EVALUATION OF SELECTED CEREAL STOVER HAYS FOR NUTRIENT COMPOSITION AND *IN VITRO* GAS PRODUCTION IN WUKARI, NIGERIA

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ABSTRACT

An experiment was conducted to determine the nutrient composition and *in vitro* gas production from six (6) cereal stovers hays in Teaching and Research Farm of Federal University, Wukari, Taraba State, Nigeria. Fresh stovers of maize, sorghum, pearl millet, finger millet, rice and acha were harvested, chopped and air-dried in late October and early November, 2018. The experimental design was Completely Randomised Design (CRD) and each treatment (each stover) was replicated three times. The *in vitro* gas production was carried out in laboratory using standard technique. The results showed that DM, CP, CF, NFE, EE, Ash, OM, CHO and fibre fractions (NDF, ADF, ADL),cellulose and hemicellulose of the selected cereal stovers hay were significantly ($P < 0.05$) different from each other except for ether extract (EE) that was similar across the treatments. Sorghum stover hay (T_3) had the highest DM value of 92.69% while T_1 had the highest CP contents of 11.78% CP. However, T6 had the highest CF value (34.00%) of all the selected cereal stovers. The *in vitro* gas production parameters such as CH_4, TGV, FE, OMD, (DMD, SCFA and ME varied significantly ($P < 0.05$) across the treatments. The TGV was highest (24.67ml) in T_2 (finger millet stover) and least (16.67ml) in T_3 (sorghum stover). The results of this study indicated that T_1 (rice stover hay) had over all best nutrient composition and *in vitro* gas production assessment.

Keywords: Cereal stovers, chemical composition, hay, *in vitro* gas production, ruminants

INTRODUCTION

In feeding livestock, the aim is to provide the animals with a balanced ration throughout the year with sufficient nutrients to meet the animal's nutrient requirements for maintenance and production. The major constraint to livestock production is feed both in quality and quantity. In Nigeria, forage and fodder supply during the dry season and drought periods is a very important factor limiting livestock productivity. Shortage of feed resources often imposed major constraints on the development of animal production in the tropics and sub-tropics. Considerable quantities of crop residues are generated every year in most developing countries in the tropics and sub-tropics which are suitable for feeding livestock. An intensive feeding system based on locally available agro-industrial by-products and crop residues is an alternative promising feeding system to rear ruminants economically. Ruminants because of their rumen physiological adaptation can utilise inexpensive agro-industrial by-products and crop residues to meet their feed requirements for maintenance, growth, and production. Agro industrial byproducts and crop residues in the diets of ruminants support growth, lactation and result in the production of human edible food. Although most have low nitrogen content, more fibre as well as low nutrient density, effective processing can raise their nutritive value (Areghore, 1994). Little information is available on the extent to which small holder farmer in Nigeria use crop residues as livestock feed. It is very likely, however, that these resources are under-utilised. Even when they are utilised, farmers may not be able to incorporate them efficiently into their year-round livestock feeding programmes because they lack suitable storage facilities and technical know-how on treatment and processing methods and on formulating feed ration. The selected cereal stovers hay (maize, sorghum, pearl millet, finger millet, rice and acha) are major food crops cultivated in northeast Nigeria. Most of these cereal stovers are left on the field to waste after harvesting the main crops.

Consequently, there is need to examine their potential feed value for ruminant animals production. Thus, a study was carried out to determine the chemical composition and evaluate nutritive value of selected cereal stover hay using *in vitro* fermentation technique.

MATERIALS AND METHODS

Experimental Site

The study was carried out at Teaching and Research Farm of the Federal University Wukari Taraba State, North-East Nigeria. Wukari is located on Latitude 7^0 51^1 North and Longitude $9^{tl}47^1$ East. Wukari is situated at elevation 189 metres above the sea level and has a mean annual rainfall of 1300mm. The maximum annual temperature ranges between 30^0C and 39.4^0C while the minimum annual temperature is between 15^0 and 23^0C (Oyatayo *et al*., 2015).

