

SOIL CHARACTERISTICS AND PROXIMATE COMPOSITION OF SOME FORAGE SPECIES IN BOBI GRAZING RESERVE, NIGER STATE, NIGERIA: IMPLICATIONS FOR RUMINANT ANIMAL NUTRITION

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ABSTRACT

The Experiment was carried out in Bobi Grazing Reserve, Niger state, Nigeria from May – October, 2014 – 2016 to evaluate soil characteristics and proximate composition of six forage species namely Paspalum commersonii Cyperus esculentus Hyparrhenia achrysegyrea Digitaria smutsii Seteria barbata and Brachiaria deflexa. Soil was obtained for analysis at 0 – 15 and 15 – 30 cm for subsoil analysis using the method of NSCS 2013. The physic-chemical analysis was done using the method outlined by ISRIC/FAO 2003. The methods of AOAC (2000) was used to determine the proximate composition of the forages. The soil acidity ranged from 6.38 – 6.90, The soil was generally sandy, the soil fertility was suboptimal. All the proximate values of the forages showed significant differences across the years 2014, 2015 and 2016, the dry matter contents of the forages ranged from 59.49 to 89.19% forage growth and nutritive value were not impressive. It was concluded that soil characteristics and rainfall influenced the nutritive value of forages in Bobi Grazing Reserve. Soil conservation and improvement , irrigation as well as planting of more legumes were recommended

Keywords: Soil Characteristics, Nutrients, Proximate Composition, Bobi Grazing Reserve

1.0

INTRODUCTION

The major challenge to livestock production is ensuring adequate feed supply throughout the year in terms of quality and quantity (Kallah. *et al.*, 1997). The situation is even worsened by desertification, leaching and urbanization, the potential to increase ruminant production on the quantity and quality of available forage are major constraints to optimum livestock production from the savanna rangelands, most especially during the dry seasons (Omokanye, *et al* 2004). The inherently low livestock productivity is attributed to low quantity and quality of feed for the livestock (Nyangito, *et al* (2008). This is because native grasses are grown on low fertile soil which is not well suited for cropping (Humphreys, 1995). Seasonal variation affect the availability of nutrients from the soil to forage species (Ezenwa *et al*, 1995). Where climate is characterised by clearly defined wet and dry season, forages growth is very rapid during the wet season, but as the soil dries out the forage matures and dies (McDowell *et al*, 1983).

The rate at which forage grows is dependent upon the environment, the nutrient available and amount of leaf within the sward which is intercepting light (Minson, 1990). Immediately after forage are grazed, there is a period of slow regrowth followed by

accelerated rate and finally a period of decreasing growth as the forages matures(Eze, 2010). The composition of dry matter of forages is very variable, for example, the crude protein content may range from as little as 30g/kg in very matured forages to over 300g/kg in young, heavily fertilised forage. The fibre content is broadly related inversely to the crude protein content, and the acid – detergent fibre may range from 200 to over 450g/kg in very mature species of forages (Thomas *et al*, 1991)

The moisture content of forages is very important where a forage is being harvested for conservation, its high in very young forages usually 750 – 850g/kg and falls as the plant matures to about 650g/kg. Weather condition, however greatly influence the moisture content (Durr *et al*, 2005).

Water soluble carbohydrates of forages include fructans and sugar glucose, fructose, sucrose, raffinose, and starchyose. Forages of tropical and subtropical origin accumulates starches, instead of fructans in their vegetative tissues and these are stored primarily in the leaves. The water – soluble carbohydrates concentration of forages is very variable ranging from as little as 25g/kg Dm in some tropical species to over 300g/kgDm in some cultivated forages (Buxton. 1996). Ruminant animals rely more essentially on pasture for their nutrients requirement than on any other feed resources. Grass-legumes mixture provide balanced diet as compared to grass meal alone. Balanced diet is essential for normal physiological functions of ruminant animals (McDonald *et al*, 1995). It has also been shown that when feed containing high amount of crude protein is given to the ruminant animals, their performance and productivity is enhanced (Ocheja,2020a) and they are better equipped to fight diseases as a result of improved immune system (Tudsri *et al*, 2002)

In Nigeria, forages species still serve as sources of essential elements for grazing animals little information is available of the nutrients status of some forages grazed by animals in different months in raining season. The nutrients status of these forages in the different months of the raining season is a function of multiple factors which interact with one another to produce varied affects (Eze, 2010). Soil characteristics/conditions also determines the nutrient composition of forage. It is vital to investigate how soil characteristics influence the nutrients components of different forages in Bobi Grazing Reserve, Niger State, Nigeria. This study was thus designed to investigate the effects of soil characteristics on the proximate composition of some forages found in Bobi Grazing Reserve, Niger State, Nigeria.

