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Assessment of nutritive value of selectively grazed forbs by cattle in communal grazing land of Ido Local Government Area, Oyo state, Nigeria

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Abstract

Forbs subsidize to nutrients pool of cattle grazing heterogeneous native land. They have sustainability potential to balance nutrients deficiency of tropical grasses that dominate unimproved grazing land. Therefore, selectively grazed forbs by cattle were evaluated with respect to their nutritive value and forage quality indices. Forbs selectively grazed were determined for their chemical composition (g/100g DM), metabolisable energy (ME, MJ/Kg DM) and in-vitro organic matter digestibility (IVOMD %) using Near Infra-Red Spectroscopy (NIRS). In vitro gas production at 24 h incubation, Organic Matter Digestibility (OMD) and Short Chain Fatty Acids (SCFA) were assessed. The Relative Feed Value (RFV) and Relative Forage Quality (RFQ) of the forbs were estimated using standard procedure. Data were analysed using descriptive statistics. Forbs selectively grazed by cattle were; Euphorbia heterophylus, Platosoma africanum, Ipomea triloba, Altherathania sessilis, Sida cordifolia, Tithonia diversifolia, Boerhavia diffusa, Sida acuta, Tridax procumbens, Talinum fruticosum, Phyllanthus amarus, Aspilla africana, Acalypa fimbriata and Euphorbia hirta. Crude Protein (CP) content ranged from 9.30% in A. sessilis to 28.69% in P. Africana. The CP values differed significantly ($p<0.05$) amongst the forb species. The ME ranged from 6.18 in T diversifolia to 8.99 in T procumbence while, IVOMD ranged from 48.29 in A. fimbriata to 65.67 in T. diversifolia showing that the grazed forbs differed significantly ($p<0.05$) from each other. OMD differed significantly ($p<0.05$) among the forbs while, SCFA did not differ ($p>0.05$). RFV and RFQ ranged from 85.63 to 66.48 and 66.48 60 217.89 in A. sessilis and T diversifolia, respectively. The findings from this study revealed forbs are enriched in nutrients, have the potential to supply requested nutrients to grazing cattle because of their great forage quality indices and high degradability.

Keywords: Grazing cattle, forbs, forage quality, chemical composition, *in vitro* gas production.

Une Évaluation de la valeur nutritive des plantes broutées sélectivement par le bétail dans les pâturages communaux de la région du gouvernement local d'Ido, État d'Oyo, Nigéria

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R**ésumé**

Les Forbs subventionnent le 'pool' de nutriments du bétail paissant sur des terres indigènes hétérogènes. Ils ont un potentiel de durabilité pour équilibrer les carences en nutriments des herbes tropicales qui dominent les pâturages non améliorés. Par conséquent, les plantes broutées sélectivement par les bovins ont été évaluées en fonction de leur valeur nutritive et des indices de qualité du fourrage. Les plantes broutées de manière sélective ont été déterminées pour leur composition chimique (g / 100 g MS), leur énergie métabolisable (EM, MJ / Kg MS) et leur digestibilité in vitro de la matière organique (in-vitro organicmatterdigestibility – le 'IVOMD'%) à l'aide de la spectroscopie proche infrarouge

(SPIR). La production de gaz in vitro à 24 h d'incubation, la digestibilité de la matière organique (DMO) et les acides gras à chaîne courte (Le Short Chain FattyAcids- le SCFA) ont été évalués. La valeur relative de l'alimentation (VRA) et la qualité relative du fourrage (QRF) des fourrages ont été estimées en utilisant la procédure standard. Les données ont été analysées à l'aide de statistiques descriptives. Forbs broutés sélectivement par le bétail étaient ;Euphorbiaheterophylus, Platosomaafricanum, Ipomeatriloba, Altherathaniasessilis, Sida cordifolia, Tithoniadiversifolia, Boerhavia diffusa, Sida acuta, Tridaxprocumbens, Talinumfruticosum, Phyllanthus amarus, Aspillaafricorbana, Acalypafimbriata et Euphorbana. La teneur en protéines brutes (CP) variait de 9,30% chez A. sessilis à 28,69% chez P. Africana. Les valeurs de CP diffèrent significativement (p <0,05) parmi les espèces interdites. Le ME variait de 6,18 dans T diversifolia à 8,99 dans T procumbence tandis que l'IVOMD variait de 48,29 dans A. fimbriata à 65,67 dans T. diversifolia montrant que les plantes broutées différaient significativement (p <0,05) les unes des autres. DMO différait significativement (p <0,05) parmi les forbs tandis quele'SCFA' ne différait pas (p> 0,05). La VRA et la QRF allaient de 85,63 à 66,48 et 66,48 60 217,89 chez A. sessilis et T diversifolia, respectivement. Les résultats de cette étude ont révélé que les plantes herbacées sont enrichies en nutriments et elles ont le potentiel de fournir les nutriments requis aux bovins de pâturage en raison de leurs excellents indices de qualité fourragère et de leur haute dégradabilité.

Mots clés : Bovins au pâturage, plantes fourragères, qualité du fourrage, composition chimique, production de gaz in vitro.

