Feed intake, morphological characteristics and economics of production of Red Sokoto goats fed urea treated ensiled cowpea husk based diets

*¹Olafadehan, O. A., ²Okunade, S. A., ³Njidda, A. A., ⁴Shoyombo, A. J. and ¹Okoye, G. C.

¹Department of Animal Science, University of Abuja, Abuja, Nigeria

²Department of Animal Production Technology, Federal College of Wildlife Management, New, Bussa, Niger State, Nigeria

³Department of Animal Science, Federal University, Kashere, Gombe State, Nigeria

⁴Department of Animal Science, Landmark University, Omu-Aran, Kwara State, Nigeria

*Corresponding Email: oaolafadehan@yahoo.com Tel.: +234(8)057035527

Abstract

Body dimension measurements have been used in estimating body weight and appropriate pricing of meat animals. Thus, 18 healthy intact growing Red Sokoto male goats, with 13.4±0.59 kg body weight (BW), were used in a completely randomized design to evaluate the inclusion rates of urea treated ensiled cowpea husk (UECH) at 0, 35 and 70% to replace 0, 50 and 100% of dried brewers' grains (DBG) on voluntary intake, body weight, morphological and testicular characteristics, and economics of production for 70 d. Daily intakes of dry matter (g/d and % BW), crude protein, organic matter, nitrogen free extract, neutral detergent fibre and lignin were not ($p>0.05$) affected by diets. Whereas intakes of ether extract and hemicellulose progressively decreased ($p<0.05$), intakes of cellulose and mineral contrastingly increased ($p<0.05$) with increasing UECH replacement for DBG. Intake of acid detergent fibre was greater ($p<0.05$) for the treatment diets relative to the control diet. Diet effects on the body weight, linear body measurements and testicular morphology of the goats were marginal ($p>0.05$), except for initial scrotal length which was markedly ($p<0.05$) affected. Cost of feeding declined with the increasing UECH rate in the diet. Cost of feed consumed/goat and cost of feeding/kg BW gain were higher ($p<0.05$) for the control diet than for the treatment diets. In contrast to savings on cost of feeding which was higher ($p<0.05$) for 70% UECH than 35% UECH, differential and relative benefits were outstanding ($p<0.05$) for 35% UECH. Value of chevon and net benefit were greater ($p<0.05$) for 35% UECH relative to 0 and 70% UECH. These findings suggest that UECH can be safely used up to 70% level in a concentrate mixture for growing goats, completely substituting dried brewers' grains, without depressing voluntary intake, body weight, morphological and testicular parameters, and improve economic benefits to farmers. However, for better economic returns, 35% UECH is superior to 70% UECH.

Keywords: Cowpea husk, urea treatment, ensiling, voluntary intake, body morphology, goats.

Introduction

Intensive crop production to feed the teeming human population worldwide has resulted in concomitant increase in availability of crop residues. Thus, crop residues are abundantly available, and may constitute nuisance to the environment, if not properly disposed. Crop residues are

mostly farm wastes which, if well harnessed, have a great potential as unconventional inexpensive feedstuffs for livestock feeding. Olafadehan (2011a) earlier posited that it is customary to feed non-conventional feedstuffs such as browse plants, tree and shrub fodders, crop residues, etc. to ruminant stock. The

abundance of crop residues makes them cheaper sources of feed for ruminants. Nevertheless, they are generally low in nutrients (Nicholson, 1984) and inherently fibrous resulting in low livestock performance when fed without any form of treatment. Various processing strategies have been deployed and adopted in improving their nutritive value and utilization as animals' feeds or components of their diets. Such strategies include treatment with fertilizer graded urea to improve the nutritional composition, particularly the CP, and anaerobic ensiling to reduce the fibre contents (Olafadehan and Adebayo, 2016), who reported enhanced nutritive value for ammoniated ensiled threshed sorghum top in goat diets. Cowpea husk (CH) has been reported as cowpea by-product used by livestock farmers to supplement fodder during the dry season (Ososanya *et al.*, 2013). Large quantities of cowpea husks are produced in the country; Adebawale (1981) reported about 82,000 metric tonnes being produced annually in Nigeria. Cowpea husk is abundantly available in the savannah zone of Nigeria, where cowpea is extensively cultivated, but its nutrient availability is perhaps limited by high fibre content which impairs feed intake, digestibility and utilisation by ruminants. Feed intake is an indispensable index of nutritive value of a feed and is more reliable than digestibility in evaluation of the feeding value of a diet, because animals will digest only what they can consume (Okunade *et al.*, 2014; Olafadehan and Okoye, 2017). Body dimension measurements have been used in estimating body weight (BW) and appropriate pricing of meat animals. Body measurements, on most farms in the tropics, help smallholder farmers who lack formal education and cannot afford or use weighing scales to estimate their animals'

