CHEMICAL COMPOSITION AND *IN SACCO* DEGRADATION KINETICS OF LEGUME STRAWS IN BUFFALO BULLS

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ABSTRACT

The present investigation was carried out to determine the nutrient composition and degradation kinetics of two locally available legume straws viz. red gram and black gram by using Nylon bag technique. The CP, NDF and ADF content in red gram and black gram straw were found to be 6.76 and 7.70, 75.80 and 69.20, 58.6 and 54.9 per cent, respectively. Three rumen fistulated male Murrah buffalo bulls (5 yrs old mean body weight of 350 ± 9.36 kg) were used to study the in situ degradation kinetics of DM, CP, NDF and ADF in selected straws. The mean value of the per cent effective degradability (ED) of DM and ADF calculated from the rumen out flow rates (0.05 % h^{-}, as average) were higher (P<0.01) in black gram straw (29.03 and 23.67) than in red gram straw (25.57 and 19.33), respectively. However, the effective degradability (%) of CP and NDF (0.05 % h^{-}, as average) were higher in black gram straw, but the differences were not statistically significant. It is concluded that legume straws are good feed resources for ruminants and can help to correct fibre shortage and black gram straw proved to be better utilized compared to red gram straw.

Key words: Legume straws, Nutrient composition, Nylon bag technique, Degradation kinetics

INTRODUCTION

In India, straws are available abundantly from the legumes cultivated majorly to obtain grain for human consumption or for animal feed (Waje et al., 2010). Agricultural crops after harvesting can produce substantial amount of biomass (straws and stovers), often considered as agricultural waste. These straws and stovers are highly lignified and also poor in digestibility, available energy, proteins and vitamins. But, they are fairly rich in structural carbohydrates which can be effectively incorporated in ruminant diets by adapting suitable processing methods. However, very little information is available regarding nutrient composition and degradability of straws and stovers.

In coastal Andhra Pradesh various legume straws *viz.* red gram straw and black gram straw are abundantly available after harvesting them for grain. In this regard, a sound knowledge on the benefits arising from the use of naturally available legume straws is

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essential for including them in the daily rations of livestock. Further, the nutritive value of these straws can be improved by incorporating them in total mixed rations for which preliminary data on degradability of straws is required. Hence, the present work has been undertaken to study the chemical composition and degradation kinetics of the locally available legume straws by *in situ* nylon bag technique.

MATERIALS AND METHODS

Sample collection and chemical analysis

The experiment was conducted at Department of Animal Nutrition, NTR college of Veterinary Science, Gannavaram, Andhra Pradesh, India. Samples of locally available legume straws *viz.* red gram straw and black gram straw were procured from nearby villages of Gannavaram. The samples were analyzed for proximate constituents (AOAC, 2007) and forage fibre constituents (Van Soest et al. 1991).

Feeding regimen

The buffalo bulls were fed daily a basal diet comprising 5 kg hybrid napier, 4 kg paddy straw and 1.5 kg concentrate mixture to meet the maintenance requirements (ICAR, 1998). The experimental animals were kept in well ventilated and hygienic stalls with individual feeding and watering arrangements. The animals were offered fresh and clean drinking water free of choice.

In situ degradation kinetics

Three rumen cannulated graded Murrah buffalo bulls (5 yrs, mean body weight 350 ± 9.36 kg) were used to determine *in situ* degradation kinetics by using nylon bag technique. The pre-weighed nylon bags (13.5cm X 7.5 cm), containing 5 g of air dried feed ground through 2 mm screen, were incubated in the ventral sac of rumen of each buffalo bull. The straws were incubated for 0, 6, 12, 24, 36, 48 and 72 h in the rumen of three cannulated Murrah buffalo bulls. The bags containing samples for 0 h were washed without incubation in rumen.