Introduction

Forbs contribute to nutrient pool of cattle on heterogeneous grazing land. Enormously, forbs add to dry matter intake of cattle while grazing with native grasses, legumes and shrubs. It has greater potential to increase the forage biomass yield for cattle productivity. Most native forbs had been noted to adapted well to local climatic stress, animal trampling, grow vigorously and often considered as weed. Forbs have been reported to contain higher protein (Holechek, 1984) which is often limiting nutrient in unimproved native tropical grasses which could lead to poor nutrient intake and poor productivity of cattle. For sustainable improvement of feeding low nutritional quality grasses that are economical (Babayemi, 2009; Kubkomawa *et al*., 2013) and bulky as feed resources to cattle (Pamo and Pieper, 2000) rear on unimproved heterogeneous grazing land in traditional system, there is a need for supplementation of forbs with native grass in conserved forms (hay and silage) or fed as fresh could be adopted. Forage conservation has proven to alleviate dry season forage shortage (Aina, 2012) and associated poor performance of cattle (Lamidi and Ologbose, 2014) in sub-sahran Africa. Better conserved feed could be made available for dry (dearth) season feeding by improving nutritional profile of conserved feed resources by conserving forbs with grasses. Also, forbs have been found to thrive through dry season by regeneration after fire and some grow in cleared farm land prepare for growing season. Forbs importance in supplementary nutrition provision for grazing cattle especially leguminous ones are desired on rangeland (Pamo and Pieper, 2000), with less concern on non-leguminous forbs. Despite these beneficial attributes of forbs, there are scanty information on nutritive value of grazed forbs by cattle in South-Western Nigeria for research intervention for optimal utilization and sustainability as forage. Inadequate nutritional knowledge is the capital factor that influences low

productivity of livestock in sub sahran Africa region as reported by several authors (Babayemi, 2007; Bakrie *et al*., 1996; Thornton, 2010). For rational-utilisation of forbs as fresh forage, conserved and as a part of total mixed rations (TMRs) for feeding cattle, accurate nutritive value information about forbs is necessary. The importance of evaluating the nutrition value of forages provides insight to energy and protein intake of livestock (Beever and Mould, 2000). The potential nutritive value of previously uninvestigated forbs could be indicated by assessing its chemical composition in association with *in vitro* digestibility, organic matter degradability and metabolisable energy. The *in vitro* gas production had been proven to be an accurate technique to predict forage digestibility (Blummel and Ørskov, 1993) and animal performance (Deutschmann *et al*., 2017). Also, it is a tool in determining the amount of short chain fatty acids, metabolisable energy (Getachew *et al*., 1999) and organic matter degradability (Getachew *et al*., 1998) of feed for ruminants. However, forage quality and value are best measured in terms of nutritive and feed value. The best measure of the quality of forage is the expression of animal performance which is a function of nutritive value of forage and its intake by animal. Thus, it is imperative to estimate grazed non-leguminous forbs by cattle using relative feed value (RFV) and relative forage quality (RFQ) indices described by Rohweder *et al*. (1978); Moore and Undersander (2002). There is need to assess grazed non-leguminous forbs by cattle for their nutritional value. As livestock are the best assessor of their feed (Babayemi and Bamikole, 2006). Therefore, this study was designed to investigate the nutritive and potential feed value of selectively grazed non-leguminous forbs based on chemical analysis, *in vitro* gas production technique and relative feed value.

Materials and methods

Site

The study was conducted at Open Access and Communal Grazing Land of Ido Local Government Area, Oyo state. Nigeria. The local Government Area falls within latitudes 7°45N, 7°15N and longitudes 3°30E, 3°50E with landmass of 986 Km^2 (Denton and Ogunkunle, 2014). The site was situated within the derived savannah with mean rainfall of 1800mm. The main rain falls during wet season and little at early dry season.

Vegetation sampling and forage collection

The grazing sites are the locations where agro-pastoral herded cattle grazed relatively for longer time and were positioned with GPS receiver. The cattle were visually observed while grazing without perturbation to identified grazed forbs. Fresh representative samples of selectively grazed forb plants by cattle were harvested by hand pluck from several stands in the grazing land between August and June. Fresh foliage samples of the harvested forbs were pooled together based on species type and oven dried to constant weight at 60^{o}C for 48 hours to determined dry matter.

Forage processing and chemical analysis of the forbs samples

Oven dried samples were milled to pass through 1mm screen and stored in air tight zip lock bag for subsequent laboratory analysis. Three grams of milled oven dried samples were scanned with NIRS and chemical composition (dry matter, crude protein, crude fibre, ash, fat, starch, neutral detergent fibre, acid detergent fibre and acid detergent lignin), metabolisable energy (ME, MJ/Kg DM), *in vitro* dry matter degradability (IVDMD, %) of the samples were assessed using equation for the feed sample analysis based on the mixed feed global calibration model using the software package (Win ISI II FOSS, Denmark,

Model NIRS™ 5000) calibrated against convectional wet laboratory analysis. Spectral information were registered in the wavelength range 1100-2500nm using NIR system mode 5000 scanning monochromatic infrared spectrophotometer.

