In situ Rumen Degradability of Treated Maize Stover by Wadara Bulls in Maiduguri, North Eastern Nigeria

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Abstract

The study's goals were to see what effects urea and poultry dropping treatments had on the chemical profile and *in situ* rumen dry matter degradability and kinetics of maize stover in Wadara cattle. There were three treatments namely, untreated; urea (at 5%) and poultry droppings (at 50:50 ratio) treated maize stover. The stover was ensiled for 21 days. In the investigation, three Wadara bulls with permanent rumen cannulas were used. The maize stover was incubated for 6, 12, 24, 48, 72, and 96 hours in the rumen of the bulls. Crude protein (CP) percentage in the stover improved significantly (P<0.05) from 5.5% in untreated to 19.4% in poultry droppings treated stover whereas crude fibre (CF) content did not change markedly (P>0.05) across treatments. Rumen degradability increased with incubation time and was always higher (P<0.05) in treated than untreated stover. The extent of degradability of DM (c) was statistically (P<0.05) higher in treated stover. Outflow rate at 24 hours after incubation was 3.1, 3.0 and 3.2%/hr in untreated, urea and poultry droppings treated stover respectively. In conclusion, the use of urea and poultry droppings in treating maize stover affects the chemical composition and DM *in situ* rumen degradability and kinetics positively. Poultry droppings can be used instead of urea in stover ammoniation effectively.

Keywords: In situ, Maize stover, Poultry droppings, Rumen, Urea.

Introduction

Rumen degradability is among the most widely used techniques in assessing the digestibility of feeds and feedstuffs. *In situ* rumen degradability of feed gives an idea of the nutrient availability to the livestock as it gives information on the rumen degradation properties of the feed material. This technique is simple and takes less time to carry out compared to most of the other methods. This method has also been used in developing models that can predict the quantity of feed livestock can take (Ørskov *et al.*, 1988; Shem *et al.*, 1995).

Lack of feed of good nutritive value is one of the major problems facing the livestock industry in Nigeria. Forages are readily available in the rainy (growing) season but inadequate conservation strategies result in acute feed shortages off-season (dry season). The available feedstuffs are mostly of low nutritive value characterized by high crude fibre, low crude protein content, intake and digestibility. One of the most abundant feeds in the dry season is the cereal crop residues.

Maize is a staple food in Nigeria and is grown all over the country. The residues from maize after harvest are large in quantity but of low feeding value. Silage is one of the most effective methods of forage conservation, improving feeding value and feed intake. Urea and poultry droppings have both been shown to increase the nutritional value of crop residues. Ensiling residues with urea or chicken droppings has been found to lower fibre content while increasing the protein and digestibility of fibrous feedstuffs (Taddesse *et al.*, 2017; Sharmin *et al.*, 2020). Increasing the information base on boosting maize stover's nutritional value and rumen degradability will help Nigeria's dry season feeding strategy. Thus, the study was conducted in Maiduguri, North Eastern Nigeria, to examine the effect of urea and poultry droppings treatment on nylon bag rumen degradability of maize stover using Wadara bulls.

Material and methods

Study area

The research was conducted at the University of Maiduguri's Teaching and Research Farm in Borno State. The farm is 354m above sea level on latitude 11°15′N and longitude 30°05′E. The area is in the Sahel ecological zone which is characterized by low rainfall (300 – 500mm) in a maximum of 5 months in a year, 32 - 40 °C temperatures and an average relative humidity of 50%.

Treatment of maize stover

The treatments were untreated, urea treated and poultry droppings treated maize stover. Complete Randomized Design (CRD) was employed in the study. The dried maize stover (Extra Early 95 TZEE-W) was collected from the Teaching and Research farm of the University of Maiduguri Teaching immediately after harvest, whole plant after cobs removal was cut into small particles size not more than 5 cm in length. Water was sprinkled on the stover and allowed in a sack overnight to raise the moisture content ideal for ensiling. The stover is divided into 3 (5kg each). The first part was not treated. The second part was treated with urea solution at 5% which is obtained by mixing 5kg of urea in 100 litres of water for 100kg of stover. The solution was sprinkled and mixed thoroughly with the stover. The third part was treated with poultry droppings. The droppings were obtained from layers kept in battery cages at the University of Maiduguri Poultry farm. It was milled to pass through a 3mm sieve, sucked in water proportionate to that used in urea treatment and mixed thoroughly with the maize stover at 50:50 % ratios. The treated stover was then ensiled in a polythene bag and buried in a pit for 21 days. After the ensiling period, the ensiled materials were opened, kept in a shade to dry and get rid of excess ammonia before taking samples for chemical analysis and rumen degradability.

Experimental animals and feeding

Three Wadara bulls with 40 mm rumen cannula were used in the experiment. The bulls were given a diet containing maize bran, groundnut haulms, sorghum husk, maize stover and wheat offal two times a day while water was served *ad libitum*. The experimental diets were untreated; urea and poultry droppings treated maize stover.

