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Chemical Composition and Nutritive Parameters of Maize Stover (*Zea Mays*) Fractions and Cassava (*Manihort Esculanta*) Foliage for Sustainable Ruminant Production

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Abstract

Chemical composition and nutritive parameters of maize stover (*Zea mays*) fractions and cassava (*Manihort esculanta*) foliage for sustainable ruminant production was studied. Cassava foliage and fractions of maize stover (stem and leaf) were gathered and oven dried for proximate composition, fibre fractions and nutritive parameters (Dry matter intake (DMI), Digestible dry matter (DDM) and Relative feed value (RFV) were calculated. The experimental design was a completely randomized design (CRD). Results shows a significant difference (P<0.05) in the all the parameters considered for the proximate composition across the experimental treatments. The contents ranged from 85.21 – 88.77% for dry matter (DM), 6.27 – 19.72%, 1.89 – 3.78%, 14.89 – 17.08%, 51.88 – 62.47%, 3.27 – 11.23% and 36.90 – 56.70% for crude protein (CP), ether extract (EE), crude fibre (CF), neutral detergent fibre (NDF), ash and non-fibre carbohydrate (NFE), respectively. Cassava foliage had highest (P<0.05) contents of fibre fractions considered. The acid detergent fiber (ADF), acid detergent lignin (ADL), cellulose (CEL) and hemicellulose (HEM) were 59.18%, 18.36%, 26.50% and 27.10%, respectively for CSL. There was a significant different (P<0.05) in the phytochemical contents across the experimental materials. Similar (P>0.05) value was recorded for DMI, DDM and RFV. Conclusively, the experimental treatments exhibited nutritional qualities that made them a feed resources for ruminant production. Cassava foliage had better proximate composition and fibre fractions, therefore it is recommended for the farmers.

Keywords: Cassava-foliage; Maize stover; Nutritive-parameters; Ruminant-production.

1. Introduction

Forages such as grasses and legumes are the main source of feed for ruminants to meet their nutritional requirements, either for maintenance or production. Natural pasture is known to be the main source of feed in ruminant livestock production in Nigeria, as most the famers can hardly afford to keep their animals on concentrate rations [1]. The Nigerian ruminant industry is facing the problem of forage scarcity with high cost of feeds precipitated by inadequate supply of feed ingredients. This constraint has affected ruminant animal production negatively and created a wide gap between the demand and supply of animal protein in Nigeria.

However, unpleasant situation has necessitated the search for alternative feed resources rich in energy and protein that are readily available and relatively cheap. Several indigenous and exotic browse species have been investigated and evaluated for inclusion in ruminant feeding systems in Nigeria [2].

Crop residues are the major feed resources for livestock especially in most of the tropical and sub-tropical countries. They include leaves, stems, roots, chaffs and any other plant part that remain after agricultural crops are grazed or harvested [3]. Crop residues could also be referred to as harvest residues such as haulms, stover and straws as well as processed waste such as oil cakes, groundnut shells and rice husks [4].

The shortage of feed resources for livestock has diverted majority of research in the field of animal nutrition to look into possibilities to overcome this nutritional crisis. A possible and perhaps the most viable proposition could be the inclusion of non-conventional feed resources such as agro-industrial by-product in livestock rations with suitable and complete feed technology that can utilize the feed sources with maximum efficiency. However, maize stover is made of leaf and stem of harvested maize which has been used for feeding of ruminants. Cassava foliage is the leaf which has been also used for livestock feeding, this study intends to evaluate the chemical composition and nutritive parameters of maize stover fractions i.e. maize leaf, maize stem and cassava foliage for sustainable ruminant production.

2. Materials and Method

Experimental site and collection of experimental materials: The experiment was conducted at Forage Science Laboratory, Department of Animal science, University of Port Harcourt, Port Harcourt, Rivers State. Cassava leaf and maize stover were harvested from the Faculty of Agriculture Demonstration Farm after maize has been harvested, maize leaf and stem separated, cassava leaf gathered from harvested cassava plants. The samples were oven dried at 60°C for 48 hours. The oven dried samples were ground using hammer mill to pass through 2mm sieve and used for chemical analysis.

2.1. Chemical Analysis

Proximate composition: The dry matter, crude protein, ether extract and ash contents of the milled grass sample were determined according to AOAC Association of Analytical Chemists [5]. Non-fibre carbohydrate was calculated as NFC = 100 - (CP + Ash + EE + NDF)**.**

Mineral contents such as calcium, potassium, sodium, zinc, copper, magnesium and Phosphorus were determined by Association of Analytical Chemists AOAC [6] methods using the Atomic Absorption Spectrophotometer**.**

Fibre fractions and anti-nutritional factors analysis**:** Neutral detergent fibre (NDF), Acid detergent fibre (ADF) and Acid detergent lignin (ADL) of the milled silage sample were determined with the procedure of Van Soest, *et al.* [7]. Cellulose content was taken as the difference between ADF and ADL while hemicellulose content was also calculated as the difference between NDF and ADF.

