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Evaluation of mulberry tree leaves based diets in Corriedale lambs

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ABSTRACT

An experiment was conducted in two phases; phase-I, five experimental rations were prepared with incorporation of mulberry leaf meals replacing concentrates @ 0% (C), 20% (TR_1), 40% (TR_2), 60% (TR_3) and 80% (TR_4), respectively and TR_4 was found the best in terms of IVDM, IVOM and IVNDF digestibility. In phase-II, TR_4 was made in two forms, mash and CFBs and were fed to six corriedale lambs in group T_1 and T_2, respectively. The control group (C) was fed with conventional ration prepared in mash form as per NRC 1985. The fortnightly dry matter intake expressed as per cent of body weight in C, T_1 and T_2 groups were 3.77, 3.90 and 4.07, respectively, and were statistically significant between T_2 and control group with highest value in T_2 group. The digestibility coefficients of DM, OM, CP, EE and NDF differ significantly amongst the groups with highest values observed in group T_2 followed by T_1 and control. However, digestibility coefficient of CF differ significantly between control and other groups (T_1 and T_2), which were statistically at par with each other. However, the digestibility coefficient values of NFE differed significantly between T_2 group and other groups that showed statistically non-significant. The DCP and TDN values differed significantly with positive balances of all nutrients amongst all treatment groups. Results revealed that mulberry leaves can replace up to 80% of concentrate mixture in corriedale lambs especially in CFB forms with positive effect on nutrient intake, digestibility and balances.

Key words: Complete feed block, Corriedale sheep, Mulberry tree leaves, Nutrient utilization

The shortage of feed and fodder especially during the winter is one of the major reasons for low productivity in sheep. Under these circumstances, it becomes important to evaluate the nutritional potential of locally available unconventional feed resources that will bridge the gap between demand and supply of feeds and fodder. Among the available unconventional feed/fodder resources, top fodders are available in abundance in Jammu and Kashmir which are cheap sources of nitrogen, energy and micronutrients. Besides it has widespread on farm availability and easy accessibility to farmers. The tree leaves can be harvested, sun dried and used as compounded protein supplements.

Mulberry leaves, traditionally used as feed for silkworm, during post-cocoon production, are sufficiently available exclusively for feeding livestock up to the onset of winter. The surplus foliages can be preserved for winter feeding to combat shortage of feeds. Its leaves are relished by sheep and goats and have high nutritive value, viz. digestible crude protein (10.16%) and total digestible nutrients (66.10%) (Ganai *et al.* 2010). This material could be appropriate protein supplement for sheep as partial or total replacement for costly concentrates. Hence, this study was undertaken to check its nutritional importance in sheep diets.

MATERIALS AND METHODS

The experiment was conducted for the evaluation of mulberry leaf based complete feed in sheep in two phases as discussed here.

Phase I: Diet formulation and conduction of in-vitro *digestibility:* During this phase, all the ingredients of experimental rations were analysed for proximate components (AOAC 2000) and fibre fractions (Van Soest *et al.* 1991).

A standard balanced ration was prepared as per NRC requirements (1985) of sheep using oats straw, maize crushed, rice bran, wheat bran, linseed cake, mustard oil cake, mineral mixture, common salt, urea and molasses @ 50, 12.5, 8, 8, 10, 7.5, 1, 0.5, 1 and 1.5%. Mulberry leaves were incorporated replacing the concentrate mixture @ 0, 20, 40, 60 and 80% maintaining their nitrogen and calorie contents through changes in proportion of other ingredients and were designated as Control, TR_1, TR_2, TR_3 and TR_4 respectively (Table 1). The *in vitro* digestibility of all these rations were carried out through two stage Tilley and Terry's method (1963) in which the feed samples were incubated for 48 h at 39°C in buffered rumen liquor taken from five adult sheep maintained on five treatment rations. The *in-vitro* digestibility of dry matter (IVDMD), organic matter

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(IVOMD) and neutral detergent fibre (IVNDFD) were calculated using standard formulae.

Phase II: Feeding trial and in vivo *digestibility:* On the basis of phase-I experiment, the best ration was selected for *in vivo* digestibility studies and the rations were prepared in two forms namely mash and complete feed blocks and were fed to two groups of lambs i.e. T_1 and T_2, respectively. Each experimental group comprised of six corridale lambs of uniform age and body weights (weighing between 13–15 kg at 4–6 months of age). The experimental rations were offered to the animals individually twice daily as per NRC (1985) standards for 21 days following recommended feeding and management practices.

At the end of experimental feeding, a metabolism trial of 5 days duration was conducted using metabolic cages, during which samples of feed offered, residue left, urine and faeces voided were collected. The samples of feed/fodder, feaces and urine collected were analyzed in the laboratory for proximate components (AOAC 2000) and fibre fractions (Van Soest *et al.* 1991).