BW and market value in terms of cost of the animals. Prasad and Neeraj (2008) reported that BW can be estimated by body measurements. The biometric parameters commonly used in predicting BW in small ruminants include: body length, chest girth and height at withers. When unconventional ingredients are used in livestock diets, it becomes imperative to examine the cost of production of the fed animals with aim of evaluating the economic benefits of such practice (Olafadehan, 2011b). It was hypothesized that inclusion of urea treated ensiled CH (UECH) up to 70% in goat ration could enhance voluntary intake, body weight, morphological and testicular characteristics, and economic returns. The study aimed to investigate the effects of feeding urea treated UECH as a replacement for dried brewers' grains (DBG) on feed intake, body measurements and economics of production of Red Sokoto goats.

Materials and methods

Study location

The study site, Teaching and Research Farm University Abuja, Abuja, is at 456 m altitude and has a tropical climate with annual rainfall and temperature of between 1100 and 1650 mm and 25.8 and 35.1 °C respectively. It lies between latitude 9° 12' North and longitude 7° 11' East.

Experimental feedstuff preparation

The CH, used in this experiment, was purchased from local farmers. Four kg of urea dissolved in 100 liter water was carefully sprinkled on 100 kg DM of CH and thoroughly mixed together. The treated CH was filled into a large drum, compacted to make it air tight, sealed tightly with polyethylene sheets and then overlaid with a heavy object placed on the lid. Anaerobic fermentation of the urea treated CH was allowed for three weeks after which the resultant urea treated ensiled (UECH) was

evacuated and aerated overnight under shade to eliminate volatile ammonia that causes ammonia toxicity if fed to animals without aeration.

Goats, management and treatments

Eighteen growing Red Sokoto male goats about 10 months old, with an average initial BW of 13.4 ± 0.59 kg, were used for the study. Prior to the inception of the study, the animals were given prophylactic treatments. They were weighed and stratified into three homogenous groups of six goats each, with each group having average similar initial BW. Each group was randomly allotted to one of the experimental diets in a complete randomized design (CRD). Goats were housed individually in cages, and two weeks of adaptation to both the cages and the experimental diets were allowed before the commencement of data collection. Three complete diets were formulated such that DBG was replaced by 0, 50 and 100% of UTECH. Thus, treatment diets contained three inclusion rates of UTECH (%): (70 DBG + 0 UTECH, 30 cassava peel meal (CPM)), 2 (35 DBG + 35 UTECH + 30 CPM) and 3 (70 UTECH + 30 CPM), and were tagged 0, 35 and 70% UTECH respectively. Goats were fed at 5% BW with daily provision for 20% refusals for 70 days. Feeding was twice daily, 08:00 h and 16:00 h, and water was available free choice. Voluntary feed intake was measured by subtracting the quantity of orts from the quantity served. Body measurements were taken weekly just before feeding using measuring tape.

Laboratory analyses

Samples of diets were dried individually in an air-draft oven at 60 °C for 96 h, ground separately to pass through a 1 mm sieve in a Wiley mill and analysed for proximate constituents, using the standard methods of AOAC (1995). Dry matter was determined

by drying at 100 °C for 24 hours. Ash concentration was determined after ignition at 550 °C for 4 hours in a muffle furnace and used to calculate organic matter (OM). Fibre fraction analysis was by the methods of Van Soest *et al.* (1991). Hemicellulose and cellulose were calculated as the differences between neutral detergent fibre (NDF) and acid detergent fibre (ADF), and ADF and lignin respectively

Economics feasibility

Cost effectiveness of UTECH replacement for DBG was evaluated using prevailing market prices to cost the diets and chevon. The charges incurred in preparing CH were included in the cost of UTECH. The cost of the feeds consumed and the value of the weight gain by the animals throughout the feeding trial was computed for each goat to quantify accruable net benefits. The variable cost of feeding the goats was considered as the cost of the feeds, as all other costs (i.e., labour, capital investment, housing) were the same for all the treatments.

