Journal of Animal Science and Products (JASP)
International peer-reviewed journal
4 (1): 73-84, 2021

Chemical Composition and Gas Production Substrates of Maize Cobs Treated with Combinations of Urea and Wood Ash

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ARTICLE INFO

Research Article

Summarised from PhD thesis and also presented at the 11th International Animal Science Conference, Cappadocia,Turkey.

Received : 19.03.2021
Accepted : 11.06.2021

Keywords

Truly degraded substrate
Microbial mass protein
Partitioning factor
Crop residue

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ABSTRACT

Effect of treating maize cobs with a combination of urea and wood ash (WA) on chemical composition and in vitro gas production truly degraded substrate (TDS) were examined. The treatments were:1) 100U = (100% urea and 0% wood ash), 2) 75U25WA = (75% urea and 25% wood ash), 3) 50U50WA = (50% urea and 50% wood ash), 4) 25U75WA = (25 % urea and 75% wood ash) and 5) 0U0WA = (Untreated maize cobs). The concentrations were reconstituted as follows: 100U = 5 kg urea dissolved in 100 liters of water /200 kg maize cobs; 75U25WA = 3.75 kg urea mixed with 7.5 kg WA in 100 liters of water/200 kg maize cobs; 50U50WA = 2.5 kg urea mixed with 15 kg WA in 100 liters of water/200 kg maize cobs; 25U75WA = 1.25kg urea mixed with 22.5 kg WA in 100 liters of water/200 kg maize cobs; Untreated = 200 kg maize cobs mixed with 100 kg water. Chemical composition of samples were analyzed to determine dry matter (DM), organic matter (OM), ash, crude protein (CP), neutral detergent fibre (NDF), acid detergent fibre (ADF) and acid detergent lignin (ADL). The samples were then incubated in vitro for 6, 12, 24, 48 and 72 hrs and their DM degradation kinetics determined. It was observed that crude protein contents declined as urea is substituted with WA while the ash contents increased. Treatment 25U75WA had the highest reduction in both NDF and ADF (660 and 360 g/kg) compared to those of 100U (700 and 380g/kg) and 0U0WA (840 and 430 g/kg). In contrast treatment 25U75 had the highest neutral detergent soluble (340 g/kg) while 0U0WA had the least (160 g/kg).Treatment 25U75WA had the highest gas production (73.5ml per 0.5mg sample; P=0.0001) and TDS (70.53%) while 0U0WA had the least. Treatment 25U75WA also resulted in the highest microbial mass protein (MMP) (53.55 mg) while 0U0WA had the least (25.20 mg). Treatment 25U75WA had the highest efficiency of microbial mass protein (EMMP) and partitioning factor (PF) (23.68 and 2.883) while 0U0WA had the least (12.00 and 2.500). It was concluded that combinations of 25% urea and 75% WA in the treatment of maize cobs had beneficial synergic effect and improved its nutritive value compared to treating it with urea alone.

Lütfen aşağıdaki şekilde atıf yapınız / Please cite this paper as following;

Abdulazeez, A., Tsopito, C.M., Madibela, O.R., 2021. Chemical composition and gas production substrates of maize cobs treated with combinations of urea and wood ash, Journal of Animal Science and Products (JASP) 4 (1):73-84.
DOI: 10.51970/jasp.879558

Üre ve Odun Külü Kombinasyonları ile İşlenmiş Mısır Koçanı'nın Kimyasal Bileşimi ve Gaz Üretimi

MAKALE BİLGİSİ

Araştırma Makalesi

Doktora tezinden özetlenmiş ve ayrıca 11. Uluslararası Hayvan Bilimi Konferansında sunulmuştur, Kapodokya, Türkiye.

