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FEED INTAKE AND BLOOD PROFILE OF RED SOKOTO GOATS FED UREA TREATED ENSILED COWPEA HUSK BASED DIETS

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ABSTRACT

This study aimed to investigate whether the substitution of dried brewers' grains (DBG) with urea treated ensiled cowpea husk (UTECH) at a high level of up to 70% causes voluntary feed intake reduction and has detrimental effects on animal welfare. Eighteen healthy growing intact male goats about 10 months old, with an average initial live weight of 13.40 ± 0.59 kg, were randomly allocated to one of the following three treatments: (i) 30% cassava peel meal (CPM) + 70% DBG (0% UTECH), (ii) 30% CPM + 35% DBG + 35% UTECH (35% UTECH) and (iii) 30% CPM + 70% UTECH (70% UTECH) in a completely randomized design. Daily intakes of dry matter, crude protein, organic matter, crude fibre, total carbohydrate and neutral detergent fibre were not ($P>0.05$) affected but intake of ether extract decreased linearly and quadratically ($P<0.001$), while non-fibre carbohydrates intake increased linearly ($P=0.001$) with increasing UTECH proportion in the diet. Both lymphocytes ($P=0.018$) and neutrophils ($P=0.030$) showed quadratic trends but other haematological parameters and serum electrolytes were similar among the diets. All the studied haematological parameters and serum electrolytes of the goats were within the established ranges for healthy goats. The results of the study show that urea treated ensiled cowpea husk had no deleterious effect on the voluntary intake and health status of the experimental animals and can be used up to 70% for sustainable ruminant production.

Keywords: Urea, treated cowpea husk, goats, haematology, serum electrolytes

INTRODUCTION

Smallholder farmers have traditionally used crop residues as a staple ruminant feed, especially during the dry season when natural forages are scanty. Crop residues are abundantly available in Nigeria due to diversion of grazing land to crop production in an attempt to feed the ever teeming human population (Olafadehan and Adebayo, 2016). However, crop residues are high in fibre and low in protein concentrations; thus various treatment methods, such as physical, chemical and biological treatments, have been used to improve their nutritive value and utilization by livestock. Though cowpea husk (CH) is copiously available in Nigeria, especially in the savannah zone of the country where cowpea is extensively cultivated, its poor nutrient contents (crude protein, 6.50%) (Jeremiah *et al*., 2015) and (neutral detergent fibre, 84.4% and acid detergent fibre, 54.22%) (Ososanya *et al*., 2013) necessitate some form of treatments. Urea treatment (ammoniation) and ensiling have been used to improve the feeding value of crop residues (Olafadehan and Adebayo, 2016). Feeding poor quality diets may be injurious to the health of animals, since health is a function of nutrition; therefore, inadequate nutrition is one of the major causes of ill health or metabolic disorders in livestock. Since the 1900s several tools for animal welfare measurement have been developed and discussed (Broom, 1991). Metabolic distress is a

situation arising from metabolic imbalances in the blood, which can lead to discomfort, impaired feed intake and eventually sickness, and is one of the means for measuring wellbeing in animals (Broom, 1991; Ohl and Van der Staay 2012). Evaluation of the blood profile of animals may give some insight to the potentials of a dietary treatment to meet the metabolic and health needs of the animals (Olafadehan *et al*., 2014a). Blood metabolite profile can assist in appreciation of the animals' welfare status, in particular in relation to their nutritional and health status. Most studies dealing with the use of non-conventional feeds focus on animal performance or product quality (Ben Salem et al. 2004; Vasta *et al*., 2008; Isah *et al*., 2015; Olafadehan and Adebayo, 2016) but very few studies consider their impact and implications on animal welfare. Though feed intake and digestibility are two crucial indices of nutritive value of a feed, feed intake is a more critical determinant and reliable index of nutritive value and performance of an animal than digestibility because animals will digest only what they can consume. This study aimed to assess the feasibility of partially substituting dried brewers' grains (DBG) with urea treated ensiled cowpea husk (UTECH) in complete diets for growing goats and to assess whether there are any metabolic disorders arising from intake of these diets.

MATERIALS AND METHODS

Experimental site

The experiment was conducted at the University of Abuja Teaching and Research Farm, Federal Capital Territory, Nigeria. The site at 456 m altitude lies between latitude 8º 55'N and 9º 00'E and longitude 7º 00'N and 7º 05'E. It has a tropical climate with temperatures of 25.8 to 42°C and 1100 to 1650 mm annual rainfall.

