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Full Length Research Paper

Intake, digestion and nitrogen balance of diets blended with urea treated and untreated cowpea husk by growing rabbit

J.A. Oluokun

Institute of Agricultural Research and Training, Obafemi Awolowo University, P.M.B. 5029, Moor Plantation, Ibadan, Nigeria. E-mail: johnoluokun @yahoo.com.

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An experiment was conducted to evaluate the performance of rabbits fed diets blended with or without urea treated cowpea husk. A total of 30-forty two day old rabbits with an average initial weight of 650 ± 1.5 g were allocated in completely randomized design to three dietary treatments containing 25% cowpea husk with the following treatments; untreated (control, A), 1% urea-treated (B) and 3% urea treated (C). The diet blended with 3% urea treated cowpea husk gave the highest dry matter intake, growth rate and best feed conversion ratio. The digestibility values of dry matter, crude protein, neutral detergent fibre (NDF) and acid detergent fibre (ADF) and nitrogen retention of the group fed 3% urea treated cowpea husk containing diet were significantly higher than for groups offered diets containing untreated or 1% urea treated cowpea husk. Therefore, urea treatment brought about improved nutritive value of cowpea husk and improved animal performance, digestibility and nitrogen retention.

Key words: Rabbits, urea, cowpea husk, performance.

INTRODUCTION

Fibrous crop by-products or farm wastes are characterized by extensive lignification of the cellulose and the hemicellulose, and by low levels of protein, soluble carbohydrates and minerals (van Hao and Ledin, 2001). About 82,000 tonnes of cowpea husks and straws are produced in Nigeria annually (Adebowale, 1985). The search for cheap, safe and simple methods for improving nutritive value of farm wastes is imperative if straws and other related farm residues are to be utilized in rabbit diets. Although responses to supplementation with urea have been variable, several workers have shown that intake of low quality diet roughages is increased when supplements of non-protein nitrogen (NPN) are given (King, 1971; Oluokun, 2001). Rabbits are capable of utilizing urea as a nitrogen source primarily because of the presence of urea activity in the caecum (Forsythe and Parker, 1985) similar to that in the rumen (Fontenot et al., 1977; Makkar and Singh, 1987). Raharjo et al. (1986) and Singh et al. (1988) observed efficient utilization of urea by rabbits.

The improvement in nutritional value of crop residue resulting from treatment with anhydrous or aqueous ammonia has been documented by several authors (Sundstol et al., 1978; Saadulah, 1981; Perdok et al., 1984; Tuen et al., 1991). The use of urea in drinking water or sprayed on the stover has been suggested as a possible means of improving the nutritive value of crop residue (Jayasuriya, 1982). It is safer to deal with urea as an indirect source of ammonia than with gaseous or liquid ammonia. Improvement in nutritive value in response to the application of urea by the above method was greater than through supplementation of the material with urea (Naga and El-shazly, 1982). Untreated cowpea husk is very high in crude fibre (30- 31%) with a moderate crude protein content of 11.6% on dry matter basis (Adebowale and Nakashima, 1992).

Information is lacking on chemical treatment of cowpea husk for rabbit feeding. Hence the study aimed at investigating the response of growing rabbits to urea-treated cowpea husk based diets and the resultant effect

Table 1. Composition of experimental diets (kg/100 kg).

Ingredients	Untreated	1% Urea treated	3% Urea treated
Maize	51.5	52.8	54.5
Groundnut cake	20	18.7	17
Cowpea husk	25	25	25
Bonemeal	2.5	2.5	2.5
Vit Min premix*	0.5	0.5	0.5
Salt	0.5	0.5	0.5

*Supplied (per kilogram of diet): Vitamin A, 71500 IU; vitamin D3, 14,500 IU; vitamin E, 31,680 IU; vitamin K, 0.749 g; vitamin B3, vitamin B2, 3600 g; vitamin B6, 7.15 g; vitamin B12, 50 g; calcium pantothenate 52.90 g; niacinamide, 179 g; manganese, 10 g; zinc, 4.50 g; copper 0.20 g; iron, 5.00 g; iodine, 0.15 g; cobalt, 0.2 g; and selenium 0.01 g.

on performance, nutrient digestibilities and nitrogen balance.

