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Effect of supplementing Rice Straw with Pigeon Pea Forage on Performance of Yankasa Sheep

G.E. Jokthan, C.A.M. Lakpini*, A.M. Adamu*, and G.N. Akpa

Department of Animal Science, Ahmadu Bello University, Zaria, Nigeria

**National Animal Production Research Institute, Ahmadu Bello University, Zaria, Nigeria.*

Corresponding Author: grace4idris@yahoo.com

Abstract

Studies were conducted to evaluation the feeding value of rice straw (RS) supplemented with varying levels of pigeon pea forage (PPF) as dry season feed for yearling Yankasa ewes. Twenty yearling ewes with an average live weight of 15.02kg were randomly assigned to four treatments. Five ewes per treatment comprising a basal RS diet fed ad libitum (0.0% PPF), and ad libitum RS supplemented with PPF at 0.5, 0.1 and 1.5% of body weight in a completely randomized design. Composition of the feed ingredients showed that RS had 10.81% CP, 5.11% lignin and 4.2% silica while PPF had 15.75% CP, 3.63% lignin and 0.5mg/kg tannin. In terms of mineral contents analyzed, PPF was higher than RS only in calcium. The result of the feeding trial showed increase feed intake with increase in level of PPF supplementation. Ewes on the unsupplemented and 0.5% body weight supplementation lost weight (-2.01kg and –1.6kg respectively) while those on 1.0 and 1.5% supplementation had minimal (1.25kg and 1.06kg respectively) weight gain. The digestibility and nitrogen balance showed significant differences (P<0.05) in the digestion of DM, OM, NDF and ADF across the treatments. Supplementing RS diet with 0.1% of body weight PPF resulted in better digestibility of all nutrients. Nitrogen retention across all treatments were high and ranged between 86.19 to 90.06 percent.

Keywords: Performance evaluation ,Rice Straw, Pigeon pea forage, Yankasa Sheep

Introduction

The detrimental effects of the long dry season in Northern Nigeria on quantity and quality of feed available to livestock are well documented (Abubakar, 1998). The attendant effect of this feed scarcity on animal performance and productivity in this region is obvious (Adebowale and Taiwo, 1996). Considering that this area is home to about 80% of the Nigerian ruminant livestock population, emphasizes the problem at hand.

Rice is principally produced for human consumption and large amounts of straw are left on the field. In South East Asia, Rice straw constitutes over ½ the available food crop residue (Moran, *et al;* 1993). The production target of rice in Nigeria by the year 2010 is 1,152,000 tonnes (Shaib *et al;* 1997). Despite the large availability of this crop residue, its utilization is limited by low voluntary intake, poor digestibility, low nitrogen content and high silica. (Bae *et al,* 1997).

Ammonia, calcium hydroxide and urea (Sekine *et al,* 2003) have all been used as chemical treatments to improve the digestibility of RS and to enhance its utilization. These treatments are technically feasible at the farm level but they have not been adopted particularly by the marginal and smallholder farmers because of the difficulty and cost involved.

There is need, therefore, to seek new ways of improving the nutrient value and utilization of RS so as to improve efficiency of utilization under conditions occurring in Nigeria.

Dual-purpose legumes such as pigeon pea (PP), offer a good opportunity to integrate livestock and crop production. The present studies were therefore, carried out to ascertain the nutritive value of Pigeon Pea Forage (PPF) as a dry season supplement to a basal diet of RS fed to yearling Yankasa ewes with the following objectives.

- To determine the chemical and mineral composition of RS and PPF and hence estimate their feeding value as maintenance rations in yearling yankasa ewes.

- To determine the digestibility and nitrogen balance of the experimental diets.

Matrials and Methods

Collection and processing of pigeon pea forage and rice straw

Pigeon pea (Cajanus cajan) forage used for this study was cultivated in May during the 2003 rainy season. The forage was harvested in September at the flowering stage at about 30cm above the ground. The forage was left on the farm to wilt. After 4 days, it was transferred to the Animal Products Laboratory.

Rice straw used was collected from a farm on the outskirts of Zaria metropolis. It was collected after the farmer had just harvested the rice. The rice was paddy rice. Both PPF and RS were chopped to about 30cm lengths using a chopper and stored in jute bags.

