Nutrient intake, digestibility and rumen metabolites in bulls fed rice straw with or without supplements

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Abstract

Nutrient intake, digestibility and rumen metabolites were determined in rumen - cannulated bulls fed rice straw or straw supplemented with urea, groundnut hay or cotton seed cake. Total dry matter intake (DMI) ranged from 7.55 to 8.29kg/d or 3.66 to 4.04% of liveweight and from 6.48 to 7.21kg/d for organic matter. Total DMI was increased by supplementation with urea and groundnut hay by about 7.6%. However, supplementation with groundnut hay and cotton seed cake reduced straw intake. Digestible organic matter intake (DOMI) was highest on straw supplemented with groundnut hay. There were no dietary differences in the digestibility of dry matter (DMD), organic matter (OMD), cellulose (CD) and hemicellulose (HCD). Digestibility of crude protein (CPD) was higher on the supplemented diets than on basal rice straw. The rumen P^H ranged from 6.42 - 8.28; ammonia-N (RAN), 6.74 - 27.70mg/100ml; volatile fatty acids (VFA), 8.79 - 12.40mmol/100ml and bacterial count, 5.73-16.10 ($\times 10^5$)/ml and those values were affected by diets (D), period of sampling (P) and their interactions (D $\times$ P).

Keywords: Nutrient intake, rumen metabolite, bull, rice straw

Introduction

One of the most difficult problems in ruminant production in the tropics is the scarcity of energy and protein feedstuffs during the dry season (Adegbola *et al.*, 1988). The available forages are dry, the protein content is very low and there is marked decrease in voluntary intake and digestibility (Obioha and Ndukwe, 1976). Weight losses which may be up to a fifth of the animal's body weight have been reported (Umunna, 1981). Measures to reverse the trend include chemical or biological treatment of low quality forages to improve intake and digestibility, or supplementation with urea, oil

seed cakes or legume hays. Supplementation of cereal crop residues with nitrogenous feeds is known to enhance voluntary intake and nutritive value (Umunna, 1982).

Crop residues especially cereal stovers from sorghum, sorghum, maize, millet and rice are in abundant supply during the dry season and their grazing may constitute 40% to 85% of total grazing time (Van Ray and De Leeuw, 1971). Rice straw is produced in smaller amount than sorghum or maize stover and is usually burnt though cattle could also consume it. The major researches on crop residues in Nigeria have

been undertaken with sorghum, maize and millet stovers (Adebawale, 1985; Alhassan *et al.*, 1983). The aim of this work was therefore to examine the nutritive value of rice straw fed to cattle with or without supplements such as cotton seed cake, urea or groundnut haulms.

Materials and methods

Animals: Two bulls weighing 200kg and 210kg fitted with rumen cannulae were used for the

study. The animals were kept in metabolism pens throughout the period of the experiment. Each of the four diets was fed in turn to the bulls for 3 weeks. Fecal and rumen sample collection was done in the 3rd week. Rumen liquor was obtained before feeding and 2 hours after feeding.

Table 1 *Chemical composition of experimental feeds*

Components	Rice Straw	Rice Urea	Straw plus	Groundnut Hay	Cotton Cake	Seed
Dry matter	88.27	80.19		83.63	91.46	
<i>On Dry Matter Basis:</i>						
Crude Protein	4.31	13.63		16.06	43.01	
Cellulose	46.58	43.41		32.83	14.03	
Hemicellulose	23.63	24.27		12.83	16.61	
Lignin	4.34	3.90		8.16	6.85	
Ash	15.67	16.69		8.79	7.38	

Table 2 *Nutrient intake and digestibility in bulls fed rice straw with or without supplements*

	Diets ⁺⁺			
	Rice Straw	Straw + Urea	Straw Groundnut Hay	Straw + Cotton Seed Cake
<i>Nutrient Intake:</i>				
Dry matter, kg/d	7.70 ^b	8.29 ^a	8.29 ^a	7.55 ^b
Straw, kg/d	7.70 ^a	8.12 ^a	5.14 ^c	6.18 ^b
Dry matter (%)				
Body weight	3.76	4.04	4.04	3.66
Organic matter, kg/d	6.49 ^b	6.89 ^{ab}	7.21 ^a	6.48 ^b
Crude protein, kg/d	0.33 ^d	1.13 ^a	0.73 ^c	0.86 ^b
Digestible Organic Matter, kg/d	4.17 ^{bc}	4.42 ^b	4.78 ^a	4.22 ^b
Digestible crude Protein, kg/d	0.17 ^c	0.76 ^a	0.50 ^b	0.54 ^b
<i>Nutrient Digestibility:</i>				
Dry matter	62.17	62.21	64.04	63.08
Organic matter	64.19	64.14	66.35	65.16
Crude Protein	50.38	67.20 ^a	62.19 ^b	62.90 ^b
Cellulose	68.21	67.72	69.42	68.65
Hemicellulose	65.54	65.90	68.74	67.01

⁺⁺ Means within the same row bearing similar superscripts, are not significantly different ($P > 0.05$).