Preparation of test ingredient

The CH was purchased from local farmers. Four kilograms of urea dissolved in 100 L water was carefully sprinkled on 100 kg dry matter (DM) of CH and mixed thoroughly together. The treated CH was filled into a large drum, compacted, sealed tightly with polyethylene sheets and then covered with a heavy object placed on the cover. The ensiled CH was left unopened for 3 weeks and thereafter opened, and aerated overnight under shade to eliminate volatile ammonia that causes ammonia toxicity if fed to animals without aeration.

Animal management and diets

In a completely randomized designed, eighteen intact Red Sokoto male goats about 10 months old were used for the study. The animals were purchased from markets and smallholder goat farmers within Abuja. All the goats were quarantined for 2 weeks, given antibiotic injection (oxytetracycline LA) at 2.5 ml/10 kg LW and ivomectin injection at 0.2 ml/10 kg LW to control both the endo and ecto parasites. Goats were housed in individual slatted floor pens (1.0 m x 1.2 m) equipped with a feeder and a drinker and fed the experimental diets during the pre-experimental stage. The animals were weighed and divided into three homogeneous groups, according to their live weight (LW, 13.40 ± 0.59 kg), and randomly assigned to one of three experimental diets fed at 5% of their LW, with daily allowance for 20% refusals. The diets, which contained three inclusion rates of UTECH at 0, 35 and 70% replacing DBG by 0 (control) 50 and 100 % respectively, were: 1) 70% DBG + 30% cassava peel meal (CPM), 2) 35% DBG + 35% UTECH + 30% CPM and 3) 70% UTECH + 30% CPM. They were tagged 0, 35 and 70% UTECH. The chemical composition of the diets are shown in Table 1. The feeding trial lasted for 70 days excluding the 14-day

adjustment period after which blood samples were collected for haematological and serum electrolytes assay. Feeding was done twice daily, at 08:00 and 16:00 h, and water was available *ad libitum*. Feed intake was measured as the difference between the quantity served and the orts. The cages were cleaned twice weekly.

Blood collection procedure

On the last day of the experimental feeding trial period, 10 mL blood samples were collected from the jugular vein of three goats per treatment using a 10-mL syringe and 21 gauge hypodermic needles. Five millilitres of blood sample was collected into labelled sterile bottles containing ethylenediamine tetra-acetic acid (EDTA) as an anti-coagulant for the determination of haematological parameters, while the remaining 5 mL blood sample for serum analysis was collected into anti-coagulant-free bottles, allowed to clot at room temperature and centrifuged at 3000 x *g* for 10 min. The supernatant sera were then decanted and deep-frozen for biochemical analysis.

Chemical analysis

Proximate composition of the diets was determined according to the methods of AOAC (2002). Neutral detergent fibre of the diets was analysed using the methods of Van Soest *et al*. (1991). Packed cell volume (PCV) and haemoglobin (Hb) concentration determination followed the procedures outlined by Dacie and Lewis (2001). Red blood cell (RBC) and differential total white blood cell (WBC) counts were determined using the Neubauer haemocytometer after appropriate dilution. Mean corpuscular haemoglobin concentration (MCHC), mean corpuscular haemoglobin and mean corpuscular volume (MCV) were calculated as described by Jelalu (2014). Mineral elements of serum samples were determined with atomic absorption spectrophotometer (Model 490, Gallenkamp and Co. Ltd., London).

Data analysis

Results of voluntary feed intake and blood parameters were analysed as a completely randomized design as:

$Yij = U + Ti + eij$,

where Yij = the observed response, U = the overall mean, Ti = the fixed effect of ith treatment (n = 3), and eij the residual error.

Results from feeding treatment diets (1–3) were analysed as an orthogonal polynomial. Linear and quadratic effects were determined by orthogonal polynomial contrasts. The level of significance was set at $P \leq 0.05$. All the computational work was performed by means of SPSS (2009).

RESULTS AND DISCUSSION

Chemical composition of experimental diets

Similar crude protein (CP) and metabolizable energy (ME) of the diets imply they were iso-nitrogenous and isocaloric (Table 1). This shows that urea treatment (ammoniation) and ensilation of the CH upgraded its nutritional contents to almost parallel levels as DBG. Higher fibre content of the control diet depicts that ensilation (a form of fermentation) was effective in reducing the fibre content of the CH compared to the DBG it replaced partially.

