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INFLUENCE OF FEEDING GRADED LEVELS OF UREA ENSILED SUGARCANE PEEL ON GROWTH AND NUTRIENT DIGESTIBILITY OF YANKASA RAMS

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Abstract
The Experiment was conducted at the Small Ruminant Unit of Prof. Lawal Abdu Saulawa Livestock Teaching and Research Farm, Department of Animal Science, Federal University Dutsin-Ma, Katsina State. The study evaluated performance, digestibility and nitrogen utilization of Yankasa rams fed different levels of urea ensiled sugarcane peels. Sixteen Yankasa rams were adjusted for weight to achieve non-significant differences and was randomly allocated into four (4) dietary treatments consisting of 0%, 5%,10% and 15% inclusion levels of ensiled sugarcane meal. Data obtained were analyzed using SAS (2000) and significant differences of the treatment means were determined using the Duncan multiple range test. No significant differences (P > 0.05) were observed in growth performance metrics, such as final body weight, total weight gain, average daily weight gain, and feed efficiency, despite numerical variations. Conversely, dry matter digestibility, crude protein, crude fiber, and ether extract demonstrated significant differences (P < 0.05), with 5% UESP exhibiting superior values. Nitrogen balance and retention were significantly enhanced (P < 0.05) in 5% UESP. These findings show the potential of urea ensiled sugarcane peels as a viable, nutritionally valuable feed supplement for Yankasa rams, optimizing nutrient digestibility and nitrogen utilization without compromising health. It is therefore recommended that ensiled sugarcane peels could be included in the feed of rams especially in periods of feed scarcity, but 10% inclusion level is the most economical.

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INTRODUCTION

Ruminant livestock are raised worldwide, providing essential economic and social benefits to communities around the globe. Small ruminant production plays a critical role in livestock farming, offering several benefits (Aruwayo *et al.,* 2024). Nigeria's livestock population is considerable, comprising around 19.5 million cattle, 72.5 million goats, and 41.3 million sheep, making it the largest livestock producer in West Africa (FMARD, 2016). Small ruminants like sheep and goat production are viable ventures in Nigeria in view of the obvious benefits and the ease of the production. Aruwayo *et al.* (2016) highlighted that ruminant constitute a noteworthy part of livestock production in Nigeria. The compact size of small ruminants is a key factor in their importance, as it enables low-cost investment, reduces the risk of loss, and makes them a preferred choice over larger ruminants due to their efficient food utilization, high reproductive rate, and effective land use (Omoike, 2006). They play vital functions in the lives of households in the rural areas, offering distinct advantages over other livestock. It constitutes one of the major protein sources to the urban and rural populace. Aruwayo and Muhammad (2018) reported that small ruminant production performs a crucial function in the provision of protein of animal origin in Nigeria, in addition to possessing an outstanding capacity to mitigate the shortage
However, Aruwayo *et al.* (2022) reported that productivity of sheep is low despite the large

population leading to a significant gap between the demand for and supply of goat meat and other goat-derived products. These issues are largely due to feed shortages, poor quality of available feed, slow feed digestibility, and inconsistent weight gain, all of which are exacerbated by seasonal feed imbalances (Aruwayo, 2025). Small ruminant farmers are particularly affected, especially when the forage is dry, scarce and nutritionally inadequate. In tropical regions, ruminants rely heavily on cut grasses and agricultural by-products as feed sources, particularly during the dry season when pasture availability is scarce (Winugroho, 1999; Sarnklong *et al*., 2010). One of the promising ways of ameliorating feed shortage is through the use agricultural waste. Example of this agricultural waste is sugar cane waste. They are abundant during harvesting period at a very cheap cost. Sugarcane peels is high in fibre; on average dry matter basis sugarcane peels which is fibrous in nature contains; Dry matter (DM) 91.6%, Crude protein (CP) 6.5%, Crude fibre (CF) 28.34%, Acid detergent fibre (ADF) 36.85%, Ether extract (EE) 4.1%, Ash 9.31%, Nitrogen free extract 51.28%. Sale and Maigandi (2014). The nutrient composition revealed the potentials of sugarcane peels which will be serving as an alternative feed ingredient for large number of ruminant livestock especially during the dry season in the North-western Nigeria. However, like many other agricultural wastes, are high in crude fibre but poor in many other nutrients. They cannot therefore be fed alone to the ruminants without supplementing or mixed concentrate. One of the ways of improving the quality of feed is the use of chemical treatment such addition of urea and enzyme. Some studies have shown substantial improvement of feed digestibility and animal performance traits (Mijinyawa *et al*., 2016). The digestibility and utilization then need to be improved through treatments hence, the use of urea to ensile sugarcane waste in this study. Therefore, this study examined the impact of diets containing graded levels of urea ensiled peels on growth performance, digestibility and nitrogen utilization of Yankasa rams.