Experimental design: Completely randomized design was applied for the experiment and the data obtained from the experiments were analysed statistically using Statistical Package for the Social Sciences, Base 15.0.

RESULTS AND DISCUSSION

Phase I: Diet formulation and conduction of in-vitro *digestibility*

Composition of the experimental rations: The organic matter contents of the test diets showed variation (88.93 to 89.37%) amongst different treatment rations (Table 1) which might be attributed to the inclusion of mulberry leaves having comparatively higher total ash (11.89%) contents. Varied levels for crude protein content (13.09–13.28%) of the test diets observed might be attributed to the inclusion of feed ingredients at different levels. Crude protein values showed decreasing trend from control to TR_4, which was attributed to decreasing proportion of oil cakes (MOC and linseed cake) from control to TR_4 as oil cakes contained highest CP amongst different feed ingredients used. The increasing trends of ether extract from control to TR_4, was due to increasing proportion of mulberry leaves from control to TR_4 because of its higher (7.25%) EE content (Table 1). Crude fibre content of the rations varied between 18.01 to

Table 1. Physical and chemical composition of different experimental rations used in *in vitro* study

Ingredient	Experimental groups				
	Control	TR_1	TR_2	TR_3	TR_4
Physical composition (%)					
Oats straw	50.00	50.00	50.00	50.00	50.00
Mulberry leaves	-	10.00	20.00	30.00	40.00
Maize	12.50	9.80	7.10	4.40	1.70
Rice bran	8.00	6.20	4.40	2.60	0.80
Wheat bran	8.00	6.20	4.40	2.60	0.80
Linseed cake	10.00	7.80	5.60	3.40	1.20
MOC	7.50	6.00	4.50	3.00	1.50
Common salt	0.50	0.50	0.50	0.50	0.50
Min mix	1.00	1.00	1.00	1.00	1.00
Molasses	1.50	1.50	1.50	1.50	1.50
Urea	1.00	1.00	1.00	1.00	1.00
Chemical composition (% DM basis)					
DM	88.19±0.15	88.43±0.29	88.79±0.83	88.81±0.16	88.95±0.12
Organic matter	89.12±0.23	89.25±0.09	89.37±0.12	88.97±0.06	88.93±0.15
Crude protein	13.28±0.06	13.28±0.08	13.19±0.04	13.12±0.02	13.09±0.02
Crude fibre	18.01±0.03	18.21±0.04	18.37±0.04	18.61±0.04	18.07±0.03
Ether extract	4.97±0.02	5.01±0.02	5.17±0.04	5.21±0.04	5.43±0.02
Nitrogen free extract	52.86±0.23	52.75±0.23	52.64±0.02	52.03±0.03	52.34±0.12
Total ash	10.88±0.23	10.75±0.09	10.63±0.12	11.03±0.06	11.07±0.06
Acid insoluble ash	6.85±0.05	6.73±0.03	6.61±0.18	6.33±0.02	6.25±0.03
Calcium	1.56±0.02	1.58±0.03	1.58±0.03	1.59±0.02	1.60±0.02
Phosphorus	0.90±0.02	0.85±0.01	0.84±0.02	0.83±0.01	0.69±0.01
Fibre fractions (%)					
NDF	52.07±0.55	51.63±0.28	51.00±0.57	50.63±0.11	50.55±0.23
ADF	24.00±0.57	25.00±1.00	26.00±0.57	26.00±1.57	27.00±1.01
Cellulose	17.00±1.01	18.00±1.02	18.00±1.15	19.00±1.03	19.00±0.57
Hemi-cellulose	28.07±0.07	26.63 ±0.78	25.00 ±1.02	24.63 ±1.50	23.55 ±1.07

Table 2. Percent *in vitro* digestibility parameters of treatment rations

Parameter	Experimental-rations				
	Control	Treatment -1	Treatment -2	Treatment -3	Treatment -4
IVDMD (%)	$42.26^a \pm$ 0.19	$44.12^b \pm$ 0.04	$46.15^c \pm$ 0.05	$48.36^d \pm$ 0.36	$50.34^e \pm$ 0.77
IVOMD (%)	$46.13^a \pm$ 0.04	$48.14^b \pm$ 0.14	$50.12^c \pm$ 0.18	$52.36^d \pm$ 0.26	$55.63^e \pm$ 0.32
IVNDFD (%)	$48.02^a \pm$ 0.12	$49.12^b \pm$ 0.10	$50.05^c \pm$ 0.13	$52.01^d \pm$ 0.07	$54.04^e \pm$ 0.14

Row-wise group means with different superscripts differ significantly ($P \leq 0.05$).

