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Research Article

Physicochemical Characteristics of *Ficus microcarpa* Leaf Meals Harvested in Southeastern Nigeria

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Abstract

Background and Objective: Indigenous plants remain green at critical times of the year and produce large quantities of year round fodder, which is regarded as unconventional feed sources in tropical countries like Nigeria. This study evaluated the physico-chemical characteristics of leaf meals derived from *Ficus microcarpa*, a domesticated browse plant at Nnobi community, southeastern Nigeria. **Materials and Methods:** The three villages in the community namely Awuda (Sample A), Ebenesi (Sample E) and Ngo (Sample N) were purposively selected for the study in order to generate representative data for the community. Fresh foliage from three stands of *F. microcarpa* at each village was collected and air-dried by spreading them under shed every day for about 6-8 days and thereafter oven dried until they became crispy and then milled to produce *F. microcarpa* leaf meals (FMLM). The leaf meals were analyzed for their physicochemical values. **Results:** Results should that FMLM was rich in Fe and Zn. The order of micro mineral concentration was Fe>Mn>Cr>Zn>Cu>Ni. **Conclusion:** The FMLM is therefore relatively rich in crude protein and energy, digestible fibers and essential minerals. Feeding trials incorporating the leaf meal are recommended in order to evaluate its true nutrient value.

Key words: Browse plant, *Ficus microcarpa* leaf meal, fodder, nutrients

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Data Availability: All relevant data are within the paper and its supporting information files.

INTRODUCTION

With the increasing demand for livestock products as a result of rapid growth in the world economies and shrinking land area, future hope of feeding the millions of people and safeguarding their food security will depend on the better utilization of hitherto neglected feed resources¹ and this has over the past few decades rekindled research interest in the use of indigenous tropical browse plants as sources of nutrients for livestock^{2,3}. Although the diversity and nutritional values of these indigenous browse species may be well known to local livestock farmers^{4,5}, limited published information exists on the physicochemical properties associated with their use at different farming locations.

Indigenous fodder trees and shrubs remain green at critical times of the year⁵ and produce large quantities of year round fodder, which is regarded as unconventional feed sources in tropical countries like Nigeria. The year round availability of these unconventional fodders when incorporated to ruminant diets planning help to tackle the effects of poor nutrition which usually manifest as loss of weight and conditions, reduced reproduction capacity, increase mortality rate, poor carcass quality among ruminants reared in many tropical environments⁶. Proper evaluation of the production characteristics of such economic browse plants like *F. microcarpa* would provide reliable data to farmers and development workers on the social, nutritional and toxicological issues associated with the plant's promotion as a browse of promise in the study area and beyond.

The use of tree fodders as feed is usually limited by their poor intake, high fibre content and in some cases the presence of toxic factors or metabolic inhibitors such as cyanogens, alkaloids, saponins and tannins, low digestibility and low nutrient content and subsequent low animal performance⁷. There is, therefore, the need to properly assay the nutritional, physicochemical and toxicological potentials of novel candidate tropical feedstuffs such as *Ficus microcarpa* before they could be promoted as fodder of commercial value in animal production. In recent times, however, a large number of researches have focused on phytochemicals as cheap sources of novel chemicals for animal production and human health/nutrition. Plants with anti-oxidant properties have received special research attention mainly due to their phenolic compounds⁸, which are beneficial in many applications in animal nutrition⁹. Therefore, identification and such characterization of the potential value of indigenous browse plants could lead to the improvement of the economic value of local plants, thereby encouraging their development for improved rural income.

However, most of the available information on indigenous browses of Nigeria are on their proximate compositions with little or no information on the physical and phytochemical characteristics of their leaf meals needed to properly characterize such animal feed resources^{10,11}. Several studies have however shown that physical properties of novel feedstuffs such as their bulk density, water holding capacity and particle size among others exhibit greater influence on feed intake than their nutrient compositions^{12,13}. There is, therefore, the need to include such physical characteristics analysis as part of the screening protocol for lesser-known but novel feedstuff of local or international application¹².

According to Okoli *et al.*³ and Udedibie¹⁴, there are currently no properly developed protocols for ranking and selecting indigenous browse plants of high nutritional potential out of hundreds of candidate plants species available in southeastern Nigeria. Development of such ranking and selection protocol could eliminate some of the frustrations experienced with many trial materials, which usually arise from poor or non-existent reliable selection protocol. In earlier studies Okoli *et al.*^{2,3,15} used a combination of indigenous knowledge (IK) and proximate profiles as tools for selecting plants of animal production potentials in southeastern Nigeria and concluded that apart from generating clues on candidate research materials, such studies could promote useful development concepts and bio-cultural diversity.

The objective of this study is to determine the physicochemical characteristics of *Ficus microcarpa*, a locally domesticated ruminant browse at Nnobi, in Idemili south Local Government Area of Anambra state, southeastern, Nigeria.

MATERIALS AND METHODS

Study area: The study was carried out at Nnobi community in Idemili south Local Government Area (LGA), Anambra Central Agricultural zone of Anambra state, Nigeria in the months of April-July, 2016. The vegetation is the rainforest type, with a tropical humid climate characterized by two distinct seasons, the rainy and the dry seasons. Livestock farming, especially small ruminant keeping and backyard poultry are popular. The farmers commonly utilized *Ficus microcarpa* (Ogbu), *Ricinodendron heudelotii* (Okwe), many abundant twigs, weeds, grasses and kitchen wastes for feeding small ruminants^{2,16}.

Nnobi community was purposively selected for the study because of the traditional practice of planting and feeding *Ficus microcarpa* (Fig. 1) to animals in the community and



Fig. 1: A *Ficus microcarpa* tree standing in a compound in the study area

also due to the active participation of the indigenes in small ruminant rearing¹⁷. The three villages in the community were also purposively selected for the study in order to generate representative data for the community. Many households/farmers were preliminarily surveyed but only three households/farmers were randomly selected from each village for the final study, thus, giving 15 households/farmers that constituted the sample size for the study.