Geliş: 19.03.2021
Kabul: 11.06.2021

Anahtar Kelimeler

Gerçek sindirilebilir madde
mikrobiyal kütle protein
Parçalama faktörü
Bitkisel artık

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ÖZET

Mısır koçanlarının, üre ve odun külü (WA) kombinasyonu ile işlemden geçirilmesinin kimyasal bileşim ve in vitro gaz üretimi gerçek sindirilebilir madde (TDS) üzerindeki etkisi incelenmiştir. Muameleler: 1) 100U = (% 100 üre +% 0 odun külü), 2) 75U25WA = (% 75 üre +% 25 odun külü), 3) 50U50WA = (% 50 üre +% 50 odun külü), 4) 25U75WA = (% 25 üre + % 75 odun külü) ve 5) 0U0WA = (işlenmemiş mısır koçanı). Örnekler kuru madde (DM), organik madde (OM), kül, ham protein (CP), nötr deterjan selüloz (NDF), asit deterjan selüloz (ADF) ve asit deterjan lignin (ADL) için analiz edildi. Örnekler in vitro olarak 6, 12, 24, 48 ve 72 saat inkübe edildi ve bunların DM bozunma kinetikleri y = a + b (1-e-ct) denklemi kullanılarak belirlendi. Üre WA ile ikame edildiğinde kül içeriği arttıkça ham protein içeriğinin azaldığı görüldü. Muamele 25U75WA, 100U (700 ve 380 g / kg) ve 0U0WA (840 ve 430 g / kg) ile karşılaştırıldığında hem NDF hem de ADF'de (660 ve 360 g / kg) en yüksek azalmaya sahipti. Buna karşılık, muamelede 25U75 en yüksek nötr deterjan çözünürlüğüne (340 g / kg) sahipken, 0U0WA en düşük (160 g / kg) bulundu. 25U75WA muamelesi en yüksek gaz üretimine sahipti (0,5 mg numune başına 73,5 ml; P = 0,0001) ve gerçek sindirilebilir madde (TDS) (% 70.53) en az 0U0WA'ya sahipti. Muamele 25U75WA ayrıca en yüksek mikrobiyal kütle proteinine (MMP) (53.55 mg) neden olurken, 0U0WA en azına (25.20 mg) sahipti. Muamele 25U75WA, mikrobiyal kütle proteini (EMMP) ve parçalama faktörünün (PF) (23.68 ve 2.883) en yüksek verimine sahipken, 0U0WA en düşük (12.00 ve 2.500) bulundu. Mısır koçanlarının muamelesinde % 25 üre ve % 75 WA kombinasyonlarının yararlı bir sinerjik etkiye sahip olduğu ve tek başına üre ile muamele edilmesine kıyasla besleyici değerini iyileştirdiği sonucuna varılmıştır.

Introduction

Crop residues are leftovers of crop harvest and threshing, they also differ from by-products of processing like oil cakes, bran etc (Nordblom&Shomo, 1995). Allen (1995) reported that many crop residues including maize cobs are low in protein and have highly lignified cell walls that reduce intake and digestibility. Most of these crop residues including maize cobs are always left in the field after harvest and sometimes burnt; however, they could be collected and stored for feeding livestock during the dry season when feeds are scarce. Various techniques are being used to improve the nutritive values of crop residues and one of the most effective and popular method is urea treatment (Chenost, 1995), however, urea is mostly imported in Africa hence beyond the reach of poor resource farmers (Abdulazeez et al., 2016). Apart from the cost, another shortcomings associated with urea is its contribution to environmental pollution when converted to ammonia (Abdulazeez et al., 2016). Wood ash had also been used in the treatment of crop residues as reported by several authors such as

Adebowale et al. (1991); Nolte et al. (1987); Rahman et al. (2009); Solomon et al. (2012). The advantage of wood ash over urea is that it is freely available at household level without cost and rich in minerals, however, its major disadvantage is nitrogen deficiency useful to rumen microbes for fibre digestion (Abduazeez et al., 2016).

