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Effect of feeding reconstituted and urea treated *bajra* grain (*Pennisetum typhoideum*) on nutrients digestibility, rumen metabolism and blood parameters in sheep

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ABSTRACT

Adult sheep (20) were equally divided into 4 groups and fed sole gram straw as control (C), gram straw + raw *bajra* grain (T_1), gram straw + reconstituted *bajra* grain (T_2), gram straw + 4%urea treated *bajra* grain (T_3). The total dry matter intake was significantly lower in the group fed solely gram straw in comparison to other groups. Crude protein (CP) was higher in T_3 than in T_1 and $T_2$and was minimum in treatment C. The digestibility coefficients of all the proximate nutrients were calculated by difference and were significantly higher in reconstituted and urea treated than that in raw *bajra* grain. The DCP in raw *bajra* grain (6.23%) was lower than that in reconstituted (8.74%) and in urea treated (13.84%); the differences between reconstituted and urea treated grain being significant. Similarly, the TDN content was higher in reconstituted (70.73%) and in urea treated (70.57%) than in raw (57.25%) *bajra* grain. Mean nitrogen fractions in SRL of sheep were significantly ($P<0.01$) higher in T_3 than that in T_1 and T_2, while the fractions peaked at 2 h post- feeding. Lower pH and higher TVFA values were recorded at 4 h as compared to 0,2 and 6 h post feeding. The NH_3–N and urea – N in serum of sheep pre-feeding (0 h) were similar in T_1, T_2 and T_3, but at 3 h post feeding the value in T_3 was considerably ($P<0.01$) higher than the values in T_1 and T_2.

Key words: Animal nutrition, *Bajra* grain treatments, Rumen metabolites, Serum nitrogen, Sheep

In 2002–03 the total millet production was 115 lakh tonnes in India (Europa 2004). In Northern India including Gujarat, *bajra* grains are used for human consumption, but now-a-days owing to the availability and preference for wheat and rice over *bajra*, more *bajra* grain is available for livestock feeding. In spite of the comparable chemical composition of *bajra* and barley, the nutritive value of *bajra* grain is low (Ranjhan 1991). The present study is an attempt to improve the nutritive value of *bajra* grain by simplest processing technique like reconstitution and urea treatments.

MATERIALS AND METHODS

Adult sheep (20: Russian Merino × Corriedale × Nali), 10-months-old, and of almost same body weight (16 to 18 kg), were divided into 4 groups of 5 sheep each. These animals in 4 respective groups were fed sole gram straw (C), gram straw + raw ground *bajra* grain (T_1), gram straw + reconstituted ground *bajra* grain (T_2) and gram straw + 4% urea treated ground *bajra* grain (T_3) along with a mineral mixture (2%), common salt (1%) and vitamin mixture (12 g/ 100 kg). Gram straw was offered *ad lib.* as a basal diet and water was made available at manger continuously. Added calculated amount of water to the *bajra* grain performed reconstitution, while in urea treatment aqueous solution was prepared by dissolving urea (4% of the grain, w/w) in

Table 1. Proximate composition of gram straw and concentrate mixtures offered to sheep (% DM basis)

Nutrients	Treatments*			Gram straw
	T_1	T_2	T_3	
DM	90.92	84.16	83.85	90.66
CP	12.99	13.12	19.95	4.32
CF	1.48	1.62	1.56	47.31
EE	4.81	4.98	4.90	1.92
NFE	71.56	71.13	63.67	39.39
Total ash	9.16	9.15	9.92	7.06

Each figure is an average of 3 observations; *mineral mixture (2%), common salt (1%) and vitamin mixture (12 g/100 kg) were added to the ground grain.

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Table 2. Dry matter and crude protein intake, digestibility, nutritive value and nitrogen balance of nutrients in sheep as affected by different diets