Determination of in situ Dry matter rumen degradability

The diets were ground to reduce the particle size to pass through a 3 mm sieve. The samples were oven-dried. Samples of 3 g were sub-sampled from each treatment for rumen incubation. Other experimental materials used include thread, surgical forceps, cotton wool and antiseptic. Each sub-sample was placed into a nylon bag (80 x 20 mm, 20 - 40µ pore size), tightly tied with long undegradable thread and placed into the rumen for incubation. The periods of sample incubation in the rumen were 0, 6, 12, 24, 48, 72 and 96 hours. After the incubation period, each sample was washed thoroughly under running tap water for 30 minutes and taken to the laboratory for dry matter determination as described by Orskov *et al.* (1980). The incubation at 0 hrs which is the washing loss was obtained by washing samples in running tap water as described above without incubation.

Dry matter disappearance in the rumen was obtained using a formula proposed by Osuji *et al.* (1993):

$$\text{DM disappearance} = \frac{a - b}{a} \times 100$$

where:
a = weight of sample before incubation, b = weight of sample after incubation.

The degradation rate of DM was estimated as follows (Orskov & McDonald, 1979).

$$P = a + b\,(1 - e^{-ct})$$

where:
P = degradability with time “t “, a = washing loss, b = Fraction of stover degraded with time, c = rate of degradation of b, t = time.

Chemical Analysis

Proximate analysis to determine the dry matter (DM), crude fibre (CF), Crude protein (CP), ether extract (EE) and ash of samples from each treatment was carried out using methods of AOAC (2005). The methods of Van Soest *et al.* (1991) were employed to evaluate Neutral detergent fibre (NDF) and Acid detergent fibre (ADF). Nitrogen free extracts (NFE) and organic matter (OM) were estimated using the following formula:

%NFE = %DM – (%CP+ %EE + % CF+% Ash)

OM = 100 - % ash respectively.

Statistical Analysis

The GLM Procedure of SPSS (2007) was used to analyse all data collected and the Least Significant Difference (LSD) of the same package was used to separate means where they differ significantly.

Results and discussion

Table 1 shows the chemical profiles of untreated, urea-treated, and poultry droppings-ensiled maize stover. Ammoniation improved the CP percentage of maize stover substantially ($P<0.05$). The higher CP percentage was observed in poultry dropping treated stover (19.40%) which was significantly different from urea ammoniated stover (10.10%). The incorporation of nonprotein nitrogen (NPN) from urea and poultry droppings was responsible for the increase in CP %. The trend in this study coincided with the reports of Ahmed *et al.* (2013); Elias & Fulpagare (2015) and Jamee *et al.* (2019) who reported an increase in CP content of fibrous plant materials when ammoniated. The CF content of all the treatments did not show statistically different ($P>0.05$) but the values were lower in untreated treatments. The findings from the experiment were contrary to the findings of Ramirez *et al.* (2007) and Parmar *et al.* (2017). This could be attributed to the initial CF content of the forages as materials with the worst higher CF are more improved when ammoniated. Although, Ngele *et al.* (2009) reported results in agreement with those found in this experiment. Nitrogen free extract values indicate an insignificant difference between untreated and urea treated stover but were higher ($P<0.05$) substantially than poultry dropping treated stover (40.11%).

Elias & Fulpagare, (2015) reported a higher NFE in untreated maize stover compared to the urea treated one. In untreated stover, NDF and ADF were considerably greater (P<0.05). A similar phenomenon was reported by Ngele *et al.* (2009) when urea and poultry droppings were used in treating rice straw.

Table 1. Chemical composition of untreated, urea treated and poultry droppings ensiled maize stover (%)

Parameters	Dietary treatment			SE	Level of significance
	Untreated	Urea	Poultry		
DM	92.30 [b]	89.26[c]	98.53 [a]	0.58	*
OM	96.30 [a]	96.40 [a]	93.67 [b]	0.43	*
CP	5.50 [c]	10.10 [b]	19.40 [a]	0.90	*
CF	33.70	31.30	33.10	1.02	NS
EE	1.03	1.03	1.06	0.072	NS
NFE	56.07 [a]	53.97 [a]	40.11 [b]	1.16	*
ASH	3.70 [b]	3.60 [b]	6.33 [a]	0.33	*
ADF	44.20[a]	40.40 [b]	42.70 [c]	0.27	*
NDF	70.30[a]	60.50[b]	62.60[b]	0.78	*

[a,b,c,] Means value within the same row with different superscripts differ significantly at P<0.05, Untreated: Untreated stover, Urea: Urea treated stover, Poultry: Poultry droppings treated stover, SE: Standard error, *: Significant at P<0.05 level of significance, NS : Non significant

The dry matter (DM) *in situ* rumen degradability of untreated, urea treated and poultry droppings ensiled maize stover is presented in Table 2. At the 6th hour after incubation, urea treated stover (26.40%) exhibited considerably higher (P<0.05) degradability. The least degradability was recorded in poultry droppings treatment (18.23%). The generally low degradability in all treatments at this stage can be attributed to the fibrous nature (high lignin and non-digestible cellular constituents in stover) of the materials as similar values were reported by Millam *et al.* (2018).

