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Effect of feeding mixed silage of oat fodder and jamun leaves on nutrient utilization in goats

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Protein is often poorly utilized by ruminants from fodders harvested for silage making, because of the extensive hydrolysis of NPN compounds occur during wilting and storage (Muck *et al*. 2003). This result increases the excretion of N into the environment, which may cause environmental pollution in intensive ruminant livestock production (Tamminga 1992). Tannins are secondary plant metabolites that react with proteins, making them resistant to breakdown by proteases (Cavallarin *et al*. 2002) and can be used as chemical binder to reduce protein degradation. Top foliages contain tannins (Singh *et al*. 2009, Barman and Rai 2008) and can be used to reduce protein degradation during ensiling. In the present study, silage was prepared using oat fodder (*Avena sativa*) alone and in combination with jamun tree leaves (*Eugenia jambolana*) to observe its effect on nutrient utilization in adult male goats.

The study was conducted on 12 adult male (Jammu local) goats (24–30 months, 25.71±1.57 kg), randomly divided into 2 groups of 6 in each. Goats in the control group were fed diet comprising concentrate mixture (27% maize, 25% mustard oil cake, 45% wheat bran, 2% mineral mixture and 1% salt) @ 10 g/kg $W^{0.75}$ with *ad lib.* oat silage. Animals of the treatment group were fed same concentrate mixture plus silage in which 25% oat was replaced with jamun leaves as source of tannins to bind protein during ensiling. Experimental feeding was done for 30 days. A 7-day digestibility trial was conducted at the end of experimental feeding to assess the nutrient digestibility and plane of nutrition. Silage was prepared from oats containing 30–35% dry matter (milk stage). For proper filling and compaction, oat fodder and jamun leaves were chaffed to 2–3 cm in size. Molasses and salt are added @ 2% and 1% (of the green weight of forage). Molasses, salt and fodder are thoroughly mixed before ensiling.

Total phenol and tannins (tannic acid equivalent) were analyzed as per Makkar *et al.* (1993). Non-tannin phenol was estimated after precipitating the tannin with polyvenylpolypyrrolidone from the tannin extract. Condensed tannin (leucocyanidin equivalent) was estimated as per Porter *et al.* (1986). Hydrolysable tannin was calculated from the difference between total tannin phenol and condensed tannin. Feeds and faeces samples were analyzed for proximate principles as per AOAC (1995). Fiber fractions were determined as per Van Soest *et al.* (1991). The data obtained during experiment were analyzed by generalized linear model ANOVA procedure (Snedecor and Cochran 1989).

Protein content (% DM) was 14.40, 13.50 and 14.80, respectively, in concentrate mixture, T_1 and T_2 group. Similarly the NFE content (% DM) was 60.29, 29.84 and 41.32 respectively in concentrate mixture, T_1 and T_2 group (Table 1). The total tannin content ranged from 0.03% –0.63% (Table 2). Silage made from 100% oat had lower ($P<0.01$) total tannins in comparison to oat-jamun mixed silage (Table 2). The addition of jamun leaves as tannin source in treatment

Table 1. Proximate composition and fiber fractions of the experimental rations

Attributes	Concentrate mixture	T_1	T_2
OM	93.15	72.46	82.56
CP	14.4	13.5	14.8
EE	7.24	3.4	3.09
Total Ash	6.85	27.54	17.44
CF	11.22	25.72	22.35
NFE	60.29	29.84	42.32
NDF	28.17	51.09	55.43
ADF	10	38.04	36.96

T_1= silage made from oats fodder; T_2: silage made from 75:25 oats fodder: jamun leaves

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Table 2. Tannin fractions (% DM) and other characteristics of the silages fed to the goats

Attributes	T_1	T_2
Tannin fractions		
Total phenols[a]	0.31	0.84
Non-tannin phenols[a]	0.28	0.21
Total tannins[a]	0.03	0.63
Condensed tannins[b]	ND	0.55
Hydrolysable tannins[a]	ND	0.08
pH and visual characteristics		
Ph	4.23	4.12
Colour	Green brown	Green brown
Smell	Lactic acid odour	Lactic acid odour
Texture	Firm; softer material undetachable	Firm; softer material undetachable

[a]Tannic acid equivalent, [b]*Leucocyanidin equivalent,* ND = not detected, T_1, silage made from oats fodder; T_2, silage made from 75:25 oats fodder: jamun leaves

Table 3. Effect of feeding mixed silages on feed intake, changes in body weight and nitrogen balance in goats

Attributes	*Groups*		*SEM*	P value
	T_1	T_2		
Dry matter intake				
g/d	624.18±6.11	668.48±8.58	8.36	0.002
% L. Wt	2.66±0.17	2.46±0.17	0.12	0.410
g/kg $W^{0.75}$	58.46±2.69	56.06±2.87	1.91	0.555
Organic matter intake				
g/d	472.59±5.18	563.55±7.50	14.38	0.000
% L. Wt	2.01±0.12	2.07±0.14	0.09	0.745
g/kg $W^{0.75}$	44.24±1.95	47.25±2.37	1.53	0.349
Concentrate intake (on DM)				
g/d	98.21±5.24	110.04±6.76	4.45	0.197
% L. Wt	0.41±0.01	0.40±0.01	0.00	0.164
g/kg $W^{0.75}$	9.09±0.00	9.09±0.00	0.00	1.000
Silage intake (on DM)				
g/d	525.96±4.97	558.44±7.55	6.52	0.005
% L. Wt	2.25±0.16	2.07±0.16	0.11	0.435
g/kg $W^{0.75}$	49.37±2.69	46.97±2.87	1.91	0.555
Changes in body weight				
Initial weight, kg	24.83±1.98	26.58±2.57	—	0.601
Final weight, kg	24.95±1.87	28.83±2.15	—	0.139
Changes in weight, kg	0.12±0.44	2.25±0.57	—	0.003
Nitrogen intake				
g/d	13.63±0.14	17.55±0.22	0.60	0.000
% L. Wt	0.06±0.00	0.06±0.00	0.00	0.360
g/kg $W^{0.75}$	1.28±0.06	1.47±0.08	0.05	0.073
Nitrogen excretion (g/d)				
Faeces	1.98±0.49	1.29±0.51	0.35	0.345
Urine	2.02±0.66	2.93±0.64	0.46	0.342
Total	4.00±0.87	4.22±0.67	0.52	0.846
Nitrogen balance (g/d)	9.63±0.91	13.33±0.65	0.77	0.008
Nitrogen retention				
% of intake	70.57±6.32	76.00±3.80	3.61	0.478
% of absorbed	82.32±5.87	82.14±3.70	3.31	0.980