***In vitro* gas production study**

The *in vitro* gas production was determined by Menke and Steingass (1988) procedure. Rumen fluid was obtained from three West African goats previously fed with 40% corn, 10% wheat offal, 10% Palm Kernel Cake, 20% groundnut cake, 5% soybean meal, 20% groundnut cake, 5% soybean meal, 10% dried brewers' grain, 1% common salt, 3.75% oyster shell meal and 0.25% fish meal, according to procedure of Babayemi (2007). The animals were not restricted to fresh water and salt lick. The rumen fluid was collected by suction tube prior to morning feeding as described by Babayemi and Bamikole (2006). The collected rumen fluid was seived by passing through layers of fibre cloth. All laboratory handling of the rumen was done at 39°C under continuous streaming with carbon IV oxide. About 200mg of the oven dried milled samples of the forbs species was added to 30 mL of inoculums containing 10mL of rumen fluid and 20 mL of buffer solution (9.8g $NaHCO_3$ + 2.7g Na HPO_4 + 0.57g KCl + 0.47g NaCl + 0.12g $MgSO_4.7H_2O$ + 0.16g /litre $CaCl_2.2H_2O$) (1:4, v/v) inside 120 mL syringes fitted with rubber silicon tube. The incubation was done at 39°C with mild shaking of the syringes at every one hour. The volume of gas produced was recorded at 3, 6, 9, 12, 15, 18, 21 and 24 h. At post incubation to estimate the amount of methane produced, 4 mL of (10M) Sodium hydroxide (NaOH) was introduced to the syringes to absorb carbon oxide (CO_2) produced at the course of fermentation while the remaining gas was recorded as methane gas as reported by Fievez *et al*. (2005). The average gas volume produced from the blanks was deducted from the produced gas volume per sample.

Calculation and statistical analysis

The gas volume produced at intervals was plotted against the incubation time. Organic matter digestibility (OMD%) of the incubated samples were estimated at 24 h post incubation gas collection using Menke and Steingass (1988) equation, while short chain acid (SCFA, µmol) was at 24 h post incubation gas collection as well, using linear equation by Getachew *et al*. (1999).

OMD = 14.88 + 0.889 +0.45CP + 0.651XA (Menke and Steingass, 1988)

SCFA = 0.0239 GV – 0.0601 (Getachew *et al*., 1999)

Where GV, CP, CF and XA are total gas volume, crude protein, crude fibre and ash, respectively.

The relative feed value (RFV) and relative forage quality (RFQ) of the forbs were calculated from the estimates of digestibility of dry matter (DDM), dry matter intake (DMI) and total digestible nutrient (TDN) according to Rohweder *et al*. (1978) and Moore and Undersander (2002).

Below are the equation used:

DMI, % of BW = 120 / (NDF, % of DM)

DDM, % of DM = 88.9 -0 .779 X (ADF, % of DM)

TDN, % of DM = OM, % of DM X OM digestibility, % / 100

RFV = DMI X DDM / 1.29

RFQ = DMI X TDN / 1.23

Forage quality was determined using the standard by Hay Task Force of American Forage and Grassland Council

Statistical analysis

Data obtained were subjected to analysis of variance (ANOVA) in completely randomized design. Significance difference between individual means was separated by Duncan's multiple range F-test procedure of the same software package of SAS (2001).

Results

Shown in Table 1 is the proximate composition of selectively grazed forbs by cattle in agropoastoral system in Ido Local Government Area of Oyo state. There was variability ($P<0.05$) in the nutrient composition of the selectively grazed forbs by cattle. The dry matter (DM) ranged from 89.09% in *E. hirta* to 93.67% in *Impobe triloba*. The highest ash content was found in *Tithonia diverisifolia* (13.35%) and the least in *Aspillia africana* (8.92%). *Aspillia africana* (7.74%) and *Tanilum fruticosum* (1.21%) had the highest and least values for ether fat, respectively. The crude fibre (CF) and crude protein (CP) ranged from 9.93% to 27.27% and 9.30% to 28.68%, respectively. However, organic matter (OM) ranged from 75.88% to 83.86%% in *E. hirta* to 83.86%, respectively.

The fibre fraction of grazed forbs by the cattle on heterogeneous grazing land is shown in Table 2. It varied significantly ($P<0.05$%) across different species selectively grazed by cattle on heterogeneous grazing land. The lowest value of neutral detergent fibre (NDF) (34.13%) and acid detergent fibre (ADF) (26.44%) were obtained from *P. africana* and *S. cordifolia*, respectively. While the highest value of 64.29% and 39.52%, were obtained in *A. sessilis* and *T. diversifolia,* respectively. The Acid detergent lignin (ADL) ranged from 5.72% in *S. cordifolia* to 28.17% in *Tithonia diversifolia.* The least organic matter digestibility of 32.69% were obtained in *A. sessilis* while, the highest of 40.10% were noted for *P. africana* and *S. cordifolia*. There were no differences ($P>0.05$) for short chain fatty acids (SCFA) while, metabolisable energy (ME) differed significantly ($p<0.05$) among the grazed forbs by the cattle with the least of 6.18 MJ/Kg DM in *T. diversifolia* and the highest of 8.99 MJ/Kg DM in *T. procumbence*. The *in vitro* dry matter degradability ranged significantly ($p<0.05$) from 48.29% in *A. fimbrata* to 65.67% in *T. diversifolia.*

