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Effect of feeding a rumen modifier on nutrient intake, growth and performance of buffalo calves

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Abstract
The study was conducted to see the effect on nutrient intake, growth and performance of buffalo calves by feeding a rumen modifier which is mixture of RM-7 [neem seed cake (Azadirachta indica), mahua seed cake (Madhuca longifolia), fennel seed (Foeniculum vulgare), harad (Terminalia chebula), fruit pulp of bahera (Terminalia bellirica), fruit pulp of amla (Phyllanthus emblica) and ajwain seed (Trachyspermum ammi) in 2:2:2:1:1:1:1 proportion] and sodium sulphate. The experiment was conducted on 21 growing buffalo calves divided into three groups, in a completely randomized design for a period of 120 days. The animals were fed roughage: concentrate in 50:50 ratio and the diet was isonitrogenous. The control group (T1) were fed basal diet, treatment group (T2) fed basal diet plus rumen modifier (RM-7 @2% DMI + sodium sulphate @0.06%) and treatment group (T3) fed basal diet plus rumen modifier (RM-7 @4% DMI + sodium sulphate @0.06%). The daily dry matter intake and digestibility showed no significant difference (P>0.05) when compared to control. The growth rate showed increasing trend numerically in treatment group when compared to control but was not significant (P>0.05).The study concludes that we can feed rumen modifier without any adverse effect on health of animal.

Keywords: Buffalo calves, RM-7, Sodium sulphate

Introduction
Ruminants harbour a complex microbial eco-system in the rumen which enables them to bio-convert poor quality lignocellulosic feed into valuable animal products like milk and meat. During feed fermentation in the rumen, CO_2 and H_2 gases are produced as by products and rumen methanogenic archaea reduce CO_2 into methane by utilizing H_2 which is eructated out through mouth leading to a loss of feed energy. In rumen, methanogenesis is an essential metabolic process to maintain a low H_2 pressure but wasteful as 2-12% dietary energy (Johnson and Johnson, 1995) [1] is wasted in the form of methane which reduces potential conversion of dietary energy into metabolizable energy thus reducing feed utilization efficiency of the animal. Also, methane being a potent greenhouse gas having 23 times more global warming potential than CO_2. Hence, the inhibition of methanogenesis has been of great concern for nutritionists since long back. By putting a check on methane production, the animal can be made more feed efficient and the environmental pollution due to increasing levels of greenhouse gases can be reduced.

The animal nutritionists are trying newer nutritional interventions to achieve this goal. In this endeavour, plant secondary metabolites (PSMs) have come up as a feasible alternative feed additive. The PSMs have antimicrobial activity therefore, their role in modulating rumen microbial ecosystem to reduce methanogenesis has been conceptualized (Kreuzer *et al*., 2009; Patra *et al*., 2010) [2, 3]. Several plant secondary metabolites such as essential oils (EOs), saponins, tannins and flavonoids have been documented for their ability to improve digestibility and feed utilization efficiency by modulating rumen microbial fermentation process (Patra *et al*., 2011; Rira *et al*., 2015; Inamdar *et al*., 2015;) [4, 5, 6].

Material and Methods
Selection and management of buffalo and experimental design
The present experiment was conducted at the Animal Farm, Indian Veterinary Research Institute (IVRI), Izatnagar, India. Twenty one growing male buffaloes of about 15-18 months of age were randomly divided into three groups (7 calves each) following completely randomized design.

The experiment was conducted for 120 days under similar managemental conditions. The animals were fed as per ICAR (2013) [7] feeding standards. The dietary treatments were divided into three groups. The first group control (T1) was fed control diet containing wheat straw and concentrate in 50:50 ratio (ICAR, 2013) without rumen modifier. The second group (T2) was fed diet similar to that of control group along with rumen modifier mixed with the concentrate (RM-7 and sodium sulphate @ 2 % and 0.06 % of DMI, respectively). The third group (T3) also was fed same diet of control group plus rumen modifier mixed with concentrate (RM-7 and sodium sulphate @ 4 % and 0.06 % of DMI, respectively).

