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EVALUATION OF FIVE CROP RESIDUES FOR DEGRADABILITY POTENTIALS IN GOATS AT JALINGO, TARABA STATE

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ABSTRACT

Nylon bag technique for rumen degradability experiment was carried out to assess the nutritive values of Sorghum Stover, Maize Stover, Cowpea haulms, Sweet potato vine and Akidi chaff in the rumen of goats. At 48 hour incubation period, Sweet potato vine had the highest (80.99%) dry matter degradability, followed by Akidi chaff (78.16%), while the least value (51.84%) of dry matter degradability was recorded in Maize Stover. The Crude Protein content is highest (14.43%) in Sweet potato vine, followed by Akidi chaff (11.46%) and least (7.64%) in Maize Stover. The predicted rumen degradability (Effective degradability) value obtained in sweet potato vine (74.9%) at 50 hour rumen incubation suggests that sweet potato vine is the most nutritive of the tested crop residues followed by Akidi Chaff (71.9%), Cowpea haulms (61.5%), Sorghum Stover (54.8%) and least (51.4%) in Maize Stover.
Keywords: *Crop residues, Dry matter (DM) degradability, Nylon bag technique, Goats, Effective degradability.*

INTRODUCTION

Poor nutrition is one of the major constraints to livestock productivity in Sub-Saharan Africa (Osuji *et al.*, 1993). The majority of ruminants in tropical Africa are raised on natural pastures which decline rapidly in quantity and quality during the dry season and such changes in nutritional status result in very irregular growth and marked fluctuations in seasonal weights (Ademosun, 1973 and Mbahi *et al.,* 2006). To be able to reduce this irregular growth rates, crop residues and other unconventional feedstuffs are relied upon by small scale farmers (Smith *et al*. 1991). According to Tuah *et al.,* (1993), most small scale farmers depend on crop residues as feed for their ruminants and these residues are generally low in nitrogen and minerals. Malau-Aduli *et al.* (2003) noted that goats are able to subsist and make appreciable gains in long dry season with crop-residue-based diets that compared favorably with conventional concentrate rations. As noted by Odunlami (1988), some of the crop residues and by-products available are potentially good feed resources which degrade readily in the rumen. Some others, however, have shown poor degradability and hence require some treatments before they can contribute to animal nutrition (Smith *et al*., 1988).
FAO (1986) recommended a degradability of 40-50% as a range for any feedstuff to be considered acceptable and that any feedstuff with degradability of 10-30% after 48hours should not be fed directly to ruminant animals except after further treatment. However, Smith *et al.* (1988) recommended a minimum rumen degradability of 60% for a proper

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utilization of a potential feedstuff by ruminant stock. Norton (1994) noted that any feed with less than 1.35%N is considered to be nitrogen- deficient and cannot provide the minimum ammonia levels required to support rumen-reticular microbial activity. Feed evaluation is important to farmers in deciding which feeds to procure and for livestock planners to assess prospective production levels to plan for food import and export strategies (Øskov, 2000). Since crop residues are generally bulky, this study was designed to evaluate the nutritive values of the crop residues so as to determine the most nutritive and justify the investment into their collection and storage for use by ruminant stock.

MATERIALS AND METHODS

Five (5) crop residues comprising Sorghum Stover, Maize Stover, Cowpea haulms, Akidi (*Sphenostylis stenocarpa*) chaff, Sweet Potato vine, were collected from Jalingo in Taraba State and used in the study. The samples were grinded through a 2mm sieve and stored in sealed bottles after drying them for 48 hours in the oven at 65^{o}C. Three (3) fistulated male goats of about two years of age and an average weight of 30kg were used for the study. The animals were housed individually on a concrete-floored pen and supplied with Groundnut haulm and Maize bran morning and evening as well as water *ad- libitum*. Salt lick was also made available to the animals throughout the experiment. During a three week pre-cannulation adaptation period, the animals were treated for ecto and endo-parasites. They were also given antibiotics to combat any hidden pathogen in them. They were thereafter surgically fitted with rumen cannulae of 43 mm internal diameter and allowed five weeks recovery period before sample incubation. Throughout the experimental period, the cannula site was dressed twice daily with antiseptic solution (savlon) to prevent contamination with rumen fluid. Three (3) grams of triplicates samples of each feed ingredient per incubation period was weighed into nylon bags of size 7cm x 12.5cm and mesh (pore) size of about 45µm. The bags were made of filter cloth, weighed and numbered for easy identification. Each bag was attached to PVC string with the aid of rubber band. The bags were incubated for 6, 12, 24, 48, and 72 hours in the rumen of the fistulated goats.