Investigations on use of urea (Preston, 1985; Chenost, 1995; Fall et al., 1989) or wood ash (Adebowale et al., 1991; Nolte et al., 1987; Rahman et al., 2009; Solomon et al., 2012) in the treatment of crop residues have been documented, however, information on combination of both in crop residue treatments is lacking. It is expected that when urea and wood ash are combined in crop residue treatments, cost would be reduced. Also both minerals and nitrogen present in wood ash and urea respectively would be incorporated into the crop residues being treated. The objectives of this research was to investigate the effect of treating maize cobs with a combination of urea and wood ash on chemical composition and truly degraded substrate (TDS) parameters of maize cobs.

Materials and Methods

The research was carried out at Botswana University of Agriculture and Natural Resources, Content Farm, Sebele, Gaborone, Botswana. Maize cobs used for the research were sourced from Molepolele village which is 70 km from the university and ground using a 4 mm sieve. In all cases, 5% urea and 30% wood ash were dissolved in 100ml of water (w/v) /200g ground maize cobs (Nolte et al., 1987) were used as a standard for the treatment. The treatments were as follows: 100U (100% urea and 0% wood ash), 75U25WA (75% urea and 25% wood ash), 50U50WA (50% urea and 50% wood ash), 25U75WA (25 % urea and 75% wood ash) 0U0WA (Untreated maize cobs). The samples were then stored in air-tight plastic bags for 7 days at temperature of 37ºC (Sundstol., 1985). After the seventh day, chemical composition of the treated samples were then determined. The untreated maize cobs were only wetted and left to dry as they were bound to go moldy when stored in air- tight plastics. The concentrations were reconstituted as follows:
100U = 5 kg urea dissolved in 100 liters of water /200 kg maize cobs.
75U25WA = 3.75Kg urea mixed with 7.5 kg WA in 100 liters of water/200 kg maize cobs.
50U50WA = 2.5 kg urea mixed with 15 kg WA in 100 liters of water/200 kg maize cobs.
25U75WA = 1.25kg urea mixed with22.5 kg WA in 100 liters of water/200 kg maize cobs.
Untreated = 200 kg maize cobs mixed with 100 kg water.

Laboratory Analysis of Samples

In determining the chemical composition of the samples, dry matter was determined by drying samples in forced air oven at 60° C for 24 hr (DM, ID number 930.15) while 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). ANKOM fiber analyzer was used to determine NDF, ADF and ADL (Ankom Technology Corporation, Fairport, NY, USA) according to the procedure of Van Soest et al, (1991). Sodium sulphite and alpha amylase were also added in the analysis of NDF. Nitrogen was determined by the Kjeldahl method according to AOAC (1999) (ID number 955.04) while CP was determined by multiplying N by 6.25 (ID number 954.01).

In vitro Gas Production

Prior to incubation of feed samples in calibrated glass syringes with rumen fluid, they were milled using 1mm sieve (Menke & Steingass, 1988). The rumen fluid was obtained from two fistulated steers fed commercial concentrate mixed with crushed corn cobs. They were fed twice daily (8am and 4pm) for three days prior to collection of rumen fluid. After collection of the rumen liquor in a thermo flask lined with four layered cheese clothes,it was then flushed with carbon dioxide in order to create an anaerobic conditions needed by rumen microorganisms. Samples (500mg) were weighed in triplicates into calibrated glass syringes of 100ml and then pre warmed at 39°C followed by injection of 30ml rumen fluid-buffer (2:1 v/v) mixture into each syringe. The introduction of the rumen fluid into the syringe was done with CO_2 flushing followed by incubation in a water bath at 39°C. The buffer used was made up of: A = $MgSO_4.H_2O$+ NaCl + KH_2SO_4 + $CaCl_2.H_2O$ + Urea and B = $NaSO_4.9H_2O$ + $NaCO_3$. The gases produced were then recorded at intervals of 6, 12, 24, 48 and 72 hours.