Parameters	Treatments				CD
	C	T_1	T_2	T_3	
Intake (g/day)					
Gram straw	517.41	431.84	433.75	448.68	NS
	±65.14	±30.47	±6.50	±9.52	
Bajra grain	-	272.76	268.90	255.74	NS
Total DM	517.41[b]	704.60[a]	702.65[a]	704.42[a]	145.83*
	±65.14	±30.47	±6.50	±9.52	
	±65.14	±30.47	±6.50	±9.52	
DM intake/day	2.91[b]	4.02[a]	4.04[a]	4.08[a]	0.87**
(kg/100 kg body weight)	±0.24	±0.11	±0.17	±0.16	
CP intake (g/day)	22.35[c]	54.08[b]	54.02[b]	70.40[a]	2.97**
	±2.83	±1.12	±0.19	±0.35	
Digestibility coefficient					
DM	46.08[c]	50.55[b]	54.78[a]	55.77[a]	3.74
	±1.79	±1.08	±0.81	±0.66	
CP	39.55[c]	42.80[b]	49.92[a]	50.37[a]	3.23**
	±1.21	±0.52	±0.81	0.83	
CF	49.48[c]	51.64[b]	53.94[a]	54.78[a]	1.64**
	±0.70	±0.61	±0.97	±0.35	
EE	40.60[c]	47.17[b]	49.43[ab]	51.16[a]	3.11**
	±0.95	±0.71	±0.71	±0.60	
NFE	51.72[b]	55.49[b]	60.90[a]	60.34[a]	4.80**
	±1.97	±1.31	±1.09	±1.54	
Nutritive value					
DCP	1.71[d]	3.46[c]	4.40[b]	6.11[a]	0.35**
	±0.06	±0.06	±0.08	±0.13	
TDN	47.27[c]	51.13[b]	56.25[a]	55.73[a]	2.84**
	±1.50	±0.75	±0.69	±0.75	
Nitrogen balance					
Nitrogen intake (g/day)	3.58[c]	8.06[b]	7.97[b]	10.57[a]	0.48**
	±0.45	±0.18	±0.03	±0.06	
Nitrogen excreted (g/day)					
Faeces	2.16[d]	4.95[b]	4.33[c]	5.59[a]	0.60**
	±0.25	±0.08	±0.07	±0.10	
Urine	0.79[c]	1.41[b]	1.36[b]	2.09[a]	0.46**
	±0.10	±0.14	±0.13	±0.45	
Total	2.95[c]	6.36[b]	5.69[b]	7.68[a]	0.89**
	±0.35	±0.21	±0.10	±0.10	
Nitrogen balance (g/day)	0.63[d]	1.70[c]	2.28[b]	2.89[a]	0.35**
	±0.11	±0.06	±0.08	±0.10	

a, b, c, d values in a row with different superscripts differ significantly (P<0.01).

calculated quantity of water to raise the moisture content of the grain to 28%. The treated grain was stored in polythene bags to avoid the contact of air to grain for 21 days. A metabolism trial was conducted for 21 days as preliminary period, after 5 days of adaptation period in metabolic cages and followed by 6 days as collection period. At the end of the trial, the rumen liquor samples were collected 4-times from each animal by using stomach tube, once before feeding, designated as the 0 hr, and other collections after feeding at 2 hr intervals. The ingesta was strained through 2 layers of muslin cloth. The feed, faeces and urine samples were analysed for proximate principles (AOAC 1990). The pH of the fresh samples was determined with a pH meter and the samples were preserved in a deep freeze after adding 1.5 ml

Table 3. Digestibility coefficient of proximate nutrients and nutritive value of raw, reconstituted and urea treated *bajra* grain in sheep (by difference)

Parameters	*Bajra* grain			CD
	Raw	Reconstituted	Urea treated	
Digestibility coefficients				
DM	57.63[b] ±2.59	68.82[a] ±2.05	71.12[a] ±1.69	9.26**
CF	55.08[c] ±0.45	61.14[b] ±0.76	64.08[a] ±0.72	2.84**
CP	47.94[b] ±0.76	66.65[a] ±1.10	69.36[a] ±0.99	4.15**
EE	57.58[c] ±0.81	63.68[b] ±1.19	69.68[a] ±1.00	5.17**
NFE	61.45[b] ±2.33	75.71[a] ±2.06	75.46[a] ±2.65	10.18**
Nutritive value				
DCP	6.23[c] ±0.10	8.74[b] ±0.15	13.84[a] ±0.20	0.66**
TDN	57.25[b] ±1.71	70.73[a] ±1.53	70.57[a] ±1.61	6.99**

a, b, c values in a row with different superscripts differ significantly (P<0.01).

of saturated mercuric chloride solution per 100 ml of SRL. The ammonia nitrogen present in the SRL was estimated before the samples were preserved. The samples were analysed for total nitrogen (Mc Kenzie and Wallace 1954), ammonia nitrogen (Weatherburn 1967), TCA- precipitated nitrogen (precipitating the protein with trichloroacetic acid and analyzing the residue after filtration as per AOAC 1990) and TVFAs (Markham 1942). Blood samples were also collected 0 and 3 h post feeding on 2 alternate days after the completion of metabolic trial. The serum was separated and stored in vials in deep freeze for further analyses. Serum ammonia nitrogen was determined by the method of Weatherburn (1967) and urea nitrogen by the method of Levin (1961). The nutritive value of raw, reconstituted and urea treated *bajra* grain was calculated by difference method (Schneider and Flatt 1975). The data were statistically analysed as per Snedecor and Cochran (1994).