After each incubation time, the bags were withdrawn from the animal; washed under running tap with gentle squeezing between the fingers until the rinse water became clean and clear. They were then allowed to drain a little before fixing them into the oven to dry at 65^{o}C for 48 hours. The dry bags with their contents were thereafter weighed and the weights recorded to determine the loss in weight due to degradation by rumen microbes. The loss in weight was then divided by the original weight of sample before incubation (3g) and then multiplied by the % dry matter content of the original feed sample to give the percent actual dry matter disappearance (ADMD) of the sample. The zero time dry matter disappearance (washing loss) was estimated by soaking three (3) bags of each feed sample in warm (about 37 ^{0}C) water for 30 minutes; washing them under running tap with gentle squeezing until the rinse water became clean and clear and drying them in the oven at 65 ^{0}C for 48 hours. The Percent Actual Dry Matter Disappearance was estimated using the same procedure as stated above. The chemical analysis of the experimental feedstuffs was conducted according to

AOAC (2000) for DM, Ash, CP, CF and EE. The DM content of each sample was determined by oven-drying the sample at 105°C for 24 hours. The ash content was determined by the complete combustion of each sample at 550°C in a muffle furnace for 3 hours. The CP, CF and EE contents were determined by the Kjeldahl method, Trichloroacetic acid (TCA) digestion method and the Soxhlet extraction method respectively. Samples were also analyzed for Neutral Detergent Fiber (NDF), Acid Detergent Fiber (ADF) and Acid Detergent Lignin (ADL) using the Van Soest *et al.* (1991) method.

The results of the incubation were analyzed using Fit curve macro (Chen, 1995) for Microsoft Excel (NEWAY Excel). Degradation constants were estimated from the non-linear equation: $PD = a + b(1 - e^{-ct})$, proposed by Ørskov and McDonald (1979).
Where PD = potential degradability of dry matter and crude protein at time t,
a = soluble fraction (intercept);
b = insoluble but rumen degradable fraction and;
c = the rate of degradation of b at time t (6, 12, 24, 48, and 72 hours).

The effective degradability (ED) of DM was calculated at rumen outflow rates (k) of 0.02, 0.05 and 0.08 /hr according to Ørskov and McDonald (1979) which corresponded to 50 hour, 20 hour and 12.5 hour respectively:

$$ED = a + \left[{}^{bc}/_{(c+k)}\right]$$

Where ED, a, b, and c are as described above and 'k' is the fractional out flow rate from the rumen where k = 1/t and t = incubation time (50, 20 and 12.5 hours as conventionally adopted). ED represents what the degradation of the feedstuff would be in the rumen if the feedstuff had been fed directly to the animals. Percent actual dry matter degradability values were analyzed in a completely randomized design using the one-way analysis of variance procedures of SAS (1999) and significant means were separated by Duncan multiple range test.

RESULTS AND DISCUSSION

Chemical Composition of Crop Residues

Table 1 shows the chemical composition of the tested crop residues. All the feedstuffs had high dry matter content which ranged from 94.78% for maize Stover to 95.29% in Sorghum Stover. Sweet potato vine had the highest (14.43%) CP followed by Akidi chaff (11.46% CP), Cowpea haulms (9.76% CP), Sorghum Stover (8.49% CP) and Maize Stover (7.64% CP). Maize Stover has the highest (70.91%) neutral detergent fiber (NDF) among the crop residues. This was followed by Sorghum Stover (53.38%), Cowpea haulms (48.77%), Akidi husk (34.03%) and Sweet potato vine (27.61%).

Table 1: Chemical composition of feed samples (%)

SAMLE	DM	CP	ASH	E.E	CF	NFE	NDF	ADF	ADL	HC	C
Crop residues											
Sorghum Stover	95.29	8.49	8.85	2.04	18.64	57.27	53.38	27.78	3.31	25.6	24.47
Maize Stover	94.25	7.64	10.23	1.24	25.99	49.15	70.91	26.05	3.16	44.86	22.89
Cowpea haulms	94.91	9.76	14.04	1.52	34.23	35.36	48.77	37.02	9.33	11.75	27.69
Sweet potato vine	94.73	14.43	15.07	2.72	13.40	49.11	27.61	20.54	6.37	7.07	14.17
Akidi chaff	94.54	11.46	7.13	9.12	15.56	51.27	34.03	26.85	4.50	7.18	22.35

