



Influence of Kamela (*Mallotus philippensis*) leaves as herbal feed additive on nutrient utilization and performances in growing crossbred calves

A SANTRA¹✉, S K DAS¹, A MANDAL¹ and T K DUTTA¹

ICAR-National Dairy Research Institute, Eastern Regional Station, Kalyani, West Bengal 741 235 India

Received: 9 January 2020; Accepted: 10 February 2020

ABSTRACT

This work was undertaken to evaluate the effect of dietary supplementation of Kamela (*Mallotus philippensis*) leaf meal as herbal feed additive on nutrients utilization and growth performance of growing crossbred calves. Ten numbers of growing Jersey male cross-bred calves were divided in to two groups (G1 and G2) and were fed individually under stall feeding on a paddy straw based mixed ration (50% paddy straw and 50% concentrate mixture) for 140 days. Two types (C1 and C2) of iso-nitrogenous concentrate mixtures were prepared. Wheat bran in concentrate mixture (C2) of test group (G2) was partially replaced (4 parts w/w) with sun dried ground *Mallotus philippensis* leaf meal. Experimental calves of test group (G2) fed *Mallotus philippensis* leaf meal @ 2% of the diet. Daily dry matter intake (g/d) was similar among the calves of two experimental groups. Apparent digestibility of DM, OM, NDF, ADF and cellulose were higher in the *Mallotus philippensis* leaf meal fed calves (G2). DCP value of the ration was similar while, TDN value of the ration was higher in the calves of *Mallotus philippensis* leaf meal supplemented group (G2). However, plane of nutrition among the calves of both experimental groups was similar. Average finishing body weight, daily body weight gain, feed conversion efficiency and blood glucose level were higher in *Mallotus philippensis* leaf fed calves (G2). The results of the study indicated that dietary supplementation Kamela (*Mallotus philippensis*) leaf meal as herbal feed additive @ 2% of total diet significantly improved the performance in growing male crossbred calves.

Keywords: Calves, Feed additive, *Mallotus philippensis*, Nutrient utilization, Performance

Manipulating the rumen microbial ecosystem to reduce ruminal methane, ciliate protozoa and ammonia nitrogen production by using feed additives for efficient utilization of dietary energy and protein is a useful strategy to improve production efficiency of ruminant animals (Cherdthong *et al.* 2019). Feed additives such as ionophores, defaunating agents, antibiotics were proved very effective in reducing dietary energy and protein losses; however, contemporary biosecurity threats have restricted their use in the diet in many European countries (Malik *et al.* 2019). Very often residue of the chemical feed additive was detected in animal products like meat and milk leading to unfit or harmful for human consumption (Liu *et al.* 2019). There has been an increase interest to use natural products containing plant secondary compounds instead of chemical feed additives to modify rumen fermentation for improving feed utilization and productive performances of ruminant animals (Singh *et al.* 2018, Cherdthong *et al.* 2019, Taku *et al.* 2019). Several *in vitro* studies showed that plant secondary metabolites seem to have the potential to favorably

manipulate rumen fermentation to reduce ruminal methane emissions and ciliated protozoal population for efficient use of dietary energy and protein (Bhatta *et al.* 2017, Singh *et al.* 2018, Malik *et al.* 2019). However, *in vivo* studies on plant secondary metabolites to use as natural feed additive to manipulate rumen fermentation for reducing ruminal methanogenesis and prozoal population to improve productivity of animals is almost lacking/very scanty. Based on our previous *in vitro* studies in our laboratory on methane and protozoa population reduction potential (Lotha 2015), Kamela (*Mallotus philippensis*) tree leaves which not yet been investigated, has been selected for *in vivo* studies. Therefore, the present experiment was conducted to study the effect of dietary supplementation Kamela (*Mallotus philippensis*) tree leaf meal as herbal feed additive on nutrient utilization and performances of growing cross bred calves.