RESULTS AND DISCUSSIONS

The proximate composition of concentrate and gram straw offered to sheep is presented in Table 1. The low level of DM in T_2 and T_3 than that in T_1 might be due to added water for reconstitution and urea treatment of the grain. The CP content in T_3 increased due to urea treatment. Low level of NFE content in T_3 than that in T_1 and T_2 might be due to urea treatment that increased CP content and hence NFE content was decreased.

The DM and CP intake, digestibility, nutritive value and nitrogen balance in sheep as affected by different diets are been presented in Table 2.The intake of gram straw and *bajra* grain did not differ among various treatments, however, the total DM intake and the DM intake/100 kg body weight was significantly (P<0.01) low in the control group than in other treatments. This low level of DM intake in control group might be due to bulkiness and low palatability of gram straw that formed the sole diet in this group. The similar intake of DM in all the treatments indicated that reconstitution and urea treatment of *bajra* grain did not affect its palatability. Similar DM intake in lambs was reported by Singh and Lohan (1998) when fed reconstitution *bajra* grain and Russell *et al.* (1988) when fed urea treated milo to cattle. The CP intake/ day was significantly (P<0.01) higher in T_3 than in T_1 and T_2 and was lowest (P<0.01) in control group, that might be due to CP, which was higher in urea treated grain and low in gram straw. The digestibility coefficients of all proximate nutrients were higher (P<0.01) in T_2 and T_3 than in C and T_1; the digestibility values being lowest (P<0.01) in the control group (C) fed solely gram straw. The DCP was minimum in C and increased in T_1, T_2 and T_3; the differences among all the treatments were significant (P<0.01). The similar increase in nutrients digestibility and nutritive value was reported by Simpson *et al.* (1985) and Kishore *et al.* (1993) due to reconstitution and Low and Kellaway (1983) and Singh and Lohan (1998) due to urea treatment. The nitrogen balance in C, T_1, T_2 and T_3 was 0.63, 1.70, 2.28, and 2.89 g/day, respectively, the differences among the treatments were significant (P<0.01). Preston *et al.* (1965) reported similar positive nitrogen balance when fed reconstituted barley to male calves.

The digestibility coefficient of proximate nutrients and nutritive value of raw, reconstitution and urea treated *bajra* grain (calculated by difference) is presented in Table 3. The digestibility coefficient of all the proximate nutrients was higher (P<0.01) in reconstitution and urea treated *bajra* grain than in raw *bajra* grain. The DCP content in raw (6.23%) was lower (P<0.01) than in reconstituted (8.74%) and in urea treated (13.84%) grain, the differences between reconstituted and urea treated grain being significant (P<0.01). The TDN content in reconstituted (70.73%) and urea treated (70.57%) *bajra* grain was statistically similar, but, higher (P<0.01) than in raw grain (57.25%). The findings were in line with DCP and TDN values reported by Kishore *et al.* (1993) in reconstituted and Singh and Lohan (1998) in urea treated grain.

The mean values of nitrogen fractions, pH and TVFA in the rumen fluid are presented in Table 4. Mean nitrogen fractions of rumen liquor of sheep were higher (P<0.01) in T_3, as compared to T_2 and T_1. This might be due to more nitrogen intake by sheep in T_3. An increased concentration of total ruminal nitrogen owing to high dietary protein and similar increase in NH_3-N when fed urea treated grain in comparison to non-treated has earlier been reported (Russell *et al.* 1988). The nitrogen fractions peaked at 2 h post-feeding

Table 4. Mean values of nitrogen fractions, pH and TVFA in the rumen fluid of sheep as affected by experimental diets and time of sampling

