumen liquor pH was measured immediately after collection using a digital pH meter. Rumen liquor samples were strained through double layer of muslin cloth. About 100 ml of rumen liquor was preserved with few drops of saturated mercuric chloride and kept in labelled polypropylene bottles in freezer for estimation of metabolites. The remainder 50 ml of the rumen liquor was preserved with 10% formalin in propylene bottles for microscopic counts of protozoa and fungi. Blood samples were collected through jugular veins in air tight vacutoner tubes using dehydrated EDTA from 4 calves in each group prior to feeding and kept in freezer for blood biochemical analysis.

Analytical techniques and statistical analysis

The DM, ash and CP of feeds offered, refusals and faeces samples were estimated as per AOAC (1990) fibre fractions (NDF, ADF, lignin and cellulose) by the method of Van Soest *et al.* (1991). DM digestibility values were used to estimate digestible energy (DE Kcal/ kg) of diets using the regression equation reported by Fonnesbeck *et al.* (1984). The DE values were converted to ME using the formula reported by Khalil *et al*. (1986).

Rumen liqour metabolites (TVFA, total N, TCA precipitate N and ammonia N) and blood metabolites (glucose, protein and urea) were analysed as described by Sastry *et al.* (1999). Method described by Moir (1951) was followed for counting the total protozoa in formalised rumen liquor, while Holotrichs and Entodiniomorphs were identified as per Ogimoto and Imai (1981). Bodyweight of calves was recorded for 2 consecutive days at monthly interval to determine their growth rate. The data on intake, nutrients digestibility, blood metabolites, nutrients efficiency and growth rate were analysed statistically (SPPS 13.0) in one way ANOVA using the General Linear Model.

RESULTS AND DISCUSSION

Feed dry matter and nutrients intake

Intake of wheat straw, berseem and concentrate mixture/ maize grain vary in groups depending on their ratio in the diet. Total feed DMI on% body weight and g/kg $w^{0.75}$ was comparable among calves of different dietary (Table 2). These values of feed intake in buffalo calves are at par with the values reported earlier (Shahzad *et al*. 2011, Singh *et al.* 2009) for buffalo calves fed different diets varying in energy and protein contents. DMI (% body weight and g/ kg $w^{0.75}$) of male buffalo calves on diets wirth different energy contents recorded by Mahmoudzadeh *et al*. (2007) was similar to the present observations. Like present trend Tauqir *et al*. (2011) observed no effect on feed consumption of growing 6 to 7 months age buffalo calves fed diets containing different protein and energy concentrations. CPI and DCPI were higher ($P<0.05$) in G_1 (320.99) than G_2 (292.00) and G_3 (289.03 g/d) but comparable when expressed on g/kg$w^{0.75}$ wt basis. MEI (K cal/d and

Table 2. Feed dry matter and nutrients intake of Bhadawari buffalo calves

Parameters	G_1	G_2	G_3	Pooled SEM
Animal wt	102.40	99.40	89.60	8.57
Intake/d				
Wheat straw (kg)	1.134	0.903	0.752	0.73
Berseem (kg)	0.477	0.813	1.067	0.81
Concentrate (kg)	1.171	0.755	-	-
Maize grain (kg)	-	-	0.484	-
DMI (kg/d)	2.78	2.47	2.30	0.20
% body weight	2.77	2.47	2.61	0.05
g/kg $w^{0.75}$	86.97	77.47	79.18	1.75
CP intake (g)*	320.99	292.00	289.03	23.47
CPI (g/kg $w^{0.75}$)	10.07	9.19	9.94	0.19
DCP intake (g)*	199.48	179.87	170.97	13.29
DCPI (g/kg $w^{0.75}$)	6.28	5.72	5.95	0.13
MEI (M cal)	6.43	5.68	5.23	0.12
MEI (M cal/ kg $w^{0.75}$)	0.200	0.178	0.179	0.02

*Differ significantly at P<0.05 level of significance; *DCP,* digestible crude protein, DE, digestible energy, ME, metabolisable energy.

Kcal/kg $w^{0.75}$) was comparable among dietary groups. The values of protein and energy intake in buffalo calves are within the range values reported by Shahzad *et al.* (2011) for 12–15 months old calves fed diets of different energy and protein levels. Feed efficiency reported by Basra *et al.* (2003) in Nili-Ravi buffalo calves also corroborated to the present findings.

Nutrients utilization

Digestibility of DM, OM and CP was comparable in buffalo calves fed on different diets (Table 3). Calves fed different diets had comparable cell wall contents (NDF, ADF and cellulose) digestibility. The extent of cell wall nutrients (NDF, ADF, cellulose and hemicelluloses) and protein digestibility recorded in present study were more or less in agreement of the earlier studies (Singh *et al*. 2009, Anjum *et al*. 2012, Shahzad *et al*. 2011, Tauqir *et al*. 2011) carried on different diets in calves of Murrah and Nili Ravi buffaloes.

