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Nutrient intake, digestibility and growth performance of Yankasa sheep fed urea-treated or untreated rice straw with supplements

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Abstract

A study was conducted at the Abubakar Tafawa Balewa University (ATBU) Research and Teaching Farm, Bauchi between December and May, 2006 to determine nutrient intake, digestibility and growth performance in Yankasa rams fed urea-treated (UTRS) and untreated rice straw (URS) with supplementation. Thirty-two (32) Yankasa rams with an average weight of 17.5kg, and aged 1.5 to 2 years old were allotted to eight (8) dietary treatments with four (4) rams per treatment in a 2 x 4 factorial design. The two basal feeds were urea-treated rice straw (UTRS) and untreated rice straw (URS). The supplements were maize bran (MB), MB + sun-dried poultry litter (MB+SDPL), MB + ensiled poultry litter (MB+EPL) and MB + cotton seed cake (MB+CSC). Total dry matter intake (TDMI), daily basal feed intake (DBFI) were significant (P<0.05) across dietary treatments. Animals on supplement MB and MB+CSC for both UTRS and URS recorded the lowest and highest DBFI. The digestible crude protein intake (DCPI) and digestible organic matter intake (DOMI) were high for rams on UTRS and, the values ranged from 17.72 to 28.36g/d and 288.81 to 482.66g/d for DCPI and DOMI respectively. Nutrient digestibility was improved by treatment of the straw and supplementation. However, crude protein digestibility was similar for animals fed URS but, significantly (P<0.05) lower compared to those fed UTRS which were also similar across supplements. Average daily weight gain ranged from 53.58 to 91.18g/d across dietary treatment with animals on supplement MB recording the lowest (53.58 and 61.43g/d for URS and UTRS respectively) and those fed supplement MB+CSC the highest (81.38 and 91.18g/d for URS and UTRS respectively) irrespective of straw treatment. Feed conversion ratio (FCR) was least for animals on supplement MB+CSC for both URS and UTRS, indicating that this supplement (MB+CSC) influenced feed utilization more positively. From the results of this trial, it may be concluded that straw treatment and/or supplementation can enhance crop residue utilization by sheep. However, mixed supplements especially MB+CSC were more efficient in enhancing the utilization of the straw and consequently animal performance.

Keywords: Nutrient intake, digestibility, growth, rice straw, supplement, Yankasa sheep.

Introduction

Inadequate nutrition is a major limitation to livestock production in Nigeria and other developing countries. The situation becomes worse during the dry season when animals are unable to meet their protein and energy need from available poor quality herbage with consequent marked weight loss and productivity (Ademosun, 1994). For example, studies have shown that the crude protein (CP) content of native grasses during the dry season is between 1.5 to 3% (Adamu *et al.*, 1993). This is far below the minimum level of 7% CP required in forages to enhance voluntary intake, digestibility and utilization by ruminants (Smith, 1993).

Huge quantities of cereal crops are grown each year all over the world. Large proportion of this production area is for grain rather than for whole-crop silage or hay (Wilman *et al.*, 1999).Consequently, large quantities of cereal straw and stover are produced which can be used for feeding ruminant animals especially during the long dry season when grasses are scarce and of low quality. These straws and stovers which are characterized by high fibre and low CP contents are poorly digested and have low metabolizability. In order to meet the maintenance and production requirements of ruminants fed on low quality roughages, such diets need to be supplemented with high quality concentrates, or alkali treated to improve digestibility (Mawuenyegah *et al.*, 1997) Research efforts in developing countries has concentrated on ways by which the feeding value of low quality roughages might be enhanced by chemical and other treatment methods (Sundstol and Owen, 1984).

Ammonia treatment and/or supplementation of low quality roughages has been reported (Chandrasekharaiah *et al.*, 1996; Bogoro, 1997; Adegbola, 2002) to improve palatability, nutrient digestibility as well as providing non-protein nitrogen (NPN) to ruminant animals.

The use of urea as a precursor of ammonia has been recommended for developing countries with low technological base for its safety in application, availability in the local markets at cheap cost and preservative properties (El-Shobokshy *et al.*, 1989). Urea treatment of poor quality roughages has earlier been reported (Lufadeju *et al.*, 1985) to improve feed utilization by enhancing rumen microbial protein synthesis, which increases forage degradation and voluntary intake.