HC = Hemi cellulose,
C = Cellulose
HC = NDF - ADF
C = ADF – ADL, CF= Crude fiber, E.E= Ether extract
NFE = DM - (CP + Ash + E.E + CF), CP = Crude protein

The DM, CP and Ash contents observed in Sorghum Stover (95.29%, 8.49% and 8.85% respectively) are higher than those reported by Adebowale (1992). The values are however similar to those reported by Mohammed *et al*. (2001) but the observed NDF and ADF are lower than those reported by same authors. This may be due to differences in variety and soil factor. The low nitrogen (<1.35%) and Crude protein (<8.4%) of Maize Stover indicates that it cannot supply the minimum ammonia levels required for microbial activity in the reticulo-rumen if fed solely (Norton, 1994).

Dry matter Degradability of Crop Residues

The mean percent actual dry matter disappearance (ADMD) by incubation time as well as the overall means by sample is shown in Table 2. At 6-hours incubation period, the % ADMD for the crop residues ranged from 27.5% for Maize Stover to 60.0% for Sweet potato vines. The general trend observed in virtually all the incubation time schedules was that the percent actual dry matter disappearance of the crop residues was in the ascending order; Maize Stover, Sorghum Stover, Cowpea haulms, Akidi husk and Sweet potato vine. On the overall, all the crop residues were well degraded with a mean degradability ranging from 45.57% in Maize Stover to 73.93% in Sweet potato vine. With these degradability values therefore, all the tested feedstuffs may be considered acceptable for ruminant feeding in accordance with the 40 – 50% degradability range recommended by FAO (1986). However, the mean degradability values observed for Sorghum Stover (55.7%) and Maize Stover (51.8%) at 48 hour incubation period are lower than the minimum of 60% recommended by Smith *et al.* (1988). Nevertheless, all the feed samples tested attained a minimum of 50% degradability

Table 2: Actual Dry Matter Disappearance (%) of feedstuffs in the rumen of goa

Sample	DM	0hr	6Hrs	12Hrs	24Hrs	48Hrs	72Hrs	Mean
Sorghum stover	95.29	20.49	29.39	32.56	52.41	55.74	74.19	48.86^{e}
Maize stover	94.25	23.56	27.49	30.63	48.54	51.84	69.36	45.57^{e}
Cowpea haulms	94.91	28.47	48.25	52.20	55.52	65.49	70.00	58.29^{d}
Sweet potato vine	94.73	37.89	60.00	68.70	78.63	80.99	81.33	73.93^{bc}
Akidi husk	94.54	25.05	49.79	67.12	75.63	78.16	82.88	0.72^{c}

at 48 hour incubation period. Furthermore, among the crop residues, Sweet potato vine and Akidi husk had significantly higher (P<0.05) degradability values (73.93% and 70.72% respectively) than the 58.29% obtained for Cowpea haulms. This in turn was significantly higher (P<0.05) than the 48.86% and 45.57% obtained for Sorghum Stover and Maize Stover respectively.

On the overall, the feedstuffs tested could be grouped into three categories on the basis of similarity of their degradability values as: highly degradable (Sweet potato vine and Akidi husk); moderately degradable (Cowpea haulms); and fairly degradable (Sorghum Stover and Maize Stover).

Means with different superscript are significantly different (P < 0.05)

Degradability parameters of feedstuffs

Table 3 shows the degradability parameters of the feedstuffs tested as described by exponential equation $P = a + b\ (1-e^{-ct})$ (Ørskov and McDonald 1979). The rate of degradation (c) ranged from 0.014 fraction /hour in Maize Stover to 0.125 fraction / hour in Akidi husk. The potential degradability (A + B) of the feedstuffs appeared to have an inverse relationship with the rate of degradation (c). Akidi husk with 'c' value of 0.125 had the least (80.3%) potential degradability value while Maize Stover with 'c' value of 0.014 had a potential degradability value of 92.2%. Two feedstuffs (Maize Stover and Akidi husk) indicated the presence of lag time of 1.7hrs and 1.1hrs respectively. This implies that degradation of the feedstuffs did not begin in the rumen until the time indicated as lag time after incubation. The delay in the commencement of degradation indicated as lag time may be due probably to anti nutritional factor but it is generally known to be the time taken for rumen microbes to enter the bags and colonize the contents. For such feedstuffs with lag time, the model of McDonald (1981); ($P = a + b\ (1-e^{-c\ (t-tl)})$ would be more appropriate in predicting their potential degradability where P = potential degradability at time t, a = water soluble fraction, b = water insoluble but degradable fraction, e = natural logarithm, c = degradation rate, t = incubation time and tl = lag time.