The procedure outlined by Makkar, (2010) was employed in the determination of TDS. The residues left after 72 hours incubation in the glass syringes were treated with NDF solution in a beaker for one hour. The residues were then filtered into a crucible, washed with hot water and then oven dried overnight at 100^0C. Weights of empty crucibles were then subtracted from the weight of crucibles plus undegraded feed residues in order to determine the weight of the undegraded feed sample. The undegraded samples were then transferred to the muffle furnace and ashed at 550^0C. In vitro truly TDS parameters were then determined according to the procedure outlined by Makkar, (2010) as follows:

Weight of undegraded residue	= a (mg)
Weight of ash	= b (mg)
Truly undegraded organic matter	= a – b
(500*DM%/100) (1-ash%/100)	= c (mg)
% organic matter digestibility	= (a – b) 100/c
Microbial mass production (mg)	= (a – b) – $2.2GP_{24hr}$
Efficiency of microbial mass production	= ((a – b) – $2.2GP_{24hr}$)/a – b
Partitioning factor	= c – (a – b)/ GP_{24hr}
ME (MJ/Kg DM)	= 2.20 +$0.136GP_{24h}$+0.057CP
2.2	= Stoichiometric factor
GP_{24hr}	= Gas production at 24 hours

Statistical Analysis

Data generated from chemical composition and TDS were analyzed using the general linear models (GLM) procedure of SAS (2002) and means separated using Duncan's multiple range test (Steel and Torrie, 1984).

Results

The chemical composition of untreated and treated maize cobs are shown in Table 1. The untreated maize cobs (0U0WA) had the highest dry matter (DM) content of 952 g/kg and differed significantly (P= 0.0068) from the treated (100U, 75U25WA, 50U50WA and 25U75WA. The DM contents of all the treated cobs were similar

Table 1. Chemical composition (g/kg) of untreated and treated maize cobs
Tablo 1. İşlenmemiş ve işlenmiş mısır koçanlarının kimyasal bileşimi (g / kg)

Chemical composition (g/kg)	Types of treatment						
	100U	75U25WA	50U50WA	25U75WA	0U0WA	SE	P values
DM	795.0^{b}	785.0^{b}	790.0^{b}	775.0^{b}	952.0^{a}	23.28	0.0068
ASH	37.74^{d}	79.59^{c}	123.5^{b}	170.8^{a}	34.11^{d}	17.42	<0.0001
OM	962.3^{a}	920.4^{b}	876.5^{c}	829.2^{d}	965.9^{a}	17.42	<0.0001
CP	127.9^{a}	84.56^{b}	70.95^{bc}	61.86^{c}	34.65^{d}	10.41	0.0009
NDF	700.0^{b}	660.0^{c}	690.0^{bc}	660.0^{c}	840.0^{a}	22.56	0.0002
ADF	380.0^{b}	360.0^{b}	370.0^{bc}	360.0^{b}	430.0^{a}	8.940	0.0024
ADL	40.00^{b}	50.00^{ab}	50.00^{ab}	70.00^{a}	60.00^{ab}	4.270	0.2100
HC	320.0^{b}	300.0^{b}	320.0^{b}	300.0^{b}	410.0^{a}	14.06	0.0025
NDS	300.0^{b}	340.0^{a}	310.0^{ab}	340.0^{a}	160.0^{c}	22.55	0.0002
ME KJ/kg	13.40	13.22	13.55	13.23	13.82	0.1682	0.8615

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. 100U=100% urea, 75U25WA=75% urea + 25% wood ash, 50U50WA= 50%urea+50% wood ash, 25U75WA=25%urea +75% wood ash, 0U0WA= Untreated

Differences (P= 0.0001) were observed for ash contents between the treated and untreated maize cobs. Treatments 0U0WA and 100U had similar organic matter contents (965.9 and 962.3 g/kg respectively) but differed (P<0.0001) significantly from the other treatments. The highest CP content was recorded for treatment 100U (127.9 g/kg) and the lowest for treatment 0U0WA (34.65 g/kg) (P= 0.0009). Treatments 75U25WA and 50U50WA had similar CP contents (84.56 and 70.95 g/kg) while 50U50WA (70.95g/kg) and 25U75WA (61.86 g/kg) also had similar contents.