Statistical analysis

Data were subjected to analysis of variance (ANOVA) for a CRD, with a model that included the diet as treatment effects, using the SPSS BASE 17 (SPSS software products, USA). When means were significant in the ANOVA, differences between means were separated using Duncan's multiple range test (DMRT). Significant differences in DMRT were accepted if $p \leq 0.05$. The statistical model was:

$$Y_{ij} = \mu + T_i + ij,$$

where Y_{ij} = each observation on i^{th} treatment due to j^{th} animal; μ = population mean; T_i = fixed effect of i^{th} treatment ($i = 3$) and ij = experimental error associated with i^{th} treatment and j^{th} animal assumed to be normally and independently distributed (0, σ^2).

Results and discussion

Chemical composition of the experimental diets is displayed in Table 1. The crude protein (CP) content of the diets was similar which implies that urea treatment and ensiling of the test ingredient upgraded its CP content to similar level as that of the DBG it replaced. It is a known fact that the CP content of untreated CH is lower than that of DBG, a good source of rumen undegradable protein (Chiou *et al.*, 1998). In contrast to the CP, the NDF and hemicellulose contents decreased with increasing level of UECH in the diets, suggesting lower levels of NDF and hemicellulose in UECH compared with DBG probably due to degradation of its

fibre component during ensiling or fermentation. Olafadehan *et al.* (2012) and Olafadehan and Adebayo (2016) previously attributed reduced fibre level of ensiled cassava peel and threshed sorghum tops to the breakdown of the fibre by certain anaerobic microbes during fermentation/ensiling. However, ADF and cellulose contents increased with increasing level of UECH. Both ash and nitrogen free extract (NFE), a readily fermentable carbohydrate, contents increased as the UECH rate increased in the diets, suggesting a lower OM and a higher soluble carbohydrate contents of the UECH relative to DBG, in concurrence with earlier observations (Olafadehan and Adebayo, 2016).

Table 1: Chemical composition of experimental diets

Nutrient (%)	Urea treated ensiled cowpea husk level (%)		
	0	35	70
Dry matter	92.38	95.18	95.88
In % dry matter			
Crude protein	17.51	17.33	17.15
Organic matter	95.40	94.36	93.44
Ether extract	3.49	1.26	1.00
Ash	4.96	5.64	6.56
Crude fibre	34.40	32.68	30.96
Neutral detergent fibre	57.02	54.78	52.55
Acid detergent fibre	30.18	35.58	38.78
Acid detergent lignin	11.27	11.84	12.19
Cellulose	18.91	23.74	26.59
Hemicellulose	26.84	19.20	13.77
Nitrogen free extract	39.64	43.09	44.33
Total carbohydrate	74.04	75.77	75.29

Feed intake is a function of many factors including palatability, fibre digestion and digesta flow rate. Similar ($p>0.05$) feed consumption among the diets (Table 2) thus implies parallel palatability, fibre digestibility and digesta flow rate through the gastro-intestinal tract. The result indicates that UECH can replace DBG in diet for goats without adverse intake. Dry

matter intake as percent body (% BW) was not affected ($p>0.05$) by diets, and was within the range of 2-6% recommendation (ARC, 1980; Susan, 2003). Dry matter intake is a critical determinant of animal performance and, most often than not, correlate with performance and productivity. Intakes of CP, organic matter (OM), neutral detergent fibre (NDF) and

Table 2: Feed and nutrient intakes of goats fed urea treated ensiled cowpea husk diets