MATERIALS AND METHODS

Collection and processing of tree leaf to use as herbal feed additive: Kamela (*Mallotus philippensis*) tree leaves were collected from Agartala, Tripura during the month of April. Both old and newly emerge type of leaves from trees were harvested and sun dried. The sun dried leaves were

Present address: ¹ICAR-National Dairy Research Institute, Eastern Regional Station, Kalyani, West Bengal. ✉Corresponding author email: santraashok@rediffmail.com

Table 1. Chemical composition (% DM) of experimental ration

Attribute	Concentrate mixture		Kamela	Paddy straw
	C1	C2	(<i>Mallotus philippensis</i>) leaf	
<i>Physical composition (%)</i>				
Kamela (<i>Mallotus philippensis</i>) leaf	00	04	—	—
Maize grain	45	45	—	—
Wheat bran	25	21	—	—
Mustard cake	23	23	—	—
Mineral mixture	2	2	—	—
Common salt	1	1	—	—
Vitablend® AD ₃	@ 20 g/100 kg concentrate mixture			
<i>Chemical composition (% DM)</i>				
Organic matter (OM)	93.7	92.9	94.8	86.6
Crude protein (CP)	18.2	17.9	14.2	3.4
Ether extract (EE)	4.7	4.5	2.9	1.9
Total carbohydrate (TCHO)	70.8	71.5	77.8	81.3
Neutral detergent fibre (NDF)	34.8	35.7	49.1	71.5
Acid detergent fibre (ADF)	11.8	12.1	24.5	41.1
Cellulose	7.6	7.8	18.9	34.3
Acid detergent lignin (ADL)	3.9	4.1	5.2	6.1

grounded (2 mm size) in a hammer mill prior to the determination of chemical composition and subsequent use in concentrate mixture preparation.

Experimental animals and feeding trial: Ten numbers of Jersey male cross-bred calves (about four months of age and 91.8 ± 1.37 kg body weight) were randomly divided in to two equal groups (G1 and G2) of five animals each on the basis of body weight so that average body weight of the two experimental groups become similar. These calves were fed individually under stall feeding on a paddy straw based total mixed ration with roughage to concentrate ratio of 50:50 for 140 days to meet out maintenance and growth (600 g average daily gain) requirement (NRC 2001). Two types (C1 and C2) of iso-nitrogenous concentrate mixtures were prepared (Table 1). Wheat bran in concentrate mixture (C2) of test group (G2) was partially replaced (4 parts w/w) with *Mallotus philippensis* leaf meal. Concentrate mixture was offered once daily at 9:00 AM after discarding previous day's residue if any. Calves of test group (G2) were fed *Mallotus philippensis* leaf meal @ 2% of total diet as herbal feed additive. Measured quantity of paddy straw was offered twice daily at 10:00 AM and 18:00 PM for an excess of 10% after discarding residue. Record of daily feed intake was maintained throughout the experimental period.

Digestibility trial: A digestion trail for 10 days (i.e. 3 days adaptation followed by 7 days sample collection) was conducted on all the ten experimental crossbred calves after 120 days of experimental feeding. During digestion trial, daily faeces voided, feed offered and residues left were recorded. Fresh samples of fodder and concentrate mixture offered, residues left, and faeces voided were collected daily in the morning after thorough mixing so as to obtain homogeneous and representative samples. The samples were dried, and stored in clean, labeled polyethene bags. Dried samples for each day of the 7 days collection were

pooled, ground to pass a 1 mm screen and preserved for chemical analysis.

Blood samples: Blood samples were obtained from each experimental cow at 0, 45 and 90 days of experimental feeding. Before offering feed, blood samples were collected from the jugular vein into 10 ml tube containing Na heparin as anticoagulant. Samples were centrifuged ($5000 \times g$ for 20 min at 4°C) within 15 min, and collected plasma was frozen immediately at -20°C until analyzed.

Growth trial: The growth trial was lasted for 140 days during which feed intake were recorded daily for each calf. Calves body weight were recorded for 2 consecutive days fortnightly immediately before offering feed and water and these values were used to determine body weight gain.

Chemical analysis: The feed offered, residues left and feces voided were analyzed for DM by drying at 100°C for 24 h, OM by ashing at 550°C for 4 h and crude protein (CP) by Kjeldahl technique (AOAC 2005). NDF, ADF and ADL were estimated following the method of Van Soest *et al.* (1991). Cellulose content was calculated by subtracting ADL from ADF. Blood glucose (Cooper and Mc Daniel, 1970), urea nitrogen (Rahamatullah and Boyde 1980), total protein and albumin (Annino 1976) were estimated in separated blood plasma.