Sample collection and preparation: Fresh foliage from three stands of *Ficus microcarpa* at each study village were collected and were used for the study. Identification of the sampled plant was made at the Department of Forestry and Wildlife Technology, Federal University of Technology Owerri (FUTO), Imo state, Nigeria. The leaves sampled from each village were plucked and air-dried by spreading them under shed every day for about 6-8 days while retaining the greenish coloration¹⁸. The samples were further dried in the oven until they became crispy to aid milling. The dried leaf samples were ground with hammer mill through a 1 mm screen to produce their respective leaf meals and were collected in sealed polythene bags, labeled and ready for physical and phytochemical analysis.

Physicochemical analysis: The analyses were carried out at the School of Agriculture and Agricultural Technology Laboratory of FUTO for their Bulk Density (BD), Water Holding Capacity (WHC), Specific Gravity (SG), proximate composition, metabolizable energy, fiber fractions and minerals. The

method described by Makinde and Sonaiya¹⁹ and modified by Omede¹¹ were used to determine the BD and WHC values, SG was calculated as the ratio of the BD of a known mass of the experimental sample to the density of water for the sample¹¹.

The proximate analysis was carried out to determine the Moisture Content (MC), Crude Protein (CP), Ether Extract (EE), Crude Fiber (CF), Nitrogen Free Extract (NFE), Total Ash (TA) and Gross and Metabolizable energy according to the methods of AOAC²⁰. All the proximate values were reported in percentages. The calorific measurements of samples for gross energy analysis were done with Cal 2 K, C1.7 bomb calorimeter. The gross energy was determined according to AOAC²⁰ using the digital CAL-2K Isothermal Automatic Bomb Calorimeter.

The fiber fractions such as Neutral Detergent Fibre (NDF), Acid Detergent Fiber (ADF), Acid Detergent Lignin (ADL), cellulose and hemicellulose (HEM) were determined according to the methods described by AOAC²⁰. Mineral composition analysis (micro and macro-element) was performed with an Atomic Absorption Spectrophotometer (AAS), Bulk scientific, model 210 VGB to determine the following minerals; Ca, K, Na, P, Mg, Mn, Fe, Cu, Zn, Co, Cr, Pb and Ni according to the methods of AOAC²⁰ using the Atomic Absorption Spectrophotometer (Bulk Scientific, 205).

Statistical analysis: Data generated were subjected to descriptive statistics such as means, Standard Deviation (SD) and Coefficient of Variation (CV) to establish the reference values of the different parameters analyzed²¹.

RESULTS

Physical characteristics of *F. microcarpa* leaf meal: Table 1 showed the Loose Bulk Density (LBD), Packed Bulk Density (PBD), Specific Gravity (SG) and Water Holding Capacity (WHC) of the FMLM samples. Sample N recorded the highest packaged bulk density which was significantly different ($p<0.05$) from the ones obtained from sample A and E. Sample N also recorded the highest loose bulk density which was also significantly different ($p<0.05$) from the values obtained from samples A and E. Sample A recorded the highest WHC which was significantly higher ($p<0.05$) than that of sample E. Sample N also recorded the highest value of specific gravity, which is also significantly different ($p<0.05$) from value obtained from sample E but not significantly different from value recorded in Sample A.

Proximate composition of *Ficus microcarpa* leaf meal: Table 2 showed the proximate composition results of FMLM samples from different locations at Nnobi. Sample E recorded the highest level of dry matter DM and was significantly higher ($p<0.05$) than the value recorded in sample N but similar to the value obtained in sample A ($p>0.05$). Sample E had significantly higher ($p<0.05$) NFE and ME than those on sample N but similar to those on sample A. Sample E recorded the highest CP value, which was significantly higher ($p<0.05$) than the sample A value but statistically similar ($p>0.05$) to the value recorded in sample N. The result also showed that sample E had significantly higher ether extract value ($p<0.05$) than sample N but similar to that of sample A ($p>0.05$). Sample N recorded significantly higher CF content than sample A ($p<0.05$) but was similar to sample E ($p>0.05$).

Sample N recorded significantly higher ash value ($p<0.05$) than sample E but similar values with sample A ($p>0.05$) while sample E recorded a higher nitrogen free extract value of 41.25% ($p<0.05$) than sample N but similar to the value recorded in sample A ($p>0.05$). Additionally, sample E had higher ME value than sample N ($p<0.05$) but was statistically similar to sample A value ($p>0.05$). Moisture content was significantly ($p<0.05$) influenced by the locations.

Fiber fractions in *Ficus microcarpa* leaf meal: The results of the fibre fractions were presented in Table 3. Sample E recorded significantly higher NDF value than sample A ($p<0.05$) but similar to sample N, which was also similar to sample A ($p>0.05$). Also, sample N recorded a significantly higher ADF value than sample E ($p<0.05$) but was similar to the value recorded in sample A ($p>0.05$). Results revealed that sample N had significantly higher ADL value ($p<0.05$) than sample E but similar to sample A value ($p>0.05$). Sample E recorded significantly higher cellulose value ($p<0.05$) than sample A but similar to the value recorded in sample N ($p>0.05$). Again, sample E recorded significantly higher ($p<0.05$) value than sample N but was similar to the value recorded in sample A.

Mineral compositions of *Ficus microcarpa* leaf meals: Data on mineral compositions of MFLM are shown in Table 4. Sample A recorded significantly higher calcium and phosphorus values and lower sodium and magnesium values than sample E ($p<0.05$), while sample N also recorded significantly higher potassium value than sample E ($p<0.05$). Generally, sample N had statistically similar Calcium (Ca), Sodium (Na), Phosphorus (P) and Magnesium (Mg) values ($p>0.05$) with samples A and E ($p>0.05$).