Shown in figure 5a and b is the *in vitro* gas production pattern of selectively grazed forbs by cattle. The pattern of *in vitro* for the forbs was similar for the forbs with progressive increasing in the volume of gas produced hourly. There was tendency for gas production beyond 24 hours of incubation. However, *Tridax procumbence* produced the least gas volume of 26.67mL, while *Sida acuta* produced highest gas volume of 36.67mL at 24 hours if incubation. The least DMI and DDM ranged from 2.31% in *Sida acuta* to 5.30% in *Tithonia diversifolia* and 58.12% in *Tithonia diverisfolia* to 68.31% in *Sida cordifolia.* The least TDN, RFV and RFQ of 38.56, 113.92 and 66.48 were obtained for *A. fimbrinata, Sida acuta* and *A. sessilis*, respectively. However, the greatest value of TDN (50.52), RFV (238.90) and RFQ (217.80) were obtained for *Tithonia diverisifolia*.

Table 1: Chemical composition (%) of selectively grazed forbs by cattle

Samples	DM	Ash	Fat	CF	CP	OM	Starch
I. triloba	93.67^{a}	11.91^{i}	1.71^{j}	17.84^{f}	23.29^{c}	81.76^{b}	6.97^{g}
B. diffusa	93.19^{b}	11.51^{j}	2.13^{i}	11.35^{i}	21.74^{e}	81.69^{c}	9.01^{c}
A. fimbriata	92.92^{c}	13.07^{c}	1.45^{k}	23.60^{b}	20.21^{i}	79.85^{f}	7.14^{e}
A. africana	92.78^{d}	8.92^{l}	7.74^{a}	20.49^{d}	21.50^{g}	83.86^{a}	7.36^{d}
T. fruticosum	92.67^{e}	12.20^{h}	1.21^{l}	9.93^{l}	22.73^{d}	80.47^{e}	18.12^{a}
P. africana	92.65^{ef}	12.76^{e}	3.40^{e}	14.83^{g}	28.69^{a}	79.89^{f}	4.38^{k}
S. cordifolia	92.63^{f}	12.75^{ef}	3.39^{e}	14.85^{g}	28.68^{a}	79.88^{f}	4.37^{k}
A. sessilis	92.55^{g}	13.32^{a}	3.30^{ef}	27.27^{a}	9.30^{m}	79.23^{i}	7.02^{f}
S. acuta	92.15^{h}	11.27^{k}	2.32^{h}	23.64^{b}	16.84^{k}	80.87^{d}	9.39^{b}
T. prub	92.09^{i}	12.67^{g}	4.48^{b}	23.39^{c}	18.81^{j}	79.43^{g}	5.53^{i}
E. heterophylus	92.09^{i}	12.72^{f}	4.07^{d}	10.51^{k}	23.67^{b}	79.37^{h}	4.86^{j}
P. amarus	91.49^{j}	12.90^{d}	4.32^{c}	19.96^{e}	21.65^{f}	78.59^{j}	1.03^{m}

Table 2: Fibre component of forbs selectively grazed by cattle

	Nutrient (g/100g DM)		
Forbs	NDF	ADF	ADL
I. triloba	49.97^{d}	32.29^{g}	6.52^{g}
B. diffusa	46.19^{e}	33.94^{e}	6.19^{i}
A. fimbriata	45.35^{f}	36.66^{c}	7.79^{c}
A. africana	39.30^{i}	29.49^{j}	6.40^{h}
T. fruticosum	34.49^{k}	32.41^{f}	6.33^{h}
P. africana	34.13^{l}	26.45^{l}	5.74^{j}
S. cordifolia	34.16^{l}	26.44^{l}	5.72^{j}
A. sessilis	64.29^{a}	38.14^{b}	6.93^{d}
S. acuta	51.97^{b}	32.42^{f}	6.60^{f}
T. prub	37.29^{j}	31.88^{h}	6.19^{i}
E. heterophylus	42.23^{g}	28.66^{k}	6.66^{f}
P. amarus	50.55^{c}	34.32^{d}	10.63^{b}
T. diversifolia	22.63^{m}	39.52^{a}	28.17^{a}
E. hirta	41.25^{h}	30.98^{i}	6.77^{e}
Mean	42.41	32.40	8.33
SEM	1.32	0.51	0.76

^{abcdefghijklm} Means of treatments along a column with different superscripts differed significantly (P<0.05)

Table 3: Metabolisable energy (ME MJ/Kg DM), in vitro organic matter digestibility, (%) Organic matter digestibility (OMD, %) and short chain fatty acids (SCFA, mmol) of forbs selectively grazed by cattle