Table 1: Ingredient and chemical composition of experimental diets

	Level of UTECH in the ration (%)		
	0	35	70
Dry matter (%)	92.38	95.18	95.88
Nutrient (% DM):			
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	4.60	5.64	6.56
Crude fibre	34.40	32.68	30.96
Neutral detergent fibre	57.02	54.78	52.55
Non-fibre carbohydrate	17.38	20.99	22.74
Total carbohydrate	74.40	75.77	75.29
Metabolizable energy (MJ/Kg)*	11.35	11.66	11.70

UTECH: urea treated ensiled cowpea husk

*Metabolizable energy was determined using the equation according to Alderman (1985):

ME = 11.78 + 0.00654 CP + (0.000665 EE)2 - CF (0.00414 EE) - 0.0118 Ash

Voluntary feed intake

The DM intake (DMI) of ruminants depends on many factors such as chemical composition, characteristics and palatability of feeds. Similarly, DMI is an important factor in the utilization of feed by ruminants and is a critical determinant of energy and performance in small ruminants (Devant *et al*., 2000). Though DMI decreased marginally ($P>0.05$) with increasing level of DBG replacement with UTECH, similar intakes (Table 2) among the treatments imply UTECH based diets did not depress palatability and acceptance and thus may guarantee improved performance. Cases of reduction in feed intake when urea treated crop residues were used in the diets of ruminants (Olafadehan and Adebayo 2016; Giang *et al*., 2016) have been attributed to fill effect due to high fibre level which is a negative index of feed intake. Except for EE intake which decreased (linear and quadratic effects; $P<0.001$) with increasing level of UTECH, intakes of other nutrients and ME were similar among the diets. Intake of EE reflects the EE content of the diets which also reduced as UTECH level increased in the diets. Lower EE content of UTECH than DBG is obviously responsible for this result. Similar intakes of other nutrients among the diets confirms earlier report (Olafadehan *et al*., 2014b) that nutrient intake is a function of feed intake and content of the nutrient in the diet.

Table 2: Dry matter and nutrient intakes (g/day) of Red Sokoto goats fed graded levels of urea treated ensiled cowpea husk

	Level of UTECH (%)			SEM	Probability value	
	0	35	70		Linear	Quadratic
Dry matter	574.63	569.44	561.64	23.6	0.597	0.951
Crude protein	100.62	98.68	96.32	4.37	0.331	0.954
Organic matter	548.20	537.32	524.80	33.2	0.331	0.967
Ether extract	20.05[a]	7.17[b]	5.62[b]	0.74	<0.001	<0.001
Crude fibre	197.67	186.09	173.89	7.89	0.024	0.965
Non-fibre carbohydrates	97.80[a]	117.28[b]	127.72[b]	4.58	0.001	0.215
Total carbohydrate	425.46	431.46	422.86	17.3	0.797	0.691
Neutral detergent fibre	323.74	311.94	295.14	16.0	0.125	0.863
Metabolizable energy (MJ/d)	6.52	6.64	6.57	0.27	0.857	0.704

UTECH: urea treated ensiled cowpea husk

Haematological indices

Blood is a critical index of the nutritional, physiological and pathological status/condition of an animal. Hence, the assessment of blood of livestock fed unconventional ingredients to ascertain the health status and suitability of the feed or otherwise. All the studied haematological indices were within the established physiological ranges for healthy caprine (Sirois, 1995; Daramola *et al*., 2005; Jelalu, 2014). Virtually all the examined haematological parameters showed no variation ($P>0.05$) among the treatments, except for Hb, lymphocytes and neutrophils which were varied ($P<0.05$) by the dietary treatments (Table 3). Similar and normal values of PCV, RBC, erythrocyte indices, WBC, monocytes, eosinophils and basophils in all the treatments indicate absence of anaemia and health challenge of the experimental goats. It appears urea treatment and ensilation of crop residues is one of the insured ways of improving their nutritive quality without compromising the health of livestock consuming such treated ingredients. This is because the results of the current study contradicts that of Okunade *et al*. (2016) where feeding of goats with untreated threshed sorghum top, a crop residue, resulted in depression of most of the haematological indices and predisposition of the animals to anaemia due to nutritional inadequacy of the threshed sorghum top.