Untreated maize cob had the highest NDF content of 840 g/kg while treatments 100U, 75U25WA, 50U50WA, 25U75WA had similar NDF contents of 700, 660 690 and 660 g/kg respectively (P=0.0009). There was effect of treatment on ADF (P= 0.0024) with treatment 0U0WA recording the highest content of 430 g/kg. Treatments 100U, 75U25WA, 50U50WA, 25U75WA had similar ADF contents of 380, 360, 370 and 360 g/kg respectively. There were no effects (P= 0.2100) of treatment on ADL contents of the treated and untreated maize cobs. Effect of treatments were observed for hemicellulose (HC) (P= 0.0025). Treatments 100U, 75U25WA, 50U50WA, 25U75WA had 320, 300, 320 and 300 g/kg of HC contents respectively and were similar but different from treatment 0UOWA which had the highest content (410g/kg).

Effect of treatments was observed for neutral detergent soluble (NDS) (P=0.0002). Treatment 0U0WA had the lowest NDS content of 160g/kg while treatments 75U25WA and 25U75WA recorded 340g/kg each. Treatments 100U and 50U50WA had similar NDS contents of 300 and 310g/kg respectively. No effect was observed for energy content between the treated and untreated maize cobs.

In vitro gas production characteristics of treated and untreated maize cobs are shown in Figure 1. Treatment 0U0WA had the highest gas production (16.5 ml) at 6 hrs of incubation and differed (P=0.0065) significantly from the rest of the treatments. Treatments 100U, 75U25WA, 50U50WA, 25U75WA had 9.5, 10.00, 10.50 and 10.50 ml gas production at 6 hrs respectively and were similar. Effect of treatment was not observed (P=0.8042) for gas production at 12 hrs of incubation; however, there was effect (P= 0.0012) at 24hrs of incubation. Treatments 100U and 50U50WA had similar gas production (48.50 and 47.50 ml) while treatments 75U25WA and 25U75WA also had similar gas production (45.00 and 44.50 ml) at this time. The least gas production at 24hrs of incubation was from treatment 0U0WA (42.50 ml).Effect of treatments was observed on gas production at 48hrs of incubation (P=0.0001). Treatment 25U75WA produced the highest gas (73.50 ml) while treatment 0U0WA produced the least gas (50.50 ml).