Forbs	ME MJ/Kg DM	IVOMD (%)	SCFA (mmol)	OMD (%)
I. triloba	8.12^{f}	57.25^{g}	0.74	37.13^{d}
B. diffusa	7.11^{k}	52.75^{j}	0.74	35.64^{i}
A. fimbriata	6.79^{l}	48.29^{l}	0.68	37.05^{e}
A. africana	8.67^{c}	57.91^{f}	0.68	33.82^{l}
T. fruticosum	7.95^{h}	58.52^{e}	0.72	36.61^{g}
P. africana	7.69^{i}	56.53^{h}	0.68	40.10^{a}
S. cordifolia	7.69^{i}	56.55^{h}	0.69	40.10^{a}
A. sessilis	8.44^{d}	55.29^{i}	0.76	32.69^{m}
S. acuta	8.85^{b}	59.33^{d}	0.85	34.02^{j}
T. prub	8.99^{a}	60.55^{b}	0.58	36.13^{h}
E. heterophylus	8.02^{g}	57.92^{f}	0.73	37.53^{b}
P. amarus	7.27^{j}	49.79^{k}	0.67	37.38^{c}
T. diversifolia	6.18^{m}	65.67^{a}	0.66	37.03^{f}
E. hirta	8.38^{e}	59.97^{c}	0.71	33.91^{k}
Mean	7.87	56.88	0.71	36.37
SEM	0.11	0.58	0.02	0.33

^{abcdefghijklm} Means of treatments along a column with different superscripts differed significantly (P<0.05).

Table 4: Forage quality indices of forbs selectively grazed by cattle

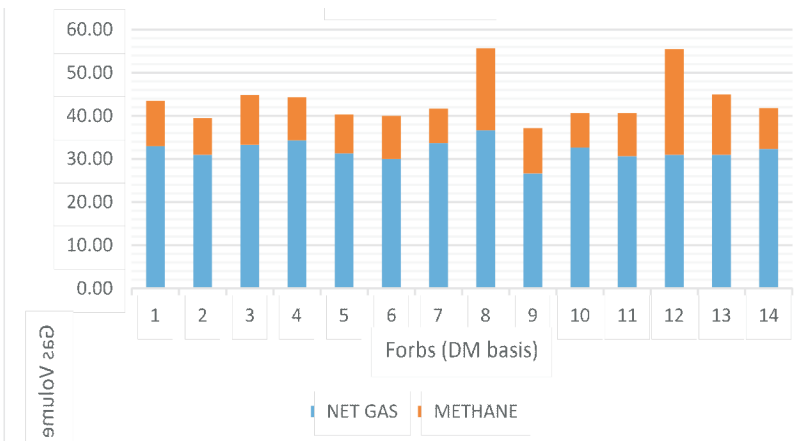
Forbs	Quality indices					
	DMI (%)	DDM (%BW)	TDN	RFV	RFQ	Quality Standard
I. triloba	2.40^{j}	63.74^{f}	46.81^{e}	118.68^{j}	91.39^{h}	4
B. diffusa	2.59^{i}	62.46^{h}	43.09^{j}	125.78^{h}	91.01^{h}	4
A. fimbriata	2.65^{h}	60.34^{j}	38.56^{l}	123.78^{i}	82.96^{j}	5
A. Africana	3.05^{e}	65.92^{c}	48.57^{b}	156.02^{e}	120.55^{e}	2
T. fruticosum	3.48^{c}	63.65^{g}	47.09^{d}	171.66^{c}	133.19^{b}	2
P. africanum	3.52^{b}	65.92^{c}	45.16^{h}	186.13^{b}	129.08^{c}	2
S. cordifolia	3.51^{b}	68.31^{a}	45.18^{h}	186.03^{b}	129.04^{c}	2
A. sessilis	1.87^{m}	59.19^{k}	43.81^{i}	85.63^{m}	66.48^{l}	5
S. acuta	2.31^{l}	63.65^{g}	47.98^{c}	113.92^{l}	90.07i	4
T. prub	3.22^{d}	64.06^{e}	48.09^{c}	159.79^{d}	125.79^{d}	2
E. heterophylus	2.84^{g}	66.57^{b}	45.97^{f}	146.66^{f}	106.22^{g}	2
P. amarus	2.37^{k}	62.17^{i}	39.13^{k}	114.40^{k}	75.52^{k}	5
T. diversifolia	5.30^{a}	58.12^{l}	50.52^{a}	238.90^{a}	217.80^{a}	1
E. hirta	2.91^{f}	64.77^{d}	45.50^{g}	146.05^{g}	107.62^{f}	1
Mean	3.00	63.66	45.39	148.10	111.91	-
SEM	0.11	0.40	0.44	5.10	4.85	-

^{abcdefghijklm} Means of treatments along a column with different superscripts differed significantly (P<0.05). DMI= dry matter intake, DDM= digestibility of dry matter, TDN= total digestible nutrient, RFV= relative feed value and RFQ= relative forage quality (RFQ).

