Nig. J. Anim. Prod. 2021, 48(5):343-352. https://doi.org/10.51791/njap.v48i5.3163
Nigerian Journal of Animal Production

Effect of substituting maize grain with cobs treated with a combination of urea and wood ash on sheep performance and rumen parameters

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Abstract

Effect of treating maize cobs with a combination of urea and wood ash (WA) on chemical composition, in vitro gas production, and in sacco degradability were examined in a previous study. The treatments were: (100U) =100% urea +0% wood ash, (75U25WA) = 75% urea +25% wood ash, (50U50WA) = 50% urea +50% wood ash, (25U75WA) =25 % urea + 75% wood ash and (0U0WA) = Untreated maize cobs. It was concluded in the study that, treatment 25U75WA gave better results in terms of all the parameters measured. This study aimed at determining the effect of feeding Twana sheep diets whose grain was substituted with maize cobs treated with 25%U and 75%WA on nutrient intake, digestibility, nitrogen utilization, rumen NH_3, pH and performance. Tswana sheep were fed experimental diet whose maize grain was substituted with graded levels of 25U75WA in the dietary ingredients and the treatments were: 100M = 100% maize grain, 66M34C = 66% maize grain plus 34% treated maize cobs, 34M66C = 34% maize grain plus 66% treated maize cobs and 100C = 100% treated maize cobs in a 4×4 Latin Square Design (4 animals were rotated in 4 periods for all the treatments). Treatment 34M66C had crude protein intake (CPI), dry matter intake (DMI), organic matter intake (OMI) and neutral detergent fibre intake (NDFI) of 0.1334, 0.9500, 0.8921 and 0.4800 kg/d respectively (P<0.05) while the crude protein digestibility (CPD), dry matter digestibility (DMD), organic matter digestibility (OMD) and neutral detergent fibre digestibility (NDFD) were 79.57, 68.02, 66.26, and 57.8% respectively (P<0.05). All the treatments had similar (P>0.05) rumen NH_3 ranging from 23.55 – 24.00 mg/ml while rumen pH were different (P<0.05) and ranged from 6.117 – 6.937 however treatment 100M had lower pH. Treatment 100M and 34M66C had average daily gain (ADG) of 0.1150 and 0.1417 kg/d, respectively (P<0.05), however, treatment 100M had lower feed conversion ratio (FCR) of 5.217 compared to 7.059 (P<0.05) for 34M66C. It was concluded that farmers should include 34M66C in the diet of Tswana sheep for optimum performance and also reduce the cost of feed.

Keywords: Maize grain, maize cob, Tswana sheep, urea, wood ash,

Effet de substituer du grain de maïs avec des épis traités avec une combinaison d'urée et de cendres de bois sur la performance des moutons et des paramètres de rumen

Résumé

Effet du traitement des épis de maïs avec une combinaison d'urée et de cendres de bois (CB) sur la composition chimique, la production de gaz in vitro et dans la dégradabilité de SACCO ont été examinées dans une étude précédente. Les traitements étaient: (100u) = 100% urée + 0% de cendre de bois, (75U25CB) = 75% d'urée + 25% de cendres de bois, (50u50wa) = 50% d'urée + 50% de cendre de bois, (25U75CB) = 25% d'urée + 75% de cendres bois et