Hours post feeding	Treatments			CD	Mean
	T_1	T_2	T_3		
Total nitrogen (mg/100 ml)					
0	53.90^{a}	56.06^{a}	61.78^{a}	NS	57.25^{c}
2	71.78^{b}	78.80^{b}	113.76^{a}	11.54**	88.11^{a}
4	64.14^{b}	72.12^{b}	85.10^{a}	10.56**	73.79^{ab}
6	57.09^{b}	60.38^{b}	72.90^{a}	11.31**	63.46^{bc}
Mean	61.73^{b}	66.84^{b}	83.39^{a}	13.81**	^{X} 15.95*
Non-protein nitrogen (mg/100 ml)					
0	15.40	15.30	15.93	NS	15.54^{b}
2	21.17^{b}	20.42^{b}	37.98^{a}	4.04**	26.52^{a}
4	19.60^{b}	18.38^{b}	26.98^{a}	4.47**	21.65^{ab}
6	16.90^{b}	16.25^{b}	21.37^{a}	4.21**	18.17^{b}
Mean	18.27^{b}	17.59^{b}	25.57^{a}	7.06**	^{X} 8.15*
TCA- precipitated nitrogen (mg/100 ml)					
0	38.50	40.76	45.85	NS	41.70^{b}
2	50.61^{b}	58.38^{b}	75.78^{a}	12.46**	60.92^{a}
4	44.54^{b}	53.74^{ab}	58.12^{a}	11.14**	52.13^{ab}
6	40.19^{b}	44.13^{ab}	51.53^{a}	10.39**	45.28^{b}
Mean	43.46^{b}	48.75^{b}	57.32^{a}	7.63*	^{X} 13.34**
Ammonia nitrogen (mg/100 ml)					
0	6.08	6.01	6.83	NS	6.31^{b}
2	7.94^{b}	7.03^{b}	20.94^{a}	1.33**	11.97^{a}
4	7.33^{b}	6.59^{b}	12.29^{a}	1.58**	8.74^{ab}
6	6.50^{b}	6.06^{b}	8.51^{a}	1.16**	7.02^{b}
Mean	6.96^{b}	6.42^{b}	12.14^{a}	5.07*	^{X} 4.58*
pH					
0	6.98	6.96	6.99	NS	6.98^{a}
2	6.83^{b}	6.66^{b}	7.06^{a}	0.20**	6.85^{a}
4	6.65^{a}	6.41^{b}	6.75^{a}	0.23**	6.60^{b}
6	6.90	6.91	6.89	NS	6.90^{a}
Mean	6.84	6.74	6.92	NS	^{X} 0.22**
TVFA (m eq/litre)					
0	56.50	55.20	54.10	NS	55.27^{c}
2	63.81^{b}	78.10^{a}	70.20^{ab}	9.54**	70.70^{ab}
4	75.30^{b}	86.20^{a}	80.90^{ab}	8.34**	80.80^{a}
6	60.30	63.40	60.40	NS	61.37^{bc}
Mean	63.98	70.73	66.40	NS	^{X} 10.88**

a, b, c values in a row with different superscripts differ significantly; NS, nonsignificant; X, CD of the means of the column; a, b, c values in the same column with different superscripts differ significantly; *(P<0.05); ** (P<0.01).

and declined later due to active degradation of feed proteins. Higher ruminal NPN content at 2 h post-feeding reflected maximum proteolytic activity. The peak value of NH_3-N observed at 2 h, thereafter declined indicated its removal either through direct absorption or entrapped component for the synthesis of microbial protein. The different diets did not show any significant difference on pH and TVFA concentration in SRL. The pH values were within the normal range due to all the diets and also in different time of sampling. Lower (P<0.01) pH and higher (P<0.01) TVFA values recorded at 4 h post feeding as compared to all other times of sampling indicated inverse relationship between pH and TVFA concentration of rumen fluid, which corroborated the findings of Kaur and Kaushal (2001).

The NH_3-N and urea-N in serum samples of sheep (Table 5) pre-feeding (0 h) were similar in T_1, T_2 and T_3 treatments, however, at 3 h post feeding the values in T_3 were higher (P<0.01) than the values in T_1 and T_2. This might be due to higher nitrogen intake in this group due to urea treatment. The NH_3-N level (Dinning *et al.* 1948) and the urea nitrogen level (Swenson 1977) in the serum was within normal limits and was significantly less to create any toxic

Table 5. NH_3-N and urea-N (mg/100 ml) in serum of sheep as affected by different feeds and time of sampling

Treatments	Hours post-feeding			
	NH_3-N		Urea-N	
	0 h	3 h	0 h	3 h
T_1	0.50	0.51[b]	12.83	14.22[b]
	±0.03	±0.02	±0.85	±0.17
T_2	0.49	0.50[b]	12.32	13.85[b]
	±0.02	±0.02	±0.72	±0.57
T_3	0.51	0.60[a]	13.11	16.03[a]
	±0.03	±0.02	±0.31	±0.39
CD	NS	0.07**	NS	1.76**

a, b, values in a column with different superscripts differ significantly (P<0.01); NS, nonsignificant.

symptoms.

It is inferred that the reconstitution and urea treatment of *bajra* grain improved its nutritive value without adversely affecting the rumen metabolites and serum nitrogen in sheep.

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