In this study, an effort was made to determine the effect of supplementation of urea-treated or untreated rice straw on nutrient intake, digestibility and growth performance in sheep.

Materials and Methods

Study area

The experiment was conducted at the Abubakar Tafawa Balewa University (ATBU) Research and Teaching Farm, Bauchi between December and May, 2006. Bauchi State is located within longitude 15°50 East and latitude 13° 30 North with a total land area of about 66,000square kilometers and an altitude of 690.2m above sea level. The average rainfall varies between 600mm (in the North) to 1300mm (in the South-west) in the State. The rainy season lasts from June to September. The mean annual minimum and maximum temperatures are about

18° and 35°C respectively. Bauchi State is in the Northern Guinea Savanna zone of Nigeria.

Experimental animals and their management

Thirty-two (32) growing Yankasa rams were purchased from weekly markets within Bauchi. The animals weighing between 16.3 to 18.4kg had an average weight of 17.5kg.

The animals were quarantined for two weeks during which they were ear-tagged (for identification), treated against ecto-parasites using Diazintol, dewormed with Albendazol (2.5% oral suspension) and injected intra-muscularly with Oxytetran-long acting broad spectrum antibiotic. The deworming was repeated in the 6th week of the trial using the same drug. The animals were later allotted to individual pens for another two weeks to enable them adapt to the pen. During the quarantine phase (in group and in individual pens), the animals were fed chopped rice straw mixed with groundnut haulms *ad libitum*, and 200g of maize bran (MB) per animal per day. Water and salt lick were provided *ad libitum*.

Experimental diets' preparation

Two experimental diets were prepared for the trial; basal and supplementary diets. Untreated rice straw (URS) and urea-treated rice straw (UTRS) were used as basal feeds.

Rice straw (RS) was collected from harvested rice farms within Bauchi metropolis. The RS, comprising the leaf and straw portions, was chopped manually using matchet to a length of approximately 3-5cm. Half of the chopped straw was used as URS.

Treatment of RS was done using urea grade fertilizer which was obtained from the Bauchi State Agricultural Development Project (BSADP), Bauchi. Four percent (4%) urea solution was used for the treatment of the RS.That is, 4kg of urea was dissolved in 100litres of water to treat 100kg RS. The treatment was done by spraying the RS with the urea solution in a metal drum that has been lined with polythene sheet. The mixture was tightly covered for a period of 21 days. After the 21 days, the ensiled RS was spread in the open air under shade (for 3 days) to enable cooling and escape of ammonia (NH_3) gas. This was referred to as urea-treated rice straw (UTRS). Details description of the treatment method has been reported (Ngele, 2008).

Four supplementary diets were prepared. The supplements consist of the following:
Maize bran (MB) alone (100%)
MB + Sun-dried poultry litter (MB+SDPL) (50:50)
MB + Ensiled poultry litter (MB+EPL) (50:50)
MB + Cotton seed cake (MB +CSC) (50:50)
Sun-drying and ensiling methods of poultry litter has been reported (Ngele *et al*., 2003). The composition of the basal and supplementary diets is shown in Table 1.

Animal feeding

The 32 growing Yankasa rams between the 1.5-2 years were randomly allotted to eight (8) dietary treatments of four (4) rams per treatment. The basal diets (URS and UTRS) were fed *ad libitum* to each animal and, 300g each of the supplement was given per animal per day. The supplements were offered at 07.00hrs followed by the basal feed. Water and salt lick were provided for each animal *ad libitum*. The trial lasted for 14weeks after a 14-day adjustment period of the animals to the experimental diets.

Table 1: Chemical composition (%DM basis) of basal and supplementary diets

Composition	BASAL FEED		SUPPLEMENTS			
	URS	UTRS	MB(alone)	MB+SDPL	MB+EPL	MB+CSC
Dry matter	92.80	89.98	89.71	88.98	93.20	92.41
Organic matter	80.95	80.49	80.95	82.87	86.97	85.28
Crude protein	4.44	12.35	11.83	21.15	22.29	24.61
NDF	69.82	65.66	55.93	53.31	53.40	49.58
ADF	58.14	44.48	37.85	41.72	41.60	38.64
Hemicellulose	11.68	21.18	18.08	11.55	11.77	10.94
Ether extract	1.06	0.98	1.70	1.33	1.23	2.31
Ash	8.93	9.49	8.76	6.11	6.23	7.13