Experimental Diet

The plant parts used for the preparation of experimental diet were brought from local market of Izatnagar, Bareilly. The seed kernel of neem (Azadirachta indica) contains bitter principles like nimbin, nimbidin and azadirachtin. Dried fruits of harad (*Terminalia chebula*) and bahera (*Terminalia bellirica*) are rich in tannins, whereas seeds of mahua (*Madhuca longifolia*) are a rich source of saponin. Fruit of amla (*Phyllanthus emblica*), seeds of ajwain (*Trachyspermum ammi*) and fennel (*Foeniculum vulgare*) are rich in essential oils. The parts were dried, powdered to prepare a blend (RM-7) in a proportion of mahua (20g/100g), fennel (20g/100g), neem (20g/100g), amla (10g/100g), ajwain (10g/100g), harad (10g/100g) and bahera 117 (10g/100g). The concentrate mixture consisted of maize, 35; solvent extracted soybean meal, 24; wheat bran, 38; mineral mixture, 2 and salt, 1 %. The substrate comprised of concentrate mixture and wheat straw in 1:1 ratio. The proximate composition of wheat straw, concentrate and rumen modifier are presented in Table 1.

Table 1: Chemical composition (% of DM) of concentrate mixture, wheat straw and RM-7 fed to growing buffalo calves

Attributes	Concentrate mixture	Wheat Straw	RM-7
Dry matter	96.68	95.09	91.33
Total ash	10.69	11.07	10.04
Organic matter	89.30	88.92	89.96
Crude Protein	18.50	2.90	10.04
Ether extract	3.51	1.90	2.80
Neutral detergent fibre	27.83	89.35	43.63
Acid detergent fibre	11.02	54.23	38.73

RM-7: mixture of neem, fennel, mahua, harad, bahera, ajwain and amla in 2:2:2:1:1:1:1 proportion

Feed Intake

The feed offered and residue left by the animals was recorded daily. The feed intake was determined by subtracting DM of residue from DM of feed offered.

Fortnightly body weight changes

The body weight of individual buffalo calves was monitored on fortnightly basis. The individual animal was weighed using an electronic weighing scale in the morning, prior to feeding and watering. The animals were weighed fortnightly up to 180 d to assess the body weight gain and feed conversion efficiency.

Metabolism Trial

A metabolism trial of 8 days duration including, 2 days adaptation in metabolic cages followed by 6 days collection was conducted after 60d of experimental feeding to evaluate the effect of feeding rumen modifiers on nutrient utilization and nitrogen balance. Body weight of the animals was recorded before and after the metabolism trial.

Feeding and sampling of feed and residue during metabolism trial

During the metabolism trial, weighed quantity of concentrate mixture (with additive for treatment groups) was offered at 9.00-10.00A.M. When the animals consumed concentrate mixture, weighed quantity of wheat straw was offered. Water was offered at 11.00AM, 16.00PM and 20.00 PM. Well-mixed representative samples of concentrate, wheat straw offered and residue left were taken daily in previously tared trays and dried at 100±2 ºC for overnight for dry matter estimation. The dried material obtained during trial period was pooled animal wise, ground to pass through 1 mm sieve and stored for proximate and fibre analysis (Van soest, 1991) [8]. Similarly faecal and urine samples were collected and analyzed.

Statistical Analysis

The data of were statistically analyzed by using one way ANOVA with Tukey's post hoc testing to compare experimental groups. For all statistical analyses, probability values less than 0.05 were considered as significant.

Result

Plane of nutrition and body weight

The effects of feeding rumen modifier on body weight change, dry matter intake and feed conversion ratio are presented in Table 2. Dry matter intake (kg/day) in rumen modifier supplemented groups was found similar to control. The intake through concentrate mixture and wheat straw revealed that the 50:50 ratio of the two was maintained throughout the feeding trial. Net body weight gain (kg) and average daily weight gain (g/d) during 120 d feeding trial was 94.66 and 676.2; 102 and 728.6; 105.1 and 751.2 in T1, T2 and T3, respectively. No significant (P>0.05) difference was observed in growth performance of the rumen modifier fed animals (T2 and T3) and the control animals (T1). No difference in feed intake and body weight gain resulted in similar feed conversion ratio in all the three groups.