2.0 MATERIALS AND METHODS

2.1 Study Area.

The experiment was carried out in Bobi Grazing Reserve located in Marigalocal Government Area of Niger State. Bobi Grazing Reserve is located on coordinate N09.0102 and E006.05682. The Grazing Reserve covers 30.222 hectares of pasture land and was carved out in 1970 and gazette in 1998 to enable the Fulani herdsman feed their cattle without wondering from one place to another.

The site is endowed with abundant natural resources such as rivers, mineral, forest resources, fertile soil and good weather condition well suited for growth of various types of crops, livestock and fish farming. The state experience two seasons dry and wet. The length of the wet season decrease from the south to the North with annual rainfall varying

from 1,600mm in the south to 1,160mm in the North. The raining season last for 5 – 6 month in the northern part and 7 – 8 months in the south beginning in April or May. The dry season period starts in October/November and extends to March/April of the succeeding year (Iloeje, 2001).

2.2 Collection of Soil Sample in Bobi Grazing Reserve for Laboratory Analysis

Soil sample was collected at random in the grazing reserve. A stainless steel, hand shovel were used in the collection of the soil sample on the grazing reserve. The samples were collected into a dried polythene bags and was thoroughly mixed together. The soil sample was collected before and after the rainy season. Sample was collected in the first week in May and First week in November, 2015. Soil Sample was collected for laboratory analysis at the dept of 15cm in a triangular row for top soil and 30cm depth for sub soil analysis (NRCS), Natural Resources Conservation Services, (2013).

2.3 Soil Sampling Preparation

Soil were packed in well labeled polythene bags and taken to the laboratory. In the laboratory, the samples were dried at room temperature 25 – 27^oc, gently crushed sieved through 2mm sieve mesh preparatory for laboratory analysis. Samples for total nitrogen and organic carbon were passed through a 0.5mm sieved.

2.4 Soil Analysis

Soil samples were analysed for some physiochemical properties following the procedure outline by the International Soil Reference and Information centre of food and Agricultural Organization. (ISRIC/FAO, 2002). The particle size was determined by the Bouyocous hydrometer method using sodium hexametaphosphate as dispersing agent. Soil pH was determined using glass electron pH meter in soil water and CaCl₂ ratio of 1:1.2 respectively. Organic carbon was determined by wakley-Black method of wet combustion involving oxidation of organic matter with potassium dichromate (K₂Cr₂O₇) and sulphuric Acid (H₂SO₄). Available phosphorus was determined by Bray 1 method. Total Nitrogen was determined by microjeldahl digestion and distillation method. Exchangeable bases (Ca², Mg²⁺, Na⁺) extracted with 1N neural ammonium acetaty (NH₄⁰, AC) Solution and amount of K and Na in sodium were measured using flame, photometer while Ca and Mg were measured by Atomic Absorption Spectrophotometer (AAS). Cation. Exchange Capacity (CEC), was determined by the neutral 1N NH₄ AC saturation method while ECEC was the summation of exchangeable bases and exchangeable acidity. Base saturation was been calculated (dividing the sum of exchangeable base by there CEC them multiply by 100 exchangeable acidity (H⁺ and Al³⁺) was determined by titrimetric method.

2.5 Collection and Preparation of Forage Samples For Proximate Analysis.

Forage samples were collected for laboratory analysis from May – October, 2014 – 2016. Forage samples collected under each quadrat was separated in to species and oven dried at 65oc to a constant dry weight. Forage samples was grounded in a laboratory miller with 1mm sieve screen for preparation of samples for proximate analysis. Samples were analysed for dry matter (DM), crude protein (CP), crude fibre (CF), ash content (AC), Ether Extract (EE), and Nitrogen free Extract (NFE), according to AOAC (2000)

2.6 Experimental Design and Statistical Analysis

Effect of botanical composition (g/m^2), dry matter yield Kgdm/ha , proximate analysis of forages and Body weight gain/hectare, grazing days/hectare, was analyzed using the GLM procedure of SAS, were analyzed as a completely randomized block design using general linear model of (SAS Inst, carries, NC 2000).

3.0 RESULTS AND DISCUSSION

3.1 Soil Analysis Results

The soil analysis result is presented in Tables 1 and 2.