Intake (g/d)	Urea treated ensiled cowpea husk level (%)			SEM
	0	35	70	
Dry matter	574.63	569.44	561.64	23.3
Dry matter (% BW)	3.82	3.40	3.58	0.15
Crude protein	100.62	98.68	96.32	4.06
Organic matter	548.20	537.32	524.80	33.2
Ether extract	20.05 ^a	7.17 ^b	5.62 ^b	0.74
Ash	28.50 ^c	32.12 ^b	36.84 ^a	1.21
Neutral detergent fibre	327.65	311.94	295.14	13.1
Acid detergent fibre	173.31 ^b	208.30 ^a	217.80 ^a	7.38
Lignin	64.76	67.42	68.47	2.65
Cellulose	108.60 ^c	135.18 ^b	149.34 ^a	4.71
Hemicellulose	148.99 ^a	109.33 ^b	77.34 ^c	10.0
Nitrogen free extract	227.78	248.37	248.98	9.72

Mean with different superscripts in the same row vary significantly ($p < 0.05$)

Table 3: Body weight, morphology and testicular characteristics of Red Sokoto goats fed urea treated ensiled cowpea husk diets

Variable	Level of urea treated ensiled cowpea husk (%)			SEM
	0	35	70	
Initial body weight (kg)	12.7	14.0	13.5	1.58
Final body weight (kg)	17.4	19.5	17.9	1.58
Heart girth (cm)				
Initial	56.67	59.33	57.3	2.91
Final	67.83	66.00	64.67	1.91
Body length (cm)				
Initial	38.67	39.67	39.67	2.06
Final	47.33	50.00	53.00	4.72
Height at wither (cm)				
Initial	55.33	53.67	51.00	4.98
Final	63.33	65.33	61.67	3.37
Scrotal circumference (cm)				
Initial	19.83	19.67	18.17	1.37
Final	28.00	28.83	27.33	1.05
Scrotal length (cm)				
Initial	13.17 ^a	12.17 ^{ab}	10.67 ^b	0.94
Final	22.00	22.17	22.00	1.06
Rump height (cm)				
Initial	54.00	52.33	54.00	1.36
Final	63.67	63.33	63.33	1.76
Neck gait (cm)				
Initial	26.33	26.33	24.67	2.16
Final	37.00	38.00	35.33	1.44
Chest depth (cm)				
Initial	26.67	27.33	27.33	0.94
Final	37.67	37.67	36.67	0.94
Pin bone width (cm)				
Initial	11.00	10.33	10.33	0.61
Final	21.17	21.00	20.33	0.80

Mean with different superscripts in the same row vary significantly ($p < 0.05$)

nitrogen free extract were marginal ($p>0.05$), reflecting the pattern of DM intake. According to Olafadehan *et al.* (2014), nutrient intake is a function of feed intake and content of the nutrient in the diet *ceteris paribus*. Intakes of ether extract, ash (mineral) and ADF were lower ($p<0.05$) for the UECH based diets compared to the

control diet. Both cellulose and hemicellulose intakes increased and decreased respectively, as the replacement level of DBG with UECH increased, reflecting the pattern of the contents of these nutrients in the dietary chemical composition (Olafadehan and Adebayo, 2016).

Table 4: Comparative cost advantage of replacement of DBG with UECH in goat diets

Variable	Urea treated ensiled cowpea husk level (%)			SEM
	0	35	70	
Cost/kg feed (₦)	51.0	42.6	34.2	
Total feed consumed (kg)	40.22	39.86	39.31	1.63
Cost of feeding (₦)	2051.43 ^a	1698.07 ^b	1344.57 ^c	79.6
Cost of feed consumed (₦/goat)	341.91 ^a	283.01 ^b	224.10 ^b	13.3
Savings on feeding cost (%)	-	16.95 ^b	34.28 ^a	3.68
Total weight gain (chevon) (kg)	4.8	5.5	4.4	0.21
Cost of feed ₦/kg BW gain	430 ^a	308.93 ^b	306.94 ^b	15.9
Cost/kg of chevon (₦)	1500	1500	1500	
Value of chevon (₦)	7155 ^b	8250 ^a	6600 ^b	311
Net benefit (₦)	5098.57 ^b	6551.93 ^a	5255.43 ^b	286
Differential benefit (₦)	-	1453.36 ^a	163.52 ^b	418
Relative benefit (%)	-	28.5 ^a	3.49 ^b	8.15

Means with different superscripts in the same row vary significantly ($p<0.05$)

DBG: dried brewers' grains; UECH: urea treated ensiled cowpea husk

Body weight and all body measurements were similar ($p>0.05$) across treatments (Table 3) for both initial and final measurements, except for the initial scrotal length which varied ($p<0.05$). Though not significantly affected, the increases in the final body measurements compared to initial measurements indicate positive linear correlations between linear body measurements and BW. Thus, lack of diet effect on body and testicular morphology may be related to similar final BW among the goats. These results contradict previous reports (Babale *et al.*, 2015) on the same breed of goats where pronounced ($p<0.05$) differences were recorded for all measured linear body parameters. Variation in results may be due to differences in nutritional regime and management of the animals.