Harvesting and Hay Making

Freshly harvested green cereal stovers (maize, sorghum, pearl millet, finger millet, rice and acha) were collected from Crop Production Teaching and Research Farm of Federal University Wukari and processed into hay. The harvesting was done in the month of October and November 2018 and the samples were collected in batches. Harvested cereal stovers were chopped with cutlass into 3-5cm size (for easy drying). Thereafter, the chopped materials were air-dried under shed for two weeks on concrete. The chopped cereals stover were constantly turned-over to ensure uniform drying and prevent mouldness and loss of nutrients. The chopped cereal stovers were then weighed and divided into equal portions (1kg) and each of the cereal stover serve as experimental treatment making six treatments. Treatment A = Maize Stover (MS); Treatment B = Sorghum Stover (SS); Treatment C = Pearl Millet Stover (PMS); Treatment D = Finger Millet Stover (FS); E = Rice Stover (RS) and F = Acha Stover (AS). All were replicated three times in a completely randomized design. However, the samples for laboratory analysis were oven dried at 65^oC and milled by 'MG 123' grinder. The samples were ground in the laboratory with hammer mill of 1mm sieve and subjected to chemical analysis for determination of dry matter (DM), organic matter (OM), crude protein (CP), crude fibre and nitrogen free extract as described by AOAC (2002). Neutral detergent fibre (NDF), acid detergent fibre (ADF) and acid detergent lignin (ADL) were assayed by the method of Van Soest *et al,* (1991). Hemicellulose was calculated as the difference between NDF and ADF and cellulose as the difference between ADL and ADF.

In vitro study

The rumen fluid was collected through the suction method by means of the hose from three West African Dwarf (WAD) goats under the same feeding regime. The animals were fed with 40% concentrate feed (40% corn, 10% wheat offal, 10% palm kernel cake, 20% groundnut cake, 5% soybean meal, 10% dried brewers grain, 1% common salt, 3.75% oyster shell and 0.25% fish meal) and 60% Guinea grass. The rumen fluid was collected into a thermos flask that had been pre-warmed to a temperature of 39^0C before morning feeding and taken to the laboratory. It was filtered through a four-layered cheese cloth into a warm flask, flushed with carbon dioxide (CO2) gas, and stirred using an automatic stirrer. Incubation was done as reported by (Menke and Steingass, (1988) using 120ml calibrated syringes in three batch incubation at 39^0C into 200mg sample in the syringe was introduced using 30ml inoculums containing strained rumen liquor and buffer ratio (1: 4 v/v) under continuous flushing with CO2. The gas production was measured at 3, 6, 9, 12, 15, 18, 21 and 24hr. At post incubation period 4ml of NaOH (10 M) was introduce to estimate methane production as reported by Fievez et al., (2005). The volume of the gas produced at intervals was recorded. Metabolisable energy (ME) was calculated as ME = 2.20 + 0.136 GV + 0.057CP + 0.0029CF (Menke and Steingass, 1988). Organic matter digestibility (OMD) = 14.88 + 0.889 GV + 0.45 CP + 0.651 XA. Short chain fatty acids (SCFA) as 0.0239GV - 0.0601(Getachew et al., (1998) was also obtained, where GV, CP, CF and XA are total gas volume (ml/200mg DM), crude protein, crude fibre and ash, respectively. Data collected were subjected to Analysis of Variance (ANOVA) using statistical package for social sciences(SPSS) version 23 and significant means were separated by the use of Duncan' Multiple Range Test.