Table 5: Quality standard for grass, legume and grass -legume mixture

	Quality standard[a]			
	CP	ADF (DM %)	NDF (DM %)	RFV[b]
Prime	>19	<31	<40	>151
1	17-19	31-40	40-46	151-125
2	14-16	36-40	47-53	124-104
3	11-15	41-42	54-60	102-87
4	8-10	43-45	61-65	86.75
5	<8	>45	>65	<75

[a]Standard allotted by Hay Market Task Force of American Forage and Grassland council;
[b]Relative Feed Value (RFV): Reference hay of 100 RFV contains 41% ADF and 53% NDF



Fi 1: Net gas and methane gas production of selectively grazed forbs at 24 h

1	*E. heterophylus*	2	*P. africana*	3	*T. triloba*	4	*A. sessilis*
5	*S. cordifolia*	6	*T. diversifolia*	7	*B. diffusa*	8	*S. acuta*
9	*T. procumbens*	10	*T. fruticosum*	11	*P. amarus*	12	*A. africana*
1	*A. fimbriata*	14	*E. hirta*				

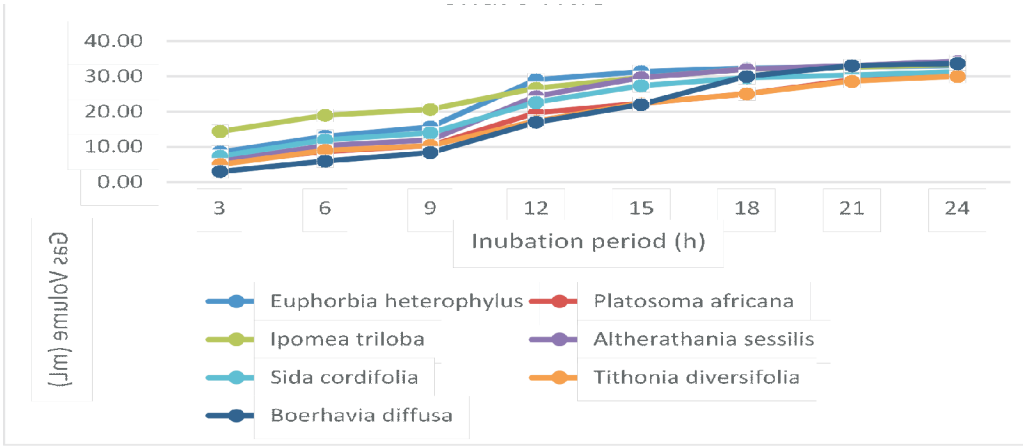


Figure 2a: *In vitro gas* production of selectively grazed forbs

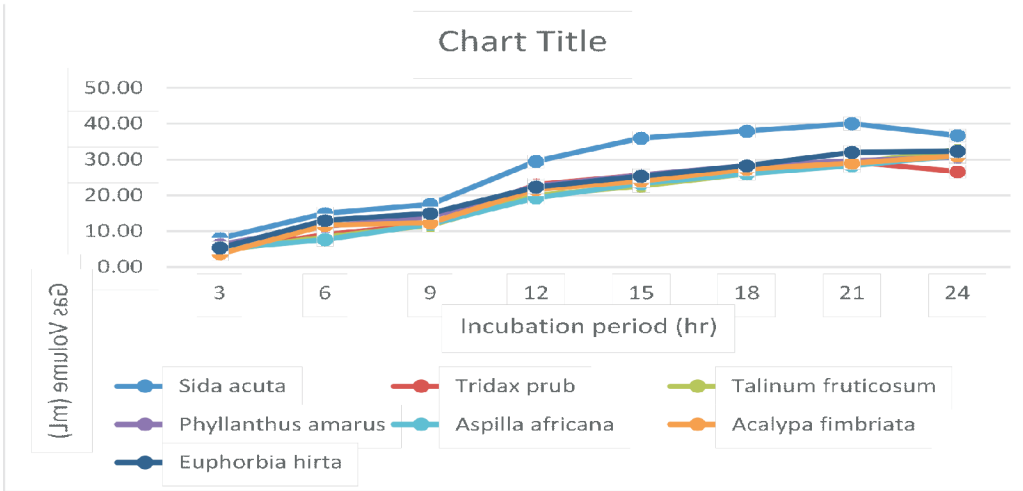


Figure 2b: *In vitro gas* production of selectively grazed forbs (cont'd)