18.61% probably due to the inclusion of feed ingredients at different levels and the total ash content was higher in TR_4 compared to other treatment rations, possibly due to higher proportion of mulberry leaves. However, the acid insoluble ash content in control ration was lowest or reversely acid soluble ash/mineral level was highest in TR_4 than the other rations. Higher inclusion levels of mulberry leaves in the TR_4 ration might be the reason for this as it contains higher mineral content. Calcium content showed increasing trend from control ration to TR_4, which could possibly be due to increasing proportion of mulberry leaves as they contain comparatively higher calcium level than the other feed ingredients. But, the phosphorus content of different experimental rations showed reverse trend as compared to calcium possibly due to decreasing proportion of bran's with increasing proportion of mulberry leaves, as the former contained comparatively higher phosphorus content, respectively.

Results of fibre fraction of different experimental rations for *in vitro* analysis suggested decreasing trend of NDF and hemi-cellulose and vice-versa for ADF and cellulose content from control ration to TR_4 and the variation in inclusion levels of different feed ingredients with increasing levels of mulberry leaves might be the reason of such variations.

In vitro *analysis of the experimental rations:* The per cent *in vitro* digestibility of dry matter (% IVDMD), organic matter (% IVOMD) and neutral detergent fibre (% IVNDFD) of different experimental rations (Table 2) indicated an increasing trend from control to TR_4 with statistically significant differences ($P \leq 0.05$) amongst the groups. The higher (above 80%) *in vitro* digestibility of mulberry leaves was also reported earlier (Kandylis *et al.* 2008, Sambul and Barman 2010).

Phase II: Feeding trial and invivo *digestibility*

Feed consumption: The daily dry matter intake (DMI)/ animal/kg body weight/kg metabolic body weight and palatability score was lower in control group as compared to T_1 and T_2 (Table 3). A significant difference between the control and T_2 group was also observed for these parameters and this could be ascribed to higher palatability of mulberry leaves (Ganai *et al.* 2010) coupled with densification of complete feed (Dhuria *et al.* 2007, Raghuvansi *et al.* 2007a, Samanta *et al.* 2008). The values of dry matter intakes in all the treatments under investigation were higher than the NRC's Feeding Standard (1985) which might be due to higher palatability of the test diets because of its inclusion of mulberry leaves and densification of complete feed in T_2 ration.

DCP and TDN intake of the experimental animals differed significantly ($P \leq 0.05$) between T_2 and the other 2 groups, which were statistically at par. Significant variation in dry matter intake between the corresponding groups might be the reason for this variation.

Digestibility coefficients of the nutrients: The digestibility coefficients of DM, OM, CP, EE and NDF differed significantly ($P \leq 0.05$) amongst different treatment groups with highest digestibility coefficients recorded in T_2-group followed by T_1 and control groups (Table 3). The variation between control and other two treatment groups (T_1 and T_2) might be due to higher digestibility of mulberry leaves (Sharma *et al.* 2007 and Kandylis *et al.* 2008) and had positive impact on rumen ecosystem (Singh and Makkar 2002). The variations in the digestibility between T_2 and other 2 groups (control and T_1) might be due to densification of complete feed that makes available of all the required nutrients and have positive impact on rumen microbial growth (Dhuria *et al.* 2007, Samanta *et al.* 2008). Digestibility coefficient of CF differed significantly ($P \leq 0.05$) between control group and the other 2 treatment groups (T_1 and T_2), which were statistically at par with each other and it might be due to incorporation of mulberry leaves in later 2 groups. Significant differences in the digestibility of NFE between T_2 and the other 2 treatment groups (control and T_1), which were statistically at par could be due to densification of feed. However, the digestibility coefficients of various nutrients (CP, EE, CF, NFE and NDF) were lower in present study than the values reported by Ganai *et al.* 2010 (61.32, 58.33, 76.74, 76.60, 62.88%), which might be due to lower digestibility of oats hay, which constituted 50% of the present ration as compared to 100% mulberry leaves in the study conducted by Ganai *et al.* (2010). The digestibility of all the nutrients in the study were also lower than the reported values of Sambul and Barman (2010) and the variations might be due to variation in ration composition, stage of maturity of leaves at harvesting time and physiological statuses of the animals.

Nutritive value of diets: It was evident that per cent DCP values showed significant differences ($P \leq 0.05$) among different test diets, which were iso-nitrogenous and significant variations in the CP digestibility amongst different experimental groups might be the reason for the same (Table 3). The increasing trend from control to T_2-group was due to significantly higher percent of DCP levels in these group. The percent TDN value was also highest in T_2-group followed by T_1 and control group, respectively, and the differences ($P \leq 0.05$) among dietary treatments might be attributed to significant variations in digestibility of different organic nutrients.