Growth Study

The first phase of the growth study involved the determination of the chemical composition and mineral content of PPF and RS. Representative samples of PPF and RS were collected and analysed for proximate composition according to AOAC (1985). Cellulose, hemicelluloses, lignin, ADF and NDF were also determined (Van Soest and Roberstson 1998) Flame spectrophotometer was used to determine the content of Ca, P, Na, Mg, K and Fe. Polyphenol was evaluated (Reed, 1995) and gross energy was estimated by a Gallenkamp ballistic bomb calorimeter.

Animals, feeds and feeding

Twenty yearling ewes with an average live weight of 15.02kg were obtained from the flock raised at National Animal Production Research Institute (NAPRI) Shika. The animals were dewormed with an anthelminthic (Albendazole) and dipped in acaricides solution. They were also administered with terramycin long acting antibiotics a week before the commencement of the adjustment period. The ewes were randomly assigned to four treatments, five animals per treatments, in a completely randomized design. The ewes were kept in individual feeding pens in the experimental unit of the Small Ruminant Research Programme, NAPRI Shika.

Animals were offered RS *ad* libitum and RS supplemented with PPF at 0.5, 0.1 and 1.5% of body weight. The PPF was offered at 0.800 hr while the basal RS was offered an hour later. The feeding trial had an initial 14days adjustment period followed by 90 days feeding trial. Animals were weighed weekly using a hanging scale. PPF offered was adjusted weekly to maintain PPF inclusion levels. Quantities of feed offered and refused were weighed daily to determine feed intake. Fresh clean drinking water was offered daily ad libitum.

Digestibility and nitrogen balance study

Three animals were randomly selected form each treatment at the conclusion of the growth study. They were put in individual metabolism crates and fed their respective rations as in the previous study. An adjustment period of 10days was allowed before the faecal and urine outputs were measured for the subsequent seven days. Total urine production was collected daily into a graduated plastic containing 50ml of 50% HCI. Feed intake was measured by finding the difference between the amount of feed offered and the amount refused. Samples of feed, faeces and urine were taken daily for initial determination of DM. A 5% aliquot of total urine output per day was removed each day and stored in a freezer (-4°C).

Faeces from animals on each treatment were bulked, thoroughly mixed and subsampled. Similarly the urine output from animals on each treatment was mixed and subsample taken.

Chemical analysis

Samples of feed offered and faecal output were analysed for DM, CP, CE, EE, and ash (AOAC 1985) ADF, NDF and hemicelluloses (Van Soest and Robertson, 1988) Urine Sample were analysed for nitrogen.

Statistical analysis

Data obtained were subjected to analysis of variance using the GLM of SAS (1985).

Results and Discussion

Table 1 shows the chemical, mineral and gross energy content of RS and PPF. The CP content of RS used in this study was higher than the CP content of RS reported by Jian-xin *et al* (2001.). They reported a range of 4.67.3% for eight varieties of RS. In general, farmers grow different cultivars of rice. This affects the nutrient composition of the straw. Doyle and Oosing (1994) attributed these differences in nutrient composition to genetic factors as well as management practice during growth and harvest.

Table 1: Chemical Composition (%) and energy content of rice straw and pigeon pea forage.

Feed ingredient	Nutrient													
	DM	CP	CF	EE	Ash	NFE	ADF	NDF	CELL	HEMI	LIG	SI	GE kcal/kg	Tannin
Rice straw	96.31	10.81	28.42	3.81	15.17	41.79	45.81	68.43	38.72	23.35	5.11	4.27	4431	-
Pigeon pea forage	92.03	15.75	29.00	5.37	5.87	44.01	37.04	49.71	23.33	38.35	3.63	-	4933	0.5 mg/kg

	Mineral (ppm)						
	Ca	P	Na	Mg	Fe	K	S
Rice straw	45.00	23.87	4.57	10.30	2.25	18.75	15.63
Pigeon pea forage	62.50	17.05	2.31	10.50	1.75	[illegible]	11.72

In this study, the CP content of rice straw was higher than what had been reported in literature. This could be because the straw contained some amounts of rice which were either not matured or left behind as a result of inefficient processing method. The ADF and NDF contents were similar to values of 49.20 - 56.00% ADF, 66.50 - 77.60% NDF, 18 -23% hemicelluloses, 34.50% cellulose (Dutta *et al;* 1999) and gross energy (Cann *et al;* 1993).