(0U0CB) = épis de maïs non traité. Il a été conclu dans l'étude que, le traitement 25U75CB a donné de meilleurs résultats en termes de tous les paramètres mesurés. Cette étude visait à déterminer l'effet de l'alimentation des régimes de moutons Twana dont le grain a été substitué aux épis de maïs traité avec 25% U et 75% de CB sur l'apport nutritionnel, la digestibilité, l'utilisation de l'azote, le rumen NH3, la performance de la pharmacie. Les moutons de Tswana ont été nourris à une alimentation expérimentale dont le grain de maïs était substitué par des niveaux de grade de 25U75WA dans les ingrédients alimentaires et les traitements étaient les suivants: 100m = 100% de grain de maïs, 66 m34c = 66% de grain de maïs de maïs plus 34% d'épis de maïs traité, 34m66c = 34% de maïs Grain Plus 66% COBS de maïs traité et 100c = 100% cobs de maïs traités dans un design carré latin 4 × 4 (4 animaux ont été tournés en 4 périodes pour tous les traitements). Traitement 34M66C avait une consommation de protéines brutes (CPB), une consommation de matière sèche (CMS), une consommation de matière organique (CMO) et une consommation de fibres de détergents neutres de 0,1334, 0,9500, 0,8921 et 0,4800 kg / j respectivement (p <0,05) tandis que le Digestibilité des protéines brutes (DPB), digestibilité de la matière sèche (DMS), digestibilité de la matière organique (DMO) et digestibilité de fibres de détergent neutres (DFDN) étaient de 79,57, 68,02, 66,26 et 57,8% respectivement (p <0,05). Tous les traitements avaient des analgésiques similaires (p> 0,05) Rumen NH3 allant de 23,55 à 24,00 mg / ml tandis que le pH de rumen était différent (p <0,05) et allait de 6,117 - 6,937 Cependant, le traitement 100M avait un pH inférieur. Traitement 100m et 34m66C avaient un gain quotidien moyen (GQM) de 0,1150 et 0,1417 kg / j, respectivement (p <0,05), cependant, le traitement 100M avait un rapport de conversion d'alimentation inférieur (CAI) de 5,217 par rapport à 7,059 (p <0,05) pour 34 m66c. Il a été conclu que les agriculteurs comprennent 34 m66c dans le régime alimentaire des moutons de Tswana pour des performances optimales et réduisent également le coût des aliments pour animaux.

Mots-clés: Grain de maïs, Épis de maïs, Mouton de Tswana, Urée, Cendre en bois

Introduction

Feed shortage is the major constraint to the development of animal production in Botswana (Aganga and Moganetsi, 1998). Madibela *et al*. (2000) also reported that livestock in Botswana are dependent on natural vegetation for the supply of their nutrients unfortunately bush clearing for building houses and adverse droughts have limited the area available for grazing thereby compounding the problems of feed shortages. Aganga and Sera (2010) observed the need for exploitation of alternative feed resource for livestock especially in the small holdings as the ranges are depleted due to changes in the environment. Crop residues such as maize cobs are increasingly becoming popular as livestock feed due to feed shortage occasioned by drought and depletion of the rangelands. Other reasons why crop residues are becoming popular could also be attributed to the high cost of grains as a result of competition between man and livestock. However, crop residues are poor nutritionally and needed to be supplemented with other sources of nutrients (Madibela *et al*., 2000). According to Wanapat and Rowlinson (2007), maize cobs can be used as source of energy in ruminant feeds. Maize cobs when used as source of non-forage fibre, increase milk fat concentration and also reduce time of rumination when fed in combination with alfalfa in dairy cattle (Depies and Armentos, 1995). Peyton and Conrad (1982) reported that ground maize cob has been used as energy source for dairy cows in concentrate mixture. Ground maize cobs have also been reported by Wanapat *et al.* (2012) as potential replacement for cassava chips as source of energy in swamp buffalo. This study was aimed at determining the effect of substituting maize grain with maize cobs treated with 25% urea plus 75% WA on performance of Tswana breed of sheep.

Materials and methods

Experimental ingredients and location of study

The study was conducted at the Botswana University of Agriculture and Natural Resources, Content Farm located 10 Km north of Gaborone in South Eastern Botswana (24.59°S 25.94°E). Maize cobs were sourced from Molepolole village farms, 70km from Gaborone and milled (4 mm sieve) at the school farm feed mill in Notwane before mixing with the rest of the ingredients.