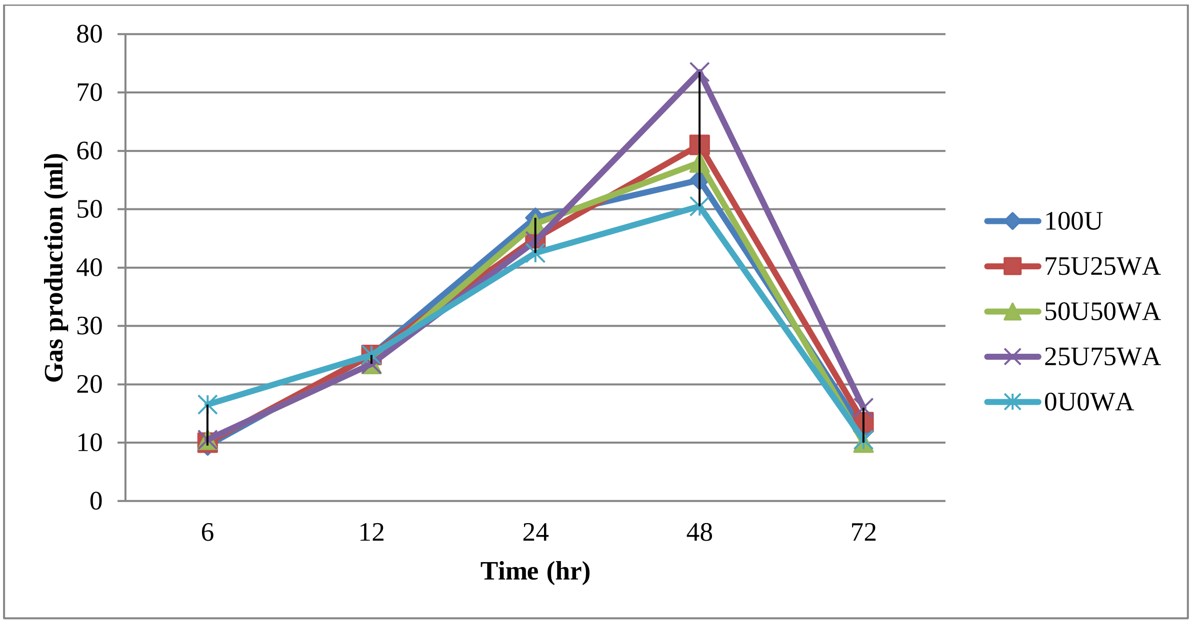

Figure 1: In vitro gas production (ml/500mg) of untreated and treated maize cobs
Şekil 1: İşlenmemiş ve işlenmiş mısır koçanlarının in vitro gaz üretimi (ml / 500 mg)

In vitro gas production parameters of untreated and treated maize cobs are shown in Table 2. Effect of treatment (P= 0.0431) was observed on rapidly soluble 'a' gas production fraction. Treatment 25U75WA had the highest 'a' fraction (8.516 ml) while treatments 100U, 50U50WA and 0U0WA all had similar 'a' fractions. Effects of treatments (P= 0. 0539) was observed on gas production 'a+b' fraction. Treatment 25U75WA had the highest potential gas production 'a+b' (47.95 ml) while those for the rest of the treatments were similar (39.50, 39.86 and 36.91 ml).

Table 2. In vitro gas production (ml/500mg) parameters of untreated and treated maize cobs
Tablo 2. İşlenmemiş ve işlenmiş mısır koçanlarının in vitro gaz üretim (ml / 500 mg) parametreleri

	Treatments						
In vitro gas production parameters	100U	75U25WA	50U50WA	25U75WA	0U0WA	SE	P values
b	39.60[ab]	39.59[ab]	39.46[b]	39.43[b]	40.40[a]	0.1428	0.1366
c	0.0926	0.0864	0.0982	0.0716	0.0996	0.0048	0.4107
a+b	39.50[b]	39.86[b]	35.74[b]	49.95[a]	36.91[b]	1.592	0.0539
ed	29.65[ab]	29.66[ab]	26.50[b]	36.01[a]	27.53[b]	1.288	0.1043

100U=100% urea, 75U25WA=75% urea + 25% wood ash, 50U50WA= 50%urea+50% wood ash, 25U75WA=25%urea +75% wood ash, 0U0WA= Untreated, a= gas production from soluble fraction, b= insoluble but fermentable gas production from insoluble but fermentable fraction, c= gas production rate, a+b= potential gas production, ed= effective gas production.

Truly degraded substrate (TDS), gas roduction (GP), microbial mass production (MMP), efficiency of microbial mass production (EMMP) and partitioning factor (PF) of untreated and treated maize cobs are shown in Table 3.No effect of treatments was observed (P = 0.7621) for TDS (mg) but observed (P = 0.0110) for TDS (%). Treatment 25U75WA had the highest TDS (70.53%) and similar to 50U50WA (63.89%). Treatment 0U0WA had the lowest TDS (45.65%). No effect (P = 0.6470) of treatments was observed for GP at 24hrs of incubation. There was effect (P = 0.0040) of treatments on MMP. Treatment 25U75WA had the highest MMP (53.55 mg) while 0U0WA had the least (25.20 mg). The MMP from treatment 25U75WA was similar to those of 100U, 50U50WA and 75U25WA while effect (P = 0.0005) of treatments was observed on EMMP. Treatment 25U75WA had the highest EMMP (23.68%) while 0U0WA had the least (12.00%). Treatments 100U, 75U25WA and 50U50WA had similar EMMP. Effect (P = 0.0005) of treatments was observed on PF and followed the same pattern as in EMMP. Treatment 25U75WA had the highest PF (2.883) while 0U0WA had the least PF (2.500). The PF for treatments 100U, 75U25WA and 50U50WA were all statistically the same.

