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Evaluation of wheat straw, paddy straw and their combination feeding on nutrient utilization in goats

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ABSTRACT

The present experiment aims to investigate the comparison between feeding of wheat straw and paddy straw in combination or as sole roughage. A total of eighteen local non-descript adult male goats (14±02 months age; 28.90±0.66 kg body weight) were selected for the experiment. The animals selected were equally assigned into three groups (n=6) *viz*.WS, PS and WP, and were fed concentrate mixture and either wheat straw (WS); paddy straw (PS) or a mix of wheat straw and paddy straw (WP) in 60:40 ratio *ad libitum* as roughage. A feeding trial of 30-days was conducted followed by a metabolism trial of 7-days at the culmination of trial. The results disclosed non-significant difference in terms of average feed intake, mean body weight, metabolic body weight ($W^{0.75}$), and digestibility of nutrients *viz*. dry matter (DM), organic matter (OM), crude protein (CP), crude fiber (CF), nitrogen free extract (NFE) and neutral detergent fiber (NDF) among the experiment groups. The balance of nitrogen also revealed non-significant difference among the treatment groups, irrespective of their diets. The feeding cost also showed depreciation when the wheat straw was mixed with paddy straw, which resulted in a saving of about 16.5% of feeding cost, without affecting performance, intake and nutrient digestibility of straw. Thus, it could be concluded that wheat straw and paddy straw show potential to be utilized in combination (60:4) without affecting the nutrient intake, their digestibility and performance of goats.

Keywords: Goats, Nutrient utilization, Paddy straw, Performance, Wheat straw

In India, the ruminant livestock are primarily kept on ration based on cereal straw. In ruminants, the intake of straw and its digestibility are chiefly influenced by the physical and chemical characteristics of straw (Reed *et al.* 1988). Wheat straw and paddy straw are almost similar in nutrient, but their physical characteristics (Singh *et al.* 2016) and microstructure is different. Additionally, they differ in their acceptability to be utilized as feedstuff by livestock rearers (Dhupia *et al.* 2015), which is mirrored in their market cost. The lignin content of paddy straw is less, but it contains more oxalic acid and silica compared to other cereal straws (Van Soest 1981, Juliano 1985). The chief limiting factor that distresses the feeding value of paddy straw is its slow ruminal degradation and low nitrogen content (Van Soest 2006). On the other hand, wheat straw contains less crude protein and phosphorous, low in calcium, and generally has high fiber and lignin content (Anderson 1978). As such, it leads to reduction in feed intake, slows down the passage rate, and also decreases the digestibility. The present analysis was aimed to assess the effect of feeding paddy straw and wheat straw (when fed alone or in combination) on the nutrient utilization and performance of goats in tropical conditions.

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MATERIALS AND METHODS

Animal source and experimental design: Eighteen (18) local non-descript adult male goats (14±02 months age; 28.90±0.66 kg body weight) were selected and allotted to three groups of six animals (n=6) each as per RBD (randomised block design), and were maintained on dietary treatments as depicted in Table 1. Feeding trial was conducted for 30 days duration, with a metabolism trial during last week of the trial. The concentrate mixture composition (by parts) is given in Table 1, and was framed to fulfil the nutritional demands of experimental animals in accordance with ICAR (2013) requirements. The WP combination level of straw used in the trial is based on the previous work of the authors (Ganai *et al.* 2017).

Housing and management: All the animals under trial were kept in well-ventilated cement floored sheds, and were placed individually following standard managemental conditions. Clean drinking water was provided *ad-libitium* (*ad lib*) twice daily. The experimental animals were fed

Table 1. Concentrate mixture composition and feeding schedule of experimental animals

Ingredient of concentrate mixture	
Ingredient	*Parts*
Mustard deoiled cake	40
Wheat bran	32
Barley	25
Mineral mixture	2
Salt	1
Total	100
Feeding schedule of experimental animals	
Dietary treatment	*Feeding schedule*
WS	Concentrate mix @20g /kg $W^{0.75}$ + Wheat straw *ad lib.*
PS	Concentrate mix @20g /kg $W^{0.75}$ + Paddy straw *ad lib.*
WP	Concentrate mix @20g /kg $W^{0.75}$ + Combination of wheat straw and paddy straw (60:40) *ad lib.*

weighed quantity of concentrate mixture at 08:00 am and 04:00 pm, throughout the experiment. After the complete consumption of concentrate mixture, respective straws were offered to the experimental animals on *ad-lib* basis.

Growth studies and metabolism trial: The body weight of experimental animals was recorded at weekly intervals. To evaluate the digestibility of nutrients, plane of nutrition and nitrogen balance, a 07-days metabolism trial was conducted during last week of experiment. The collection of urine and faeces separately was done daily throughout the metabolism trial. The samples of feed offered, residue left and faeces collected, were analyzed in laboratory for their proximate components (AOAC 2005) and fiber fractions (Van Soest *et al.* 1991).

Statistical analysis: The data so obtained was subjected to one way ANOVA (Snedecor and Cochran 1994), using, SPSS Software, Base 23.0, Marketing Department, SPSS Inc. Chicago, USA.