Table 1: Physical characteristics of *Ficus microcarpa* leaf meal

Parameters	Sample A	Sample E	Sample N	Mean $\pm$ SD	SEM	CV
LBD (g mL ⁻¹)	0.23 ^{ab}	0.22 ^b	0.31 ^a	0.25 $\pm$ 0.05	0.03	0.20
PBD (g mL ⁻¹)	0.40 ^{ab}	0.40 ^b	0.44 ^a	0.41 $\pm$ 0.02	0.01	0.05
SG	0.37 ^{ab}	0.36 ^b	0.41 ^a	0.38 $\pm$ 0.03	0.02	0.08
WHC (%)	440.00 ^a	415.80 ^b	421.40 ^{ab}	425.73 $\pm$ 12.67	7.31	0.03

Means within the same rows show that means are significantly different ($p<0.05$), Sample A: Awuda, Sample E: Ebenesi, Sample N: Ngo, SD: Standard deviation, SEM: Standard error of the mean, CV: Coefficient of variation

Table 2: Proximate and metabolizable energy compositions of *Ficus microcarpa* leaf meal

Parameters	Sample A	Sample E	Sample N	Mean $\pm$ SD	SEM	CV
Dry matter (%)	92.60 ^{ab}	94.60 ^a	89.10 ^b	92.10 $\pm$ 2.78	1.61	0.03
Moisture content (%)	7.40 ^{ab}	5.40 ^b	10.90 ^a	7.90 $\pm$ 2.78	1.61	0.35
Crude protein (%)	11.58 ^b	13.59 ^a	12.50 ^{ab}	12.56 $\pm$ 1.01	0.58	0.80
Ether extract (%)	2.30 ^{ab}	2.52 ^a	1.58 ^b	2.13 $\pm$ 0.49	0.28	0.23
Crude fibre (%)	24.42 ^b	24.49 ^{ab}	29.98 ^a	26.30 $\pm$ 3.19	1.84	0.12
Total ash (%)	14.12 ^{ab}	12.75 ^b	14.67 ^a	13.85 $\pm$ 0.98	0.57	0.07
NFE (%)	40.18 ^{ab}	41.25 ^a	30.37 ^b	37.27 $\pm$ 6.00	3.46	0.16
ME (Kcal kg ⁻¹)	2333.16 ^{ab}	2467.63 ^a	1914.44 ^b	2238.41 $\pm$ 288.51	166.57	0.13

Means within the same rows show that means are significantly different ($p<0.05$), Sample A: Awuda, Sample E: Ebenesi, Sample N: Ngo, SD: Standard deviation, SEM: Standard error of the mean, CV: Coefficient of variation

Table 3: Fiber fraction of *Ficus microcarpa* from different locations at Nnobi

Parameters (%)	Sample A	Sample E	Sample N	Mean±SD	SEM	CV
NDF	53.34 ^b	56.15 ^a	53.54 ^{ab}	54.34±1.57	0.91	0.03
ADF	40.31 ^{ab}	38.76 ^b	43.46 ^a	40.84±2.40	1.38	0.06
ADL	16.06 ^{ab}	10.99 ^b	16.19 ^a	14.41±2.97	1.71	0.21
Cellulose	24.25 ^b	27.77 ^a	27.27 ^{ab}	26.43±1.90	1.10	0.07
Hemicellulose	13.03 ^{ab}	17.39 ^a	10.08 ^b	13.50±3.68	2.12	0.27

Means within the same row shows that means are significantly different ($p<0.05$), Sample A: Awuda, Sample E: Ebenesi, Sample N: Ngo, SD: Standard deviation, SEM: Standard error of the mean, CV: Coefficient of variation

Table 4: Macro-mineral concentrations (mg kg^{-1}) of *Ficus microcarpa* leaf meal

Parameters	Sample A	Sample E	Sample N	Mean±SD	SEM	CV
Ca	8605.37 ^a	2236.65 ^b	5656.53 ^{ab}	5499.52±3187.26	1840.17	0.58
K	39326.79 ^{ab}	29811.11 ^b	41205.42 ^a	36781.11±6108.84	3526.94	0.17
Na	2176.69 ^b	2286.29 ^a	2285.74 ^{ab}	2249.57±63.12	36.44	0.03
P	2651.34 ^a	2102.86 ^b	2399.11 ^{ab}	2384.44±274.53	158.50	0.12
Mg	2859.34 ^b	4059.03 ^a	3935.42 ^{ab}	3617.93±659.86	380.97	0.18

Means within the same rows show that means are significantly different ($p<0.05$), Sample A: Awuda, Sample E: Ebenesi, Sample N: Ngo, SD: Standard deviation, SEM: Standard error of the mean, CV: Coefficient of variation

Table 5: Micro-mineral composition (mg kg^{-1}) of *Ficus microcarpa* leaf meal from Nnobi

Parameters	Sample A	Sample E	Sample N	Mean±SD	SEM	CV
Mn	55.10 ^b	93.50 ^a	52.69 ^{ab}	57.10±34.41	19.87	0.60
Fe	661.78 ^b	706.66 ^{ab}	743.68 ^a	704.01±41.01	23.68	0.06
Cu	30.32 ^{ab}	43.93 ^a	23.97 ^b	32.74±10.20	5.88	0.31
Zn	34.29 ^{ab}	32.52 ^b	34.71 ^a	33.84±1.16	0.67	0.03
Co	0.00	0.00	0.00	0.00±0.00	0.00	-
Cr	56.16 ^a	33.26 ^b	55.19 ^{ab}	48.20±12.95	7.47	0.27
Pb	0.00	0.00	0.00	0.00±0.00	0.00	-
Ni	16.90 ^a	0.69 ^b	14.48 ^{ab}	10.69±8.74	5.05	0.82

Means within the same rows show that means are significantly different ($p<0.05$), Sample A: Awuda, Sample E: Ebenesi, Sample N: Ngo, SD: Standard deviation, SEM: Standard error of the mean, CV: Coefficient of variation

Table 6: Calcium/phosphorus and sodium/potassium ratios of *Ficus microcarpa* from Nnobi

Parameters (%)	Sample A	Sample E	Sample N	Mean±SD	SEM
Ca/P ratio	3.2456 ^a	1.0636 ^b	2.3578 ^b	2.2223±1.0972	0.6335
Na/K ratio	0.0553 ^b	0.0767 ^a	0.0553 ^b	0.0625±0.0123	0.0071