RESULTS AND DISCUSSION

Chemical composition of selected cereal stovers hay

Table 1 showed the chemical composition of selected cereal stovers hay (Rice, Finger millet, Sorghum, Maize, Pearl millet and Acha). The T_1 (rice stover hay) ($p<0.05$) was significantly higher both in crude protein (11.78%) and ash content (14.40) while T_4 (Maize stover hay) was significantly $P<0.05$) higher (34.00%) in CF compare to other cereal stover hays. Similarly, T_3 (sorghum stover hay) was significantly ($P<0.05$) higher in DM (92.69%), OM (91.65%) and CHO (80.73%) respectively. The crude protein contents which was the major nutrient of the selected cereal stovers hay ranged (8.90 -11.78%) was higher than the critical value of 7.0% recommended by National Research Council (NRC 1981) and also higher than the minimum CP level of 7% required for optimum rumen function (Van Soest, 1994).

Tab le 1: Chemical composition (g/100g DM) of selected cereal stovers hay

Treatments

Parameters	T_1	T_2	T_3	T_4	T_5	T_6	SEM
Dry Matter	92.56^{ab}	91.69^{c}	92.69^{a}	92.10^{bc}	92.14^{bc}	91.91^{c}	0.30
Crude Protein	11.78^{a}	11.70^{a}	9.60^{b}	8.90^{b}	9.35^{b}	9.05^{b}	0.92
Crude Fibre	31.62^{a}	32.00^{a}	31.05^{b}	31.55^{b}	31.53^{b}	34.00^{a}	1.67
Nitrogen Free Extract	40.52^{c}	43.55^{b}	48.42^{a}	48.15^{a}	43.71^{bc}	44.95^{ab}	2.33
Ash	14.40^{a}	11.50^{b}	8.35^{c}	10.75^{b}	14.20^{a}	10.80^{b}	0.72
Ether Extract	1.15	1.25	1.20	1.15	1.20	1.20	0.11
Organic Matter	85.60^{b}	76.94^{c}	91.65^{a}	89.25^{b}	85.80^{b}	89.78^{b}	1.06
Carbohydrate	72.81^{c}	75.55^{b}	80.73^{a}	79.20^{a}	75.25^{b}	78.95^{a}	1.31

a,b,c= means on the same row with different superscripts are significantly ($P<0.05$) different.

T_1 = Rice stover, T_2 = Finger millet stover, T_3 = Sorghum stover, T_4 = Maize stover, T_5 = Millet stover, T_6 = Acha stover, SEM = Standard Error of Mean

Fibre fraction of selected cereal stovers hay

Presented in Table 2 is the fibre fractions (NDF, ADF, NDS, ADL, Cellulose and Hemicellulose) of selected cereal stovers. There were significant ($P<0.05$) differences among treatments, except for ADF which was similar across the treatments. Fibre fractions (NDF, ADF, ADL) and cellulose were significantly ($P<0.05$) higher in T_5 (Pearl millet stover hay) compare to other cereal stovers hay. The fibre fractions, cellulose and hemicellulose of the selected cereal stovers hay are relatively low, therefore ruminants can digest them.

Table 2: Fibre fractions (g/100g DM) of selected cereal stovers hay

	Treatments						
Parameters	**T_1**	**T_2**	**T_3**	**T_4**	**T_5**	**T_6**	**SEM**
NDF	65.05^{abc}	65.41^{ab}	63.81^{bc}	63.21^{c}	66.52^{a}	66.26^{a}	1.20
ADF	45.32^{b}	45.66^{b}	45.01^{b}	44.16^{b}	47.51^{a}	44.34^{b}	1.11
NDS	0.36^{d}	1.83^{d}	9.83^{a}	8.09^{b}	0.87^{d}	4.0^{c}	1.04
ADL	22.03^{b}	21.49^{b}	21.61^{b}	21.41^{b}	23.05^{a}	21.64^{b}	0.58
Cellulose	23.28^{b}	23.17^{b}	23.40^{b}	22.75^{b}	24.46^{a}	22.71^{b}	0.58
Hemillulose	19.69^{ab}	20.75^{ab}	19.13^{b}	19.05^{b}	19.01^{b}	21.92^{a}	1.63

a,b,c = means on the same row with different superscripts are significantly ($P<0.05$) different.

