Nutritional Evaluation and Phytochemical Screening of Common Plants used in Smallholder Farming System.

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ABSTRACT

With the pressure on land for crop production and low yield from common grasses, there is need to exploit the nutrient composition of available browse species and other forages in a small holder farming system to meet up with the need for small ruminant production. This study was conducted to access the nutritional composition and phytochemicals present in common forages used in a small holder farming system. There were significant ($P<0.05$) differences among most of the nutrient constituents, fibre fraction and phytochemical constituents. The significantly higher nutrient composition observed for forages considered in this study indicate their relative potentials as fodder resources in ruminant nutrition. Hence, the browse species examined in this study can be used as promising supplement in small ruminant nutrition.

(Keywords: nutrient composition, phytochemical screening, forages, small holder farming system)

INTRODUCTION

In the traditional setting, nutritional demand by the animals is presumptuously met through the basal supply of natural pasture grass. Natural pasture grasses are wild and are characterized by low yield and poor nutrients (Babayemi and Bamikole 2006) as they grow on infertile and erosion degraded soils.

Pastures represent the cheapest source of ruminant feed and sustain most animal production systems worldwide (Hogan, 1996). Production of animal feed is driven by the three climatic variables temperature, light and moisture and by properties of the soil (Hogan, 1996). In tropical regions, as indicated by Fitzpatrick and Nix (1970), temperature and light generally do not limit plant production. However effective soil moisture, in a region where potential evaporation exceeds precipitation every day of the year, is the dominant factor determining the rate of pasture growth and the period of the year over which the growth of green feed extends.

Small ruminants in a small holder farming system roam around freely and eat a variety of grasses, legumes and kitchen wastes. However, during the dry season, green forages are less nutritive, particularly grasses which are lignified (Le Houérou, 1983). The feed problem is further magnified by the handling of small-ruminant production as a minor enterprise with few or no inputs. With the pressure on land for crop production and low yield from common grasses, there is need now, more than ever before, to look for alternative sources of feed for small ruminants both in the dry and wet season.

MATERIAL AND METHODS

Sources of Plants Materials and Preparation of Samples

A visit was made to four villages (Aderupoko, Alagbagba, Ikereku and Alabata) in Odeda Local government, Abeokuta, Ogun State. The farmers in these villages were interrogated about the forages used in small ruminant feeding in the dry season.

The leaves of the four forages (*Sida acuta, Andropogon gayanus, Ficus exasperate* and *Ficus thonningii.*) common to these villages were collected, air-dried, crushed and bulked for analysis to access their nutrient and phytochemicals constituent.

Proximate Analysis

The samples were grounded using a suitable laboratory mill (Cyclotec), with a screen of particle size less than 1 mm and were analyzed for Moisture, Crude Protein, Crude Fat, Crude Fiber and Total Ash contents according to the methods of AOAC (2000).

Moisture was determined by the loss in weight that occurs in the sample upon drying to constant weight in an oven at 75^{o}C. Fat was determined by extracting the dry sample with ether. The weight of the extract was determined after distilling the ether and weighing the residue. Crude protein was determined by measuring the nitrogen content of the feed and multiplying this by 6.25. This factor is based upon the fact that on average, a pure protein contains 16% nitrogen. Thus 100/16 = 6.25.

The nitrogen content the plant leaves was determined usually by the Kjeldahl methods. The Kjeldahl involves conversion of the nitrogen in feedstuffs to an ammonium salt by digestion with concentrated sulfuric acid in the presence of a suitable catalyst. The ammonia is distilled from the digestion mixture into a collecting vessel after the sample is made alkaline. The amount of ammonia is determined by titration with standard acid, and then nitrogen, and hence crude protein are calculated.

Ashing combusts all organic constituents in the sample leaving behind only the mineral elements. Crude fiber refers to the organic residue of a feed that is insoluble after successive boiling with H_2SO_4 and NaOH solutions according to specified procedures. The determination of crude fiber is an attempt to separate the more readily digestible carbohydrates from those less readily digestible

Fibre Fraction Analysis

Neutral detergent fiber, acid detergent fiber and lignin were determined using the method of Van Soest *et al* (1991) and as modified by Nahm (1992).

Determination of Neutral Detergent Fibre

To simplify filtration, 1.00 g (+/- 0,001 g) of Celite was weighed into the crucible. 0.5 g of sample to an accuracy of ± 0,1 mg was weighede into a pre-dried crucible (W_1).

Step I – De-fatting: Cold Extraction
The crucibles were placed in the Fibertec Cold Extraction Unit and 25ml Acetone was added to each. There were made to stand for 10 minutes and then filter. This procedure was repeated three times then wash with water.