Means within the same rows show that means are significantly different ($p<0.05$), Sample A: Awuda, Sample E: Ebenesi, Sample N: Ngo, SD: Standard deviation, SEM: Standard error of the mean, CV: Coefficient of variation

Table 5 showed the micro-mineral composition of *F. microcarpa* leaves from different locations at Nnobi. Sample A had significantly lower ($p<0.05$) manganese (Mn) concentration than sample E, while sample N recording a significantly higher iron (Fe) value than sample A ($p<0.05$) but similar to sample E ($p>0.05$). Sample N had significantly higher zinc (Zn) value than sample E value. Chromium (Cr) and nickel (Ni) values in sample E were lower ($p<0.05$) than in sample A but similar to those on sample N ($p>0.05$). Copper (Cu) on sample E recorded significantly ($p<0.05$) higher value than in sample N.

The calcium to phosphorus and sodium to potassium ratios of the study plant from different locations were shown in Table 6. Sample E recorded a significantly higher Na/K ratio value ($p<0.05$) than the samples A and N.

DISCUSSION

Usually, feedstuffs have nutritional characteristics²², which could be divided into the biophysical and biochemical components that determine nutrient uptake and availability, respectively^{10,23}. The feed value of forage is, however, a function of its nutrient content digestibility, its palatability (which determines its consumption level) and the associative effects of other feeds²⁴. Furthermore, the nutritional characteristic of a finished ration is an aggregation of the proximate, physical and toxicological characteristics of the individual ingredients used in compounding the ration. Therefore, a proper understanding of all these component characteristics in all feed raw materials is imperative^{10,22}.

Sample N had significantly high loose bulk density than those on samples E and A which was similar to the value reported for *Microdesmis puberula* leaf meal by Omede¹¹. Even though there were statistical differences across data obtained from the different samples, their coefficient of variation values at the range of 0.03-0.20 indicated narrow margins between sample values implying that the mean values could be trusted as the representative physical characteristic values for FMLM obtained from the study area. Sample A recorded the highest WHC value of 440.00% which was significantly higher than that of sample E indicate that the dry leaf meal of the sampled plant will absorb a reasonable amount of water when included in the diets of monogastric animals and ruminants¹². The CV value across sample measurements for WHC was narrow indicating that the samples have similar WHC attributes. The present high WHC results is probably a pointer to significant levels of non-starch polysaccharides (NSPs) contents of the leaves as a result of their maturity¹². Since the specific gravity values in this study were derived mathematically from the BD values, the recorded similar trends of SG and BD of the test materials was expected.

It was observed that samples that recorded higher BD values also recorded higher specific gravity and lower WHC values, while samples that recorded lower BD values recorded low SG and high WHC values. Low BD values suggested high fibrous matter, while low SG implies low retention time and faster passage of feed particles in and through the GIT respectively²⁵. Kyriazakis and Emmans²⁶ noted that WHC is a good predictor of feed intake in pigs compared to feed digestibility and dietary fibre content. This major effect of WHC on digestion is due to the ability of the NSPs in the feedstuff to hold considerable quantities of water that could increase bulk and passage rate of digesta²⁷. High WHC obtained from the present study, therefore, indicate that the FMLM would absorb high volumes of water when used in feeding ruminant or poultry.

The loose BD values obtained in this study agreed with the 0.02 g m^{-3} reported by Omede *et al.*¹² for *M. puberula* leaf meal. The loose BD values were much lower than the 0.59, 0.42 and 0.41 g mL^{-1} values obtained by Udedibie¹⁴ in *Gongronema latifolium*, *Mucuna pruriens* and *Garcinia kola* leaf meals, respectively. The packed BD value is however similar to that of *G. latifolium* and *G. kola* but much higher than that of *M. pruriens*¹⁴. The $0.61 \text{ g water/g feed}$ WHC reported for *M. puberula* leaf meal is higher than the mean $425.73 \pm 12.67\%$ obtained for FMLM in this study, implying that the *M. puberula* leaf meal contained more NSPs than the FMLM analyzed in this study. Udedibie¹⁴ reported much

lower WHC values of 245.45 and 250% in *G. latifolium* and *M. pruriens*, respectively but similar value of 440% in *G. kola* leaf meal. Omede *et al.*¹² also reported that Particle Size (PS) modification of a leaf meal could alter its BD and WHC attributes. For example, when the particle size of *M. puberula* leaf meal was reduced from unmodified to $<1.00 \text{ mm}$ PS, the WHC increased from 0.61-5.50 g water/g feed, a 901.64% increase in WHC. There is, therefore, the need to properly characterize the WHC attributes of FMLM, especially as influenced by PS of the leaf meal.

Results of the proximate analysis are extensively employed in research and industry for quick estimation of nutrient potentials of feedstuffs. Although such results may not give a true indication of the nutritive value of a feed, they supply clues in research to plants of potential value for further *in vitro* or *in vivo* studies^{18,28,29}. Proximate analysis is specifically useful in screening the potentials of the array of tropical browse plants utilized by indigenous farmers for ruminant feeding³⁰. Standard Deviation (SD) values across DM, MC, CP, EE, CF and TA were narrow indicating the reliability of these mean values as reference values for the leaf meal. However, the CV values were low (0.03-0.23), indicating that the mean value may serve as a reliable reference value for the leaf meal in the study area. Dry Matter (DM) content of FMLM as obtained in the current study was much higher than the mean dry matter value of 65.10% reported by Carew *et al.*³¹ for browse plants in the derived savannah area of Nigeria but fell within the reference values of tropical plant leaves used in livestock feeding as reported by Anunobi³². Udedibie¹⁴, however, obtained a slightly higher range of values in some selected leaf meals from southeastern Nigeria. The differences in the dry matter content of the browses could be due to the processing methods such as drying at different room temperatures before laboratory analysis. The variability in the nutrient content of fodder trees and shrubs have also been attributed to the state of hydration (fresh, wilted and dry) and drying procedure^{33,34}. Oguntola³⁵ had ascribed wide variation in the values of nutrient content of leafy vegetables to variations in nutrient and fertilizer status of the soil on which the crops were grown, sample preparation procedure before analysis and analytical procedure which may vary in technique and quality. A high DM content of plants is obviously an advantage as it would serve as a veritable source of nutrients and would assist in meeting the bulk needs of ruminant animals fed with the browse, while relatively high moisture content of any sample suggests that it stands the risk of microbial deterioration and spoilage during storage.