Table 2: Effect of feeding rumen modifier on body weight change and feed conversion ratio of growing buffalo calves

Attributes	T1	T2	T3	SEM	P value
Initial wt (kg)	238.0±9.43	237.8±10.2	234.8±9.97	13.9	0.968
Final wt (kg)	326.6±12.8	339.8±12.2	340.0±10.3	16.5	0.881
ADG (g)	676.2±0.03	728.6±0.03	751.2±0.02	0.04	0.277
Concentrate DMI (kg)	2.83±0.00	2.83±0.00	2.83±0.00	0.00	0.16

WS DMI (kg)	3.09±0.11	3.19±0.08	3.15±0.05	0.12	1.00
WS:Concentrate	1.06±0.04	1.12±0.03	1.07±0.02	0.04	0.111
DMI (kg/d)	5.92±0.13	6.02±0.09	5.98±0.17	0.19	0.892
DMI (%BW)	2.91±0.04	3.02±0.06	2.95±0.03	0.08	0.47
Total DMI (kg)	791±15.8	807±12.2	798±20.6	23.4	0.791
Feed conversion ratio	6.34±0.32	5.97±0.27	5.72±0.25	0.40	0.330

T1, Control; T2, RM-7 + sodium sulphate @ 2 and 0.06% of DMI; T3, RM-7 + sodium sulphate @ 4 and 0.06% DMI; RM-7: mixture of neem, fennel, mahua, harad, bahera, ajwain and amla in 2:2:2:1:1:1:1 proportion.

Effect of Rumen Modifier on Plane of Nutrition during Metabolism Trial

Effect of feeding rumen modifier on plane of nutrition of growing buffaloes is given in Table 3. Mean body weight during metabolism trial were comparable among all the three groups. The intake of DM, CP, DCP and TDN showed no significant difference on supplementation of rumen modifier to both the treatment groups as compared to T1 indicating that the animals of all the three groups were in similar plane of nutrition. The CP and TDN intake was as per the requirement recommended by the feeding standard of ICAR (2013).

Table 3: Effect of feeding rumen modifier on plane of nutrition in growing buffalo calves during metabolism trial

Attributes	T1	T2	T3	SEM	P value
BW (kg)	307.1±5.43	298.5±6.48	302.1±3.53	7.48	0.53
Metabolic BW (kg)	73.36±0.97	71.80±1.17	72.46±0.63	1.34	0.53
Dry matter intake					
Kg/d	6.48±0.20	6.39±0.31	6.52±0.20	0.34	0.93
g/kg $W^{0.75}$	88.34±0.04	88.92±0.06	89.98±0.05	0.07	0.83
% BW	2.11±1.95	2.14±3.06	2.16±2.53	3.62	0.90
Crude protein intake					
g/d	655.8±13.5	646.3±14.0	656.9±12.7	19.02	0.83
g/kg $W^{0.75}$	8.94±0.13	9.00±0.05	9.06±0.14	0.16	0.76
% BW	213.5±3.20	216.5±0.77	217.4±3.45	3.90	0.60
DCP intake					
g/d	415.6±6.36	411.3±9.59	429.2±2.66	9.64	0.20
g/kg $W^{0.75}$	5.67^{a}±0.04	5.73^{a}±0.05	5.92^{b}±0.03	0.06	0.009
TDN intake					
Kg/d	3.70±0.11	3.83±0.23	3.78±0.09	0.22	0.96
g/kg $W^{0.75}$	51.40±1.42	53.26±2.38	52.21±1.08	2.43	0.75
Recommended nutrients intake for 500g daily weight gain (ICAR 2013)					
CP (g/d)	617	617	617		
TDN (kg/d)	3.73	3.73	3.73		
Actual intake					
CP (g/d)	655	646	656		
TDN (kg/d)	3.70	3.83	3.78		
Difference (%) between recommended and actual intake (ICAR)					
CP (g/d)	+6.15	+4.70	+6.32		
TDN (kg/d)	-0.80	2.68	1.34		

T1, Control; T2, RM-7 + sodium sulphate @ 2 and 0.06% of DMI; T3, RM-7 + sodium sulphate @ 4 and 0.06% of DMI; RM-7: mixture of neem, fennel, mahua, harad, bahera, ajwain and amla in 2:2:2:1:1:1:1 proportion.