MATERIALS AND METHODS

The research took place at the Small Ruminant Unit, Prof. Lawal Abdu Saulawa Livestock Teaching and Research Farm, Department of Animal Science, Federal University Dutsin-Ma, Katsina State. The Farm's geographical coordinates are 12°27ˈ18ˈN and 7°29ˈ29ˈE, with an elevation of 605 meters above sea level. The area receives an average annual rainfall of 700mm and falls within the Sudan savannah ecological zone (Garba *et al*., 2024).

Sourcing and Preparation of the test diets

Sugarcane peels were collected from sugarcane market and other sales centres in Dutsin-Ma, Katsina State. The peels were sorted and cleaned against debris and other dirts such as polythene bags, stone, irons, sticks and leaves. The sugarcane peels were chopped using farm crushing machines for easy mixing with urea solution and to be compactable in the container during ensilage.

Test Ingredient Preparations

The sugarcane peels were mixed with dissolved solution of urea and water at ratio 4% (4kg of urea was dissolved in 60 litres of water and mixed with 100kg of sugarcane peel). The solution was sprayed and thoroughly mixed with the sugarcane peels. The treated sugarcane peels were ensiled in airtight sacs that was well tied and then stored in plastic drums for a period of 21 days. The resultant ensiled sugarcane peels were shade dried for seven (7) days for proper aeration and drying before being used in the formulation of the experimental diets.

Experimental Animals and Management

A total of twenty (20) Yankasa rams were purchased from Dutsin-Ma market. The rams were quarantined for two (2) weeks before the commencement of the experiment and dewormed with Albendozol and also given Oxytetracycline (antibiotics). Ivermectin was also administered to treat external parasite. They were fed with groundnut hay, maize offal, cotton seed cake, salt and bone meal throughout the period. Water was also provided *ad libitum*.

Experimental Design

The research was carried out in a Completely Randomized Design (CRD) that involved the use of twenty (20) Yankasa rams, constituting five (5) per treatment in a random distribution into four (4) experimental treatments namely A, B, C, and D and each of them constituted a replicate.

Formulation of Experimental Diet

Four experimental diets were formulated with varying levels of urea-ensiled sugarcane peel, specifically 0%, 5%, 10%, and 15%, and labeled as diets A, B, C, and D, respectively. Other ingredients are cotton seed cake, maize offal, groundnut hay, salt and bone meal. Table 1 provides the gross composition of the experimental diets used in this study.

Table 1: Gross Composition of the Experimental Diets

Ingredients (%)	Treatments			
	A (0%)	B (5%)	C (10%)	D (15%)
Sugar cane peels	0.00	5.00	10.00	15.00
Maize offal	63.50	58.50	52.50	46.00
Cotton seed cake	14.00	14.00	15.00	16.50
Groundnut hay	20.00	20.00	20.00	20.50
Bone meal	2.00	2.00	2.00	2.00
Salt	0.50	0.50	0.50	0.50
Total	100	100	100	100
Calculated energy (Kcal/kg)	2139.40	2180.60	2142.50	2161.25
Calculated CP (%)	12.25	12.05	12.00	12.03
Calculated CF (%)	22.24	22.16	22.21	22.31
Feed cost (₦/kg)	253.56	247.37	241.21	233.76

Growth performance

Feed intake: Daily feed intake was measured throughout the experiment by weighing the feed offered and feed leftover the previous day.

Feed intake = feed consumed – leftover feed

Weight gain: Each animal was measured at the beginning of the experimental trial and on weekly basis after overnight fasting. This was always carried out between 8:00 to 9:00 am throughout the feeding trial. Weight gain was calculated by subtracting the initial body weight from the final body weight within the period of the feed trial.