Silica content of 4.27% obtained is slightly below the range of 5.16% reported by Bae (1997). Vadiviloo (1992) had earlier stated that silica uptake from soil and content in plant depends on its concentration in soil solution and its deposition in plants varies among rice varieties. In general, farmers grow different cultivars of rice. This affects the nutrient composition of the straw. Doyle and Oosing (1994) attributed the difference in nutrient composition to genetic factors as well as management practices during growth and harvest.

The ash content (15.17%) is within the range reported by Ahoefa *et al;* (2001). Calcium was higher in PPF than in RS. This is generally true for most legumes. Levels of Na, Mg, K, Fe and S observed in this study were within the range reported for dry roughages (Kearl 1982).

Tannin content of PPF, used in this study was low. Singh (1988) reported that PP contains considerable amounts of polythenolic compounds. He however, stated that the contents of tannins were much higher in pigeon pea cultivars with dark seed coats. The variety used for this study had a white seed coat. Moreso, the work of singh (1988), was mainly on the seed while the present study focused on the forage.

Mineral content of Diets

The calcium and phosphorous contents of all the treatment diets (table 2) were within the range of 1:1 to 7:1 that can be tolerated by ruminants. The most appropriate ratio of 2:1 Ca : P recommended by ARC (1984) was obtained in all the treatments except for PPF

Table 2: Mineral content (ppm) of diets

Element	Pigeon pea levels (% of body weight)			
	0.0	0.5	1.0	1.5
Calcium	2.41	2.60	2.87	1.88
Phosphorous	1.28	1.28	1.33	1.22
Sodium	0.24	0.24	0.25	0.22
Magnesium	0.56	0.58	0.62	0.58
Iron	0.12	0.12	0.10	0.12
Potassium	1.00	0.20	1.03	0.94
Sulphur	0.84	0.20	1.09	0.94

supplementation at 1.5% of body weight where the ratio is slightly less.

Feed intake

There was an increase in DM intake as a result of PPF suppelmentation (Table 3). This is similar to the work of Moran *et al;* (1983) who reported increase in DM intake when RS was supplemented with Leuceana leucocephala. The decline in DM intake at 1.5% of body weight PPF supplementation agrees with the work of Muanyuchi *et al;* (1997). They found that legume forage supplementation increased total feed intake up to a point, beyond 40% there was a decline. Similar result was obtained by Mosi and Butterworth (1984) when inclusion of Trifolium tembense hay exceeded 34.70%.

There was a decline in silica intake as the level of PPF consumed increased. The opposite was obtained for tannin. The intake of tannin increased form 31.77mg/kg at 0.5% to 65.94mg/kg at 1.5%. These tannin levels were too low to cause any deleterious effect. Donnelly and Anthony (1969) reported that the tannin level required for rejection by grazing animals is about 20mg/g DM.

Weight changes and Feed Efficiency

Results of this study (Table 4) show a high percentage of nitrogen retention across all treatments. This could be because protein nitrogen sources released ammonia at a lower rate than NPN source, more closely coinciding with the release of energy from the cellulose component thereby enhancing microbial production. The pattern of degradation of nitrogen is a major factor influencing its retention for efficient utilization of crop residues.

A significant difference in the percent digestion of DM, OM, NDF and ADF across the treatments was observed in this study. One percent body weight supplementation of PPF gave better results in all these parameters even though it was not significantly different from the 1.5% body weight supplementation. The values obtained at 1.0% body weight supplementation thought similar were slightly lower than results obtained by Moran *et al;* (1983). They reported

Table 3: Feed intake and performance of Yankasa sheep fed rice straw supplemented with varying levels of pigeon pea forage.