Table 3: Degradability parameters of feed samples (%)

Sample name	A	B	c	A+B	C	Lag time (hrs)
Sorghum Stover	20.50	73.40	0.016	93.90	6.10	0.0
Maize Stover	23.60	68.60	0.014	92.20	7.80	1.7
Cowpea haulms	28.50	54.90	0.015	83.40	16.60	0.0
Sweet potato vine	37.90	43.70	0.098	81.50	18.50	0.0
Akidi husk	25.10	55.20	0.125	80.30	19.70	1.1

Key:
A = washing loss (water soluble fraction)
B=rumen degradable fraction
c= degradation rate constant (fraction/hr)
A+B = Potential degradability.
C= Undegradable fraction

Effective Degradability of Feedstuffs

Table 4 shows the Effective Degradability (ED) of feedstuffs at degradability constants a, b, c and rumen fractional outflow rate K = 0.02, K = 0.05 and K= 0.08. The ED values shown are the predicted degradability of the feedstuffs if fed to the animals and are retained in the rumen for 50hrs, 20hrs and 12.5hrs respectively (K = 0.02, 0.05, 0.08). The rumen outflow rate (k) is an inverse of the Mean Retention Time (MRT) of feedstuffs in the rumen of animals. Fractional outflow (k) ranges of 0.02 – 0.10h^{-1} and 0.017 – 0.05h^{-1} were predicted for protein supplements and roughages respectively (Chen, 1995). It implies then that the MRT range for protein supplement is 10 – 50 hours while for roughages is 20 – 60hrs. Effective degradation (degradation in the rumen) depends on how long the food remains in the rumen which is also a function of the quantity of the feed fed to the animal (Reddy, 2001). For the tested feedstuffs, Sweet potato vine had the highest (68.3%) ED, followed by Akidi husk (62.6%), Cowpea haulms (53.2%), Sorghum Stover (40.3%) and Maize Stover (37.7%) being the least degradable at rumen fractional outflow rate (k) of 0.05 (i.e. MRT = 20hrs). At the rumen outflow rate constant (k) = of 0.02 (i.e. MRT = 50hrs), Sweet potato vine had the highest (74.9%) ED value while Maize Stover had the least (51.4%). By FAO (1986) recommendation of degradability range of 40-50% at 48 hours MRT, all the feedstuffs tested may be considered qualified as feedstuffs for ruminants on the basis of DM degradability. However, by the minimum rumen degradability of 60% recommended by Smith *et al*. (1988), Sorghum Stover (54.8% ED) and Maize Stover (51.4% ED) may need some forms of treatment for a proper utilization by ruminant stock (Smith *et al*., 1988). As observed in this study, Sweet potato vine and Akidi husk are highly (> 70%) degradable; Cowpea haulms is moderately (> 50%) degradable while Sorghum Stover and Maize Stover are fairly (> 50%) degradable on the basis of percent actual dry matter disappearance.

Table 4: Effective Dry Matter Degradability (%) of feed samples at degradability constants a, b, c and fractional outflow rate K=0.02, K =0.05 & K=0.08, ED = a + [bc/(c+k)]

Sample Name	a	b	c	RSD	Effective Degradability at K=0.02	K=0.05	k=0.08
Sorghum Stover	22.8	71.1	0.016	6.66	54.8	40.3	34.9
Maize Stover	21.9	70.2	0.014	6.08	51.4	37.7	32.8
Cowpea haulms	45.2	38.3	0.015	1.15	61.5	53.2	51.2
Sweet potato vine	42.3	39.2	0.098	0.82	74.9	68.3	63.9
Akidi husk	16.6	63.7	0.125	2.66	71.9	62.6	56.1

Key:
a = fitted soluble fraction
b = fitted insoluble but degradable fraction
c = degradation rate constant
k=fraction outflow rate from the rumen at 50hr, 20hrs and 12.5hrs mean retention time respectively.

CONCLUSION

All the feedstuffs tested are good feed resources for ruminants with at least 50% degradability at 48-hours incubation period. Maize Stover peels may however not be fed solely to ruminants as it is low in crude protein required for rumen microbial activities.
Based on Crude Protein content and rumen degradability of the samples as nutritive value determinants, Sweet potato vine is the most nutritive among the crop residues, followed by Akidi chaff and Cowpea haulms.

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