Step II: Cold Extraction
The crucibles in the Fibertec Cold ExtJraction Unit and it was added 25 ml Acetone. Filter with the procedure Repeated once.

Drying and Ashing

The solvent was evaporated and the crucibles were dried at 130 ±2 ^{O}C for 2hrs and were cool to room temperature in a desiccator and weighed (W_2).

The sample was ashed in the crucible at 520 ±25 ^{O}C for at least 3 hrs and was cool to room temperature in a desiccator and weigh (W_3).

Calculation

$$\% \text{ NDF} = \frac{W2 - W3 + \text{blank corr.}}{W1} \times 100$$

W1 = Sample weight
W2 = Crucible + Residue
W3 = Crucible + ash residue

Determination of Acid Detergent Fibre

To simplify filtration, 1.00 g (+/- 0,001 g) of Celite was weighed into the crucible. 0.5 g of sample to an accuracy of ± 0,1 mg was weighede into a pre-dried crucible (W_1).

Step I – De-fatting: Cold Extraction
The crucibles were placed in the Fibertec Cold Extraction Unit and 25ml Acetone was added to each. There were made to stand for 10 minutes and then filter. This procedure was repeated three times then wash with water.

Step II- Cold Extraction
The crucibles in the Fibertec Cold Extraction Unit and it was added 25 ml Acetone. Filter with the procedure Repeated once.

Drying and Ashing

The solvent was evaporated and the crucibles were dried at 130 ±2 ^{O}C for 2hrs and were cool to room temperature in a desiccator and weighed (W_2).

The sample was ashed in the crucible at 520 ±25^{O}C for at least 3 hrs and was cool to room temperature in a desiccator and weigh (W_3).

Calculation

$$\% \text{ NDF} = \frac{W2 - W3 + \text{blank corr.}}{W1} \times 100$$

W1 = Sample weight
W2 = Crucible + Residue
W3 = Crucible + ash residue

Determination of Acid Detergent Lignin

To simplify filtration 1.00 g (+/- 0,001 g) of Celite 545 was weighed into the crucible. 1 g of sample to an accuracy of ± 0.2 mg was weighede into a pre-dried crucible (W_1).

Step I – De-fatting: Cold Extraction
The crucibles were placed in the Fibertec Cold Extraction Unit and 25ml Acetone was added to each. The were made Stand for 10 minutes and then filter. This procedure was repeated three times then wash with water.

Step II: Cold Extraction
The crucibles were placed in the Fibertec Cold Extraction Unit and 25 ml Acetone was added to each crucible. It was left for 10 minutes then filter. The procedure was repeated once.

A glass rod was placed into each crucible for stirring, 25 ml of 72% H_2SO_4 was added then it was cooled to 15 ^{O}C. It was stirrred with glass rod and filtered off after 3 h. Stirring is done at one hour intervals. It was then washed with water until free from acid.

Drying and Ashing

The solvent was evaporated and the crucibles were dried at 130 ±2 ^{O}C for 5hrs and were cooled to room temperature in a desiccator and weighed (W_2).

The sample was ashed in the crucible at 525 ± 15 ^{O}C for 3 h and was cooled to room temperature in a desiccator and weighed (W_3).

Calculation

$$\text{ADL } (\%) = \frac{w2 - w3}{W1} x\ 100$$

W_1 = Sample weight
W_2 = Crucible + Residue
W_3 = Crucible + ash residue

Phytochemical Screening

The phytochemical constituents were determined using the methods of Plant Science (2011).

Flavonoids

One gram of well blended sample was weighed into a flask or beaker containing 10ml of 80% methanol. It was left to stand for 2hours then filtered into a weighed glass Petri-dish. The Petri-dish containing the filtrate was dried in the oven at 40^{o}c for 30 minutes. The Petri- dish was weighed when it dries to constant weight

Mg/100g flavonoid = Weight of Petri-dish + filtrate after drying – weight of empty Petri- dish.

Tannins

The sample was prepared with solvent mixture of 80: 20 i.e Acetone: 10% Glacial Acetic Acid. One gramme of the sample was weighed into 25ml of the solvent mixture in a conical flask and left for 5 hours for extraction and filtered. The absorbance was measured at 500nm wavelength using UV-Visible Spectrophotometer. Also, the absorbance

of the blank reagent (Tannic Acid) was measured. A standard graph was made with 10, 20, 30, 40, and 50mg/100g of Tannic Acid solution. The concentration of Tannin was read taking into consideration any dilution factor.