Rumen metabolites in bulls fed rice straw

Table 3 The pH, ammonia - N, volatile fatty acids and bacterial count of rumen fluid in bulls fed rice straw with or without supplements

Measurement	Period	Diets ⁺⁺			
		Straw	Straw + Urea	Straw + Groundnut Hay	Straw + Cotton Seed Cake
pH	BF	6.64	7.64	6.42	6.54
	AF	8.28	7.81	6.55	6.74
	Mean	7.46 ^a	7.72 ^a	6.49 ^b	6.64 ^b
Ammonia - N Mg/100ml	BF	8.40	14.52	16.48	27.70
	AF	6.74	13.63	16.14	24.86
	Mean	7.57 ^a	14.08 ^b	16.31 ^c	26.28 ^d
Volatile fatty acids Mmol/100ml	BF	12.40	9.94	10.74	10.93
	AF	8.79	10.99	11.32	12.31
	Mean	10.60 ^a	10.47 ^a	11.03 ^a	11.62 ^a
Bacterial Count (X 10s)	BF	5.73	8.65	7.59	7.81
	AF	11.18	16.10	12.42	12.97
	Mean	8.46	12.38	10.01	10.39

BF = Before feeding

AF = After feeding

⁺⁺ Means within the same row bearing similar superscripts are not significantly different (P>0.05).

Feeds: Each animal was given 10kg of rice straw and supplements once daily at 8.00a.m as follows:

Diet 1: Rice straw

Diet 2: Rice straw + urea (250g)

Diet 3: Rice Straw + groundnut hay (3.75kg)

Diet 4: Rice straw + cotton seed cake (1.50kg)

Diet 2 was prepared by dissolving 250g of urea in one litre of water and sprayed on 10kg of rice straw. This was allowed to dry overnight before feeding. For diets 3 and 4, the bulls were allowed to consume the supplements first. Water was provided *ad libitum* and mineralised salt blocks were provided.

Chemical analysis

The nitrogen content of the feeds and the total volatile fatty acids in the rumen fluid were determined by the A. O. A. C. (1975) methods.

The various fibre components (cellulose, hemicellulose, lignin) were determined according to Georing and Van Soest (1970). Ruminal ammonia was also determined (Whitehead *et.al.*, 1967). Data were analysed by analysis of variance and differences between means determined by Duncan's multiple range test method (Steel and Torrie, 1960).

Results and discussion

The chemical composition of the rice straw, rice straw and urea, and the supplements of groundnut hay and cotton seed cake is presented in Table 1. The crude protein content of rice straw is similar to values of 4.0-4.8% reported for some varieties of rice straw (Nakashima and Orskov, 1990).

Table 4 Regression equations and correlation coefficients for pH, ruminal ammonia – N and total volatile fatty acids (VFA) in ruminal fluid of bulls

X	Y	EQUATIONS	R
pH	Ruminal ammonia-N	$Y = 45.00 - 4.01X$	0.64**
pH	Total VFA	$Y = 20.15 - 1.27X$	0.54**
Ruminal NH ₃ -N	Total VFA	$Y = 8.39 + 0.16X$	0.55**

Addition of urea increased the crude protein to 13.6%. The cell wall components were also within the range of values given by Jackson (1977) and Nakashima and Orskov (1999) who reported that there were varietal differences in chemical components. The crude protein content of groundnut hay (16.06%) is much higher than 11.2% reported by Lakpini and Adu (1987) for groundnut haulms. Differences in crude protein content reported may be due to stage of harvest and method of preservation of hays and haulms. The crude proteins content of 43.01% for cotton seed is similar to 43.28% reported by Ikurior and Fetuga (1985).

The nutrient intake and digestibility of rice straw with or without supplements are Presented in Table 2. Total dry matter intake (DMI) ranged from 7.55kg/d on straw plus cotton seed cake to 8.29kg.d urea and groundnut hay supplements. Addition of urea to rice straw significantly increased total DMI ($P < 0.05$). However, intake of rice straw was not significantly increased ($P < 0.05$). Umunna (1982) had shown that total forage DMI was improved when urea was used as supplement to native hay. The intake of rice straw was significantly reduced by groundnut hay and cotton seed cake supplementation, indicating that a substitution effect had taken place at the levels of supplementation. However, total DMI was increased at the supplementation levels with groundnut hay but not with cotton seed cake. Ikhatua and Olubajo (1981) have reported non-significant difference ($P > 0.05$) in total DMI as a result of supplementing hay or fresh

forage with groundnut cake. The total DMI (% body weight) which ranged from 3.66 to 4.04 is higher than 2.2 to 2.9 reported for cattle by Saadullah *et al.* (1981), Iwuanyanwu and Umunna (1985) and Ikhatua and Olubajo (1981). Supplementation of rice straw with urea or cotton seed cake did not lead to increased intake of organic matter (OM) but supplementation with groundnut hay improved ($P < 0.05$) both OM intake and digestible (OM) intake. Both crude protein intake (CPI) and digestible crude protein intake (DCPI) were increased by addition of supplements.