The high CP value of suggests that FMLM will serve as a good source of protein diet for small ruminants since Nastis and Malechel³⁶ reported an acceptable range of 7-14% CP for ruminants. Devendra and McLeroy³⁷ reported 11% CP to be ideal for normal weight gain in sheep and goats. Le-Le Houerou³⁸ reported a mean CP of 12.5% for tropical browses, while Onwuka³⁹ reported 15.87% for browses of Southern Nigeria. Udedibie¹⁴ reported much higher CP (24.46 and 20.73%) in *G. latifolium* and *M. pruriens*, respectively but similar value the reported in *G. kola* leaf meals. Okoli *et al.*¹⁸ also reported a CP value of 18.23% for *Ricinodendron heudelotii*, a plant closely associated with *F. microcarpa* in the cafeteria feeding of small ruminants at the study area. The result was also similar, though slightly lower than the report of Njidda⁴⁰ for the CP content of *Ficus polita*, *Ficus thonningii* and *Leptadenia lancifolis* at a range of 13.85-16.65%. The values reported by Okoli *et al.*¹⁵, however, seem to suggested that some *Ficus species* native to southeastern Nigeria may yield much higher CP in their leaf meals. Ahamefule *et al.*⁴¹ specifically reported a higher CP content of heavily browsed species plants of southeastern Nigeria used in ruminant feeding (14.70-20.65% with a mean value of 17.92%), moderately browsed plants (13.66-24.85% with a mean value of 18.35%) and occasionally browsed plants (13.65-25.55% with a mean value of 18.62 $\pm$ 4.34), indicating higher values than the result of the present study. This high variability in the nutrient content of browse plants often encountered in research have been attributed to within species variability, plant part, season, harvesting regimen, location, soil type and age⁴⁰⁻⁴³.

Okoli *et al.*¹⁸ reported EE value of 7.00% for *R. heudelotii*, while for *Ficus* spp. indigenous to southeastern Nigeria a much lower value of 0.95% was reported by Okoli *et al.*¹⁵. The result was lower than the mean EE content of 5.07% for selected browses of southeastern Nigeria as reported by Okoli *et al.*¹⁸. The value is much lower than the 6.32 and 3.77% reported in *G. latifolium* and *G. kola* leaf meals but higher than the 1.35% reported in *M. pruriens* leaf meals obtained from southeastern Nigeria. The EE contents of the study plant agree with that of Njidda⁴⁰ who reported a range of 2.00-5.00% for EE of northeastern Nigeria browse forages. It is also similar to the reported EE content of 2.30-5.80% as given by Mecha and Adegbola⁴⁴ and 2.80% for *Panicum maximum* reported by Arigbede *et al.*⁴⁵.

The CF content of 24.42-26.30% reported for the study plant is in agreement with the 25.25% CF reported by Okoli *et al.*¹⁸ for *Ficus* spp. of southeastern Nigeria and the 26.93% reported by Kubkomawa⁶ for the most preferred browses during the dry season in Adamawa state. The values

obtained were however higher than the mean CF content of 11.6% reported for selected browses of southeastern Nigeria by Okoli *et al.*¹⁸ but similar to the mean value of 27.72% reported by Udedibie¹⁴ in selected plants from the zone. The values are lower than the 18.30% mean CF content reported for browses of west Africa by Le-Houerou³⁸. The observed variations in the crude fibre content of the browses could be attributed to the season of harvest, stage of maturity, type of browse plants, climatic conditions of the area and inherent genetic characteristics of each plant^{46,47}.

Okoli *et al.*¹⁵ reported a much lower 5.20% total ash (TA) content for *Ficus* spp. of southeastern Nigeria, while a TA content value of 9.80% was reported for *R. heudelotii* a browse plant closely associated with *F. microcarpa* in the small ruminant feeding practice at the study area. The values obtained from the present study were high when compared with the mean values of 10.90% reported for West African browse plants or the 7.19 and 8.51% for Southeastern Nigeria browses^{18,37,44}. The values are similar to the 12.21% reported by Udedibie¹⁴ in *G. latifolium* but much higher than the 6.56 and 5.33% reported in *M. pruriens* and *G. kola* leaf meals. Ash values are affected by stage of growth. Le Houerou³⁸, Mecha and Adegbola⁴⁴ and Gohl⁴⁸ stated that the different figures obtained in the ash content of browse plants in many regions may be due to differences in soil, species and season. The lower range of the NFE obtained in this study is similar to the 30.82% reported by Okoli *et al.*¹⁵ for *Ficus* spp. of southeastern Nigeria but lower even at its upper range than the 46.27% reported for *R. heudelotii* in the same study area¹⁸. Udedibie¹⁴ also obtained similar results (36.53%) as the mean value for the three plants analyzed in southeastern Nigeria. The study plant can serve as a good source of energy material for ruminant animals due to its high energy value. The mean ME value of the study plant at 2238.41 Kcal kg⁻¹ was quite high for a leaf meal and compares favorably with the value obtained for grains by-products⁴⁹. The values are however slightly similar to the 2937.50, 2275.70 and 2525.02 Kcal kg⁻¹ recorded for *G. latifolium*, *M. pruriens* and *G. kola* respectively by Udedibie¹⁴.