Discussion

Forbs selectively grazed by cattle were*; Euphorbia heterophylus, Platosoma africanum, Ipomea triloba, Altherathania sessilis, Sida cordifolia, Tithonia diversifolia, Boerhavia diffusa, Sida acuta, Tridax procumbens, Talinum fruticosum, Phyllanthus amarus, Aspilla africana, Acalypa fimbriata and Euphorbia hirta*. All the forbs contain high dry matter (DM) similar to residual dry matter for some browse herbs (Onwuka, 2007). The value of protein among the grazed forbs species were higher than CP content previously reported for some leguminous browse forage by Aleton and Omodara (1994) and tropical grasses by Babayemi (2007). However, the results were within the range of 12-30% for tropical leguminous trees accounted by Norton (1998) and tropical browse (Le Houerou, 1980). The CP content of the forbs grazed by the cattle on the average is above the 7% needed for both rumen microorganism (Njidda, 2010) and their body growth (Gadberry, 2018) and this prevent decline in forage intake that could occur when the CP is below 7% as attributed to nitrogen deficiency due to low protein

supply to the rumen which impede microbial activity. Also, forbs grazed is above 5- 10% CP in forage recounted by Ward and Scholljegerdes (2017). This showed that the derived savannah area of Oyo state, Nigeria is endowed with forbs that are high in crude protein. Forbs maintain higher protein content as their growth advances when compare with tropical grasses that fall in CP progressively as they mature. Besides, leguminous fodders, forbs are the cheapest source of protein to grazing cattle and this makes them excellent fodder for grazing cattle. The selective process of cattle for nutritious forages helps them to make preference while grazing and this is the reason of grazing on forbs to meet their nutritional requirement. Fibre which is composed of soluble and insoluble fractions is essential for healthy and proper function of the rumen. It is a substrate for microbial activity in the retico-rumen. Fibre level is an important factor of consideration in determining forage energy value (Newman *et al*., 2001). Also, it regulates intake and milk synthesis by cattle. Thus, fibre level of forage determines its feeding value and promotes better rumination by stimulating chewing activity (Kononott, 2005), maintains steady flow of saliva and buffers ruminal pH (Li *et al*., 2014). The mean CF value (17.23%) of the forbs is within the tolerable limit of 17% requirement for cattle (NRC, 2000; Moran, 2005) for proper digestive function and adequate rumination. The forbs fibre is lower than that of crop residue and tropical grasses at maturity. Considering this moderate fibre level of forbs, they would not impair intake, digestive function and gut's health of the cattle. In the context of this study, NDF and ADF mean value of 39.84% and 35.24% shows that the forbs are good source of effective dietary fibre in cattle diet formulation to guarantee proper fibre. The mean NDF content of the forbs is below 40% and ADF content slightly above 35% that is considered as good quality indicator for marking good quality legume forage (Moore and Undersander, 2002). The NDF mean value for these forbs could satisfy the NRC (2001) recommendation of 30% NDF in cow ration with minimum of 21% NDF being supply from forage origin. Therefore, NDF content of forage is not consider on its functionality in aiding digestive process alone, but also as an important index of interest for energy intake and overall preference by the animal. Also, NDF is a perquisite in determining maximum milk yield and fat content from dairy cattle (Beauchemin, 1996). Selecting these forbs on this basis is an obvious means of enhancing energy value of the cattle feed, because net energy value of the grazed forages and TMR is an additive effect of each of the forages involved. Gases are products of fermentative degradation of feed substrates in the ruminal environment (Blummel *et al*., 1997a), and related to volatile fatty acids (VFAs) (Blummel and Ørskow, 1993). Thou, Murrillo *et al*. (2011) were of the opinion that gas production is a wasteful product of ruminal fermentation but could be used to estimate ME, OMD and SCFA of feedstuffs. The gas production could be used as an indicator to the rate and extent of feed substrate degradation (Getachew *et al*., 2004), by ruminal microbial activity. Gas produced by the forbs was progressively increasing with the incubation period. Although, the rate of production and total volume produced at 24 hours of incubation varied for the forbs and this probably due the fact that there is discrepancy in their nutrients (crude protein and crude fibre) composition. This support the earlier finding by Blummel and Becker (1997); Babayemi (2007) that nutrient determines the extent and volume of gas produced during fermentation. *Aspilla africana* and *Sida acuta* produced the largest net gas volume, which might be