Statistical analysis: Data were analyzed by the methods described by Snedecor and Cochran (1994). The data were subjected to analysis of variance (one way ANOVA) and significant treatment effect was determined by comparing the means with Duncan's multiple range test (Duncan 1955).

RESULTS AND DISCUSSION

Chemical composition of experimental diet: The chemical composition of concentrate mixture, *Mallotus philippensis* leaf and paddy straw is presented in Table 1. The overall nutrient composition of concentrate mixture

(C1) for feeding to the control group (G1) and concentrate mixture (C2) for feeding to the test group (G2) was similar. The chemical composition of paddy straw used in the present experiment was comparable to the values reported earlier by Santra *et al.* (2013a). In the present experiment *Mallotus philippensis* leaf contained crude protein higher than earlier reported value for tree leaves from North-Eastern state (Taku *et al.* 2019).

Feed intake, nutrient digestibility and plane of nutrition: In this experiment, calves of control (G1) and test (G2) groups were offered roughage (paddy straw) and concentrate mixture in the ratio of 50:50 under cafeteria system of feeding management. However, the actual intake roughage and concentrate ratio by the calves in G1 and G2 experimental groups was 47.8: 52.2 and 48.9:51.1, respectively. Dietary supplementation of *Mallotus philippensis* leaf meal as herbal feed additive did not have any effect on voluntary feed intake. Daily dry matter intake in terms of per kg body weight as well as per kg metabolic body size was similar among the calves of two experimental groups (Table 2). Olafadehan *et al.* (2016) reported that inclusion of tannin-containing *Ficus polita* foliage up to 700 g/kg of DM in a total mixed ration for goat did not

compromise voluntary feed intake. Supplementation of *Sapindus mukorossi* leaves @ 3% in diet as herbal feed additive had no effect on daily feed intake in Rathi calves (Meel *et al.* 2015). Similarly, a non-significant effect of tropical tree leaves supplementation as herbal feed additive on dry matter intake (DMI, g/d) was reported in sheep between control and test group (Malik *et al.* 2017).

The digestibility of dry matter, organic matter, neutral detergent fibre, acid detergent fibre and cellulose were improved ($P < 0.01$) due to dietary supplementation of *Mallotus philippensis* leaf meal as feed additive. However, digestibility of crude protein and ether extract was not influenced by dietary supplementation of *Mallotus philippensis* leaf meal. In the present experiment, dry matter digestibility improved by 3.7% due to dietary supplementation of *Mallotus philippensis* leaf meal as feed additive. Earlier it was reported that dry matter digestibility was increased by 4.8% due to dietary supplementation of *Piper sarmentosum* leaf meal at 2.4 g/head/d in cattle in comparison to control (Cherdthong *et al.* 2019). This result could be attributed to protozoa, which are capable of ingesting fibrolytic bacteria; therefore suppressing these protozoa is expected to increase number of fibrolytic bacteria in the rumen, which can enhance feed digestibility in animals (Cherdthong *et al.* 2019). However, the present study could not confirm whether fibrolytic bacterial number enhances or not to improve feed digestion. Previous *in vitro* studies in our laboratory confirmed that inclusion of *Mallotus philippensis* leaf meal in incubation media reduced rumen protozoal population (Lotha 2015). Meel *et al.* (2015) reported that incorporation of *Sapindus mukorossi* (Reetha) leaf @ 3% in the diet as herbal feed additive improved the digestibility of nutrients in Rathi calves. Similarly supplementation of *Moringa oleifera* leaves, improved nutrient digestibility as well as fermentation of rumen in dairy cows (Li *et al.* 2019).

Digestible crude protein (DCP) content of ration was similar in G1 and G2 group. However, total digestible nutrients (TDN) content of the ration was higher ($P < 0.01$) for *Mallotus philippensis* leaf meal fed calves (G2). Higher TDN content in the ration of G2 group might be due to higher nutrient (DM, OM, NDF, ADF and cellulose) digestibility. Dietary supplementation of *Mallotus philippensis* leaf meal as herbal feed additive had no effect on daily nutrient intake/plane of nutrition of growing calves. Similar plane of nutrition of the two experimental groups e.g., G1 and G2 in the present experiment was due to similar daily dry matter intake between the two experimental groups as well as slightly higher body weight of the calves in G2 group during digestion trial.