In vivo study

Four Tswana male sheep sourced from the school farm (18 months old, 32±1 kg) were used in a 4×4 Latin Square Design (4 treatments and 4 periods) and housed in metabolism cages suitable for collection of urine and faeces separately. Prior to commencement of the trial, sheep were weighed, vaccinated against Enterotoxaemia Pasteurella followed by deworming with Ecomectin 14 days later. The trial lasted for forty eight days with 7 days of adaptation and 5 days for collection (12 days/period).

Data collection and chemical analysis

Feed offered and refused were recorded daily throughout the experimental period. Feed were offered twice daily (500g at 8am and 500g at 4pm) while samples of the experimental diets including refusals and faeces (5% samples) were collected daily in the morning before feeding during the 5 days collection period. Samples of concentrate mixture and faeces for each treatment group were then composited and stored at -20°C for later chemical analysis. The samples were divided into two parts, first part for dry matter (DM) analysis, while the second part was kept and pooled for analysis of ash, CP, NDF, ADF and ADL. Feeds, refusals and faecal DM (DM, ID number 930.15) for all samples were determined by drying in forced air oven at 60° C for 24 hr. Organic matter (OM) (OM, ID number 942.05) and ash were obtained by difference in weight after ignition at 550° C in a muffle furnace (Muffle Furnace Size 3, Gallenkamp, UK). The NDF, ADF and ADL were determined with ANKOM fiber analyzer (Ankom Technology Corporation, Fairport, NY, USA) according to the procedure of Van Soest *et al.* (1991). In the analysis of NDF, sodium sulphite and alpha amylase were also added. Nitrogen was determined by a Kjeldahl method (ID number 955.04) according to AOAC (1999) and CP determined as Nitrogen (N) × 6.25 (ID number 954.01). Daily collection of urine for each treatment before feeding was acidified with 50% H_2SO_4 (10ml 50% H_2SO_4 to 1L urine to maintain pH 3) to prevent ammonia volatilization, stored and then mixed at the end of the trial. The urine samples were then analyzed for N according to AOAC (1999). Rumen liquor was collected 3 hours post feeding after every period in the morning using a mechanical suction pump. The rumen fluid was then measured for pH using digital pH meter and the fluid sample was then strained through four layers of cheesecloth. Rumen fluid (45 ml) was kept in a plastic bottle to which 5 mL of 1M H_2SO_4 was added to stop fermentation. About 20 to 30 ml of supernatant was collected and analyzed for NH_3- N according to AOAC (1999).

Table 1: Ingredients and chemical composition of experimental diet

	Treatments				
Ingredients (%)	100M	66M34C	34M66C	100C	
Maize cob	0	15	30	45	
Maize grain	45	30	15	0	
Lucerne	39	36	32.5	29.5	
Wheat bran	10	10	10	10	
Sun Flower Cake	5	8	11.5	14.5	
Salt	0.5	0.5	0.5	0.5	
DCP	0.5	0.5	0.5	0.5	
Chemical composition (g/kg)					SD±
DM	945.0	950.0	950.0	955.0	4.630
ASH	82.01	100.0	107.9	175.4	38.68
OM	918.0	900.0	892.1	824.6	38.68
CP	134.3	131.0	133.5	133.5	3.740
NDF	470.0	470.0	480.0	570.0	54.97
ADF	160.0	220.0	250.0	360.0	78.51
ADL	53.20	63.20	85.20	114.4	28.61
HC	310.0	250.0	230.0	210.0	53.45
NDS	530.0	530.0	520.0	430.0	54.97
ME MJ/kg	18.94	19.19	19.28	17.24	0.938

DM= dry matter, OM=organic matter, CP=crude protein, NDF=neutral detergent fibre, ADF=acid detergent fibre, ADL=acid detergent lignin, HC=hemicellulose, NDS=neutral detergent soluble, ME=metabolizable energy, DCP= Di calcium phosphate. 100M= 100% maize, 66M34C=66% maize 34% treated maize cobs, 34M66C=34% maize 66% treated maize cobs, 100= 100% treated maize cobs, SD = standard deviation.