All the parameters analysed for the 0 – 15cm depth were significantly different across the 3 sites except values for exchange acidity and Sodium . The pH is very slightly acidic (6.40 – 6.90). ISRIC/FAO, (2003) the soil type is mostly sandy soil. All the parameters analysed for the 15 – 30cm depth were all significantly ($P < 0.05$) different across the three sites..the soil was very slightly acidic , the pH ranged from 6.38 – 6.58 . The soil type was mostly sandy soil (NSCS 2013)

Table 1: Soil Characteristics of Bobi Grazing Reserve Taken at 0-15cm Depth 2016

Chemical/physical Parameters	Slite 1	Slite 2	Slite 3(values)	SEM	P.value
pH (H_2O)1:1	6.900 ^a	6.600 ^b	6.400 ^c	0.078	0.0025
Organic Carbon(gkg^{-1})	3.480 ^a	1.2010 ^c	2.640 ^b	0.334	<.0001
Available P(mgkg^{-1})	15.420 ^c	16.060 ^b	19.420 ^a	0.620	<.0001
Exchangeable Cations (smolkg^{-1})					
Ca	3.040 ^a	2.050 ^c	2.320 ^b	0.147	<.0001
Na	0.120	0.000	0.140	0.019	0.4830
K	0.32 ^b	0.220 ^c	0.340 ^a	0.018	<.0001
Exchange Acidity	0.020	0.030	0.010	0.004	0.1250
Soil texture (gkg^{-1})					
Sand	775.00 ^b	794.00 ^a	715.00 ^c	11.907	<.0001
Clay	84.66 ^c	95.00 ^b	125.00 ^a	6.057	<.0001
Slit	140.00 ^b	110.00 ^c	160.00 ^a	7.270	<.0001

^{abc} Means with different superscript on the same row are significantly ($p < 0.05$) different SEM Standard error of mean

Table 2: Soil Characteristics of Bobi Grazing Reserve Taken at 15-30 CM Depth, 2016

Chemical/physical	Slite 1	Slite 2	Slite 3(values)	SEM	P.value
Parameters					
pH (H ₂ O)1:1	6.588 ^b	6.388 ^a	6.500 ^b	0.057	0.0125
Organic					
Carbon(gkg ⁻¹)	3.720 ^a	3.240 ^c	3.488 ^b	0.075	0.0032
Available					
P(mgkg ⁻¹)	14.948 ^c	15.826 ^b	17.826 ^a	0.427	<.0001
Exchangeable					
Cations (smolkg ⁻¹)					
Ca	3.120 ^a	2.088 ^b	2.160 ^b	0.167	<.0001
Na	0.090 ^b	0.060 ^c	0.120 ^a	0.009	0.0010
K	0.260 ^b	0.230 ^c	0.320 ^a	0.013	<.0001
Exchange Acidity	0.030 ^a	0.020 ^a	0.020 ^a	0.003	0.4219
Soil texture (gkg ⁻¹)					
Sand	725.00 ^a	804.66 ^b	815.00 ^c	14.219	<.0001
Clay	85.00 ^b	85.00	115.00 ^a	5.006	<.0001
Slit	100.00 ^c	110.00 ^b	160.00 ^a	9.284	<.0001

^{abc} Means with different superscript on the same row are significantly (p< 0.05) different

SEM Standard error of mean

3.2 Proximate Composition of *Paspalum commersonii* in Bobi Grazing Reserve

Proximate composition of *Paspalum commersonii* as presented in Table 3, showed that dry matter, crude protein, crude fibre, was statistically significant (p<0.05) in High dry matter (DM), crude protein (CP), analysed was as a result of farming activities allowed on the grazing land. Application of organic and inorganic fertilizer to sown crops might have increase forage growth, yield and crude protein value in all the forages species because of wash down of some of these nutrients through rain water to the grazing area. Also the early rain received in early month of May, could have contributed to early forage growth and development which allowed absorption of dissolve nutrients in the soil. Other factors that have contributed to high dry matter and crude protein in 2014, was as a result of mineralization of organic matter in soil (Mohammed, 2019) because of adequate moisture in the soil which allowed decay and decomposition and release of nutrients to the soil for forage use (Omalle *et al*, 2022).