Rumen and blood metabolites

An inverse relationship was recorded in pH values and volatile fatty acids (TVFA) concentrations in rumen liquor

Table 3. Nutrients digestibility (%) in growing Bhadawari buffalo calves on different diets

Parameters	G_1	G_2	G_3	Pooled SEM
Nutrients digestibility				
DM	59.22	58.85	58.20	0.93
OM	59.65	59.41	58.95	0.95
CP	62.34	62.48	59.80	0.10
NDF	56.63	54.79	52.11	1.16
ADF	49.73	47.28	51.21	1.40
Cellulose	63.71	63.15	65.38	0.94
Hemicellulose	66.19	66.68	67.99	2.13

Table 4. Rumen and blood metabolites concentration of Bhadawari buffalo calves fed different diets

Parameters	G_1	G_2	G_3	Pooled SEM
Rumen metabolites				
pH	6.68	6.63	6.89	0.05
TVFA meq/l	100.0	110.0	90.0	3.90
Total N mg/100ml*	122.43	78.40	89.6	9.26
TCA precipitable N m/100ml*	64.59	56.20	55.90	2.73
Ammonia N mg/100ml*	14.93	11.67	12.13	0.49
Rumen microbes				
Total protozoa ($\times 10^5$/ml)	3.55	3.25	3.33	0.03
Entodiniomorphs ($\times 10^5$/ml)	2.7	2.62	2.61	0.02
Holotrichs ($\times 10^5$/ml)	0.88	0.63	0.72	0.01
Sporangia count*	3.15	3.62	4.21	0.02
Blood metabolites				
Blood urea mg/100ml	8.15	7.61	7.29	0.23
Blood glucose mg/100ml	46.29	44.87	45.05	1.15
Blood protein g /100ml	6.77	7.07	7.15	0.08
Growth rate				
Initial body wt (kg)	77.60	77.80	77.00	5.84
Final body (kg)	114.50	107.60	104.30	7.31
Gain (kg)	36.90	29.80	27.30	2.10
Growth rate (g/d)	410	377.8	350	23.40

*Differ significantly at P<0.05 level of significance.

of calves maintained on different diets (Table 4). This trend for pH and VFA in rumen liquor of buffalo calves fed different levels of concentrates was reported by Helal *et al*. (2011). On the other hand the concentration of total nitrogen, TCAP-N and ammonia nitrogen in rumen liquor of G_1 calves was higher (P<0.05) than G_2 and G_3. This may be due to low dietary protein contents in G_2 and G_3, groups. Further the higher blood urea contents in G_1 substantiates the pattern of ammonia production in present study as earlier workers (Paengkoum and Yanee 2009) reported increased blood urea nitrogen is associated with elevated ammonia concentration in rumen. Nitrogen metabolites and volatile fatty acid concentration in rumen liquor of buffalo calves fed total mixed rations recorded by Thakur *et al*. (2006) were comparable to our results.

Total protozoa counts in rumen liquor of buffalo calves were comparable in different dietary groups and ranged from 3.33 to 3.55 × 10^5/ml. Entodinimorpphs protozoa constitute 78–80% of the total protozoa population as observed in earlier studies (Odenyo *et al*. 1997, Singh *et al*. 2013). Protozoa counts reported by Thakur *et al*. (2006) in rumen liquor of buffalo calves fed total mixed rations were similar to the present findings. Sporangia counts were higher (P<0.05) in rumen liquor of G_3 calves than G_1 which was due to higher proportion of roughage in diet of this group as on high roughage diets rumen fungus growth is more.

Energy and protein level and their source in diets of calves had no significant effect on the concentration of blood metabolites (urea, glucose and protein). The value of blood metabolites (urea, glucose and protein) were

Table 5. Feed, protein and energy conversion ratio and their efficiency for growth of Bhadawari buffalo calves fed different diets

Parameters	G_1	G_2	G_3	Pooled SEM
Nutritive value				
DCP (%)	7.23	7.44	7.51	0.16
DE (M cal/kg)	2.80	2.79	2.76	0.04
ME (M cal/kg)	2.30	2.29	2.27	0.03
Nutrients efficiency				
FCR	7.63	8.73	8.80	0.62
CPCR	0.88	1.04	1.11	0.08
MECR	17.44	19.84	19.95	1.35

within the range of normal physiological values of buffalo calves.

Total gain and growth rate was higher in calves of G_1 than G_2 and G_3 groups, but the differences were nonsignificant. Relatively lower growth in G_2 and G_3 groups than G_1 might be due to low protein and energy intakes. Shahzad *et al*. (2011) also recorded nonsignificant higher average daily gain in buffalo calves on diets varying in protein and energy levels and the growth rate of calves obtained in present study was at par with the growth rate of buffalo calves recorded earlier (Tauqir *et al*. 2011and Shazad *et al.* 2011) .

Nutritive value, nutrients conversion ratio and efficiency for growth

Nutritive value of diets in terms of DCP and ME were comparable among different dietary groups (Table 5). Feed, protein and energy conversion ratio to produce a kg weight of buffalo calves was lowest for diet of G_1 and maximum for diet of G_3 group but were statistically nonsignificant. Shahzad *et al*. (2011) observed no effect of protein and energy levels on feed conversion ratio in 12–15 months old buffalo calves. The values of FCR, CPCR and MECR in the range of 7.3–10.2, 0.57–1.14 and 17.39–25.77 for male buffalo calves on diets varying in energy and protein observed by Mahmoudzadeh *et al*. (2007) were within the range of present findings. These workers further reported that dietary energy level influenced FCR, CPCR and MECR values while protein level had influence on CPCR only. Values for FCR, CPCR and MECR observed by Mahmoudzadeh and Fazaeli (2009) were higher for high and low energy diets than standard diet and values were also within the range of present findings.

FCR feed conversion ratio (kg of DMI per kg weight gain), *CPCR* crude protein conversion ratio (g of CP intake per kg weight gain, *MECR* metabolisable energy conversion ratio (M cal of ME intake per kg weight gain).

Results revealed that level and source of nutrients offered through the present diets had no effect on buffalo calves intake, nutrients digestibility, blood metabolites, nutritive value and growth rate but had significant effect on rumen liquor N contents and sporangia counts.

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