Table 3. Intake, digestibility and balances of nutrients (%) different experimental rations

Parameter	Treatment-groups		
	Control	Treatment-1	Treatment-2
Feed intake			
DMI (g/day)	536.09 [a] ±12.45	543.19 [ab] ±1.47	561.08 [b] ±3.44
DMI (g/kg BW)	37.74 [a] ±0.65	39.00 [ab] ±0.90	40.67 [b] ±0.91
DMI (g/kg MBW)	7.31 [a] ±0.09	7.22 [ab] ±0.12	7.17 [b] ±0.30
DMI (kg/100kg) BW (P.S.)	3.77 [a] ±0.04	3.90 [ab] ±0.03	4.07 [b] ±0.03
DCP intake (g/day)	39.85 [a] ±0.99	41.43 [a] ±0.12	44.39 [b] ±0.26
TDN intake (g/day)	327.45 [a] ±7.90	337.96 [a] ±1.37	358.03 [b] ±4.01
CP intake (g/day)	71.22± 1.64	71.10 ±0.19	73.44 ±0.45
Digestibility of nutrients (%)			
DM	54.40 [a] ±0.56	60.99 [b]±0.29	64.45 [c]±0.17
OM	61.03 [a]±0.52	65.09 [b]±0.10	69.39 [c]±0.16
NDF	52.04 [a] ±0.13	53.14 [b]±0.11	54.37 [c]±0.10
CP	55.94 [a]±0.13	58.28 [b]±0.18	60.45 [c]±0.19
CF	70.28 [a]±0.20	71.16 [b]±0.12	71.36 [b]±0.30
EE	52.11 [a]±0.22	52.71 [b]±0.21	54.37 [c]±0.20
NFE	66.47 [a]±0.15	67.43 [a]±0.20	69.47 [b]±0.82
Balances of nutrients (%)			
Nitrogen intake (g/day)	11.39±0.26	11.37±0.17	11.75±0.12
Excretion (g/day)			
a. Faecal	5.01 [b]±0.10	4.74 [a]±0.08	4.66 [a]±0.09
b. Urinary	1.11 ±0.02	1.14 ±0.01	1.15 ±0.02
Nitrogen balances (g/day)	5.26 [a]±0.18	5.49 [a]±0.12	5.95 [b]±0.11
Calcium intake (g/day)	8.77±0.14	8.67±0.16	8.65±0.14
Excretion (g/day)			
a. Faecal	5.37±0.15	5.24±0.12	5.17±0.10
b. Urinary	0.26±0.003	0.27±0.007	0.25±0.004
Calcium balances (g/day)	3.14±0.10	3.15±0.11	3.22±0.05
Phosphorus intake (g/day)	4.51±0.02	4.52±0.03	4.56±0.02
Excretion (g/day)			
a. Faecal	2.15±0.02	2.14±0.02	2.15±0.01
b. Urinary	0.20±0.005	0.19±0.003	0.20±0.002
Phosphorus balances (g/day)	2.16±0.03	2.19±0.02	2.21±0.02
Nutritive values (%)			
% DCP	7.43 [a] ± 0.02	7.63 [b]±0.03	7.91 [c]±0.02
% TDN	61.04 [a] ±0.05	62.21 [b]±0.10	63.80 [c]±0.43

Row-wise group means with different superscripts differ significantly ($P \leq 0.05$).

Nitrogen balance: Although the nitrogen intake values amongst groups showed no significant differences, the feacal nitrogen excretion was significantly higher in control-group, might be due to lower CP digestibility. Thereby it reflects significant differences ($P \leq 0.05$) of nitrogen balances amongst the groups with highest value observed in group T_2 followed by T_1 and control. The positive nitrogen balances in sheep fed with mulberry leaf based diets were in the same line of the earlier reports (Ahmad *et al.* 2006 and Ganai *et al.* 2010). The densification of complete feed also revealed significant improvement of nitrogen balances in T_2 group (5.95g/day) compared to T_1 (5.49 g/day) and control (5.26 g/day) was in good agreement with the findings of Dhuria *et al.* (2007).

Mineral balance: The lower calcium and phosphorus excretion and higher intakes of calcium and phosphorus in T_2-group could be ascribed to densification of complete feed although there was no significant difference amongst the groups might be due to lower calcium and phosphorus excretion. However, the positive balances of calcium and phosphorus acnes in sheep under different treatments of the present study are in congruence with the recorded values of Ahmad *et al.* (2006) and Ganai *et al.* (2010). The availability of Ca and P can be influenced by various dietary factors, presence of oxalates, phytates etc or any one of these might influenced the utilization of minerals in the study.

It was concluded that mulberry leaves (*Morus multicaulis*) have the potential to be used in sheep ration replacing concentrate mixture up to 80% level (40kg/100kg complete feed) with positive effect on nutrients intake, their digestibility and balances. Complete feed blocks prepared by incorporation of mulberry leaves replacing concentrate @ 80% level had better nutritive value in comparison its mash form.

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