RESULTS AND DISCUSSION

Chemical composition of experimental feed: The chemical composition of different straws and concentrate mixture (Table 2) fed to the experimental animals during feeding trial to the dietary groups differed significantly ($p \leq 0.01$). The highest OM, CF, NFE, NDF, ADF, calcium and phosphorus levels were present in wheat straw, with intermediate levels for combination and lowest levels for paddy straw. The per cent of CP, EE, total ash and AIA were highest in paddy straw. The levels were comparable among wheat straw and wheat-paddy combination for CP and AIA, whereas lowest for wheat straw and intermediate for wheat-paddy combination for EE and total ash. The higher fibre fractions of wheat straw were diluted by addition of paddy straw, whereas higher AIA levels of paddy straw were decreased in combination by inclusion of wheat straw.

Feed consumption, body weight gain and feed cost: The feed intake of experimental animals during feed trial in given in Table 3. The mean intake of concentrate mixture and straw remained comparable ($p>0.05$) throughout the experiment, irrespective of the period and the type of straw fed. This is in contrast to most of the previous reports (Rahal *et al.* 1997, Soebarinoto *et al.* 1997) that reported significant variation between different intakes of straw based on their chemical composition. However, no report is available regarding direct comparison between paddy and wheat straw intake. It has been suggested that the key factor for deciding the voluntary feed intake is the ruminal capability to process the feed (Baile and Forbes 1974). The capacity of rumen processing is described by its filling time, rate of degradation and the passage rate (Sarnklong *et al.* 2010). Similar intake, irrespective of the compositional difference of straw was also observed by Attoh-Kotoku (2011), Farooq *et al.* (2015) and Singh (2016), however, the observation was limited to paddy straw only.

The periodic live weight (kg) of experimental animals in presented in Table 3. The average body weight of experimental animals did not vary significantly ($p>0.05$)

Table 2. Proximate composition, fibre fractions and mineral content (%DM) of the feedstuffs* used in feeding trial

Attribute		Concentrate mixture	Straw		
		Wheat straw	Paddy straw	$W_{60}P_{40}$	
Proximate composition	OM	92.14±0.01	92.87^{c}±0.01	85.31^{a}± 0.02	89.46^{b}±0.02
	CP	19.52±0.01	4.35^{a}±0.01	4.76^{b}±0.03	4.37^{a}±0.02
	EE	3.51±0.03	1.34^{a}±0.00	1.43^{c}±0.01	1.38^{b}±0.01
	CF	6.33±0.006	37.82^{c}±0.057	31.42^{a}±0.060	35.19^{b}±0.083
	NFE	62.78±0.005	49.40^{c}±0.080	47.70^{a}±0.063	48.70^{b}±0.025
	TA	7.86±0.01	7.13^{a}±0.01	14.69^{c}±0.02	10.54^{b}±0.02
	AIA	1.29±0.01	5.35^{a}±1.01	10.29^{b}±0.01	7.03^{a}±0.02
Fibre fractions	NDF	48.53±0.02	78.04^{c}±0.03	72.09^{a}±0.05	74.57^{b}±0.09
	ADF	14.01±0.02	53.51^{c}±0.02	50.12^{a}±0.02	51.14^{b}±0.01
Minerals	Calcium	0.92±0.01	0.53^{c}±0.002	0.31^{a}±0.002	0.44^{b}±0.002
	Phosphorus	0.51±0.01	0.21^{c}±0.002	0.11^{a}±0.003	0.17^{b}±0.002

^{abc}Mean values with respect to straw bearing different superscripts within a row differ significantly ($p<0.01$); *Each value is a mean of three observations (analysed in triplicate)

Table 3. Periodical feed intake (dry matter basis) and live weight (kg) of experimental animals

Attribute/ Group	Week				Group mean ± SEM	*p*-Value
	I	II	III	IV		
			Concentrate intake (gpd)			
WS	236	235	227	231	232±9.9	
PS	231	234	232	242	235±8.1	
WP	238	239	231	238	236±6.9	
Period mean ±SEM	235±10.2	236±9.3	230±9.0	237±9.7	235±4.7	0.969
p value					0.943	
			Straw intake (gpd)			
WS	289	374	409	388	365±25.4	
PS	276	376	418	416	372± 24.3	
WP	293	392	426	416	382±19.4	
Period mean ±SEM	286^{a}±15.9	381^{b}±23.6	418^{b}±22.7	408^{b}±24.7	373±12.9	0.001
p value					0.842	
			Total intake (gpd)			
WS	525	608	636	619	597±34.0	
PS	507	610	650	659	607±30.8	
WP	531	631	658	654	618±24.9	
Period mean ±SEM	522^{a}±25.6	618^{ab}±32.6	649^{b}±31.7	645^{b}±3.3	608±16.8	0.041
p value					0.875	
			Live weight (kg)			
WS	29.0				28.5 ± 1.42	
PS	28.9				29.1 ± 1.12	
WP	29.4				29.1 ± 0.95	
Period mean ± SEM	29.1 ± 1.52				28.9 ± 0.66	1.000
p value					0.933	

[ab]Values bearing different superscripts within a row differ significantly.

between time periods and between dietary groups, thus non-significant interaction ($p>0.05$) was observed between periods and dietary treatments. The reports of Safari *et al*. (2023) revealed that the replacement of different levels of rice straw by wheat straw has no negative effect on the final weight, daily weight gain and dry matter intake of fattening lambs.