Alkaloids

One gramme of sample (w) was weighed into a conical flask and 20 ml of 10 % acetic acid in ethanol was added. It was agitated and allowed to stand for 4 hours and filtered. The filtrate wash evaporated to about a quarter of its original volume. Then few drops of conc. NH_4OH solution was added, the precipitate formed was filtered through a weighed filter paper (w_1). The filter paper was placed in the oven and allowed to dry at 60^{o}C to a constant weight for about 30-60 min. The filter paper was weighed again and the weight was recorded as (W_2).

$$\% \text{ alkaloids} = \frac{W_2 - W_1}{W_1} \times 100$$

Antioxidants

The sample was prepared with 80: 20 concentrations of solvent mixture (i.e., Acetone : 0.2% formic acid, respectively). Two grams of sample was weighed into 20ml of the solvent mixture in a flask and allowed to stand for 2 minutes and filtered. The 3 ml of methanol and 0.5ml 2, 2 – diphenyl picryl hydrasyl (DPPH) was added and absorbance was measured off at wavelength of 570nm.

Statistical Analysis

Data obtained were analyzed according to the procedure of SAS (1999) and significant means separated using the Duncan multiple range test of the same package. The experimental model was

$$Y_{ij} = \mu + \alpha_i + \beta_j + \varepsilon_{ijk}$$

Where:

Y_{ij} = individual observation,
μ = general mean of the population,
α_i = treatment effect,
β_j = block effect due to legumes and
ε_{ij} = composite error effect.

RESULTS AND DISCUSSION

Nutritional composition of four plants used in small holder farming system is shown in Table 1. There were significant ($p<0.05$) differences among most of the nutrients content of the tested plants except for the crude fat. *Sida acuta* had the highest moisture content (11.10%) compared to other plants with *Ficus exasperate* and *Ficus thonningii* having comparable values while *Andropogon gayanus* had the least moisture content. Also, *Sida acuta* had higher crude protein (CP) value (24.87 %) compared to other plant tested.

The significant difference in CP content among species can be explained by inherent characteristics of each species related to the ability to extract and accumulate nutrients from soil and/or to fix atmospheric nitrogen, which is the case for legumes plants. However, the CP contents in the tested browse plants and grass specie were far above the minimum level required (7%) for microbial activities in the rumen as observed by Norton, (1998) indicating relative potentials as fodder resources in ruminant nutrition. Similarly, the CP content observed for the tested plants except *Andropogon gayanus* were above the nutritional requirements for various classes of sheep and goats as stated by NRC (2007).

The crude fibre contents were highest in *Ficus thonningii* and *Andropogon gayanus* compared to *Sida acuta* and *Ficus exasperate.* Crude fibre represents the plant cell wall, which is utilized as an energy source by the rumen microflora, and is extensively degraded by rumen micro-organisms. Apart from *Ficus exasperate* other plants had higher fibre content that the (12 %) minimum requirement in goats' diet (Mamoon, 2008). Suffice it to say, these forages fulfil their importance in terms of their nutrient composition as the addition of forage legumes and other browse species to grazing provide additional protein, energy, and palatability to the feed produced (Rocky and Brown, 2008). The highest crude fiber observed for the grass specie can be hinged on the fact that, on average, browses contain more crude protein and organic matter, but less fiber, than tropical grasses.

Ficus exasperate had higher value for Total ash compared to others in the group. Although the crude fat was not differ significantly, however, values obtained for *Ficus thonningii* was highest

followed by *Ficus exasperate* while *Sida acuta* had the least value.

The energy, as well as protein content of forages, depends upon the maturity of the forage when it is being grazed for forage (Rocky and Brown, 2008). While other factors causing variation in the chemical composition of browse forages include soil type (location), the plant part (leaf, stem, and pod), age of leaf and season. With regard to the location, some authors have reported that browse plants in the Sahelian zone are higher in Nitrogen compared to plants in the humid zone (Rittner and Reed, 1992).

Table 2 shows the fiber fraction of four plants used in small holder farming system .There were significant ($p<0.05$) difference for the fiber fraction content of NFE and NDF while ADF and ADL were not ($p>0.05$) differ significantly. *Ficus exasperate* had the highest NFE value (48.21) compared to other plants, while *Sida acuta* had the lowest.

Andropogon gayanus had higher NDF value (71.51 %) compared to others plants in the group. The values obtained for *Andropogon gayanus* and *Ficus thonnigii* in this study were higher than those reported by Njidda *et al.* (2010) for browse forages. However, the values obtained for *Sida acuta* is slightly below the observed value by Njidda et al (2010) while that of *Ficus exasparate* is within the reported range. On the other hand, the values observed in this study for *Ficus exasparate* was lower compared to that reported by Isah *et al.* 2012.

The non-significant nature of the ADF was lower compared to the range of 19 -43 % reported by Fall (1993). These values were also lower compared to that of Njidda *et al* (2010). The observed value for ADL ranges between 5.72 - 7.78 %. This was within the range reported by Njidda et al. (2010).