Statistical analysis

Data generated from various *in vivo* parameters were subjected to Analysis of Variance (ANOVA) using the General Linear Model procedures of SAS (2002) and treatment means were separated using Duncan's Multiple Range Test (Steel and Torrie, 1984).

Results

Nutrient intake and digestibility of experimental diets are shown in Table 2. Effect ($P<0.0001$) of treatments was observed on crude protein intake (CPI), dry matter intake (DMI), organic matter intake (OMI) and neutral detergent fibre intake (NDFI). Treatment 34M66C had the highest CPI (0.1334 kg/d) but similar to treatment 66M34C (0.1309 kg/d) while treatment 100M had the least (0.0805 kg/d). Treatments 66M34C and 34M66C had similar DMI (0.9500 kg/d) followed by treatment 100M (0.6685 kg/d) while treatment 100C recorded the least (0.5670 kg/d). Treatment 66M34C and 34M66C had similar OMI (0.9000 and 0.8921 kg/d) followed by treatment 100C (0.5772 kg/d). The least OMI was recorded for treatment 100M (0.5507 kg/d). Treatments 100M, 66M34C, 34M66C and 100C recorded NDFI of 0.3720, 0.5300, 0.4800 and 0.4060 kg/d, respectively.

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Table 2: Nutrient intake (Kg/day) and digestibility (%) of sheep fed experimental diet

Parameters	Types of treatment					
	100M	66M34C	34M66C	100C	SE	P value
Intake						
CPI	0.0805[c]	0.1309[a]	0.1334[a]	0.0934[b]	0.0060	<0.0001
DMI	0.6685[b]	0.9500[a]	0.9500[a]	0.5670[c]	0.0438	<0.0001
OMI	0.5507[c]	0.9000[a]	0.8921[a]	0.5772[b]	0.0429	<0.0001
NDFI	0.3720[d]	0.5300[a]	0.4800[b]	0.4060[c]	0.0164	<0.0001
Digestibility						
CPD	94.14[a]	81.33[b]	79.57[b]	81.41[b]	1.629	0.0011
DMD	59.12[c]	65.54[b]	68.02[b]	56.23[d]	1.258	<0.0001
OMD	59.79[b]	66.28[a]	67.20[a]	50.58[c]	1.797	0.0003
NDFD	56.82[a]	56.00[a]	57.80[a]	50.12[b]	0.8908	0.0199

100M= 100% maize, 66M34C=66%maize 34% treated maize cobs, 34M66C=34% maize 66% treated maize cobs, 100C= 100% treated maize cobs, CPI= crude protein intake, DMI= dry matter intake, OMI=organic matter intake, NDFI= neutral detergent fibre intake, CPD=crude protein digestibility, DMD= dry matter digestibility, OMI= organic matter digestibility, NDFD= neutral detergent fibre digestibility.

NDFI of 0.3720, 0.5300, 0.4800 and 0.4060 kg/d respectively. Effect (P= 0.0011) of treatments was observed on crude protein digestibility (CPD). Treatment 100M had the highest CPD (94.14%) while those of the rest of the treatments were similar. Effect (P<0.0001) of treatment was observed on dry matter digestibility (DMD). Treatment 34M66C had the highest DMD (68.02%) while treatments100M, 66M34C and 100C had DMD values of 59.12, 65.54 and 56.23% respectively. Effect (P=0.0003) of treatments was observed on organic matter digestibility (OMD). Treatment 34M66C had the highest OMD (67.20%) and similar to treatment 66M34C (66.28%). Treatment 100M had 59.79% OMD while treatment 100C had the least (50.58%). There was effect (P= 0.0199) of treatments on neutral detergent fibre digestibility (NDFD). Treatment 34M66C had the highest NDFD (57.80%) and similar to those of treatments 100M (56.82%) and 66M34C (56.00%). Treatment 100C had the least NDFD (50.12%). Nitrogen utilization of sheep fed experimental diets is shown in Table 3. Effect (P = 0.0001) of treatments was observed on nitrogen intake (NI). Treatment 34M66C had the highest NI (21.35 g/d) and similar to treatment 66M34C (20.94 g/d) followed by treatment 100C (14.94 g/d). The least NI (12.89 g/d) was recorded for treatment 100M. Effect (P <0.0001) of treatments was observed on fecal nitrogen (FN). Treatment 100M had the lowest FN (1.161g/d) followed by treatment 100C (4.097 g/d). Treatment 34M66C had the highest FN (7.496 g/d) and was similar to treatment 66M34C (6.490 g/d). Effect (P<0.0001) of treatment was observed on urinary nitrogen (UN). Treatment 100M had the least UN (2.120 g/d) while the rest of the treatments had similar UN. Effect (P = 0.0002) of treatments was observed on nitrogen balance (NB). Treatment 100M had the highest NB (9.609 g/d) while treatment 100C had the least (1.081 g/d). Treatments 66M34C and 34M66C had similar NB (6.215 and 4.483 g/d).