Linear body measurement is a more dependable index for estimating the changes in growth and live weight/BW of animals. Olafadehan *et al.* (2015) previously attributed increase in BW of Red Sokoto goats to increase in linear body measurements of the animals. Heart girth (HG), a more reliable predictor of the BW (Adeyinka and Mohammed, 2006; Bello and Adama, 2012; Olafadehan *et al.*, 2015), values were close to the range of 55.1 – 65.65 cm indicated by Babale *et al.* (2015) for the same breed of goat. The values for height at wither were higher than 58.19 cm reported for Red Sokoto goats (Jibir *et al.*, 2013) but were within the range of 62 - 72 cm reported by Devendra and McLeroy (1982). The values of chest depth were higher than the overall mean chest depth

value of 25.73 cm reported by Jibir *et al.* (2013). Variation in values could be attributed to differences in husbandry practices and strains of Red Sokoto goats breeds used in different experiments. The body length values were, however, similar to the reported overall mean body length of 48.84 cm (Jibir *et al.*, 2013). The size of the scrotum has been identified to positively correlate with the fertility and reproductive efficiency of the male offspring genetically. Therefore, the similar ($p>0.05$) values for scrotal circumference and scrotal length among the diets indicate that complete replacement of DBG (70% inclusion rate of UECH) did not compromise the reproductive potential of the experimental goats. However, further studies on libido, fertility, semen volume and quality, and reproductive performance of male goats fed a diet containing up to 70% UECH may be needed to confirm this conjecture in the current assay.

A reduction of N353 and N707/kg of diet was obtained when 50 and 100% UECH respectively replaced DBG. Based on this cost reduction, savings on the feeding cost were 16.95 and 34.28% for 35% UECH and 70% UECH relative to the control (0% UECH). Cost of feed (N)/kg BW gain revealed that it was significantly cheaper and more economical to produce 1 kg of BW by replacing DBG with UECH. These results corroborate findings of previous studies (Olafadehan, 2011b; Olafadehan *et al.*, 2014; Olafadehan *et al.*, 2017) where unconventional feedstuffs were used to replace conventional ones. The higher net economic benefit in the treatment diets relative to the control diet reflected the cost/kg of the diets. However, 35% UECH gave a higher net benefit compared with 70% UECH. Both differential and relative benefits indicated that goats fed 35% UECH and 70% UECH had higher benefits

of N145.36 and N163.52 and N28.5 and N3.49 respectively than the control group goats. These results depict that smallholder goat farmers can obtain economic returns as much as 28.5% and 3.49% respectively by replacing DBG with 35% UECH and 70% UECH respectively. Therefore, higher net, differential and relative benefits of 35% UECH than 70% UECH show that these diets were economically superior and of better quality (Olafadehan *et al.*, 2017). The greater economic benefit of UECH is an indication that simple processing and adoptable technologies such as urea treatment and ensiling can enhance the feeding value of fibrous crop residues such as CH. The greater economic returns of UECH compared with DBG thus reflected its enhanced nutritive value as a feed for goats, and lower price. Based on economic returns, 35% UECH (50% replacement of DBG with UECH) is a more economically viable option in practical goat diets.

Conclusion

The study shows that urea treated ensiled cowpea husk can be used up to 70% in a practical low cost goat ration without any adverse effect on feed consumption, body weight and linear body measurements of buckling goats. However, 35% inclusion level gave better economic returns than 70% inclusion rate. Further studies on the effect of dietary inclusion of 70% urea treated ensiled cowpea, as a complete replacement for dried brewers' grains, in goat ration on other indices of animal performance such as digestibility, ruminal fermentation and nitrogen utilisation are recommended.

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