Paspalum commersonii from 2014 – 2016

Forage species	Composition	2014	2015	2016	SEM
<i>Paspalum</i>	dry matter	80.43 ^a	71.70 ^b	69.50 ^c	1.944
	Crude aprotein	7.33 ^a	5.31 ^c	6.31 ^b	0.0610
	Crude fibre	12.50 ^a	6.50 ^c	10.16 ^b	0.873
	Ether Extract	0.95 ^b	0.95 ^b	1.21 ^a	0.043
	Ash content	8.33 ^b	4.33 ^c	8.71 ^a	0.700
	Nitrogen free extract	51.65 ^b	55.63 ^a	43.11 ^c	1.846

ab,c mean with different superscript on the same row are significantly ($p < 0.05$) different
SEM Standard Error of Means

3.3 Proximate Composition of *Cyperus esculentus*

Proximate composition of *Cyperus esculentus* is presented in Table 4

Dry matter, crude protein, ash content, and nitrogen free extract were significantly ($p < 0.05$) different in 2014. Ether extract and crude fibre were also significant ($p < 0.05$) in 2015 and 2016. Crude protein, ether extract and nitrogen free extracts were low in 2016. Also the early rain received in early month of May, 2014 could have contributed to early forage growth. The crude protein values were generally, a pointer to low quality of the forage, crude protein is one of the quality parameters used in evaluating forages (Van Soest, 1994)

Table 4 Proximate Composition of *Cyperus esculentus* FROM 2014 - 2016

Forage Species	Composition	2014	2015	2016	SEM
<i>Cyperus Esculentus</i>	Dry matter	83.42 ^a	62.00 ^c	75.37 ^b	3.678
	Crude protein	8.71 ^a	7.90 ^b	6.77 ^c	0.817
	Crude fibre	12.99 ^b	5.80 ^c	17.12 ^a	1.653
	Ether extract	0.98 ^b	2.30 ^a	0.94 ^c	0.223
	Ash content	10.49 ^a	5.66 ^c	10.11 ^b	0.775
	Nitrogen free extract	50.22 ^a	40.44 ^b	40.33 ^c	1.639

ab,c mean with different superscript on the same row are significantly ($p < 0.05$) different
SEM Standard Error of Means

3.4 Nutrient composition of *Hyparrhenia chrysegyrea*

Nutrient composition of *Hyparrhenia chrysegyrea* is presented on Table 5

All the nutrients were statistically significant ($p < 0.05$) in 2014, 2015 and 2016. The fairly high high dry matter and crude protein in 2014, may be as a result of mineralization of organic matter in soil because of adequate moisture in the soil which allowed decay and decomposition and released of nutrients (Omalle *et al*, 2022) to the soil for forage use.

***Hyparrhenia chrysegyrea* from 2014 – 2016**

Forage Species	Composition	2014	2015	2016	SEM
<i>Hyparrhenia chrysegyrea</i>	Dry matter	87.66 ^a	81.66 ^b	70.79 ^c	1.944
	Crude protein	10.66 ^a	8.00 ^c	8.39 ^c	0.610
	Crude fibre	15.22 ^a	6.50 ^c	10.16 ^b	0.873
	Ether extract	0.95 ^b	0.95 ^b	1.21 ^a	0.043
	Ash content	8.33 ^b	4.33 ^c	8.71 ^a	0.700
	Nitrogen free extract	51.64 ^b	55.63 ^a	43.11 ^c	1.846

a,b,c Means with different superscript on the same row are significantly ($p < 0.05$) different SEM Standard Error of Means

3.5 Proximate Composition of *Digiteria smutsii*

Proximate composition of *Digiteria smutsii* is presented in Table 6

Result showed that dry matter, crude protein, crude fibre, nitrogen free extracts and ash contents were all significant ($p < 0.05$) in 2014, 2015 and 2016. Nutrients wash down through rain water was not feasible, slow rate of mineralization of organic matter in the soil because of inadequate moisture contributed to low nutrients. The forage had access to greater share of available nutrients (response to phosphorus) in the soil which resulted in improved growth of *Digiteria*, this was in consonance with the findings of Tanko *et al* (2014) in which they reported that plant length and dry matter yield of Lablab was better at 30kg/haposphorus fertilizer rate.

Table 6 : Proximate Composition of *Digiteria smutsii* FROM 2014 – 2016

Forage Species	Composition	2014	2015	2016	SEM
<i>Digiteria Smutsii</i>	Dry matter	89.19 ^a	83.60 ^c	84.87 ^b	1.167
	Crude protein	10.74 ^a	8.40 ^b	7.94 ^c	0.759
	Crude fibre	19.44 ^a	4.73 ^c	9.33 ^b	2.172
	Ether extract	1.30 ^b	3.20 ^a	0.70 ^c	0.376
	Ash content	11.54 ^a	5.00 ^c	7.31 ^b	0.957
	Nitrogen free extract	46.20 ^c	66.30 ^a	49.51 ^b	3.116
Forage Species	Composition	2014	2015	2016	SEM
<i>Digiteria Smutsii</i>	Dry matter	89.19 ^a	83.60 ^c	84.87 ^b	1.167
	Crude protein	10.74 ^a	8.40 ^b	7.94 ^c	0.759
	Crude fibre	19.44 ^a	4.73 ^c	9.33 ^b	2.172
	Ether extract	1.30 ^b	3.20 ^a	0.70 ^c	0.376
	Ash content	11.54 ^a	5.00 ^c	7.31 ^b	0.957
	Nitrogen free extract	46.20 ^c	66.30 ^a	49.51 ^b	3.116