Table 3: Nitrogen utilization of sheep fed experimental diet

Parameters (g/day)	Treatments				SE	P value
	100M	66M34C	34M66C	100C		
NI	12.89[c]	20.95[a]	21.35[a]	14.94[b]	0.9614	<0.0001
FN	1.161[c]	6.490[a]	7.496[a]	4.097[b]	0.6523	<0.0001
UN	2.120[b]	8.250[a]	9.372[a]	9.768[a]	0.8293	<0.0001
NB	9.609[a]	6.215[b]	4.483[b]	1.081[c]	0.8321	0.0002

100M= 100% maize, 66M34C=66%maize 34% treated maize cobs, 34M66C=34% maize 66% treated maize cobs , 100C= 100% treated maize cobs

Rumen ammonia and pH of sheep fed experimental diets are shown in Table 4. Effect (P = 0.5635) of treatments was not observed on rumen ammonia while it was observed on rumen pH (P<0.0001). Treatment 100M had the lowest pH (6.12) while 100C had the highest (6.94). Treatments 66M34C and 34M66C had similar pH of 6.77 and 6.74, respectively.

Table 4: Rumen ammonia and pH of sheep fed experimental diet

Parameters	Treatments				SE	P value
	100M	66M34C	34M66C	100C		
Rumen ammonia (mg/ml)	24.00	23.62	23.55	23.75	0.1023	0.5638
Rumen pH	6.120[c]	6.770[b]	6.740[b]	6.940[a]	0.0824	<0.0001

100M= 100% maize, 66M34C=66%maize 34% treated maize cobs, 34M66C=34% maize 66% treated maize cobs, 100C= 100% treated maize cobs

Performance characteristics of sheep fed experimental diets are shown in table 5. Effect (P= 0.0001) of treatments was observed on feed intake (FI). Treatments 66M34C and 34M66C had the highest FI (1.0000 kg) and were similar followed by treatment 100M (0.7000 kg). The least FI was recorded for treatment 100M (0.6000 kg). Effect (P<0.0001) of treatments was observed on final weight (FW). Treatment 34M66C had the highest FW (35.25 kg) followed by treatment 66M34C (34.00 kg). Treatments 100M and 100C had similar weight of 33.45 and 33.00 kg respectively. Effect (P<0.0001) of treatments was observed on weight gain (WG). Treatment 34M66C had the highest WG (1.700 kg) followed by treatment 66M34C (1.600 kg) while treatments 100M and 100C gained 1.380 and 1.200 kg respectively. Effect (P<0.0001) of treatment was also observed on average daily gain (ADG) and followed the same trend as in WG. Treatment 34M66C had the highest ADG (0.1417 kg/d) followed by treatment 66M34C (0.1333kg/d) while treatments 100M and 100C gained 0.115 and 0.1000 kg/d respectively. Effect (P<0.0001) of treatment was observed on feed conversion ratio (FCR). Treatment 100M had the least feed consumption to gain (5.217) while treatments 66M34C, 34M66C and 100C had 7.500, 7.059 and 7.000 FCR, respectively.