MB =Maize bran, SDPL = Sun-dried poultry litter
EPL= Ensiled poultry litter
CSC= Cotton seed cake
NDF= Neutral detergent fibre
ADF=Acid detergent fibre
URS=Untreated rice straw
UTRS= Urea-treated rice straw

Digestion trial

The feeding trial was immediately followed by a digestion trial in which two (2) rams per treatment (totaling 16) were randomly selected. The animals were kept in individual metabolic crates. The animals continued feeding on the same diet as in the growth trial. After a 14-day adjustment period, total faeces were collected daily into labeled, sterilized sample bottles just before feeding in the morning. The faeces for each animal was bulked and stored in a refrigerator pending laboratory analysis.

Urine was collected from each animal in plastic bottles by gravity over 20ml concentrated hydrochloric acid (HCl). The volume of urine was recorded and 10% aliquot was taken daily into large labeled sample bottles of each animals' weekly collection for laboratory analysis. The digestion trial lasted for 10 days.

Data collection

During the feeding trial, residual feed (both basal and supplement) and water was weighed daily to estimate feed and water intakes. Weight of individual animals was measured at the on set of the trial and subsequently on weekly basis.

Faeces and urine collected from the animals during the digestion trial was to determine nutrient intake and digestibility.

Chemical analysis

The chemical composition of the experimental diets (basal and supplement) were determined using the procedure of AOAC (1980).

Faecal samples were oven dried at 70°C to determine dry matter (DM). Determination of neutral detergent fibre (NDF), acid detergent fibre (ADF) was according to Goering and Van Soest (1970). Hemicellulose was calculated as the difference between ADF and NDF. Urine samples were analysed for total nitrogen (AOAC, 1980).

Statistical analysis

The design of the trial was a 2 x 4 factorial experiment (two basal feeds and four supplements) in a randomized complete block design (Steel and Torrie, 1980). Data collected were subjected to a two-way analysis of variance (ANOVA) using the General Linear Model (GLM) in SPSS for windows (SPSS, 1996) and, differences between means determined by Duncans' Multiple Range test (Duncan, 1955).

Results

Nutrient intake of the animals is shown in Table 2. The total dry matter intake (TDMI) was significant (P< 0.05) across dietary treatments. The TDMI ranged between 548.68 to 679.53g/d and 568.23 to 701.50g/d for animals on URS and UTRS respectively. The daily dry matter intake of the basal feed was also significantly (P<0.05) influenced by treatment. The values ranged from 285.50 to 440.65g/d across dietary treatments.

Table 2: Nutrient intake and growth performance of rams fed untreated or urea-treated rice straw with supplementation

Nutrient intake	URS				UTRS				SEM
	MB	MB+SDPL	MB+EPL	MB+CSC	MB	MB+SDPL	MB+EPL	MB+CSC	
TDMI(g)	548.68^{b}	631.65^{ab}	629.41^{ab}	679.53^{ab}	568.23^{ab}	657.03^{ab}	667.58^{ab}	701.50^{a}	56.70
DBFI(g)	285.58^{b}	384.40^{a}	354.17^{ab}	395.48^{a}	316.78^{ab}	425.20^{a}	404.30^{a}	440.65^{a}	49.79
DSI(g)	263.10	244.13	277.48	284.05	251.45	233.83	263.28	260.65	21.79
DCPI(g)	6.33^{d}	12.95^{cd}	11.39^{cd}	15.12^{cd}	17.72^{bc}	26.58^{ab}	25.09^{ab}	28.36^{a}	1.38
DOMI(g)	234.88^{c}	276.47^{c}	317.82^{bc}	349.32^{bc}	288.81^{bc}	304.63^{bc}	480.33^{a}	482.66^{a}	50.10
DWI(l)	1.15	1.20	1.44	1.35	0.95	1.15	1.39	1.19	0.11
DWG(g)	53.58^{bc}	55.08^{bc}	71.60^{ab}	81.38^{a}	61.43^{bc}	69.75^{ab}	71.31^{ab}	91.18^{a}	5.99
FCR	10.37^{ab}	11.69^{a}	8.86^{ab}	8.37^{ab}	7.91^{b}	8.01^{ab}	8.31^{ab}	7.65^{b}	0.71