Feed efficiency was obtained by dividing weight gain by the feed intake.

$$FE = \frac{\text{Weight gain}}{\text{Feed intake}}.$$

Digestibility and Nitrogen utilization

At the conclusion of the feeding trial, a digestibility study was conducted with three representative animals from each treatment. The animals were placed in individual metabolic cages and fed the identical experimental diets used during the feeding trial. The study lasted for 21 days with 14 days adjustment period in the metabolic cages and one (1) week collection of the faeces with harness bag. Daily feed intake and total faecal output from each animal were recorded. After thorough mixing, they were bulked and 5% of the samples were taken to the laboratory for proximate and crude fibre fraction analysis.

The nitrogen utilization study was conducted using urine that was collected via urinary funnel piped into the bottle containing 2 ml 10% sulphuric acid to trap the nitrogen content. 10% of the total daily urine from each animal was stored in a refrigerator at 4ºC for nitrogen determination.

The formula used to calculate apparent digestibility is presented as:

$$\text{Digestibility} = \frac{\text{Nutrient in feed} - \text{Nutrient in faeces}}{\text{Nutrient in faeces}} \times 100$$

Statistical Analysis

The data generated was subjected to analysis of variance (ANOVA) using SAS Package (2000). Where significant differences between the means existed, Duncan Multiple Range Test (DMRT) (Duncan, 1955) was used to separate the means. The following model was used:

$Yij = \mu + Tj + eij$

Where:

μ = Overall mean

T_j = Effect of the j^{th} treatment diet (j = 1… 5)

eij = Random error.

Results and Discussion

Proximate Composition of Experimental Diets

The proximate composition and crude fibre fraction of the experimental diets is shown in Table 2.

Table 2: Proximate Composition and crude fibre fraction of Experimental Diet

Parameters (%)	Treatments				
	A (0%)	B (5 %)	C (10%)	D (15%)	USCP
Dry Matter	95.54	96.24	95.88	96.54	94.20
Ether Extract	2.59	2.16	2.16	2.00	0.89
Crude Protein	16.13	16.70	16.94	16.64	7.75
Crude Fibre	22.23	22.13	22.41	22.18	28.80
Ash	9.00	9.60	9.63	9.32	6.81
NFE	50.05	49.41	48.86	49.86	55.75
Acid Fibre Fraction					
ADF	31.59	32.45	30.16	32.23	36.01
NDF	72.70	72.81	70.28	72.48	73.59
Lignin	12.21	10.30	11.10	10.89	20.89

NFE= nitrogen free extract, ADF= acid detergent fibre, NDF= neutral detergent fibre, USCP = Urea Ensiled Sugar cane peel

This study found that the crude protein (CP) levels in the diets varied from 16.13% treatment A to 16.94% in treatment C. The values obtained here supported the report 15 – 18% crude protein (CP) level by Adu (1985) in growing sheep; but were higher than the 11% CP for fattening sheep (30-55kg) reported by ARC (1998) and 12% CP level for growing rams as reported by Roberts (2021). The higher levels of CP in the experimental diets could have influenced the higher feed intake of the experimental diets observed across the treatments in this study. This result is consistent with the findings of Chriya *et al*. (1997) that high CP and low CF levels in ruminants' diets increase voluntary feed intake. The range of CF levels of 22.18 – 22.41% obtained across the treatments was slightly lower than the levels of 23 – 32% reported by Muhammad *et al*. (2008) in Sokoto red goat. The slight increase in contents of CF, NDF, ADF and ADL of the diets might be due to the higher CF of sugarcane waste 28.80% as shown in the study. Njidda (2011) reported that semi-arid browse plants are generally high in fiber and their inclusion in diets tends to increase its fiber level. The results also conformed to that of Ganovoski and Ivanov (1982) who reported 22% to 25% CF for small ruminants. The ether extract (EE) values (2.0 – 2.59%) obtained here were lower than 3.90% EE value reported by Maigandi (2001) when he fed 20% FSD as replacement for cowpea husk in diets of Uda sheep in Sokoto. The nitrogen free extract (NFE) values ranged from 48.86% in 10% UESP to 50.05% in 0% UESP. These values were slightly higher than the range values of 39.02 – 41.15% reported by Aruwayo *et al.* (2011) and 36.20% NFE value reported by Maigandi (2001) in Uda rams. The values obtained here were however in agreement with the report of Rogosic *et al*. (2006) that the balance of energy and essential nutrients in a diet plays a crucial role in determining both the average intake and the efficiency of nutrient utilization in animals.