Blood profile, body weight changes and feed conversion efficiency: Blood glucose level was higher ($P < 0.05$) in the *Mallotus philippensis* leaf meal fed calves (G2). Dietary supplementation of *Mallotus philippensis* leaf meal as feed additive had no influence on plasma urea, serum total protein and serum albumin concentration (Table 3). Higher blood glucose level in *Mallotus philippensis* leaf meal fed

Table 2. Effect of dietary Kamela (*Mallotus philippensis*) leaf supplementation as herbal feed additive on intake, nutrient utilization and plane of nutrition in growing crossbred calves

Attribute	Level of kamela leaf (%)		SEM	Level of significance
	0 (G1)	2 (G2)		
<i>DMI</i>				
Roughage (g/d)	2.2	2.3	0.03	NS
Concentrate (g/d)	2.4	2.4	0.05	NS
Total (g/d)	4.6	4.7	0.11	NS
DMI (% b. wt.)	3.3	3.2	0.09	NS
DMI (g/kg ^{0.75} /d)	112.7	111.6	5.13	NS
<i>Nutrient digestibility</i>				
DM	60.2	62.4	0.47	P<0.01
OM	62.3	64.3	0.57	P<0.01
CP	65.8	66.5	0.51	NS
EE	69.6	69.8	0.64	NS
NDF	52.7	54.8	0.43	P<0.01
ADF	47.3	49.3	0.39	P<0.01
Cellulose	49.7	52.1	0.45	P<0.01
<i>Nutritive value</i>				
DCP (%)	7.3	7.3	0.13	NS
TDN (%)	60.1	63.4	0.42	P<0.01
<i>Plane of nutrition</i>				
DCP intake				
g/d	335.8	343.1	16.19	NS
g/kg b. wt./d	2.4	2.3	0.05	NS
g/kg w ^{0.75} /d	8.3	8.2	0.17	NS
TDN intake				
g/d	2.8	3.1	0.04	NS
g/kg b. wt./d	19.9	21.1	1.09	NS
g/kg w ^{0.75} /d	70.1	73.4	2.15	NS

NS, Non significant; SEM, Standard error of mean.

Table 3. Effect of dietary Kamela (*Mallotus philippensis*) leaf supplementation as herbal feed additive on blood metabolites, growth performance and feed conversion efficiency in growing crossbred calves

Attribute	Level of Kamela leaf (%)		SEM	Level of significance
	0 (G1)	4 (G2)		
<i>Blood profile</i>				
Plasma glucose (mg/dl)	60.50	63.700	0.41	P<0.05
Plasma urea (mg/dl)	36.10	35.70	0.67	NS
Serum total protein (g/dl)	6.90	7.10	0.13	NS
Serum albumin (g/dl)	3.10	3.20	0.06	NS
Serum globulin (g/dl)	3.80	3.90	0.09	NS
Albumin:globulin ratio	0.81	0.82	0.04	NS
<i>Growth performance</i>				
Initial b.wt. (kg)	92.10	91.50	1.32	NS
Final b.wt. (kg)	166.70	170.70	2.17	P<0.01
Total b.wt. gain (kg)	74.60	79.20	1.29	P<0.01
Average daily gain (g)	532.90	565.70	9.35	P<0.01
<i>Plane of nutrition during experimental period</i>				
Total DM intake (kg)	534.90	529.20	26.39	NS
Total DCP intake (kg)	39.10	38.60	3.28	NS
Total TDN intake (kg)	321.5	335.50	19.57	NS
<i>Feed conversion efficiency</i>				
DM intake (kg/kg gain)	7.20	6.70	0.03	P<0.05
DCP intake (kg/kg gain)	524.10	487.80	11.69	P<0.01
TDN intake (kg/kg gain)	4.30	4.20	0.02	P<0.05
Feed efficiency (%)	13.90	14.90	0.03	P<0.05

NS, Non significant; SEM, Standard error of mean.

calves might be due to higher nutrient digestibility and ruminal propionate production (Santra *et al.* 2013b).