The *in sacco* degradability of dry matter (DM), crude protein (CP), neutral detergent fibre (NDF) and acid detergent fibre (ADF) of legume straws were determined as per the procedure of Orskov and McDonald (1979). The bags containing feed samples incubated in the rumen were drawn in a sequential removal method (Osuji et al. 1993). After removal, the bags were washed under slow running tap water by rubbing between fingers and the thumb for ten minutes, oven dried at 70^0C for 48 h to constant weight and DM loss during the incubation was calculated. The CP, NDF and ADF content in the residue was analyzed to determine their respective degradabilities. From the degradability data obtained at different intervals, the constant a, b and c from the expression $P=a+b\ (a-e^{-ct})$ were obtained. Where, P is the degradability at time t, the constant, 'a' is the intercept or instantly degradable fraction, 'b' is the potentially degradable and 'c' is the degradation rate or rate constant. The effective nutrient degradability (%) of legume straws were calculated by time measurements and fitted values in NEWAY programme (Model based on McDonald, 1981) using a computer, assuming an outflow rate (K) of 0.05%/hr. The data were analyzed statistically (Snedecor and Cochran, 1989) and tested for significance by Duncan's multiple range test (Duncan, 1955) using SPSS 17.0 version.

RESULTS AND DISCUSSION

Chemical composition of red gram straw and black gram straw was presented in Table 1. The CP content was lower but NDF and ADF values were higher in red gram straw of the present study than the values reported by Suryanarayana et al. (2009). Similarly, the CP content was lower in black gram straw of the present study but the values of NDF and ADF were similar to the values given by Jhadhav and Deshmuk (2001). Variations in nutrient content of crop residues observed in the present study may be attributed to various factors such as climate, type of fodder, variety and stage of harvesting, leaf to stem ratio, growing conditions (geographic, seasonal variations and soil characteristics), extent of foreign materials and impurities. The *in sacco* disappearance (%) of DM, CP, NDF and ADF of red gram and black gram straw was presented in Table 2.

Degradability studies

The DM, CP, NDF and ADF disappearance (%) of red gram straw and black gram straw (Table 2) increased with increased time of incubation. Since, the *in sacco* nutrient disappearance values are relevant to the specific periods of incubation in the rumen, the constants 'a' (readily soluble), 'b' (insoluble but degradable with time) and 'c' (rate constant/h) and effective degradability (ED) values of DM, CP, NDF and ADF were calculated from the *in sacco* nutrient disappearance data (Negi et al., 1988 and Khazaal et al., 1994).

The DM disappearance (%) at 72 h was higher ($P<0.05$) in black gram straw than red gram straw. The readily degradable fraction (a) and potentially degradable fraction (PD) were higher ($P<0.01$) and insoluble but degradable fraction (b) was lower ($P<0.01$) in black gram straw compared to red gram straw. The ED (%) of DM was higher ($P<0.01$) in black gram straw compared to red gram straw. Similar findings in GN haulms (Singh et al., 2002) and in green gram chuni (Radha Krishna et al., 2002) were reported for DM degradability. The CP disappearance (%) of straws progressively increased with the time of incubation and the differences were non-significant. The fraction 'a' was lower ($P<0.05$), while the fractions 'b' and 'a+b' were higher ($P<0.05$) in red gram straw as compared to black gram straw. However, the differences in ED (%) of CP in legume straws were non-significant. The ED values of CP reported by Singh et al. (2002) for GN haulms were higher, while Radha Krishna et al. (2002) reported lower values in green gram chuni when compared to the present study.

Data revealed that as the period of incubation was extended from 0 to 72 h in the rumen, the NDF disappearance (%) of legume straws progressively increased and the differences were non-significant. The rapidly soluble fraction 'a' was lower ($P<0.05$) in black gram straw but the fractions 'b' and PD were non-significantly higher in black gram straw than in red gram straw. The ED (%) of NDF was comparable among the legume straws. On the contrary, Kamal Shojaeian and Thakur (2007) reported lower NDF (%) degradability values compared to the present study. Perusal of data revealed that as the period of incubation extended from 0 to 72 h in the rumen, the ADF disappearance (%) of straws progressively increased. The ADF disappearance (%) at 72 h was higher ($P<0.05$) in black gram straw than in red gram straw. The ED (%) of NDF was

higher (P<0.01) in black gram straw than in red gram straw. However, the degradability constants a, b and a+b were higher in black gram straw when compared to red gram straw but the differences were statistically non-significant.

The variation in degradability values for DM, CP, NDF and ADF in feeds based on *in situ* nylon bag technique may be due to several factors. These can be categorized into animal characteristics, substrate characteristics, bag characteristics, other procedural aspects and mathematical components (Vanzant et al., 1998). These variable results underline the need for caution while comparing degradability data among studies from different processing methods.