Tannin and saponin contents were determined according to the methods described by Lamidi and Ogunkunle [8]. Oxalate was according to Munro [9] while phytate was determined as described by [Prokopet and Unlenbruck [10]].

Nutritive parameters such as Dry matter intake (DMI), Digestible dry matter (DDM) and Relative feed value (RFV) were calculated as follows:

DMI = (120 ÷ NDF% dry matter basis)

DDM = 88.9 - (0.779 x ADF% dry matter basis)

RFV = (DDM% x DMI5 x 0.775) [11, 12].

2.2. Data Analysis

The experimental design was a completely randomized design (CRD), in which the experimental treatments were the only source of variability.

The model of analysis is as follows: $Xij = \mu + Ti + \sum ij$

Where Xij = value of observation; μ = population mean; Ti = treatment effect; $\sum ij$ = error term

All data obtained were subjected to the analysis of variance (ANOVA). Means were separated using Least Significant Difference (LSD) [13] package.

3. Results

The proximate composition of maize stover fractions (leaf and stem) and cassava foliage shown in Table 1. There was a significant difference (P<0.05) in the all the parameters considered for the proximate composition across the experimental treatments. The contents ranged from 85.21 – 88.77% for dry matter (DM), 6.27 – 19.72%, 1.89 – 3.78%, 14.89 – 17.08%, 51.88 – 62.47%, 3.27 – 11.23% and 36.90 – 56.70% for crude protein (CP), ether extract (EE), crude fibre (CF), neutral detergent fibre (NDF), ash and non-fibre carbohydrate (NFE), respectively. Cassava foliage had highest (P<0.05) contents of DM, CP, EE, CF, NDF, ash and NFE, followed by maize leaf, least content was observed in maize stem.

Table-1. Proximate composition of maize stem, maize leaf and cassava foliage

		Experimental treatments			
Parameters	MST	MSL	CSL	SEM	LOS
Dry matter	85.21^{c}	87.55^{b}	88.77^{a}	0.52	**
Crude protein	6.27^{c}	7.58^{b}	19.78^{a}	2.09	**
Ether extract	1.89^{c}	3.57^{b}	3.78^{a}	0.22	**
Crude fibre	14.89^{c}	15.86^{b}	17.08^{a}	1.32	**
Neutral detergent fibre	51.88^{c}	59.18^{b}	62.47^{a}	1.57	**
Ash	3.27^{c}	9.93^{b}	11.23^{a}	1.23	**
Non-fibre carbohydrate	36.90^{c}	42.81^{b}	56.70^{a}	2.93	**

[a, b, c] Means on the same row with different superscripts differ significantly (P<0.05

SEM= Standard error of mean; MST= Maize stem; MSL= Maize stem; CSL= Cassava foliage; LOS= Level of significant

Table 2 shows the fibre fractions of fractions of maize stover (leaf and stem) and cassava foliage. There were significant differences in fibre fraction across the experimental treatments. Cassava foliage had highest (P<0.05) contents of all fibre fractions considered. The acid detergent fiber (ADF), acid detergent lignin (ADL), cellulose (CEL) and hemicellulose (HEM) were 59.18%, 18.36%, 26.50% and 27.10%, respectively for CSL. The MST had least (P<0.05) contents of fibre fractions ANF, ADL, CEL and HEM with 35.39%, 12.54%, 22.36% and 14.32%, respectively

Table-2. Fibre fractions of maize stem, maize leaf and cassava leaf

		Experimental treatments			
Parameters	MST	MSL	CSL	SEM	LOS
Acid detergent fibre	35.39[c]	51.86[b]	59.18[a]	3.52	**
Acid detergent lignin	12.54[c]	13.03[b]	18.36[a]	0.93	**
Cellulose	22.36[c]	23.25[b]	26.50[a]	0.63	**
Hemicellulose	14.32[c]	16.09[b]	27.10[a]	2.00	**

[a, b, c] Means on the same row with different superscripts differ significantly (P<0.05
SEM= Standard error of mean; MST= Maize stem; MSL= Maize stem; CSL= Cassava foliage; LOS= Level of significant

Phytochemical composition for fractions of maize stover (leaf and stem) and cassava foliage shown in Table 3. There was a significant different (P<0.05) in the phytochemical contents across the experimental materials. Cassava foliage had higher (P<0.05) contents of tannin (0.008%) and saponin (0.62%), while oxalate was higher in maize stover leaf (0.097%), maize stover stem had higher (P<0.05) content of phytate (0.67%).