Feed/Nutrient intake (g/day)	Pigeon pea forage levels (% of body)				
	0.0	0.5	1.0	1.5	SEM
Rice straw intake	534.89^{a}	489.60^{ab}	475.34^{ab}	417.72	37.9
Pigeon pea forage intake	-	63.54^{b}	116.22^{ab}	131.87^{a}	32.9
Total feed intake	534.89^{b}	553.14^{ab}	591.56	549.59^{b}	19.8
CP intake	53.49^{b}	58.97^{a}	65.83^{a}	62.54^{a}	4.6
NDF intake	366.03^{b}	372.92^{ab}	394.62^{a}	364.59^{b}	11.6
ADF intake	245.03^{ab}	247.81^{ab}	260.76^{a}	240.16^{b}	2.1
Hemicelluloses	159.45^{b}	162.93^{b}	177.28^{a}	164.78^{ab}	6.4
Cellulose	207.11^{a}	203.51^{a}	211.19^{a}	192.53^{b}	6.4
Silica intake	22.84^{a}	20.91^{a}	20.30^{a}	17.84^{b}	1.6
Tannin (mg/kg)	-	31.77^{b}	58.11^{ab}	65.94^{a}	16.5
Metabolisable energy (Kcal/kg)	2382.60^{b}	2584.30^{b}	2813.00^{a}	1038.96^{b}	655.7
Initial weight (kg)	15.06	15.04	14.98	15.06	NS
Final weight (kg)	13.05^{b}	13.43^{b}	16.23^{a}	16.12	1.7
Weight gain (g/day)	-2.01	-1.61	1.25	1.06	NS
Feed efficiency (g/kg)	-	-	473.25	518.48	NS

^{a,b} Means on the same row bearing different superscripts are significantly ($P<0.05$) different

37.60 and 46.00 digestion coefficient for DM and OM, respectively when alkali treated RS was fed to Ongola cattle and Buffalo. Rahal *et al*; (1997), reported varietal differences in voluntary intake and *in vitro* digestibility of different cultivars of RS. They reported a range of 490 to 587kg OM digestibility for three varieties of rice. Supplementation of RS with PPF at 1.0% of body weight would enable yearling Yankasa sheep maintain bodyweight. Thus poor farmers in the northern part of the country who are unable to use concentrate supplement and therefore, experience extreme feed scarcity during the peak of the dry season can use this ration to maintain the body weight of non-producing animals. This will help in reducing the weight fluctuations these animals experience between the rainy and dry seasons and the subsequent waste of time and resources that occur during compensatory growth. Animals will therefore, be ready to start production at the onset of the rainy season when feed materials are in abundance.

The slight decline in digestibility recorded when PPF inclusion exceeded 1.0% agrees with the work of Cann *et al*; (1993). They stated that digestibility increased with the level of CP in the

Table 4: Nutrient digestibility and nitrogen retention of sheep fed rice straw supplemented with Pigeon pea forage

Parameter	PPF inclusion in diet (% of body weight)				
	0.0	0.5	1.0	1.5	SEM
Total DM intake (g/day)	2884.30	3132.70	365.41	399.30	NS
% N retained	89.83	88.82	90.06	86.19	NS
DM digestibility (%)	13.05^{c}	16.09^{c}	33.47^{a}	23.88^{b}	2.28
OM digestibility (%)	24.21^{c}	28.12^{c}	42.62^{a}	33.00^{b}	1.89
NDF digestibility (%)	13.71^{c}	12.11^{c}	33.85^{a}	20.53^{b}	2.45
ADF digestibility (%)	2.38^{c}	4.63^{c}	28.04^{a}	15.73^{b}	2.35
Hemicelluloses digestibility (%)	37.25	32.81	50.24	35.20	NS

a,b,c. Means on the same row with different superscripts are significantly (P<0.05) different

NS – not significant

diet up to a point. Once the level of nitrogen deficiency of crop residues had been overcome, there is little or no advantage in feeding additional forage legume.

Generally, the digestibility of RS and RS based diets especially for 0.5% PPF supplementation was poor. The RS used in this study contained silica (4.27%) and lignin (5.11%); these components tend to limit cell wall digestion.

Conclusion and Recommendation

Supplementing yearling ewes on a basal RS diet with PPF had a positive effect on body weight gain. Supplementation at 0.05% of body weight reduced the amount of weight lost by 0.40kg. For ewes to maintain body weight, PPF should be given at the rate of 1.0% of body weight. Supplementation of RS with PPF to sheep also increased DM digestibility from 13.05% in the unsupplemented diet to 33.47% on the 1.0% treatment. The study also showed that pigeon pea forage in addition to increasing the amount of rumen degradablenitrogen from 53.48% to 65.83g/day also increased the amount of rumen degradable OM from 24.21% to 42.62% to 42.62%

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