The degradability trends in 12 and 24 hours of incubation were the same. Ammoniated treatments were statistically similar and higher than untreated treatments. At the 12th hour, rumen degradability was 29.49, 38.86 and 37.89% for untreated, urea treated and poultry dropping treated maize stover respectively. Degradability increased at 24th hours as treated stover recorded 46.41% (urea treated) and 46.83% (poultry droppings treatment). These trends are similar to the report of Taddesse *et al.* (2017) who worked on sorghum stover. The gradual rise of degradability at the 24th hour in treated materials is a result of the higher friability of the cell constituents and structures caused by the ammoniation.

At 48 hours post incubation, the urea ensiled stover was the most degradable as 62.25% DM disappearance was observed. However, the degradability of all treatments at this crucial stage was above the 40-50% expected to qualify fibrous feed materials to be optimal (Preston, 1986). Jeon *et al.* (2013) reported a lower degradability in rice straw at this stage but similar values were observed in the findings of Ngele *et al.* (2009) on rice straw in Nigeria. At 72 and 96 hours after incubation, the DM disappearance trend was the same.

Table 2. Dry matter *in situ* rumen degradability of untreated, urea treated and poultry droppings ensiled maize stover

Incubation Period (Hours)	Dietary treatment			SE	Level of significance
	Untreated	Urea	Poultry		
6	20.52 ^{b}	26.40 ^{a}	18.23 ^{c}	0.44	*
12	29.49 ^{b}	38.86 ^{a}	37.89 ^{a}	1.70	*
24	35.00 ^{b}	46.41 ^{a}	46.83 ^{a}	0.84	*
48	49.72 ^{c}	62.45 ^{a}	54.39 ^{b}	0.26	*
72	53.55 ^{b}	65.25 ^{a}	64.75 ^{a}	1.15	*
96	65.60 ^{b}	76.58 ^{a}	78.76 ^{a}	1.30	*
Constants					
a	9.10 ^{b}	12.04 ^{a}	14.12 ^{a}	0.39	*
b	56.50 ^{b}	64.54 ^{a}	64.64 ^{a}	4.05	*
c	0.0256 ^{b}	0.0317 ^{a}	0.0294 ^{a}	0.0020	*
k at 24th hr	3.1	3.0	3.2		

^{a,b,c,} Means value within the same row with different superscripts differ significantly at P<0.05, Untreated: Untreated stover, Urea: Urea treated stover, Poultry: Poultry droppings treated stover, SE: Standard error, a: Washing loss, b: Fraction of stover degraded with time. c: Rate constant for degradation of ‘b’. k: Rate of outflow at 24th hr (%/hr), *: Significant at 0.05 level of significance

Ammoniated treatments were similar (P>0.05) but differed (P<0.05) statistically from untreated treatments. This is due to the fact that at 72 hours most of the cellular structures that were dissociated as a result of ammoniation were already degraded, thus, the similarity in degradability of the ammoniated treatments. At 72 hours, the highest degradability values were recorded in urea ensiled stover (65.25%) while the lowest values were obtained in untreated stover (53.55%). Poultry droppings ensiled stover were highest in degradability percentage (78.76%) as the untreated stover recorded 65.60% in the 96th hour of incubation.

The washing losses ‘a’ (zero incubation period) in this research were significantly higher (P<0.05) in treated stovers (12.04% and 14.12%) compared to the untreated stover (9.10%). This is expected as both urea and poultry droppings are very soluble in water and thus, will be washed out significantly. Fractions of stover degraded with time ‘b’ followed a pattern similar to that of ‘a’. The treated stovers showed higher ‘b’ as ammoniation aided in softening the cell wall components of the stovers making them more vulnerable to rumen degradability. The increased availability of NPN also plays a vital role here. The NPN is utilised by rumen microbes which energised them to degrade the stover rapidly. The c which is determined by the ‘a’ and ‘b’ values thus, followed a pattern comparable with the ‘a’ and ‘b’ values. The highest ‘c’ value was obtained in urea treated stover (0.0317) while the lowest was in untreated stover (0.0294). The ‘c’ value in the experiment was similar to the values reported by Kibon (1993) in Sorghum and millet. But Ahmed *et al*. (2013) reported lower ‘b’ at 3 weeks ensilage period of sugarcane bagasse.

Conclusion

Ultimately, both urea and poultry droppings can improve the chemical composition and degradability of maize stover in the rumen of Wadara cattle in North Eastern Nigeria. These will help in providing more nutritive feedstuff and better utilisation of maize stover for cattle during periods of feed scarcity.

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