Means within the same row with different superscripts are significantly different (P<0.05), SEM= Standard error of mean.
URS – Untreated rice straw;UTRS – Urea-treated rice straw;TDMI – Total dry matter intake;DBFI – Daily basal feed intake
DSI – Daily supplement intake; DCPI – Digestible crude protein intake; DOMI – Digestible organic matter intake
DWI – Daily water intake; DWG– Daily weight gain; FCR – Feed conversion ratio;
SUPPLEMENTS Maize bran (MB)(100%)
MB + Sun-dried poultry litter (SDPL) (50:50).
MB+Ensiled poultry litter (EPL) (50:50).
MB +cotton seed cake (CSC) (50:50).

Animals on supplement MB recorded the lowest basal feed intake being 285.58 and 316.78g/d for URS and UTRS respectively.

Dry matter intake of the supplements was not significant across treatments. Water intake which ranged between 0.95 to 1.44litre/day was also not significant across dietary treatments. Digestible crude protein intake (DCPI) was significant ($P<0.05$) across dietary treatments. Animals on UTRS basal feed recorded high DCPI (between 17.72 and 28.36g/d) compared to those on URS (between 6.33 and 15.12g/d) basal feed. However, animals on supplement MB+CSC recorded high DCPI for both URS and UTRS basal feeds.

Digestible organic matter intake (DOMI) was also significant ($P<0.05$) across dietary treatments with animals on UTRS basal feed in relation to respective supplements recording high values. Similar to DCPI, animals on supplement MB+CSC recorded high DOMI for both URS and UTRS feeds.

The average daily weight gain (ADWG) and feed conversion ratio (FCR) were also influenced ($P<0.05$) by dietary treatments. As shown in Table 2, there was a gradual increase in ADWG across supplements for both URS and UTRS basal feeds. The values ranged from 53.58 – 81.38g/d and 61.43 – 91.18g/d for both URS and UTRS basal feeds respectively.

The digestibility coefficient of the various nutrients were similar for animals on UTRS basal feed irrespective of supplementation (Table 3). The DM and CP digestibility for animals on UTRS ranged between 64.57 - 77.25 %, and 72.52 - 79.19% respectively. Animals fed URS basal feed on supplement MB recorded low nutrient digestibility compared to those on UTRS fed the same supplement (i.e. MB).

Discussion

The mean total dry matter intake (TDMI) of the rams was quite variable. The lowest TDMI was recorded for animals on URS basal feed fed

Table 3: Nutrient digestibility in rams fed untreated or urea-treated rice straw with supplements

Nutrient	URS				UTRS				SEM
digestibility	MB	MB+SDPL	MB+EPL	MB+CSC	MB	MB+SDPL	MB+EPL	MB+CSC	
Dry matter	46.26^{b}	66.32^{a}	66.15^{a}	69.85^{a}	64.57^{a}	76.63^{a}	76.08^{a}	77.25^{a}	2.76
Organic matter	48.01^{b}	43.51^{b}	51.64^{b}	57.55^{ab}	67.33^{a}	65.25^{ab}	68.46^{a}	70.72^{a}	3.49
Crude protein	38.89^{b}	42.59^{b}	50.63^{b}	52.05^{b}	73.28^{a}	79.19^{a}	72.52^{a}	76.74^{a}	5.99
NDF	55.60^{b}	64.08^{ab}	70.90^{a}	66.00^{ab}	65.92^{ab}	74.50^{a}	74.20^{a}	79.10^{a}	2.17
Hemicellulose	46.15^{b}	47.00^{b}	54.15^{ab}	63.30^{ab}	76.43^{a}	67.00^{ab}	66.75^{ab}	76.25^{a}	3.88

Means within the same row with different superscripts are significantly different ($P<0.05$), SEM=Standard error of mean.
URS – Untreated rice straw, UTRS – Urea-treated rice straw, NDF- Neutral detergent fibre
SUPPLEMENTS: Maize bran (MB)(100%)
MB + Sun-dried poultry litter (SDPL) (50:50)
MB+ Ensiled poultry litter (EPL) (50:50)
MB +cotton seed cake (CSC) (50:50).

supplement MB (548.68g/d). This result is consistent with earlier reports (Manyuchi *et al.*, 1994) that supplementing with readily fermentable carbohydrate in the absence of rumen degradable nitrogen cannot improve the utilization of crop residues by ruminant animals. However, the combined effect of rice straw treatment and supplementation resulted in increased TDMI compared to those on the URS. The basal feed intake was relatively high for animals fed UTRS. This could be attributed to the delignification of the rice straw by the urea-treatment (ammoniation) thereby rendering it easier for the rumen microbes to breakdown the straw and, subsequently high intake.