T_1 = Rice stover (RS), T_2 = Finger millet stover (FMS), T_3 = Sorghum stover (SS), T_4 = Maize stover (MS), T_5 = Pearl Millet stover (PMS), T_6 = Acha stover (AS), NDF = Neutral Detergent Fibre, ADF = Acid Detergent Fibre, NDS = Neutral Detergent Soluble, ADL = Acid Detergent Fibre, SEM = Standard Error of Mean

In vitro fermentation parameter of selected cereal stovers hay

Table 3 showed the *in vitro* gas fermentation parameter of selected cereal stovers hay. The parameters observed differs significantly ($P<0.05$) across the treatments. The *in vitro* gas fermentation technique

provided a useful basis from which metabolisable energy (ME), organic matter digestibility (OMD), short chain fatty acid (SCFA) and methane (CH_4) production of feeds samples be measured. The values of ME (5.14-6.23) obtained among the treatments were significant. The *in vitro* fermentation technique has been widely used to evaluate the energy value of several classes of feed (Getachew *et al.,* 1998).The OMD is said to be a measure of degradability potentials of the microbes on the substrate in the presence of sufficient ammonia nitrogen (NH_3-N) that has influence on bacteria fermentation. The values (45.54-52.58%) obtained were higher than ranged values (35.45 - 46.0%) reported by Falola *et al.,* (2015) for vetiver grass *(Chrysopogon zizanioides L., Roberty)* and 36.45 - 45.93%) reported by Alasa *et al.,* (2010) for *Panicum maximum* intercropped with two cultivars of *Lablab purpureus.* Similarly, SCFA ranged values (0.36 - 0.53ml) obtained in this study were higher than the ranged values (0.31 - 0.36ml) reported by Alasa *et al.,* (2010) but relatively inclined to range values (0.42 - 0.68ml) reported by Falola *et al.,* (2015).The ranged values of OMD, DMD, ME, SCFA and TGV indicated that the cereal stovers are degradable, digestible and could provide energy to ruminants animals.

Table 3: *In vitro gas* fermentation parameters of selected cereal stovers hay

Parameters	Treatments						
	T_1	T_2	T_3	T_4	T_5	t_6	SEM
TGV (ml)	18.67^{b}	24.67^{a}	16.67^{b}	18.00^{b}	18.67^{b}	17.33^{b}	5.94
CH_4 (%)	13.33^{b}	17.33^{a}	9.33^{c}	10.67^{c}	11.33^{c}	12.00^{b}	5.14
FE (g/GVml)	4.07^{ab}	2.86^{c}	5.62^{a}	3.62^{b}	3.84^{b}	3.59^{b}	2.17
OMD (%)	47.30^{ab}	52.58^{a}	45.54^{b}	49.64^{ab}	47.30^{ab}	46.12^{b}	5.75
DMD (%)	74.67^{a}	69.80^{ab}	66.77^{ab}	69.67^{ab}	70.93^{a}	61.40^{b}	7.60
ME (MJ/Kg DM)	5.42^{ab}	6.23^{a}	5.14^{ab}	5.78^{a}	5.42^{ab}	5.24^{ab}	0.89
SCFA (^ml)	0.39^{b}	0.53^{a}	0.34^{c}	0.45^{ab}	0.39^{b}	0.36^{b}	0.16

a,b,c= means on the same row with different superscripts are significantly ($P<0.05$) different.

T_1 = Rice stover, T_2 = Finger millet stover, T_3 = Sorghum stover, T_4 = Maize stover, T_5 = Pearl millet stover, T_6 = Acha stover, TGV =Total Gas Volume, CH_4 = Methane, FE = Fermentation Efficiency, OMD = Organic Matter Digestibility, DMD = Dry Matter Degradability, ME = Metabolisable Energy, SCFA = Short Chain Fatty Acid, SEM = Standard Error of Mean

CONCLUSION

It was concluded from this study that rice stover hay (T_1) was higher in nutrient (crude protein), dry matter and DMD as revealed by chemical composition and *in vitro* gas production compare to other stover hays.

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