Final body weight, average daily body weight gain and feed conversion efficiency were higher (P<0.01) for the calves supplemented with *Mallotus philippensis* leaf meal as feed additive (G2) than the non-supplemented calves (G1). Better growth rate and feed conversion efficiency in the *Mallotus philippensis* leaf meal fed calves might be due to higher nutrient digestibility resulting in better utilization of dietary energy, leading to better body weight gain and feed conversion efficiency. Nutrient intake e.g. DM, DCP and TDN intake during total experimental period was similar among the calves of two experimental groups (G1

and G2). The calves of G1 and G2 group consumed 112.7 and 111.6 g DM, 8.3 and 8.2 g DCP, 70.1 and 73.4 g TDN per kg metabolic body size and had an average daily gain of 532.9 and 557.8 g, respectively. The calves of the present experiment meet the nutrient requirement of ICAR (2013) for DM, DCP and TDN. The presence of secondary metabolites such as flavonoids, saponins, tannins etc. in plants, produce some biological activity in ruminant animals resulting in better body weight gain and feed conversion efficiency (Cherdthong *et al.* 2019). It was reported that *Mallotus philippensis* leaf contains various phyto chemicals like tannin, saponin, flavonoids etc. (Velangann *et al.* 2011) which might be reduced the ruminal methanogenesis and protozoal population resulting in a better body weight gain and feed conversion efficiency in the growing crossbred calves in the present experiment. In our laboratory, we observed inclusion of *Mallotus philippensis* leaf meal in the culture media reduce ruminal methanogenesis and protozoal population *in vitro* (Lotha 2015). Meel *et al.* (2015) reported that incorporation of *Sapindus mukorossi* (Reetha) leaf @ 3% in the diet as herbal feed additive improved the average daily gain and feed conversion efficiency in Rathi calves. It was observed that feeding of tanniniferous tropical tree leaves e.g., *Ficus benghalensis*, *Artocarpus heterophyllus* and *Azadirachta indica* through concentrate mixture (10 parts, w/w basis, wheat bran in concentrate mixture replaced by these tree leaves) as a natural feed additive reduced ruminal methane production and improved body weight gain in sheep (Malik *et al.* 2017).

In conclusion, the results of the present study showed that dietary supplementation of sun dried Kamela (*Mallotus philippensis*) leaf meal as natural feed additive @ 2% of total diet/ration was effective for improving dry matter digestibility, body weight gain and feed conversion efficiency in growing crossbred calves. Thus, supplementation of Kamela (*Mallotus philippensis*) leaf meal as herbal feed additive in ruminant feeding is recommended for manipulating rumen fermentation to improve productivity of ruminants.

ACKNOWLEDGEMENT

The authors are thankful to Director, NDRI, Karnal, Haryana and Head, ERS, NDRI, Kalyani for providing necessary research facility.

REFERENCES

- Annino J S. 1976. Determination of total proteins and albumins in serum. *Clinical Chemistry: Principles and Procedures*, 4th ed. Little Braken and Company, Bogoton, pp. 184–188.
- AOAC. 2005. *Official Methods of Analysis*. 18th edn. Association of Official Analytical Chemists. Maryland, USA.
- Bhatta R, Saravanan M, Baruah L, Malik P K and Sampath K T. 2017. Nutrient composition, rate of fermentation and *in vitro* rumen methane output from tropical feed stuffs. *Journal of Agricultural Science* **155**: 171–83.
- Cherdthong A, Khonkhaeng B, Foiklang S, Wanapat M, Gunun N, Gunun P, Chanjula P and Polyorach, S. 2019. Effects of supplementation of *Piper sarmentosum* leaf powder on feed