Table-3. Phytochemical composition for fractions of maize stover (stem and leaf) and cassava leaf

		Experimental treatments			
Parameters	MST	MSL	CSL	SEM	LOS
Tannin	0.002[c]	0.007[b]	0.008[a]	0.01	**
Saponin	0.28[c]	0.32[b]	0.62[a]	0.05	**
Oxalate	0.40[b]	0.97[a]	0.32[c]	0.42	**
Phytate	0.67[a]	0.12[c]	0.43[b]	0.52	**

[a, b, c] Means on the same row with different superscripts differ significantly (P<0.05
SEM= Standard error of mean; MST= Maize stem; MSL= Maize stem; CSL= Cassava foliage; LOS= Level of significant

Dry matter intake, digestible dry matter, and relative feed value for fractions of maize stover (stem and leaf) and cassava foliage were indicated in Table 4. There was no significant difference (P>0.05) in dry matter intake (DMI), digestible dry matter (DDM), and relative feed value (RFV) for fractions of maize stover (stem and leaf) and cassava foliage. The values were the same (2.09) for DMI, 58.76 – 58.77 for DDM and 95.12 – 95.15 for RFV.

Table-4. Dry matter intake, digestible dry matter, and relative feed value for fractions of maize stover (stem and leaf) and cassava foliage

		Experimental treatments			
Parameters	MST	MSL	CSL	SEM	LOS
Dry matter intake	2.09	2.09	2.09	0.06	N/S
Digestible dry matter	58.76	58.77	58.77	1.21	N/S
Relative feed value	95.12	95.13	95.15	3.65	N/S

[a, b, c] Means on the same row with similar superscripts did not differ significantly (P>0.05
SEM= Standard error of mean; MST= Maize stem; MSL= Maize stem; CSL= Cassava foliage; LOS= Level of significant; N/S= Not significant

4. Discussion

The DM recorded for the experimental treatments (85.21 – 88.77%) were close to 89.26 – 89.88% recorded by Lamidi and Ogunkunle [8] for common feedstuff used in South-west, Nigeria. The CP (6.27%) recorded for maize stover stem is far below 7 to 8 % CP suggested as threshold for sufficient utilization of feed by McDonald, *et al.* [14]. This might be the reasons why maize stem were not used solely by the famers. However, the 7.58% CP recorded for maize stover leaf might be very close it might not guarantee the effective and efficient utilization of nutrients by the rumen microbes. The 19.78% CP for cassava foliage is above 8.98 – 15.69% CP catalogued for *Centrosema pascuorum* a forage legume at different stages of growth by Lamidi, *et al.* [1]. It shows that cassava foliage is rich in protein and would provide the adequate nitrogen requirement for the rumen microorganisms to maximally digest the main components of dietary fibre leading to the production of volatile fatty acids [15, 16] which in turn facilitate microbial protein synthesis [17]. Mixture of the cassava foliage and the fractions of maize stover will be a perfect feed for sustainable ruminant production.

The NFE is an indicator of carbohydrate content of feedstuff or ingredient that is soluble or easily digested and available for animal. It implies that the soluble carbohydrate could support the production of volatile fatty acids in the rumen during fermentation [18]. The higher NDF value obtained in this study is an indication that it will be a useful feeding stuff as good energy source in ruminant animal production as NDF is preferred measure for ruminant feeds and dietary balancing programs [7].

The level of ADF is an indicator of digestibility. Schroeder [19], states that as the ADF content increases, forage digestibility decreases. Ball, *et al.* [20], classified forages with ADF values greater than 43.00 – 45.00% as low quality forages.

The tannin content for fractions of maize stover and cassava foliage show the range from (0.002 – 0.008%) this tannin level is much lower than the level of 5% at which goat may reject feed [21]. The tannin and saponin contents of these experimental treatments further explain the abilities they have in reducing enteric methane production. Hess, *et al.* [22], attributed the methane reduction ability of plants rich in saponin to their anti-protozoa effects while Rira, *et al.* [23] reported tannin's reduction of methanogenesis in sheep through its direct effects on the activity of the methanogenic archaea. Oxalates bind calcium and are excrete through urine or form crystals which might cause kidney stones [24].

The similar value recorded for DMI, DDM and RFV in the experimental treatments, can be view within the context of ADF and NDF level. Meanwhile, the experimental treatments had the nutritional qualities that qualified it to be a feed resources especially during the dry season.

5. Conclusion and Recommendations

Conclusively, the fractions of maize stover (stem and leaf) and cassava foliage exhibited nutritional qualities inters of the proximate composition, fiber fractions, phytochemical profile and calculated nutritive value (DMI, DDM and RFV) which made them a feed resources for sustainable ruminant production. Cassava foliage had better proximate composition and fibre fractions, therefore it is recommended as a sole feeding or combination with other feedstuff for feeding of ruminant especially sheep and goat.

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