3.6 Nutrient composition of *Seteria barbata*

The nutrient composition of *Seteria barbata* is presented on Table 7

All the nutrients showed significance ($p < 0.05$) in 2014, 2015 and 2016. The proportion of crude protein and ether extract was low in 2016.

Low level of organic matter in soil analysed in Bobi Grazing Reserve which affect the rate at which nutrients is available, dissolve and absorbed for forage use (Holmes,

1989), could have slow down forage growth and yield on the reserve. Also high proportion of sandy soil to clay soil in the grazing reserve. Sandy soil are porous and low in organic matter composition . The crude protein range of 7.30 – 9.66% may be sufficient to maintain minimum ammonia levels in the rumen (Ocheja *et al* 2020b) to guarantee proper rumen function (Lakpini *et al* ,2002), this value is adequate for maintenance (Ocheja *et al.*,2022) but will not meet the requirements for high producing dairy cows of 19% as reported by Sebahastin *et. al.*,(2011)

Table 7: Proximate Composition of *Seteria barbata* FROM 2014 - 2016

Forage Species	Composition	2014	2015	2016	SEM
<i>Seteria Barbata</i>	Dry matter	87.74 ^a	59.49 ^c	66.83 ^b	4.554
	Crude protein	9.66 ^a	7.33 ^b	7.30 ^c	0.724
	Crude fibre	22.22 ^a	4.41 ^c	8.16 ^b	2.710
	Ether extract	1.00 ^b	2.34 ^a	0.16 ^c	0.317
	Ash content	10.45 ^a	4.33 ^c	10.10 ^b	0.992
	Nitrogen free extract	44.41 ^a	41.11 ^b	40.34 ^c	0.629

a,b,c Means with different superscript on the same row are significantly (p<0.05) different SEM Standard Error of Means

3.7 Proximate composition of *Brachiaria deflexa*

The proximate composition of *Brachiaria deflexa* is presented in Table 8

All the proximate parameters values were significantly (p<0.05) different, for years 2014, 2015 and 2016. Pasture growth in Bobi Grazing Reserve is extremely slow and result in to poor forage seasonal distribution and low quality forages yields because of slight soil acidity and low level of organic matter. Moderate concentration of phosphorus in Bobi Grazing Reserve soil could have been the reason why there was high biomass of *Paspalum, linus, Sida acuta, Boerhaviadiffusa, and Clematopsis*, this is because forage respond to phosphorus alone better than potassium (Macleod, 2000).

Table 8: Proximate Composition of *Brachiariadeflexa* FROM 2014 - 2016

Forage Species	Composition	2014	2015	2016	SEM	
<i>Brachiaria Deflexa</i>	Dry matter	88.80 ^a	65.89 ^c	78.80 ^b	3.884	
	Crude protein	10.41 ^a	8.37 ^c	8.39 ^b	1.005	
	Crude fibre	17.57 ^a	4.81 ^c	11.12 ^b	1.841	
	Ether extract	0.88 ^c	2.94 ^a	1.33 ^b	0.312	
	Ash content	10.45 ^a	4.55 ^c	9.71 ^b	0.924	
	Nitrogen free extract	49.49 ^a	46.31 ^c	44.33 ^b	1.517	

a,b,c Means with different superscript on the same row are significantly (p<0.05) different SEM Standard Error of Means

4.0 CONCLUSION AND RECOMMENDATIONS

4.1 Conclusion

The soil characteristics of Bobi grazing reserve was less than optimum. The proximate composition of the forages in Bobi Grazing Reserve differed significantly across 2014, 2015 and 2016. Variations in the proximate composition of the forages was due to species differences, soil characteristics and rainfall amount and distribution.

4.2 Recommendations

There is need for soil conservation practices and improvement in the soil characteristics, such as organic and inorganic fertilizer application. More legumes should be planted to further improve the fertility of the soil. Irrigation should be carried out to supplement rain fall.

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