Table 5: Performance characteristics of sheep fed experimental diets

Parameters	Types of treatment					
	100M	66M34C	34M66C	100C	SE	P value
FI(kg)	0.6000[c]	1.0000[a]	1.0000[a]	0.7000[b]	0.0461	<0.0001
IW(kg)	32.07[bc]	32.40[b]	33.55[a]	31.80[c]	0.4614	<0.0001
FW (kg)	33.45[c]	34.00[b]	35.25[a]	33.00[c]	0.4802	<0.0001
WG (kg)	1.380[c]	1.600[b]	1.700[a]	1.200[d]	0.0501	<0.0001
ADG (kg)	0.1150[c]	0.1333[b]	0.1417[a]	0.1000[d]	0.0042	<0.0001
FCR	5.217[d]	7.500[a]	7.059[b]	7.000[c]	0.2257	<0.0001

100M= 100% maize, 66M34C=66%maize 34% treated maize cobs, 34M66C=34% maize 66% treated maize cobs, 100C= 100% treated maize cobs.

Discussion

Despite the fact that the maize grain-based diet (100M) had low NDF, ADF and ADL, it was characterized by low intake and digestibility. All animals on this treatment had diarrhea and not willing to eat much probably because they initially selected the more palatable grains that were rapidly fermented. The reason for the low intake and digestibility may be attributed to the rapid fermentation of the grain leading to a drop in the rumen pH, hence the inability of the microbes to digest fibre (Nocek and Tamminga, 1991). According to Oba and Allen (2000) when forages that are more fermentable are fed, rumen pH could be lowered leading to low NDF digestibility. Similarly, Overton *et al.* (1995) reported that when rapidly fermentable grains are fed, ruminal pH is lowered leading to lower NDF digestibility, however, there is an increase in ruminal starch digestibility. Oba and Allen (2000) also reported that when ruminal starch is too rapid, flux of propionate to the liver might limit DM intake if oxidized instead of being used for gluconeogenesis. Therefore, in order to avert ruminal starch fermentation, site of starch digestion can be shifted to the intestine by increasing the NDF contents of ruminants feed (Overton *et al.*, 1995) since starch is low in NDF which could be the reason for the rapid ruminal fermentation. Low intake and digestibility also observed on the treatment with 100% urea-wood ash treated maize cob based diet (100C) may be attributed to its high NDF, ADF and ADL compared to the rest of the treatments since more fibrous feed reside longer in the rumen thereby reducing passage rate and hence low intake. Allen and Mertens (1988) reported that NDF digestibility is determined by the fraction of NDF that is potentially digestible, the rate of NDF degradability in the rumen and the rate of passage from the rumen. According to Jung and Allen (1995), filling properties of feed is dependent on how fibrous a feed is since a more fibrous feed degrades and passes from the reticulorumen more slowly than the non fibrous feed. Van Soest (1964) reported that NDF and ADF were negatively related to voluntary dry matter intake (VDMI) in sheep fed forage diet and that NDF was more related to VDMI than ADF in both legumes and grasses. Jung and Allen (1995) also reported that higher VDMI would increase in ruminants consuming forages with low NDF content. Treatment 34M66C had better intake and digestibility than the rest of the treatments probably due to its moderate grain content that did not impede the activities of rumen. This is because ruminal digestion of fibre and starch might interact to shift the site of nutrient digestion from the rumen to the intestinal tract (Voelker and Allen, 2003). The reason why treatments 66M34C and 34M66C lost more nitrogen in faeces and urine may be attributed to their higher intakes of nitrogen compared to treatments 100M and 100C with. Van Soest (1994) reported that excess nitrogen derived from microbial nitrogen and proteins that are not part of microbial proteins is normally secreted in milk or lost in faeces and urine of ruminants. Groff and Wu (2005) also reported that when CP in diets is increased there is a general increase in intake and this leads to increased losses of nitrogen into milk, urine and faeces. Even though all the treatment groups had positive nitrogen balance, treatment 100M had the highest because its nitrogen losses to faeces and urine were minimal compared to the rest of