Table 1: Nutritional Composition of Four Plants used in Small Holder Farming System.

Parameters	*Ficus thonningii.*	*Andropogon gayanus*	*Sida acuta*	*Ficus exasparate*	SEM
Moisture %	8.70^{ab}	7.70^{b}	11.10^{a}	10.40^{ab}	0.55
Crude Protein %	15.42^{b}	13.90^{b}	24.87^{a}	15.44^{b}	1.28
Crude Fat %	2.97	2.18	1.78	2.38	0.25
Crude Fiber %	29.20^{a}	31.28^{a}	18.93^{ab}	10.54^{b}	2.93
Total Ash %	5.02^{b}	5.38^{b}	8.18^{ab}	13.03^{a}	1.26

Table 2: Fiber Fraction of Four Plants used in Small Holder Farming System.

Parameters	*Ficus thonningii*	Andropogon gayanus	Sida acuta	Ficus exasparate	SEM
NFE %	38.69^{bc}	39.56^{b}	35.14^{c}	48.21^{a}	3.71
NDF %	53.98^{ab}	71.51^{a}	36.30^{b}	38.86^{b}	4.55
ADF %	14.54	15.95	10.35	8.44	1.75
ADL %	7.78	5.73	6.11	5.72	0.69

Table 3 shows the phytochemical screening of plants used in small holder farming system. There were significant differences among most of the phytochemical constituents of the tested plants except for Flavonoid. *Ficus thonningii* had the highest tannin (390.0 g/kg) followed by *Sida acuta* (212.50 g/kg) and *Ficus exasperate* (142.50 g/kg) with compared values while *Andropogon gayanus had the least value* (0 g/kg). ." Alkaloids values range from 0.00 % in *Andropogon gayanus* to 5.80 % in *Ficus exasparate.*

Tannin in this study ranges from 0 g/kg in *Andropogon gayanus* to 390 g/kg in *Ficus thonningii* . The lowest value (0 g / kg) obtained for *Andropogon gayanus*, may be attributed to the fact that tannin is not prevalent in grasses or most temperate legumes. Tannins are prevalent, however, among dicotyledonous forbs, shrubs and trees leaves (Haslam, 1979). The observed tannin values for *Ficus thonningii*, *Sida acuta* and *Ficus exasperate* were above the concentration (50-100 g/kg DM) consider toxic to ruminant micro-organism (Albrecht and Muck, 1991). In contrast, a report by Beck and Reed (2001) revealed that some herbivores (e.g. goats, moose, mule deer) counteract the negative effect of tannin by secreting tannin binding salivary proteins (e.g., proline) from enlarged salivary glands. Thus, when browsing animals eat tannin – containing plants, these salivary compounds bind with the tannins, making them inactive. These tannin-salivary protein complexes enhance greater digestion of fibre and protein than cattle and sheep.

Antioxidant values range from 0.00 g in *Andropogon gayanus* to 1.09 g in *Ficus thonningii.* Flavonoid values range from 0.01 g in *Andropogon gayanus* to 0.05 g in *Ficus thonningii.* The presence of antioxidant and flavonoids in these plants indicated that they might be useful in curbing the harmful effect of free radicals in ruminant health. Antioxidants are first line of defense against free radical damage, and are critical for maintaining optimum health and wellbeing. The need for antioxidants becomes even more critical with increased exposure to free radicals (Perciva, 1998). Perciva (1996) also stated that Phenolic compounds such as flavonoids are ubiquitous within the plant kingdom, approximately 3,000 flavonoid substances have been described. In plants, flavonoids serve as protectors against a wide variety of environmental stresses while, in humans, flavonoids appear to function as "biological response modifiers.

CONCLUSION

Since most tropical grasses cannot meet the nutrient requirements of ruminants for most the year, even during the rains they can only satisfy maintenance requirements. The appreciable nutrient constituents of the browse species in this study compare to that *Andropogon gayanus* showed that they can be used as supplement in small ruminant nutrition and subsequently improve their performance.

Table 3: Phytochemical Screening of Plants used in Small Holder Farming System.

Parameters	Ficus thonningii	Andropogon gayanus	Sida acuta	Ficus exasparate	SEM
Flavonoid mg/100g	0.05	0.01	0.03	0.02	0.49
Tannin g/kg	390.0[a]	0.00[c]	212.50[b]	142.50[b]	40.00
Alkaloid %	2.90[b]	0.00[c]	2.04b[c]	5.80[a]	0.67
Antioxidants mg/100g	1.09[a]	0.00[b]	1.06[a]	0.97[b]	0.17

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