Effect of Rumen Modifier on Nutrient Digestibility

Intake and digestibility of various nutrients and fibre fractions are given in Table 4. The intake of DM, OM, CP, EE, NDF, ADF as well as digestibility of all the nutrients were comparable among all the three groups. Digestibility of DM ranged from 61.27 to 64.36. Digestibility of CP and EE varied from 63.41 to 65.40 and 71.20 to 71.59. Digestibility of NDF and ADF varied from 54.37 to 61.27, 41.83 to 48.37, respectively. All the parameters were in normal range (P>0.05).

Table 4: Effect of Rumen Modifier on nutrient digestibility

Attributes	T1	T2	T3	SEM	P- value
Dry Matter					
Intake (kg/d)	6.48± 0.40	6.39 ±0.62	6.52 ±0.40	0.34	0.93
Digested (kg/d)	3.90±0.20	4.10±0.16	3.90±0.19	0.15	0.68
Digestibility (%)	61.27±1.52	6.60±3.09	61.39±1.75	1.57	0.14
Organic Matter					
Intake (kg/d)	5.60±0.27	5.71±0.17	5.67±0.35	0.30	0.93
Digested (kg/d)	3.48±0.17	3.50±0.18	3.47±0.20	0.18	0.98
Digestibility (%)	62.14±0.46	61.31±1.00	61.16±0.81	1.12	0.66
Crude Protein					
Intake (g/d)	655.8±13.5	646.2±14.0	656.9±12.7	19.0	0.83
Digested (g/d)	427.9±11.9	418.2±13.1	404.9±6.29	15.4	0.36
Digestibility (%)	63.41±0.55	63.63±0.47	65.40±2.41	1.15	0.22
Ether Extract					
Intake (g/d)	113.8±2.80	112.2±3.82	114.2±2.80	4.53	0.89

Digested (g/d)	81.10±1.20	83.23±2.67	81.83±3.45	3.70	0.84
Digestibility (%)	71.30±0.85	74.20±1.17	71.59±2.16	2.12	0.36
Neutral detergent fibre					
Intake (kg/d)	3.98±0.30	3.92±0.53	4.01±0.33	2.85	0.95
Digested(kg/d)	2.15±0.06	2.39±0.18	2.37±0.16	1.06	0.10
Digestibility (%)	54.37±3.5	61.27±4.6	59.12±2.48	2.58	0.06
Acid detergent fibre					
Intake (kg/d)	2.25±0.18	2.25±0.32	2.27±0.19	1.72	0.95
Digested (kg/d)	9.42±0.16	9.95±0.26	11.0±0.10	1.32	0.50
Digestibility (%)	41.83±6.46	44.17±6.09	48.37±1.93	3.71	0.25

T1, Control; T2, RM-7 + sodium sulphate @ 2 and 0.06% of DMI; T3, RM-7 + sodium sulphate @ 4 and 0.06% of DMI; RM-7: mixture of neem, fennel, mahua, harad, bahera, ajwain and amla in 2:2:2:1:1:1:1 proportion.

Discussion

The present study was carried out to see how nutrient intake,growth and animals performance would differ during four months feeding trial where growing buffalo calves were fed different experimental diet having rumen modifier. The experimental diet was rich in tannin, saponin, flavenoids and essential oils which impart characteristic properties to each component. The non-significant effect in DMI, Daily gain and FCR might be due to lesser number of animals chosen for conducting the experiment trial. Apart from less number of animals, a suboptimal dose of the rumen modifier as well as sulphur could also be responsible for the insignificant result. After the experimental feeding of 120 d, metabolism trial of 6 d duration was conducted to study the nutrient digestibility and N balance. Effect of various rumen modifiers on plane of nutrition of growing buffaloes. The intakes of DM, CP, DCP and TDN were similar (P>0.05) among all groups. Similar to the present findings Kumar *et al*., (2011) [9] and Someshwar (2009) [10] reported that DMI was not affected by combination of fennel seed, harad seed pulp and leaves of jamun and guava in fistulated buffaloes. The result of experiment revealed that rumen modifiers did not have any adverse effect on plane of nutrition.

Conclusion

Rumen modifier could be fed to animals without any adverse effect on nutrient intake, growth and performance of animals as well as being cost effective.

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