Table 3: Growth performance of the Yankasa rams fed the experimental diets

Parameters	**Treatments**				
	A (0%)	B (5%)	C (15%)	D (10)	SEM
IBW (kg)	20.00	20.00	19.75	20.00	1.53
FBW (kg)	32.6	31.97	34.24	31.79	4.00
TWG (kg)	12.60	11.97	14.49	11.79	1.50
AWG (g/day)	150.00	142.50	172.50	142.50	17.14
FE (g/day)	0.20	0.19	0.21	0.16	0.02
TFI (kg)	64.72	64.85	74.03	76.80	4.21
TFI/DM (%)	62.48	62.47	71.16	72.36	4.01
AFI (g/day)	770.56	772.10	881.36	903.07	48.79
AFI/DM (%)	743.75	743.85	845.04	850.77	40.56
Cost of feed/Kg (N)	253.56	247.37	241.21	233.76	-
COFDC (N)	16465.67	16043.62	17857.01	18261.30	1019.49

COF/LWG (N/kg)	1359.58	1362.56	1265.57	1616.91	144.92

abc=Means within the same row with different superscripts differ significantly (P<0.05).
IBW= Initial Body Weight, FBW= Final Body Weight, TWG= Total Weight Gain, AWG=Average Weight Gain, FE= Feed Efficiency, TFI= Total Feed Intake, TFI/DM= Total Feed Intake/Dry Matter, AFI=Average Feed Intake, COFDC= Cost of Feed Consumed, COF/LWG=Cost of Feed /Live Gain

Growth Performance of Yankasa rams fed the experimental diets

The growth performance of Yankasa rams fed the experimental diets are shown in Table 3.
The lack of significant difference in final body weight and live weight gain suggests that the experimental animals utilized the test ingredients (ensiled sugarcane peel) similarly. Other parameters were not significantly difference across the treatments (P>0.05). Notably, the average daily body weight gain observed in this study exceeded the range reported by Wada *et al*. (2014) for Yankasa rams fed graded levels of *P. biglobosa*. The observed differences may be due to the breed or age of the animals. The average daily weight gain (AVDG) values obtained in this experiment ranged from 0.15kg/day to 0.17kg/day. These values were better than 0.05kg/day reported by Abil *et al.* (1992) when they replaced cotton seed cake (CSC) and maize with wheat bran in the diet of sheep. The dry matter intake of the animals provided further insight into the growth performance trends. The lack of significant differences in live weight gain and dry matter intake was mirrored by non-significant differences (P<0.05) in feed efficiency, indicating a direct relationship between these parameters.

Nutrient Digestibility of the Yankasa Rams fed the Experimental Diets

The nutrient digestibility of the Yankasa rams fed the experimental diets is shown in Table 4.

Table 4. Nutrient digestibility of Yankassa Rams fed the experimental diets

Parameters (%)	Treatments				SEM
	A (10%)	B (5 %)	C (10 %)	D (10%)	
DMD	75.64^{ab}	91.29^{a}	88.25^{a}	71.45^{ab}	3.49
CPD	85.17^{c}	95.33^{a}	90.38^{b}	86.56^{bc}	1.54
CFD	88.28^{b}	91.98^{ab}	95.73^{a}	94.95^{a}	1.16
EED	93.25^{b}	97.69^{a}	96.14^{ab}	96.09^{ab}	0.66
NFED	64.96	85.50	69.53	80.82	3.68
ADFD	82.73	93.66	88.78	90.45	1.86
NDFD	74.14	91.97	88.60	94.34	3.63
LGD	82.41^{b}	95.24^{a}	87.63^{ab}	82.30^{b}	2.15

^{abc}Mean within the same rows with different superscripts differ significantly (P<0.05) DMD= Dry matter digestibility CPD= crude protein detergent digestibility CFD= crude fibre digestibility EED= ether extract digestibility ADFD= acid neutral detergent fibre digestibility NDFD= neutral detergent fibre digestibility LGD= lignin digestibility.