attributed to similarity in their CF content. This was in line with Babayemi *et al*. (2004a) that nature and level of fibre determine the volume of gas produced during fermentation. Secondary metabolites in the forbs were not assessed have been ascertain to have negative influence on feed degradation (Babayemi *et al*., 2004b) and resultant gas production (Getachew *et al*., 2004; Okunade *et al.,* 2014). The average gas (31.98 mL/ 200mg DM) by the forbs are within the range of gas volume produced by browse species reported by Okunade *et al*. (2014), greater than 6.52-22.88 mL/200 mg DM produced by crop residues (Tona *et al*., 2015) and lesser than 45-45.7 mL/200 mg DM, 49.7-54.3 mL/200mg DM and 41- 59.7 mL/200mg DM reported by Babayemi (2007) for tropical grasses, legumes and browse, respectively. *Aspilla africana* and *Sida acuta* that has the highest net gas volume was noted to produced more of methane gas than other forbs. This implies that these forbs (*Aspilla africana* and *Sida acuta*) enhanced methanogenesis activity in the rumen. Methane production is an energy loss to ruminants (Getachew *et al*., 2004, Babayemi and Bamikole, 2006b). Also, this affirms the findings of Babayemi (2007) that most often times, feedstuffs that have higher tendency for gas production, produce more methane gas. Therefore, the volume of methane (19mL and 14mL) per 200mg DM (*Aspilla africana* and *Sida acuta)* in relation to their net gas volume (36.67mL and 31mL), respectively, indicate that they contribute more to greenhouse effect due to their higher methanogenic potential when fed sole or more to ruminant animals. At large, ME values on the average (7.76 MJ/Kg DM) for the forbs is enough to supply metabolisable energy intake to meet the demand of 930Kcal that required daily by zebu cattle of 400 body weight on maintenance ration suggested by Paulino *et al*. (2004), moderately support cow and bull that requires 8 MJ/kg DM for maintenance. The value is higher than 3.28-3.82 MJ/Kg DM report on tropical browse by Getachew *et al*. (2002) and 4.44-5.41 MJ/Kg DM for browse plants (Omoniyi *et al*., 2013). This reflects modest fibre and protein levels in the grazed forbs by the cattle which are indices to net gas production in which the ME is estimated. The estimation of ME value is necessary for ration formulation and establishing economic value of feedstuffs (Okunade *et al.,* 2014). Although, the estimated ME values were within the wide range for broad number of feedstuffs (Krishnamurthy *et al.,* 1995), some forbs species showed a distinct variation. The variation in the ME of the grazed forbs species was as a result of different level of fermentative carbohydrate (starch) and CP that is the primary source of nitrogen for microbial activity. The forbs had low OMD of 36.37% on the average that falls within 31.93-74.47% reported for some browse trees (Onwuka, 2007), slightly lower than 61.30- 75.54% reported for legume hays (Karabulut, 2007), but comparable to the OMD values reported by Omoniyi *et al.* (2013) for browse plants. The discrepancies between the forbs and other feedstuffs are probably due to nature of NDF which determines the extent of microbial activity. Karabulut *et al*. (2007) pronounced NDF to be negatively correlate with gas production was not supported by the finding of this study because gas production is a reflection of NDF digestion (Buxton, 1996), and this could affect feed intake and digestibility. Average SCFA of $0.71mmol^{-1}$ for the forbs is relatively lower than average of 0.95mmol obtained from agricultural feedstuffs reported by Akinfemi *et al.* (2009) and some forage selected by steers on range reported by Murillo *et al*. (2011). SCFA is the main source of energy to the ruminants which could be used to determine nutritional value

of feed in diet formulation for animal. The IVDMD of the forbs were high and relatively comparable to results for some browse plant in guinea savannah (Okunade *et al*., 2014) and some grazed plant by cattle in humid and sub-humid (Omoniyi *et al.,* 2013) areas of Nigeria. Ruminal micro-organism play crucial role in dry matter degradability of forage (Ando 2004). Specifically, the quantity of ruminal micro-organism and their activity contribute to extent of forage degradability (Hungate, 1966). Forage quality has direct influence on cattle production performance and economic profitability from their production. Forage of low quality with high poor fibre content caused low intake by cattle. This contradict belief from other clime that animals eat more of low nutritive feed to meet their energy or nutrients requirement (Ahiwe *et al.,* 2018). Since, it is imperative to conserve forage against dearth seasons in tropical climate. It is necessary that from harvesting, to formulation and to feeding, forage quality and feeding value should be considered to avoid economical loss such as lower milk production, delay estrus and loss of body condition due to low intake. The mean RFV of 240.20 from this study is better when compare with 143.26 reported by Okunade *et al*. (2014) for some selected browse plant species. The relative feed value (RFV) and relative forage quality (RFQ) are indices of forage quality (Moore and Undersander, 2002) which varied across grazed forb species. This variation is a function of forage type, harvesting age (Tilahun *et al.,* 2017) and stage of growth (Buxton, 1995). All these affect the forage fibre level and ultimately the intake by the animals. Forbs (*Aspilla africana*, *Tanilum fruticosum*, *Platosoma africana*, *Sida cordifolia* and *Tithonia diverisolia*) with quality standard of rank 1 are of better quality, because they are of higher index value. Better performance is expected by cattle fed with these forbs as opined by (Castilo and Remere, 2016) that higher the index value, the greater the quality of the forage and consequently the greater the animal's performance. TMR should not be balanced on ADF values of these forbs because their RFQ is lower than RFV to avoid lower animal performance as suggested by Castilo and Remere (2016).

Conclusion

The study has revealed the potential of forbs as good nutritive feed resource and promising forages with economic importance in cattle enterprising. Chemical composition showed that the selectively grazed forbs by cattle are rich in protein, have adequate fibre level. Their extent of *in vitro* organic matter degradability and predicted dry matter digestibility make them forage of good quality for improved animal performance. From the point of view in this study, forage quality indices viz; relative feed value and relative forage quality, dry matter digestibility and dry matter intake showed that *Tithonia diversifolia* exhibited higher index value which designate greater forage quality with high propensity for good auction price and subsequently greater animal's performance and better economic return. In conclusion forbs hold high potential as forage source to livestock. In line with this study, forbs are forage with pool of nutrients that could sustain cattle production in derived savannah area of Oyo, state Nigeria. Thus, there should be further study into their genetics and agronomic basis for improved yield and nutrition.

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