Table 3. In vitro truly degraded substrate parameters of treated and untreated maize cobs
Tablo 3. İşlenmiş ve işlenmemiş mısır koçanlarının in vitro gerçek anlamda bozulmuş substrat parametreleri

Parameters	Types of treatment						
	100U	75U25WA	50U50WA	25U75WA	0U0WA	SE	P values
TDS (mg)	212.5	216.3	221.3	226.3	210.0	3.772	0.7621
TDS (%)	55.62[bc]	59.84[b]	63.89[ab]	70.53[a]	45.65[c]	2.933	0.0110
GP(24hrs)(ml)	77.00	77.50	80.50	78.50	84.00	1.447	0.6470
MMP(mg)	43.10[b]	45.75[ab]	44.15[ab]	53.55[a]	25.20[c]	3.221	0.0040
EMMP	20.32[b]	21.13[b]	19.92[b]	23.68[a]	12.00[c]	1.329	0.0005
PF	2.761[b]	2.790[b]	2.748[b]	2.883[a]	2.500[c]	0.1682	0.0005

100U=100% urea, 75U25WA=75% urea + 25% wood ash, 50U50WA= 50%urea+50% wood ash, 25U75WA=25%urea +75% wood ash, 0U0WA= Untreated, TDS= truly degraded substrate, GP= gas production at 24 hours, MMP= microbial mass production, EMMP= efficiency of microbial mass production, PF= partitioning factor.

Discussion

The ash content of the 25U75WA was highest because it had the highest inclusion rate of wood ash. As can be observed, the ash content increased as the amount of wood ash substitution also increased, which is in agreement with the findings of other workers (Adebowale et al., 1991; Imbeah, 1999; Ramirez et al., 1991; Nolte et al.,1987). Treatment of maize cobs with 100% urea led to increase in its CP contents, however, when portions of the urea were substituted with wood ash, the CP contents reduced. Several authors have also reported increases in CP contents of urea treated crop residues (Preston, 1985; FAO, 2002; Fall et al., 1989; Chenost, 1995; Rahman et al., 2009). Sundstol, (1985) treated crop residues using a combination of urea and lime with the hope of incorporating nitrogen from urea and calcium from lime into the treated crop residues. It has also been reported that combinations of urea and lime inhibit mould formation as a result of the action of ammonia generated by urea compared to when lime was used alone for treatments (Zaman and Owen, 1990; Zaman et al., 1994; Trach et al., 2001). The combinations of urea and wood ash in maize cobs treatment therefore has the advantage of increasing CP contents, inhibition of mould formation at the same time incorporating minerals from wood ash.

Individually urea and wood ash have been implicated in the reduction of NDF and ADF contents of crop residues (Preston, 1985; FAO, 2002; Fall et al., 1989; Chenost, 1995; Adebowale, 1985; Imbeah, 1999; Ramirez et al., 1991; Nolte et al., 1987). It has been reported that alkali from lime which is more potent than ash solution was stronger than ammonia released during treatment of crop residues (Chaudhry, 1998). Therefore, a combination of urea and wood ash would then be synergistically beneficial. Indeed this was observed in the current study where cobs treated with 25% urea combined with 75% WA had their NDF and ADF reduced significantly compared to those treated with 100% urea. The same effect was reflected in the hemicellulose where those of the untreated remained high. This implied that the synergistic effect of combining both urea and wood ash were more efficacious in reducing both the NDF and ADF contents of maize cobs compared to when urea was used alone probably because the combination of alkali in wood ash and urea was more potent than the ammonia generated by urea treatment alone (Chaudhry, 1998). According to Makkar (2003), urea was efficient in disrupting lignin-carbohydrate complexes, thus improving fibre digestion and also increasing the nitrogen contents of feed. Jackson (1977) attributed the decrease in fibre content to the disruption of the cell wall by solubilizing hemicelluloses, lignin and silica, hydrolyzing uronic acid, acetic acid esters and swelling cellulose.