The present NDF values reported for the study plant are moderate when compared with low quality roughages which ruminants can effectively degrade⁴⁷. The present result is similar to the mean 51.54% NDF reported by Okoli *et al.*¹⁸ in selected browses of southeastern Nigeria, with *R. heudelotii* recording 49.91%. The value is also lower than the 58.86% reported for *Mucuna pruriens* but higher than the 43.13 and 44.42% reported for *G. latifolium* and *G. kola*, respectively¹⁴. The result is, however, slightly higher than the upper limit of the findings of Njidda⁴⁰ who reported 37.3-51.2% NDF for

browse forages in northeastern Nigeria. The moderate NDF contents of the analyzed material may be a reflection of the level of maturity of the plant leaves which has provided an opportunity for fibre accumulation in the plant tissues. The voluntary DM intake and digestibility are dependent on the cell wall constituents (fibre), especially the NDF and lignin⁵⁰. The NDF is the total cell wall which comprises the ADF fraction and hemicellulose. The NDF fraction, therefore, reflects the amount of forage the animal can consume and increases as DM intake decreases. The level of NDF in the animal ration also influences the time of rumination, although the concentration of NDF in feeds is negatively correlated with energy concentration⁵¹.

The overall mean ADF of 40.84% obtained in present study compares favourably with the 38.50% ADF value obtained by Okoli *et al.*¹⁸ in selected browses of southeastern Nigeria and the values earlier reports by Oduguwa *et al.*⁵², Oji and Isilebo⁵³ and Udedibie¹⁴. It is also similar to the findings of Njidda⁴⁰ who reported ADF contents of 41.2% in some browse forages of northeastern Nigeria. The findings, however, did not corroborate the mean value of 23.30% ADF recorded in 30 browse species analyzed by Gidado *et al.*⁵⁴. The ADF value refers to the cell wall portions of the forage made up of cellulose and lignin. The ADF values relate to the ability of an animal to digest the forage. Therefore, as ADF increases the digestibility of the forage decreases⁵⁵. Lignin is the prime factor influencing the digestibility of plant cell wall material. As it increases, the digestibility intake and animal performance usually decrease. The mean 14.41% recorded in this study was similar to the 13.88% reported by Udedibie¹⁴ and particularly lower than the 18.22% reported for *G. kola* leaf meal.

The mean cellulose value recorded in this study is similar to the 29.34% reported for *M. pruriens* but higher than the 20.50 and 19.90% reported for *G. latifolium* and *G. kola* leaf meals, respectively¹⁴. Again, the mean hemicellulose value obtained in the present study is similar to the mean 11.66% reported by Udedibie¹⁴ for some leaf meals from southeastern Nigeria and specifically higher than the 6.30% reported for *G. kola* leaf meal. This result is also higher than the reported values of 4.9-12.7% hemicellulose for browse forages in northeastern Nigeria by Njidda⁴⁰ indicated that FMLM contains a more digestible fraction. The amount of hemicellulose recorded in the study plant showed that it will have a high level of digestible carbohydrate. The present result is however similar to the mean hemicellulose value of 13.04% reported by Okoli *et al.*¹⁸ for selected browses of Southeastern Nigeria but much lower than the 29.26 and 25.23% reported for *Diodia scandens* and *M. puberula*,

respectively by the same authors. Aderemi *et al.*⁵⁶ also reported such higher hemicellulose values (30.3 and 21.60%) in wheat offals and cassava root chaff respectively.

The FMLMs were rich in all the macro minerals but extremely rich in potassium with the order of mineral concentration being K>Ca>Mg>P>Na, similar to the order published by Udedibie¹⁴ for the *G. latifolium* but different P>Mg in *M. pruriens*. Udedibie¹⁴ also reported much different macro-mineral order (Ca>K>Mg>P>Na) for *G. kola* leaf meal indicating that probably, K and Ca are the highest macro minerals and Na the least in southeastern Nigeria plants. Okoli *et al.*¹⁵ had earlier shown that generally, browses from southeastern Nigeria are rich in phosphorus and calcium, with *Ficus* spp. from the region recording mean 1.19% calcium and 2.50% phosphorus indicating that there is no need to supplement these minerals in the rations of ruminants reared at the study area. These findings, therefore show that the plant has the capacity to yield high macro mineral portions and that this could be linked to the soil types at the study location, which has been reported to range from 4.97-5.57 pH^{15,53}. The study plant was therefore rich in iron and zinc and there were no traces of Co and Pb in the plant samples. The order of micro mineral concentration in the leaf meal of the plant is therefore Fe>Mn>Cr>Zn>Cu>Ni, which was similar to the trend published by Udedibie¹⁴ for *G. latifolium* but much different from the micro mineral order of Fe>Zn>Cr>Cu>Mn>Ni and Fe>Mn>Cu>Zn>Cr reported in *M. pruriens* and *G. kola* leaf meals, respectively¹⁴. It is therefore probable that iron is the highest micro mineral and Ni the least in most southeastern Nigeria plants with Co and Pb being absent in most cases. These results indicate that FMLM is rich in trace minerals and the assayed Fe and Cu levels could support rich hematological profits in animals consuming the plant leaves.

The observed mean ratio values of 2.223 and 0.0625 reported for calcium/phosphorus and sodium/potassium ratios respectively indicate that for every single unit of phosphorus in the plant there are 2.2 units of calcium. These high calcium levels may be reflecting variation in the calcium contents at different locations in the study area. These findings are however at variance with Ca/P ratio of 0.49 in which for every unit of P there were only 0.49 units of calcium in the most cherished browses of Southeastern Nigeria as reported by Okoli *et al.*¹⁵ or the same trend of 0.49 obtained in *Ficus* spp. by the same workers at Anambra state. Udedibie¹⁴ also reported Ca/P ratios of 0.49, 2.97 and 6.06 in *G. latifolium*, *M. pruriens* and *G. kola*, respectively with a mean value of 3.17 for the three plants, a figure much higher than the

2.35 recorded for *F. microcarpa*. These findings seem to indicate that southeastern Nigerian plants may have varied Ca/P ratios. The Na/K ratios obtained in this study were much lower than the 0.66 obtained by Okoli *et al.*¹⁵ on the mean for most cherished browses of southeastern Nigeria or the 0.72 obtained by the same workers in *Ficus* spp. of the same study location. The values recorded in *F. microcarpa* are also much lower than the 0.58, 0.47 and 0.11 ratios reported by Udedibie¹⁴ in *G. latifolium*, *M. pruriens* and *G. kola* leaf meals.