CONCLUSIONS

Based on chemical composition and degradation characteristics, it can be concluded that legume straws can be used as good feed resources for ruminants. Among the legumes straws in the present study, black gram straw proved to be better utilized compared to red gram straw. Further, animal experiments are suggested for effective inclusion of legume straws in daily rations of livestock.

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Table 1
Chemical composition (% DM basis) of locally available legume straws

Particular	Red gram straw	Black gram straw
Organic Matter	97.75	93.36
Total Ash	2.25	6.64
Crude Protein	6.60	7.70
Ether Extract	1.47	1.28
Crude Fibre	64.22	58.02
Nitrogen Free Extract	25.46	26.36
Neutral Detergent Fibre	75.80	69.20
Acid Detergent Fibre	58.60	54.90
Hemi-cellulose	17.20	14.30
Cellulose	44.61	40.36
Acid Detergent Lignin	14.23	14.92

Table 2
I*n sacco* DM, CP, NDF and ADF disappearance, degradation kinetics and effective degradability (% DM basis) of red gram and black gram straw

Incubation period (h)	Straws	DM	CP	NDF	ADF
12	Red gram	19.61 ± 0.47	21.37 ± 1.35	22.89 ± 1.21	14.17 ± 0.41
	Black gram	22.41 ± 0.31	22.48 ± 0.71	22.64 ± 0.61	20.13 ± 0.67
24	Red gram	35.68 ± 1.08	34.62 ± 0.92	35.54 ± 0.86	26.44 ± 0.51
	Black gram	38.15 ± 0.87	35.40 ± 1.69	35.33 ± 0.21	29.06 ± 0.15
36	Red gram	43.50 ± 0.45	44.10 ± 1.02	46.35 ± 0.68	34.30 ± 0.43
	Black gram	47.11 ± 0.23	46.39 ± 0.39	48.07 ± 0.78	38.98 ± 0.68
48	Red gram	50.68 ± 0.55	56.10 ± 2.15	56.45 ± 0.29	40.26 ± 0.37
	Black gram	51.50 ± 0.27	55.52 ± 0.86	57.76 ± 0.40	42.78 ± 1.00
72	Red gram	56.22^{b} ± 0.49	64.73 ± 1.28	61.82 ± 1.05	44.64^{b} ± 0.51
	Black gram	57.59^{a} ± 0.41	61.68 ± 0.35	63.91 ± 0.82	49.33^{a} ± 1.35
Degradation Kinetics					
a	Red gram	8.50^{b} ± 0.58	10.84^{b} ± 0.40	11.27^{a} ± 0.44	6.20 ± 0.21
	Black gram	14.49^{a} ± 0.16	12.09^{a} ± 0.18	10.72^{b} ± 0.43	7.63 ± 0.34
b	Red gram	51.47^{a} ± 0.18	72.20^{a} ± 4.03	60.14 ± 0.97	42.36 ± 0.67
	Black gram	45.56^{b} ± 0.88	58.59^{b} ± 2.67	63.55 ± 2.13	48.31 ± 1.75
c	Red gram	0.0398	0.0215	0.0292	0.0288
	Black gram	0.0441	0.0285	0.0292	0.0379
PD (a+b)	Red gram	56.76^{b} ± 2.59	83.04^{a} ± 4.27	71.41 ± 0.98	48.55 ± 0.82
	Black gram	60.04^{a} ± 1.02	70.67^{b} ± 2.50	74.27 ± 2.18	55.94 ± 1.84
RSD	Red gram	0.96 ± 0.30	2.02 ± 0.68	2.14 ± 0.62	0.61 ± 0.19
	Black gram	0.84 ± 0.09	2.00 ± 0.83	2.24 ± 0.20	1.27 ± 0.10
ED (0.05 %)	Red gram	25.57^{b} ± 0.47	27.73 ± 0.90	28.57 ± 0.62	19.33^{b} ± 0.15
	Black gram	29.03^{a} ± 0.09	28.40 ± 0.32	28.57 ± 0.32	23.67^{a} ± 0.59
Significance	**	*	*		**

a, b and c are constants of the exponential equation ($P=a+b\ (a-e^{-ct})$ where 'a' is the rapidly degradable fraction, 'b' the slowly degradable fraction and 'c' the rate of degradation of fraction 'b', PD the potential degradable fraction, ED: Effective degradability (outflow rate; 0.05 h^{-1}), RSD: Residual standard deviation. Values with different superscripts with in column differ significantly, ** P<0.01, * P<0.05.

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