the treatments. Many factors can lead to excretion nitrogen into urine or faeces. According to Tamminga (1992), urinary nitrogen can result from ammonia lost from the rumen, metabolic losses from the gut, maintenance losses and inefficient conversion of absorbed amino acid into milk and body proteins. Groff and Wu (2005) reported that replacing by-product NDF with starch in an isonitrogeneous diets increased urinary excretion and decreased fecal excretion of nitrogen. The shift from urinary to fecal nitrogen as fibre replaces starch might be as a result of fibre fermented in the hindgut or by lower microbial capture of ruminally degradable protein in the rumen since fibre is less fermentable than starch (Gressley and Armentos, 2007). It has been observed that increased DMI stimulated by RUP may also lead to increased fecal nitrogen in diets with high RUP and not as a result of excretion of undigested feed protein (Flis and Wattiaux, 2005). The rumen ammonia concentrations in all treatments were similar. The range of NH_3-N concentration was 23.55 to 24.00 mg/100ml. This observation was similar to the figures reported by Hamad *et al*. (2010) who reported values of 22.87 to 23.64 mg/100 ml in lambs fed maize cob-based diet measured 6 hrs post feeding. Khan *et al*. (2006) reported 20.6 to 25.3 mg/100 ml concentration after 6 hours in buffalo bulls fed restricted diets containing urea treated maize cobs ensiled with or without different additives. Similarly, Wanapat *et al.* (2012) reported mean values of 19.4 mg/100 ml NH_3 when ground maize cobs wholly replaced cassava chips in buffalo diet. Preston and Leng (1987) suggested 15 mg/100 ml rumen fluid to maximize fibre digestion and 20 mg/100 ml fluid to maximize intake. Values obtained in the present study were all above the requirements for maximization of both fibre digestion and intake as suggested by Preston and Leng (1987). The result of the rumen pH showed that it ranged from 6.117 to 6.937. Orskov and Ryle (1990) reported that cellulolytic bacteria require pH of 6.2 – 7 while Wanapat and Pimpa (1999) also reported that optimum level of pH in the rumen should be 6.5 to 7.0 which were optimal for microbial growth when animals feed mostly on roughages. The normal rumen pH implied that volatile fatty acids (VFA's) which are by-products of fermentation rapidly diffused through the rumen wall instead of accumulating within the rumen. Accumulation of VFA's could lead to drop in pH because of increased acidic environment hence resulting in decreased DM digestibility. The low pH recorded for the 100% maize grain-based diet might have led to the low intake and digestibility observed as a result of the rapid fermentation of the maize grain in the rumen. When rapidly fermentable grains are fed, ruminal pH is lowered leading to lower NDF digestibility but increased ruminal starch digestibility (Overton *et al.*, 1995). The high amount of grain in treatment 100M might have induced the diarrhea and low intake observed in all the animals that were on this diet in each period. The higher feed intake and digestibility recorded for treatment 34M66C had also translated into higher WG and ADG as compared to the rest of the treatments. However, treatment 100M had lower feed consumption to gain ratio which was as a result of the lower feed intake. Various authors have also reported improvement in intake and digestibility of ruminants fed urea treated maize cobs (Khan *et al*., 2006; Hamad *et al*., 2010; Wanapat *et al*., 2012).

Conclusion

Substitution of 66% maize grain with urea-wood ash treated maize cobs resulted in higher FI, digestibility, WG and ADG. It was, therefore, concluded that maize cobs treated with 25%U and 75%WA could replace 66% maize grain in sheep diet with added advantage of reducing cost of feed at the same time supplying minerals present in wood ash to the animal.

Acknowledgement

Tertiary Education Trust Fund (TETFUND) Abuja, Nigeria, is acknowledged for sponsorship of the research work.

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Received: 24th April, 2021
Accepted: 16th August, 2021