Digestibility coefficient of nutrients and nitrogen balance: Effect of feeding different straws on digestibility of nutrient in experimental animals in presented in Table 4. Similar ($p>0.05$) DM and OM digestibility was observed among all dietary groups. The EE digestibility however, differed significantly ($p\leq0.05$) among different groups with lower EE digestibility in PS group as compared to WS fed group. However, as the ether extract content of all straw is quite low, no significant effect of this observation may get reflected over animal performance. This difference in EE digestibility with change in straw type is in accordance to the observation of Singh (2016) and Singh *et al.* (2016), who reported difference in EE digestibility between different paddy straw varieties. Safari *et al*. (2023) had conducted a trial on fattening lambs and concluded that the addition of 30% of refined straw has led to a considerable reduction in digestibility of the raw protein ration.

The balance of nitrogen in experimental animals is presented in Table 4. The nitrogen intake, outgo and balance (g/d) were comparable ($p>0.05$) among experimental animals, irrespective of the diets. All the experimental animals were in positive nitrogen balance, indicating adequacy of the ration in fulfilling their nutritional requirements.

Feeding cost and depreciation: Taking into consideration, similar mean intake of straw, irrespective of the type of straw and difference in the prevailing market price of paddy and wheat straw (Rs. 4/kg and Rs. 8/kg, respectively), it is estimated that mean expenditure over roughage (straw) per goat is Rs. 2.92 for WS group, Rs. 1.49 for PS group and Rs. 2.44 for WP group (Fig. 1). This indicate that, if paddy straw is available simultaneously with wheat straw, the dilution of wheat straw with paddy straw will result in a saving of about 16.5%, without affecting general performance, intake and nutrient digestibility of straw.

The findings of present experiment revealed that wheat straw and paddy straw show potential to be utilized in combination without affecting the feed intake, nutrient digestibility and performance of goats under tropical conditions. The feeding cost was also decreased by feeding a combination of wheat straw and paddy straw to the adult goats. Though, further studies using large number of animals for longer duration are recommended

Table 4. Effect of feeding wheat straw and paddy straw on nutrient digestibility (%) and nitrogen balance of experimental animals

Attribute	Group			SEM	*p*-Value
	WS	PS	WP		
DM	68.81±6.082	64.44±5.513	68.05±3.613	2.672	0.816
OM	71.71±5.371	66.24±5.451	70.32±3.411	2.533	0.713
CP	72.95±4.914	71.68±6.513	70.09±4.707	2.843	0.928
CF	50.15±9.154	41.98±3.915	44.85±6.027	3.628	0.707
NFE	81.20±4.679	81.11±2.987	81.63±2.472	1.777	0.993
EE	88.38^{b}±2.388	74.00^{a}±4.023	82.06^{ab}±2.086	2.215	0.020
NDF	74.42±4.879	69.91±4.676	73.45±2.969	2.222	0.736
ADF	67.04±6.108	58.32±6.510	65.62±3.780	3.108	0.510
		Nitrogen balance			
		Nitrogen intake			
g/d	9.91±1.069	10.73±0.995	10.34±0.694	0.484	0.831
% live weight	0.04±0.001	0.04±0.001	0.04±0.001	0.001	0.490
g/Kg W $^{0.75}$	0.81±0.013	0.84±0.016	0.82±0.006	0.007	0.233
		Nitrogen excretion (g/d)			
Faeces	2.79±0.714	2.96±0.663	3.16±0.659	0.361	0.928
Urine	4.91±0.389	4.58±0.749	4.97±0.659	0.336	0.901
Total	7.71±0.972	7.54±0.527	8.13±0.882	0.446	0.873
Nitrogen balance (g/d)	2.20±0.216	3.19±0.514	2.21±0.375	0.243	0.183
		Nitrogen Retention			
% of intake	22.63±2.432	29.19±2.236	22.09±4.263	2.002	0.309
% of absorbed	30.93±1.901	41.04±2.048	31.53±5.424	2.465	0.193

^{ab}Values bearing different superscripts within a row differ significantly.

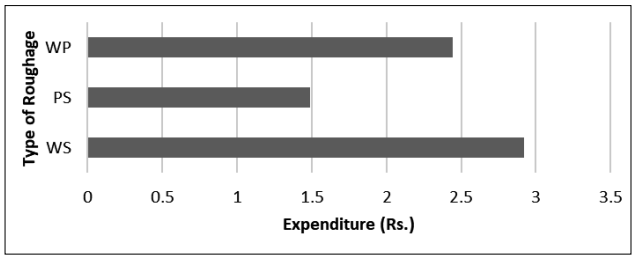

Fig. 1. Mean expenditure (in Rs.) per experimental goat over straw feeding during feeding trial

to ascertain the physiological, productive and reproductive performance of the goats.

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