MATERIALS AND METHODS

Cowpea husk processing

Large bales of dried cowpea husks were collected from various threshing slabs located in several Institutes' experimental stations and threshing slabs in farms. Two thirds of the husks were soaked for 24 h in 1000 L drums containing appropriate solutions made up of 1 and 3% (w/w) fertilizer grade urea. The drums were filled to the brim with water and covered with jute bags and polythene sheets to prevent escape of ammonia gas following reaction of urea with water. After 24 h, the treated cowpea husks were removed and sun dried for 4 days. Both the treated and non-treated cowpea husks were ground to pass a 2 mm screen.

Experimental animals design and diets

The animals were selected from a flock of rabbits raised in the Institute rabbitry. The experiment involved 30, forty two day old, weaned, male New Zealand white rabbits selected to constitute uniform live weight groups. All rabbits weighed between 550 and 650 g when the experiment started. The rabbits were randomly assigned to three treatments of ten animals per treatment. For the digestibility experiment, five rabbits were randomly selected from each experimental group and confined to metabolism cages for the total collection of faeces and urine during the last five days of the trial. Three diets were formulated (Table 1) such that diet A was the control without treated cowpea husks. Each diet contained 25% of either treated or non-treated cowpea husks, mixed thoroughly and offered in mash form moistened with water to prevent respiratory problem.

Feeding and management

The rabbits in the growth experiment were individually housed and fed *ad libitum*. In the digestibility experiment, the rabbits were kept in simple metabolism cages that allowed separation of faeces and urine. Drinking water was available at all times. The animals were fed twice per day at 09.00 and 14.00 h. A forage supplement of wild sunflower (*Tithonia diversifolis*) at 50 g wilted weight per rabbit per day was provided. The experiment ran a course of twelve weeks.

Data collection and analyses

During the growth period, animals were weighed when the experiment started and then once weekly. The feed consumption was recorded and the unconsumed feeds were collected from each animal and weighed every day in the morning before fresh feed was served. During the collection period of the digestibility experiment lasting 5 days, samples of feed were taken every day. Unconsumed feeds were collected every morning from individual animals and weighed. Samples of faeces and urine were collected every morning (urine into a solution with sulphuric acid), weighed and kept in deep freezer for subsequent analysis. The animals were weighed before the commencement of total collection and on the last day of collection period.

Samples for the chemical analysis were taken from previously bulked feed, unconsumed feeds and faeces pre-dried at 60^{o}C for 48 h before grinding using a 1 mm screen and a hammer mill. Dry matter in the samples was determined by drying to constant weight at 100^{o} C. Nitrogen was determined using the macro Kjekdahl method (AOAC, 1990). Ash content was determined by incinerating the samples at 500^{o}C for 5 h. Neutral detergent fibre (NDF) and acid detergent fibre (ADF) were determined using procedure described by Goering and Van Soest (1970).

RESULTS

The chemical compositions of the untreated, urea treated cowpea husks and experimental diets are presented in Table 2. Urea treatment increased the nitrogen content of cowpea husks by 36 and 56.27% for 1% and 3% urea-treated over the untreated cowpea husk, respectively. Furthermore the colour of the treated husks was changed from whitish yellow to brown colour and the texture was also softened. The protein content of the compounded diets was about 17% on the average.

The daily dry matter intake, live weight gain and feed conversion ratio during the feeding trial are shown in

Table 2. Chemical Composition of untreated, urea treated cowpea husk and experimental diets (g/kg).

Chemical component	Untreated cowpea husk	1% urea treated cowpea husk	3% urea treated cowpea husk	Diet A	Diet B	Diet C
Dry Matter	920.1	905	902.5	915	912.5	913.5
Crude Protein	123.5	155	178.5	170.8	170.5	170.2
Crude Fibre	302.5	301.5	301.8	98.4	99.9	97.5
Ether Extract	6.5	6.3	6.6	34.2	33.9	33.6
Ash	86.5	88.5	99.7	65.4	73.5	77.2
Nitrogen free extract	481	448.7	413.4	631.2	602.2	621.5
Neutral detergent Fibre	542	559	564	159.1	157.7	137.6
Acid detergent Fibre	411	405	402	235.5	234.1	232.4

Table 3. Performance of rabbits fed untreated and urea treated cowpea husk based diet.