Supplementation of rice straw did not affect digestibility of DM, OM, cellulose and hemicellulose. A similar result had been obtained by Ikhatua and Olubajo (1981). However, Hannah *et al.*, (1991) found that digestibility of OM was improved by protein supplements. The significant increase in crude protein (CP) digestibility of straw with protein supplementation is in agreement with the results of Hannah *et al.*, (1991). Cellulose and Hemicellulose digestibility was not affected by protein supplementation. This has been reported by Hannah *et al.* (1991). The DMD of rice straw is higher than the value of 52.32% reported by Alhassan and Akofur (1982) for sheep but the CPD is similar to 52.41 reported by the same workers. Rice straw is relatively more digestible than other straws and stovers since its stem is more digestible than the leaves, which is the opposite of what obtains for other cereal straws and stovers (Jackson, 1978).

Rumen metabolites in bulls fed rice straw

The pH, ammonia -N, total volatile fatty acids (VFA) and bacterial count of the ruminal fluid of cattle fed rice straw with or without supplement are presented in Table 3. The pH ranged from 6.42 on groundnut hay supplement to 8.28 on straw only. There were differences due to diet (D), sampling period (P) and interaction (DXP). The pH increased significantly after feeding and was higher for high fibre diets (rice straw and straw/urea). It has been shown that high fibre diets increased rumination hence production of saliva (P^H 8-8.2) which elevates the pH of rumen fluid (Kaufman *et al.*, 1980). The low pH on groundnut hay indicates that it has a high level of soluble carbohydrates which produces acid on fermentation and results in low pH. Ruminal ammonia -N(mg/100ml) ranged from 6.74 for straw after feeding to 27.7 for cotton seed cake supplement before feeding. Differences in the concentrations of ammonia - N (RAN) due to diets and period of sampling were highly significant ($p<0.01$). All the supplements increased RAN levels significantly over that of straw only, and the values were greater before than after feeding. The RAN levels were higher than 5mg/100ml reported by Satter and Slyter (1974) for optimum microbial production *in vitro* but the values obtained on straw post feeding were lower than 8.5mg/100ml for optimal protein yield (Okorie, 1981) and 8mg/100ml which is the critical ammonia concentration for rumen function (Leng *et al.*, 1977). However, only cotton seed cake supplement gave RAN level higher than 19-25mg/100ml considered optimum for forage digestion (Mehrez and Orskov, 1977). Low RAN level could be the most limiting factor to microbial activity in animals fed rice straw, hence the need for protein supplementation.

Levels of total VFA ranged from 8.79mmol/100ml on rice straw post feeding to 12.4mmol/100ml pre-feeding. There were no significant effects of diet or sampling period on

VFA level but interaction effect was highly significant ($P<0.01$). However, supplementation increased the post feeding values of VFA. The total VFA values reported here are similar to those of Ibeawuchi and Akinsoyinu (1989) for White Fulani cows fed varying levels of brewers dried grains.

There were significant dietary differences ($p<0.05$) in the bacterial count of rumen fluid with straw/urea diet giving the highest count. Bacterial count of rumen fluid is dependent on rumen ammonia concentration and pH of rumen fluid and both factors are dependent on type of diet (Thorley *et al.*, 1968). The low bacterial count on unsupplemented straw diet may indicate that ammonia is limiting for bacterial growth (Leng *et al.*, 1977; Okorie, 1981; Adegbola *et al.*, 1988). The bacterial count on the three supplemented straw diets would appear to support a sufficiently high number of rumen bacteria (Hungate, 1966).

The correlation co-efficient (Table 4) between the post feeding values of pH and ammonia - N ($r=0.64$), pH and total VFA ($r = 0.54$), ammonia N and total VFA ($r = -0.54$) were highly significant ($P<0.01$). Similar relationships have been reported by Ibeawuchi and Akinsoyinu (1989). The significantly high correlation coefficients indicate the effect of the levels of rumen metabolites on pH and by implications, on rumen microbial function (Thorley *et al.*, 1968). The regression equations presented in Table 4 may be useful in predicting the concentrations of rumen ammonia - N and VFA and thus the nutritional status of ruminants given diets similar to those used in the present report.

From the results it may be concluded that total dry matter intake could be improved by supplementing rice straw with urea or groundnut hay. However, rice straw alone is inadequate to provide rumen degradable N for

inadequate to provide rumen degradable N for microbial protein synthesis, hence the need for protein supplementation.

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