CONCLUSION

From this study, it is concluded that leaf meals derived from *Ficus microcarpa* are relatively rich in crude protein, nitrogen free extract, metabolizable energy, digestible fibers and essential minerals. Animal feeding trials incorporating *Ficus microcarpa* are recommended in order to evaluate the performance of animals fed with the browse plant.

SIGNIFICANCE STATEMENT

This nutritional study showed that *F. microcarpa* leaf meal is a good source of essential nutrients that could be included in animal feed to improve productivity. This study has formed the baseline for future research on the nutritional compositions of some common browse plants utilized in animal production in the tropical climate.

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REFERENCES

- Makkar, H.P.S., 2002. Application of the *In-Vitro* Gas Method in the Evaluation of Feed Resources and Enhancement of Nutritional Value of Tannin-Rich Tree/Browse Leaves and Agro-Industrial by-Products. In: Development and Field Evaluation of Animal Feed Supplementation Packages. Proceedings of an IAEA Technical Co-Operation of Regional AFRA Project, IAEA (Ed.), Organization by Joint FAO/IAEA Division of Nuclear Techniques in Food and Agriculture, Cairo, Egypt, pp: 23-40.
- Okoli, I.C., C.S. Eber, M.C. Uchegbu, C.A. Uda and I.I. Ibeawuchi, 2003. A survey of the diversity of plants utilized for small ruminant feeding in South-Eastern Nigeria. *Agric. Ecosyst. Environ.*, 96: 147-154.
- Okoli, I.C., E.C. Ogundu, C.C. Achonwa, E. Obichili, I.H. Kubkomawa and C.G. Okoli, 2014. Selection of candidate indigenous browse plants for domestication in the rainforest zone of South-Eastern Nigeria. *Int. J. Agric. For. Fish.*, 2: 73-80.
- Okafor, J.C. and E.C. Fernandes, 1987. Compound farms of Southeastern Nigeria. *Agrofor. Syst.*, 5: 153-168.
- Balehegn, M., E.A., Eniang and A. Hassen, 2012. Estimation of browse biomass of *Ficus thonningii*, an indigenous multipurpose fodder tree in northern Ethiopia. *Afr. J. Range Forage Sci.*, 29: 25-30.
- Kubkomawa, H.I., 2012. Studies on characteristics of pastoral cattle production in Adamawa state, Guinea Savannah zone of Nigeria. Ph.D. Thesis, Federal University of Technology Owerri, Imo State, Nigeria.
- Adegbola, T.A. and P.C. Oduozo, 1992. Nutrient intake, digestibility and performance of rabbits fed varying levels of fermented and unfermented cassava peal meal. *J. Anim. Prod. Res.*, 12: 41-47.
- Florou-Paneri, P., I. Giannenas, E. Christaki, A. Govaris and N. Botsoglou, 2006. Performance of chickens and oxidative stability of the produced meat as affected by feed supplementation with oregano, vitamin C, vitamin E and their combinations. *Arch. Ge ugelkd.*, 70: 232-240.
- Atawodi, S.E., O.E. Yakubu and I.A. Umar, 2013. Antioxidant and hepatoprotective effects of *Parinari curatellifolia* root. *Int. J. Agric. Biol.*, 15: 523-528.
- Okoli, I.C., A.A. Omede, I.P. Ogbuewu and M.C. Uchegbu, 2009. Physical characteristics as indicators of poultry feed quality: A review. Proceedings of the 3rd Nigeria International Poultry Conference, February 22-26, 2009, Abeokuta, Ogun State, Nigeria, pp: 124-128.
- Omede, A.A., 2010. The use of physical characteristics in the quality evaluation of some commercial poultry feeds and feed stuff. M.Sc. Thesis, Federal University of Technology Owerri, Nigeria.
- Omede, A., V.M.O. Okoro, M.C. Uchegbu, I.C. Okoli and G.A. Anyanwu, 2012. Macro-biophysical properties of candidate novel feedstuffs for poultry feeding. *Pak. J. Biol. Sci.*, 15: 1176-1181.
- Omede, A.A., I.C. Okoli and M.C. Uchegbu, 2011. Studies on the physical characteristics of some feed ingredients in Nigeria. 1: Protein sources and industrial by-products. *Online J. Anim. Feed Res.*, 1: 191-197.
- Udedibie, C., 2015. Evaluation of some tropical leaf meals as alternative feed raw materials. B. Agriculture Technology Project Report, Federal University of Technology Owerri, Nigeria.
- Okoli, I.C., C.S. Eber, O.O. Emenalom, M.C. Uchegbu and B.O. Esonu, 2001. Indigenous livestock production paradigms revisited. III: An assessment of the proximate values of most preferred indigenous browses of South Eastern Nigeria. *Trop. Anim. Prod. Invest.*, 4: 99-107.