Parameters	A (Untreated)	B (1% Urea treated)	C (3% Urea treated)	SEM
Days of trial	84	84	84	-
No of Animals	10	10	10	-
Av.Initial live weight (g)	597	599	595	-
Final live weight (g)	1460	1760	1965	-
Total weight gain (g)	863	1161	1370	-
Av. Daily weight gain (g)	10.38^{c}	13.82^{b}	16.31^{a}	± 1.72
Ar. Daily feed inlike (g)	56^{c}	65.0^{b}	70^{a}	± 4.10
Feed/gain ratio	5.39^{a}	4.70^{b}	4.29^{a}	± 0.18

Figures within rows with different superscripts are significantly different at P< 0.05.

Table 4. Apparent nutrient digestibility by rabbits on untreated urea treated cowpea husk based diets.

Parameters	A (Untreated)	B (1% Urea treated)	C (3% Urea treated)	SEM
Dry matter	51.31^{c}	58.65^{b}	64.5^{a}	± 3.82
Crude protein	51.60^{c}	60.65	71.35	± 5.71
Acid detergent fibre	35.28^{c}	40.35	48.42	± 3.83
Neutra detergent fibre	52.32^{b}	62.55	65.60	± 4.02

Figures within rows with different superscripts are significantly different at P< 0.05.

Table 3. Intakes of dry matter varied significantly with the control treatment recording the lowest dry matter intake of 56 g/h/d. Dry matter intake was increased by inclusion of urea treated cowpea husks in diets B and C by 4.61 and 11.43%, respectively. Both the acid detergent fibre (ADF) and neutral detergent fibre (NDF) intakes of urea treated cowpea based diets were significantly higher than the untreated cowpea husk based diet.

Rabbits that were fed 3% urea treated cowpea husk based diet gained significantly more weight than did those on 1% urea treated cowpea husk based diet which in turn gained significantly than the untreated cowpea husk based diet. Efficiency of feed utilization was significantly influenced by the inclusion of urea treated cowpea husk. Rabbit fed urea treated cowpea husk based diets utilized their feed more efficiently than the untreated cowpea husk based diet. Digestibility data are presented in Table 4. Dry matter, crude protein, ADF and NDF digestibility values were observed to be higher in rabbits receiving diets incorporated with urea-treated cowpea husk. The digestibility values for the nutrients increased with increasing urea concentrations.

Utilization of nitrogen in the three experimental groups is shown in Table 5. The intake of nitrogen in groups B and C was significantly higher compared to that in group A. The daily excretion of N through faeces which decreased with urea concentration was significantly lower in groups B and C than that in group A which was offered

Table 5. Nitrogen balance in rabbits fed an untreated or urea treated cowpea husk based diets.

Parameters	A (Untreated)	B (1% Urea treated)	C (3% Urea treated)	SEM
Nitrogen intake (g day^{-1})	2.21^{c}	2.80^{b}	3.05^{a}	± 0.25
Nitrogen Excreted (g day^{-1})	-	-	-	-
Through faeces	0.56^{a}	0.38^{b}	0.3^{4b}	±.06
Through urine	0.27^{b}	0.42^{a}	0.46^{a}	±.06
Total	0.83^{a}	0.80^{a}	0.84^{a}	±.04
Nitrogen balance	1.38^{c}	2.00^{b}	2.21^{a}	± 0.25

Figures within rows with different superscripts are significantly different at P< 0.05.

untreated cowpea husk based diet. Faecal excretion of N accounted for 67.46, 47.5 and 40.48% of the total N excreted in rabbits fed on untreated, 1% urea and 3% urea treated cowpea husk based diet, respectively. However excretion of nitrogen through urine was significantly higher in rabbits receiving the urea treated cowpea husk based diets.

DISCUSSION

The modification of the chemical composition of cowpea husks as a result of their exposure to urea treatment involves primarily an increase in nitrogen content, a slight increase in neutral detergent fibre, a slight decrease in acid detergent fibre and softening in texture. This is in agreement with the findings of Tuen et al. (1991)

The increased dry matter intake that occurred when urea treated cowpea husk was incorporated into experimental rations suggests strongly that urea treatment could be considered as an effective straw extender. Also, the increased dry matter intake resulting from the inclusion of urea treated cowpea husk may be associated with an improved pattern of caecal fermentation. Perdok et al. (1984) and Tuen et al. (1991) reported improvements in both intake and live weight gains from both urea treatment and urea supplementation of straw given to cattle, buffaloes and goats. Our results showed that urea treatment was effective in increasing feed intake by the rabbits and improving their ability to digest the diet. The positive effect of ammonia treatment on dry matter intake and the observed improvement could probably be attributed to the softening of forage fibre and the resulting reduction of the mastication load as well as fermentation enhancement in the cecum of the rabbits.