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) reported that VDMI would increase in ruminants consuming forages with low NDF content. The NDF content of forage has been reported as the best chemical predictor of VDMI (Waldo, 1986). It is therefore evidently clear that perhaps treatment 25U75WA would result in increase in VDMI due to reduction in NDF and ADF contents of maize cobs. The neutral detergent soluble (NDS) of 25U75WA were also higher (340 g/kg) than those of the 100U-treated (300 g/kg), implying that treatment 25U75WA resulted in richer cell soluble materials that would be readily available to the rumen microbes. The untreated maize cobs had the highest hemicellulose compared to the treated which may not be readily available for microbial degradation due to its association with lignin than any other polysaccharide fraction and its bonding to phenolic compounds (Van Soest et al., 1991; Tuah and Orskov, 1989).

The gas production characteristics for the treated and untreated maize cobs indicated that at 48 hrs of incubation, treatment 25U75WA had the highest gas production (73.00 ml) while treatments 100U and 0U0WA had 55.00 and 50.50 ml respectively. Treatment 25U75WA also had the highest gas production ‘a’ and ‘a+b’ fractions, indicating its superiority over the rest of the treatments. Gas production alone however may not be used to characterize quality of feed since some of the gases produced are products of bicarbonate buffer and not from substrate fermentation (Makkar, 2010). More information can only be generated from its *in vitro* truly degraded substrate parameters. Measurement of gas alone with time only implies the measurement of nutritional wasteful and environmentally hazardous products (CO_2 and CH_4) (Makkar, 2010). In order to select feeds with high microbial efficiency, adoption of gas measurements alone, which is a reflection of short chain fatty acids (SCFA), would be misleading and might result in selection against maximum microbial mass yield (Blummel et al., 1997; Makkar, 2010). It is, therefore, necessary to determine the truly degraded substrate parameters concomitantly with the gas production profile in order to have a more reliable result.

Despite the fact that the untreated maize cobs (0U0WA) had the highest gas production at 24 hrs, treatment 25U75WA had the highest percent truly degraded substrate (TDS) which corroborated the assertion that gas production only should not be used for characterization of feed qualities since some of the gases could have been generated from the buffering of bicarbonate buffer (Blummelet al., 1997; Makkar, 2010). Treatment 0U0WA had the least microbial mass production and partitioning factor (PF) while the highest was recorded for treatment 25U75WA. Presence of higher ash contents in 25U75WA might have catalyzed rapid microbial multiplication hence more attachment to fibre and digestion. Higher concentrations of microbial mass production in 25U75WA imply availability of more ruminal microbes that would be enzymatically digested at the hind gut to the benefit of the host animal. Several authors have suggested that substrates should be selected based on high PF and TDS but low gas production (Blummel et al., 1997; Makkar, 2010). Based on data presented by this study, it would appear that perhaps 25U75WA could be the treatment of choice.

Conclusion

It was concluded that, treatment with 25% urea combined with 75%WA (1.25kg urea mixed with 22.5 kg WA in 100 liters of water/200 kg maize cobs) could improve the chemical composition, gas production and TDS parameters of maize cobs.

Acknowledgement

Tertiary Education Trust Fund (TETFUND) Abuja, Nigeria is hereby acknowledged for the research grant.

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