- efficiency, rumen ecology and rumen protozoal concentration in Thai native beef cattle. *Animals* **9**: 130.
- Cooper G R and Mc Daniel V. 1970. Determination of glucose by orthotoluidine method. *Standard Method of Clinical Chemistry*. Academic Press, New York, pp. 159.
- Duncan B B. 1955. Multiple range and multiple F-test. *Biometrics* **11**: 1–42.
- Li Y, Guang-Ninga Z, Hong-Jiana X, Shuanga Z, Xiu-Jinga D, Congb L, Xing-Yib Z, Hong-Boc Z and Yong-Gena Z. 2019. Effects of replacing alfalfa hay with *Moringa oleifera* leaves and peduncles on intake, digestibility, and rumen fermentation in dairy cows. *Livestock Science* **220**: 211–16.
- Liu Y, Tao M, Chen D, Zhang N, Si B, Deng K, Tu Y and Diao Q. 2019. Effect of tea saponin supplementation on nutrient digestibility, methanogenesis and ruminal microbial flora in Dorper crossbred ewe. *Animals* **9**: 29–40.
- Lotha M. 2015. Evaluation of tree leaves for its effect on rumen fermentation and methanogenesis *in vitro*. M.V.Sc. Thesis, ICAR-NDRI, Karnal, Haryana, India.
- Malik P K, Kolte A P, Baruah L, Saravanan M, Bakshi B and Bhatta R. 2017. Enteric methane mitigation in sheep through leaves of selected tanniniferous tropical tree species. *Livestock Science* **200**: 29–34.
- Malik P K, Uyeno Y, Kolte A P, Kumar R, Trivedi S and Bhatta R. 2019. Screening of phyto sources from foothill of Himalayan mountain for livestock methane reduction. *SN Applied Sciences* **1**: 232–40.
- Meel M S, Sharma T, Dhuria R K, Pal R S and Nehra R. 2015. Influence of *Sapindus mukorossi* (reetha) as herbal feed additive on rumen fermentation and nutrient digestibility in Rathi calves. *Indian Journal of Animal Nutrition* **32**: 164–67.
- NRC. 2001. *Nutrient Requirements of Dairy Cattle*. 7th rev. ed. National Research Council, National Academy Press, Washington, DC, USA.
- ICAR. 2013. *Nutrient Requirements of Animals—Cattle and Buffalo (ICAR-NIANP)*. 3rd ed. Indian Council of Agricultural Research, New Delhi, India.
- Olafadehan, O A, Njidda A A, Okunade S A, Adewumi M K, Awosanmi K J, Ijanmi T O and Raymond A. 2016. Effects of feeding *Ficus polita* foliage-based complete rations with varying forage:concentrate ratio on performance and ruminal fermentation in growing goats. *Animal Nutrition and Feed Technology* **16**: 373–82.
- Rahamatullah M and Boyde T R C. 1980. Improvements in the determination of urea using diacetyl monoxime methods with and without deproteinization. *Clinical Chemistry Acta* **107**: 3–9.
- Santra A, Mondal A, Konar S, Banerjee A, Chatterjee A, Das S K and Ghosh M K. 2013a. Influence of graded replacement of paddy straw with brewer's spent grain on rumen protozoa, enzyme profile and feed fermentation under *in vitro*. *Indian Journal of Animal Sciences* **83**: 806–10.
- Santra A, Konar S, Banerjee A, Chatterjee A and Das S K. 2013b. Effect of sunflower oil supplementation on nutrient utilization and growth performances of crossbred calves. *Indian Journal of Animal Sciences* **83**: 67–72.
- Singh I, Hundal J S, Wadhwa M W and Lamba J S. 2018. Assessment of potential of some tannins and saponins containing herbs on digestibility of nutrients, fermentation kinetics and enteric methane production under different feeding systems: an *in vitro* study. *Indian Journal of Animal Sciences* **88**: 443–52.
- Snedecor G W and Cochran W G. 1994. *Statistical Methods*. 8th edn. Iowa State University Press, Ames, Iowa, USA.
- Taku T, Santra A, Barik S, Mandal D K and Das S K. 2019. Assessment of fodder quality and methane production potential of north-eastern Himalayan forest tree leaves. *Indian Journal of Animal Sciences* **89**: 90–96.
- Van Soest P J, Robertson J B and Lewis B A. 1991. Methods for dietary fibre, neutral detergent fibre and non-starch polysaccharide in relation to animal nutrition. *Journal of Dairy Science* **74**: 3583–97.
- Velanganni J, Kadamban D and Tangavelou A C. 2011. Phytochemical screening and antimicrobial activity of the stem of *Mallotus Philippensis*. *International Journal of Pharmacy and Pharmaceutical Sciences* **3**: 160–63.