Linear increase in Hb with increasing UTECH level depicts that the treatment diets promoted the utilization of iron for the production of Hb better than the control diet. The results also suggest higher level of iron in the UTECH than in DBG. Both lymphocytes and neutrophils increased as the level of UTECH increased from 0 to 35% but decreased as UTECH level further increased to 70% (quadratic effects, $P<0.05$). The obtained values are suggestive of a well-developed immune system in the goats with such number of immune cells to proffer good health (Daramola *et al*., 2005). Lymphocytes and neutrophils are important differential counts of WBC that play active roles in immunity of animals against infection. Lymphocytes are essential for humoral and cell-mediated immunity responses (Mahgoub *et al*., 2008). Jelalu (2014) pointed out that differential leukocytes are responsible for the defence of the organism; depressed levels of lymphocytes might indicate either a depleted immune system or an elevated neutrophil level in an active infection. Higher lymphocytes and neutrophils of goats fed the treatment diets relative to those fed control diet indicate that UTECH based diets did not compromise the immune status of the goats but rather improved it.

Table 3: Effect of urea treated ensiled cowpea husk based diets on haematological indices of Red Sokoto goats

	Level of UTECH (%)			SEM	Probability value	
	0	35	70		Linear	Quadratic
Packed cell volume (%)	32.33	33.67	35.0	2.09	0.249	0.998
Haemoglobin (g/L)	100.36	104.0	109.3	2.53	0.012	0.716
Red blood cell (x 10^{12}/L)	13.2	14.0	14.62	1.19	0.272	0.938
Mean corpuscular volume (fl)	23.07	23.83	23.57	0.91	0.604	0.538
MCH (fmol)	7.85	7.42	7.51	0.32	0.814	0.668
MCHC (%)	33.03	31.20	33.57	1.66	0.759	0.194
White blood cell (x 10^{9}/L)	6.04	6.42	7.50	1.51	0.362	0.789
Lymphocytes (%)	56.30	62.5	57.93	1.91	0.435	0.018
Monocytes (%)	3.3	2.54	2.5	0.70	0.299	0.570
Eosinophils (%)	5.70	5.02	5.30	1.04	0.529	0.958
Basophils (%)	1.27	0.80	0.87	0.27	0.194	0.303
Neutrophils (%)	34.0	39.1	36.9	2.74	0.267	0.030

UTECH: urea treated ensiled cowpea husk,
MCH: Mean corpuscular haemoglobin,
MCHC: Mean corpuscular haemoglobin concentration

Serum minerals

All serum electrolytes were within the established ranges for healthy goats (Sirois, 1995; Daramola *et al*., 2005) and were not (P>0.05) affected by diets (Table 4). Lack of diet effects on serum minerals have been reported in goats fed threshed sorghum diet (Okunade *et al*., 2016) and forage-based diets (Olafadehan *et al*., 2014a). Similar and normal values of serum electrolytes indicate that UTECH can be included up to 70% in a complete ration for goats without distorting the serum mineral balance of the animals or causing serum mineral depletion (Olafadehan, 2011; Okunade *et al*., 2016). For example, normal serum calcium level of the animals, especially those fed high UTECH diet, suggests that feeding of UTECH to goats may not have any deleterious effects as to cause hyperparathyroidism, hypervitaminosis D, multiple myoloma and neoplastic diseases associated with high serum Ca levels or osteomalacia, rickets and renal failure in low serum Ca levels (Cheesebrough, 2004). Similarly, the normal serum phosphorus levels also suggest absence of any injurious effects since a significant increase in serum inorganic P level is often associated with nephritis and a mild rise associated with decreased parathyroid activity, while a decreased level may indicate rickets and other related problems (Cheesebrough, 2004).

Table 4: Effect of urea treated ensiled cowpea husk based diets on serum major minerals of Red Sokoto goats

	Level of UTECH (%)			SEM	Probability value	
	0	35	70		Linear	Quadratic
Calcium (mmol/L)	1.31	1.36	1.32	0.10	0.076	0.926
Phosphorus (mmol/L)	5.00	5.55	5.33	2.64	0.804	0.695
Sodium (mmol/L)	149	142	147	3.09	0.065	0.996
Potassium (mmol/L)	5.6	5.6	6.43	0.52	0.542	0.997
Chloride (mmol/L)	99.7	98.3	97.8	0.33	0.163	0.394
Magnesium (mmol/L)	2.30	2.50	2.70	1.58	0.556	0.439

UTECH: urea treated ensiled cowpea husk

CONCLUSION

The results indicate that the animals were able to cope with a diet containing up to 70% of urea treated ensiled threshed sorghum without adverse effect on feed intake and welfare. The blood profile results showed that the animals did not suffer from any clinical diseases, nutritional stress or show any symptoms of metabolic disorders caused by feeding toxic or nutritionally inadequate or deficient diets. It is thus concluded that urea treated ensiled cowpea husk can be included up to 70% in the diets of goats for sustainable production without jeopardizing the feed consumption and health of the animals.

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