Supplementation of animals fed UTRS basal feed resulted in a higher digestible crude protein intake (DCPI). This could be due to the increased CP content of the feed resulting from the ammoniation of the rice straw. Similar observation has been made (Adegbola, 2002) with bulls fed treated rice straw with or without supplementation.

The digestible organic matter intake (DOMI) which was highest for all animals fed UTRS basal feed could be due to the combined effect of ammoniation of rice straw and supplementation. The urea treatment of the rice straw must have delignified the straw thereby making available more fermentable carbohydrate for the animals in addition to the supplementation.

The average daily weight gain improved considerably when the URS and UTRS basal feeds were fed with supplementation. However, animals on UTRS recorded high daily gains compared to those fed URS on the same supplement. This observation confirms earlier reports (Adu *et al.*, 1993; Jaiswal *et al.*, 1988) where average daily gain was improved when ammonia (urea) treated rice straw was fed to sheep and cattle with a source of protein of low solubility in the rumen. Similarly, Saadullah (1985) reported that calves (50kg) fed a basal diet of urea-treated straw recorded an increase in live weight gain from 57g/d to 198g/d and 80g/d to 203g/d when 59g/d fishmeal was offered.

The feed efficiency recorded in this study is within range of 5.38 to 18.86kg feed /Live Weight Gain (LWG) and 10.42 to 19.19kg feed/LWG when reported (Bogoro, 1997) for ram on urea-treated and untreated sorghum stover respectively. However, animals on UTRS basal feed utilized their feed more efficiently compared to those on URS with the same supplementation. This implies that treating the rice straw and supplementation was more effective in improving the utilization of the feed.

The generally lower nutrient digestibility of animals on URS offered supplement MB may be attributed to the sub-optimal rumen degradable nitrogen even though a readily fermentable carbohydrate was present. This observation agrees with earlier reports (Butterworth and Mosi, 1986; Hannah *et al.*, 1991, Oddoye *et al.*, 2005) that for the rumen microbial flora to perform at an optimum level, the presence of nitrogen and soluble carbohydrate had to be synchronized. Similar studies (Williams, 1983; Jaiswal *et al.*, 1988) have shown that digestibility of low quality roughages have been improved by ammoniation and supplementation. However, the result of this study is contrary to earlier report (Adamu *et al.*,

1995) that ammoniation and supplementation had no effect on dry matter digestibility but, resulted in increased digestibility of NDF and ADF by sheep and that the increase were not significant.

The comparatively high nutrient digestibility of animals on mixed supplements (i.e. MB+SDPL, MB+EPL, MB+CSC) implies that the proportion of energy and protein sources in the supplement was appropriate to enhance the activity of the rumen microbes. The high digestibility of animals on UTRS basal feed in this study could be due to solubilization of the fibre fraction in the straw by the ammonia gas released from the urea. The treated straw is also enriched with nitrogen which enhances rumen microbial activity.

Supplement MB+CSC recorded the best nutrient digestibility which could be attributed to the gradual solubility of CSC thereby making nitrogen available over a long period of time. Similar observation has been reported (Silva and Orskov, 1984) that it is possible to improve the digestibility of low quality roughages by either treatment or supplementation or both.

Conclusion

From the results of this trial, it may be concluded that supplementing treated rice straw with protein (nitrogen) and/or energy source is an effective method of enhancing the utilization of the straw and subsequent performance of ruminant animals. Supplementing rice straw with mixed supplements especially, a mixture of maize bran (MB) and cotton seed cake (CSC) gave the best result in terms of feed intake, digestibility, and weight gain and feed efficiency. However, in the absence of CSC due to high cost, ensiled poultry litter can substitute CSC which will also improve nutrient intake and ruminant animal performance.

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