The dry matter digestibility (DMD) value of 71.5 - 91.3% obtained in the present study showed significantly varied (P<0.056) and were within the range reported by Maigandi and Abubakar (2004); and Aruwayo and Muhammad (2018). The CP digestibility depicts significantly higher (P<0.05) values in rams fed ensiled sugarcane peels and may be attributed to fermentation losses during the ensiling process, which is consistent with previous research indicating that biochemical changes during ensiling lead to proteolysis and result in minor losses of soluble carbohydrates, dry matter, and energy due to the actions of lactic acid bacteria and the production of high-energy compounds like ethanol (McDonald *et al.*, 2002). The crude protein digestibility (CPD) digestibility showed that dietary protein is highly utilized by the animals. The general high digestibility values in all the treatments in this study was supported by the reports of Fajemisin *et al.* (2008) that adequate nitrogen in diets enhanced the activities of rumen microbes which eventually improved the crude protein (CP) digestibility in diets. The CF digestibility values treatments that contained the test ingredients in the present study significantly improved (P<0.05) compared with the control and higher than 56.99 – 69.28% reported by Maigandi and Abubakar (2004). The superior digestibility of ADFD and EED in the 15% UESP diet could be due to the ability of linamarase to maintain its stability at low pH values under sun drying and ensiling conditions. The high digestibility values recorded for animals on the diets generally was reflected in the higher body weight gains of the animals. The results show non-significant difference in CFD, NFED, NDFD and LGD digestibility for animals fed diets containing ensiled sugarcane peel.

Nitrogen Utilization of the Yankasa Rams fed the Experimental Diets

The nutrient utilization of the Yankasa rams fed the experimental diets is shown in Table 5.

Table 5: Nitrogen Utilization of ensiled sugarcane peels

Parameters (%)	Treatments				
	A (10%)	B (5 %)	C (10 %)	D (15%)	SEM
Nitrogen Intake (g)	21.16[b]	26.35[a]	23.96[ab]	23.99[ab]	0.75
Nitrogen in Feaces (g)	3.39[ab]	1.20[b]	3.04[ab]	4.44[a]	0.49
Nitrogen in Urine (g)	1.69	1.06	1.06	1.04	0.09
Nitrogen Absorbed (g)	17.77[b]	25.12[a]	20.93[b]	19.55[b]	1.07
Nitrogen Balance (g)	16.08[b]	24.06[a]	19.87[b]	18.51[b]	1.06
Nitrogen Retained (%)	75.99[b]	91.30[a]	82.92[ab]	77.16[b]	2.08

abc=Mean within the same rows with different superscripts differ significantly (P<0.05)

The nitrogen intake shown in Table 5 revealed means that varied from 21.6 to 26.35g/day with significant differences (P<0.05) were higher than the values (12.89 to 21.35g/day) obtained by Abdullazeez *et al*., (2020) and lower than 27.52 to 32.44g/day recorded by Adamu *et al.,* (2021), when the author determined the effects of *Parkia biglobosa* pulp inclusion levels on nitrogen balance of growing red sokoto bucks. Faecal nitrogen was affected by the treatment means, the values ranged from 1.2 to 4.44g/day and were lower than the values (6.17 to 6.72g/day) obtained by Salisu *et al.* (2018). Ruminant nutrition emphasizes the importance of synchronizing protein and dietary carbohydrate availability in the rumen to optimize microbial synthesis and minimize nitrogen loss (Bastos *et al*., 2014). Notably, the greatest nitrogen loss was observed in the control and T4 treatments. The presence of a large proportion of non-protein nitrogen (NPN) from dietary urea, combined with nitrogen produced in the liver during metabolism, probably contributed to this observation (Santos *et al.,* 2014). The percentage of nitrogen retained was higher to that of Abubakar *et al*. (2010). Nitrogen retention is widely regarded as a key indicator of protein status in ruminants, providing a reliable estimate of the nitrogen available for incorporation into body tissues (Bastos *et al*., 2014; Yulistiani *et al*., 2015). The observation of positive nitrogen retention in rams supplemented with ensiled sugarcane peel in this study implies that the diets provided sufficient nitrogen, with ample protein available for the animals' requirements. The positive nitrogen retention observed across all treatments indicates minimal protein or nitrogen loss, confirming efficient dietary protein absorption and utilization for tissue growth and maintenance.".

Conclusion and Recommendation

The proximate composition and the crude fraction obtained in the study were within ranges that satisfied the nutrient requirements of the experimental animals. Based on the growth performance indices such as feed intake, weight gain and feed efficiency did not indicate any significant differences (P>0.05) across the treatments. However, 10% inclusion levels of UESP were numerically higher in weight gain than other treatments. The cost of feed per unit of live weight gain (COF/LWG) was numerically lower in 10% UESP than all the treatments (N1265.57). The digestibility of the nutrients showed significant differences (P<0.05) in some of the parameters with CP digestibility being better in 5% UESP. Urea ensiled sugarcane peel inclusion in the diets of rams up to 15% is recommended but the most economic level of inclusion is 10%.

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