T_1, Silage made from oats fodder; T_2, silage made from 75:25 oats fodder: jamun leaves.

silage increased the level of hydrolysable and condensed tannins by 0.08 and 0.55% of DM, respectively, whereas they were not detected in control silage. The pH was lower in pure oat silage (4.03) and increased with addition of tree leaves (4.22), which might be due to low availability of soluble sugar in tree leaves.

Guo *et al.* (2008) reported that increase in silage pH with addition of tannic acid. Reed (1995) reported that tannin addition reduced the water soluble carbohydrate content of the silage. Tobacco *et al.* (2006), however, reported the reverse trend. Intakes (g/d) of dry matter, organic matter and silage were significantly higher (P<0.01) in goats receiving tannin containing silage (Table 3). Change in body weight was significantly higher in T_2 groups in comparison to T_1 group which might be due to higher protein intake in T_2 group (Table 3). Nutrient digestibility (%) was similar in both groups (Table 4). This is in corroboration of report of Miller and Ehlke (1993), who suggested that although CT concentrations in the range of 25 to 85 g/kg DM reduced ruminal protein degradation, little or no corresponding reduction in DM digestibility was observed. Although there was no significant difference in DM and OM digestibility between T_1 and T_2 groups, however, its digestibility was reduced (P>0.05) in T_2 groups by 3.44 and 1.25% respectively. Deaville *et al*. (2010) also reported that tannin additions reduced (P<0.001) *in vivo* apparent digestibility of dry matter (DM) and organic matter (OM) in comparison to untreated control silage. In the present study, CF digestibility was reduced (P<0.05) by 8.84% in T_2 group in comparison to T_1 group. Similar finding was also reported by Deaville *et al*. (2010) for neutral detergent fibre (aNDFom) digestibility. The mechanisms by which tannins reduces ruminal degradation of different dietary components are not entirely clear. Among the most accepted are substrate deprivation (McMahon *et al*. 2000), enzyme inhibition (Jones *et al*. 1994) and direct action on rumen microorganisms (Scalbert 1991). It was suggested that fibre digesting bacteria are more sensitive to condensed tannin than proteolytic bacteria (Bae *et al.* 1993). Nitrogen balance (g/d) was significantly higher (P<0.01) in T_2 group in comparison to T_1 group which might be due to significantly higher (P<0.01) N intake in T_2 group. There was no significant difference in nitrogen excretion through faeces and urine in both the

Table 4. Effect of feeding mixed silages on nutrient digestibility in goats

Attributes	Groups		*SEM*	P value
	T_1	T_2		
DM	80.23±1.48	77.47±1.14	0.98	0.171
OM	80.71±1.54	79.13±1.04	0.92	0.416
CP	85.36±3.57	92.70±2.92	2.46	0.142
EE	72.27±3.77	79.44±1.68	2.24	0.113
CF	78.97±1.58	71.99±1.37	1.45	0.007
NFE	81.07±2.93	77.17±2.08	1.81	0.303
NDF	70.82±2.35	70.45±1.83	1.42	0.904
ADF	65.24±2.55	59.33±3.36	2.20	0.191

DM, dry matter; OM, organic matter; CP, crude protein; EE, ether extract; CF, crude fibre; NFE, nitrogen free extract; NDF, neutral detergent fibre; ADF, acid detergent fibre; T_1, silage made from pure oats fodder; T_2, silage made from 75:25 oats fodder: jamun leaves.

groups. Nitrogen intake as percent intake was similar in both the groups (Table 3). Ally and Kunjikutty (2003) also found positive N balance in goat fed on tree leaves containing 3.4 and 5.5% tannin.

SUMMARY

Twelve local adult male goats (24–30 months, 24.35±0.67 kg), divided into 2 equal groups (6 each) were fed concentrate mixture plus *ad lib.* oat silage (T_1) and similar concentrate mixture plus *ad lib.* mixed silage containing 75:25 oat fodder : jamun leaves (T_2). The mixed silage (T_2) contained higher level of total phenol and tannin (0.84 and 0.63% vs. 0.24 and 0.03% on DMB) than T_1 group. Animals of T_2 group showed significant difference in dry matter, organic matter and silage intake as compared to T_1 group, but it was comparable as percent live weight and g/kg $W^{0.75}$. The digestibility of various nutrients was similar in both the groups except higher crude fibre digestibility in T_1 group. Nitrogen balance (g/d) was significantly higher in T_2 group in comparison to T_1 group. Nitrogen retention as % intake was apparently higher in T_2 group as compared to T_1 group. It is concluded that jamun leaves and maize fodder can be used at 25:75 ratio (w/w) on fresh basis to make silage for feeding to goat without any adverse effect on intake and nutrients utilization.

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