The daily weight gains observed in this study were similar and comparable to the values previously reported in a similar experiment with rabbit (Adegbola, 1991; Doma et al., 1999). Similar results were obtained in sheep given ammoniated maize stover and maize cobs (Tubei and Sand, 1981) or chopped paddy rice straw sprayed with 5% urea (Wanapat et al., 1984). Similarly, it has been shown that lambs born to ewes supplemented with either by product urea treated ration or fish meal were heavier than the controls (Talavera, 1987). Perdok et al. (1984) reported improvements in both intake and live weight gains from both urea treatment and urea supplementation of straw given to cattle and buffaloes. The results obtained in this study showed that the inclusion of urea treated cowpea husk treatment was effective in increasing feed intake by the rabbits and improving their ability to digest the diets. Similar response has been reported for goats by Tuen et al. (1991). The nitrogen intake values which ranged from 2.21 g/d on the untreated cowpea husk based diet to 3.05 g/d on 3% urea treated cowpea husk based diet are within the range of 2.40 to 3.08 g/d reported by Singh et al. (1988) for rabbits fed urea supplemented diet in humid tropical environment.

In this study, nutrient digestibility was significantly (P< 0.05) improved by urea treatment of the cowpea husk incorporated in diets B and C, respectively. Dry matter, crude protein, and detergent fibre and neutral detergent fibre digestibility values were observed to be higher in rabbits receiving urea treated cowpea husk based diets. This is in agreement with the observation of Robinson et al. (1986) who reported high crude protein digestibility values in urea-fed rabbits. The low ADF digestibility in rabbits on untreated cowpea husk based diet (group A) is in accordance with the observation of Sanchez et al. (1985) who observed lower ADF digestibility in rabbits on a low protein diet. The high contents of indigestible plant materials, lignin and silica, in ADF probably accounted for its low digestibility. Similarly it has been found that urea treatment of rice straw (Jaya suriya and Perera, 1982; Saadullah et al., 1981) or barley straw (Kowalcrzyk, 1994) significantly improved *in vitro* organic matter digestibility. This effect is likely to be associated with the higher bacterial and protozoa mass in the ceacum with the urea treated cowpea based diets.

The faeces of rabbits in group A which received the untreated cowpea husk based diet were hard. This probably reduced cecotrophy and thus decreased the digestibility of available nutrients in the faeces such as the undigested microbial and feed protein as well as the B vitamins. Similar observations was reported by Udoma et al. (1999) for rabbits fed diets containing untreated cowpea shell and maize cobs at 20 and 40% levels.

The urea treatment not only improved the dry matter intake and daily nitrogen intake but also nitrogen balance.

Better utilization of nitrogen in groups receiving urea treated cowpea based diets may reflect greater absorption of ammonia resulting from the hydrolysis of urea from the digestive tracts of rabbits in these groups. Though the nitrogen balance was positive in the three groups, retention was higher in groups B and C that received urea treated cowpea husk based diets, suggesting that urea-fed rabbits were capable of utilizing urea nitrogen. Hoover and Heitmann (1975) attributed positive effect of urea feeding on nitrogen retention to tissue synthesis of non-essential amino acids from absorbed ammonia and (or) ceacotrophy. Emaldi et al. (1979) reported that bacteria which are able to utilize ammonia had a numerical predominance in the rabbit. It has been reported that endogenous urea can be converted to bacterial protein in the rabbit caecum (Vinllard, 1984).

In conclusion, the positive effects of urea treatment of cowpea husk translated to significantly higher intake of dry matter, better performance, superior nutrient digestibility and significant nitrogen retention by rabbits over those offered untreated cowpea husk based diet. The study has also shown that among the chemical treatment methods as reported in the literature, only urea ammonia treatment has practical applications at the small holder level. It can be concluded that chemical treatment of cowpea husks as other straws using urea solution could be adopted as feeding strategy for rabbits by small holder farmers.

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