16. Okoli, I.C., M.O. Anunobi, B.E. Obua and V. Enemu, 2003. Studies on selected browses of southeastern Nigeria with particular reference to their proximate and some endogenous anti-nutritional constituents. *Livestock Res. Rural Dev.*, Vol. 15, No. 9.
17. Chah, J.M., U.P. Obi and H.M. Ndofo-Foleng, 2013. Management practices and perceived training needs of small ruminant farmers in Anambra state, Nigeria. *Afr. J. Agric. Res.*, 8: 2713-2721.
18. Okoli, I.C., M.O. Anunobi, B.E. Obua and V. Enemu, 2003. Studies on selected browses of southeastern Nigeria with particular reference to their proximate and some endogenous anti-nutritional constituents. *Livestock Res. Rural Dev.*, Vol. 15, No. 9.
19. Makinde, O.A. and E.B. Sonaiya, 2007. Determination of water, blood and rumen fluid absorbencies of some fibrous feedstuffs. *Livestock Rural Res. Dev.*, Vol. 19.
20. AOAC., 2010. International Official Methods of Analysis. 18th Edn., Association of Official Analytical Chemists, Washington, DC., USA.
21. SAS., 1999. SAS/STAT User's Guide: Statistics Version 8.00. SAS Institute Inc., Cary, NC., USA.
22. Omede, A.A., M.N. Opara and I.C. Okoli, 2008. The significance of phytohormones in animal production. *Int. J. Trop. Agric. Food Syst.*, 2: 89-104.
23. Emmans, G.C., 1989. The Growth of Turkeys. In: *Recent Advances in Turkey Science*, Nixey, C. and T.C. Grey (Eds.). Butterworths, London, pp: 135-166.
24. Smith, O.B., 1992. Small Ruminant Feeding Systems for Small Scale Farmers in Humid West Africa. In: *The Complementarity of Feed Resources for Animal Production in Africa*. Proceedings of the Joint Feed Resources Networks Workshop held in Gaborone, Botswana, 4-8 March, 1991. Africa Feeds Research Network, Stares, J.E.S., A.N. Said and J.A. Kategile (eds.). International Livestock Centre for Africa, Addis Ababa, Ethiopia, pp: 363-376.
25. Bhatti, S.A. and J.L. Firkins, 1995. Kinetics of hydration and functional specific gravity of fibrous feed by-products. *J. Anim. Sci.*, 73: 1449-1458.
26. Kyriazakis, I. and G.C. Emmans, 1995. Voluntary intake of pigs given feeds based on wheat bran, dried citrus pulp and grass meal in relation to measurement of feed bulk. *Br. J. Nutr.*, 73: 191-207.
27. Smits, C.H.M. and G. Annison, 1996. Non-starch plant polysaccharides in broiler nutrition-towards a physiologically valid approach to their determination. *World's Poult. Sci. J.*, 52: 203-221.
28. D'Mello, J.P.F. and K.W. Fraser, 1981. The composition of leaf meal from *Leucaena leucocephala*. *Trop. Sci.*, 23: 75-78.
29. D'Mello, J.P.F., 1992. Nutritional Potentialities of Fodder Trees and Shrubs as Protein Sources in Monogastric Nutrition. In: *Legume Trees and Other Fodder Trees as Protein Sources for Livestock*. Proceedings of the Food and Agricultural Organization Export Consultation held at Kuala Lumpur, Malaysia, 14-18 October 1991. FAO Animal Production and Health Paper 102, Speedy, A. and P.L. Pugliese (Eds.), FAO., Rome, Italy, pp: 145-160.
30. Okoli, I.C., H.I. Kubkomawa, C.C. Ugwu, I.C. Unamba-Opara and C.G. Okoli, 2014. Links between pastoral practices and agro-pastoral conflicts in the rainforest zone of southeastern Nigeria. Proceedings of the 4th Agricultural Science Week and 11th General Assembly of CORAF/WE CARD, June 16-20, 2014, Niamey, Niger.
31. Carew, B.A.R., A.K. Mosi, A.U. Mba and G.N. Egbunike, 1980. The Potential of Browse Plants in the Nutrition of Small Ruminants in the Humid Forest and Derived Savanna Zones of Nigeria. In: *Browse in Africa: The Current State of Knowledge*, Le Houerou, H.N. (Ed.). International Livestock Centre for Africa, Addis Ababa, Ethiopia, pp: 307-311.
32. Anunobi, M.O., 2001. Evaluation of the nutrient composition and anti-nutritional factors of selected browses of Southeastern Nigeria. B. Agriculture Technology Project Report, Federal University of Technology Owerri, Nigeria.
33. Palmer, B. and A.C. Schlink, 1992. The effect of drying on the intake and rate of digestion of the shrub legume *Calliandra calothyrsus*. *Trop. Grasslands*, 26: 89-93.
34. Dzowela, B.H., L. Hove and P.L. Mafongoya, 1995. Effect of drying method on chemical composition and *in vitro* digestibility of multipurpose tree and shrub fodder. *Tropical Grassland*, 29: 263-269S.
35. Oguntona, T., 1998. Green Leafy Vegetables. In: *Nutritional Quality of Plant Food*, Osagie, A.U., O.U. Eka and V.O. Igodan (Eds.). Post Harvest Research Unit, Dept. of Biochemistry, University of Benin, Benin City, Nigeria, ISBN-13: 9789782120021, pp: 120-133.
36. Nasis, A.C. and J.C. Malachuk, 1981. Digestion and utilization of nutrients in oak browse by goats. *J. Anim. Sci.*, 52: 283-290.
37. Devendra, C. and G.B. McLeroy, 1982. Goat and Sheep Production in the Tropics. 1st Edn., Longman Group Ltd., London, England, ISBN: 9780582609358, Pages: 271.
38. Le Houerou, H.N., 1983. The Role of Browse in the Sahelian and Sudanian Zones. In: *Browse in Africa: The Current State of Knowledge*, Le Houerou, H.N. (Ed.), International Livestock Centre for Africa, Addis Ababa, Ethiopia, pp: 55-82.
39. Onwuka, C.F.I., 1996. Plant phytates and oxalates and their effects on nutrient utilization by goats. *Niger. J. Anim. Prod.*, 23: 53-60.
40. Njidda, A.A., 2010. Chemical composition, fibre fraction and anti-nutritional substances of semi-arid browse forages of North-Eastern Nigeria. *Niger. J. Basic Applied Sci.*, 18: 181-188.

41. Ahamefule, F.O., J.A. Ibeawuchi and C.I. Agu, 2006. Comparative evaluation of some forages offered to goats in umudike, Southeastern Nigeria. J. Sustainable Trop. Agric. Res., 18: 79-86.
42. Bamikole, M.A., U.J. Ikhatua, O.M. Arigbede, O.J. Babayemi and I. Etela, 2004. An evaluation of acceptability as forage of some nutritive and anti-nutritive components and of the dry matter degradation profiles of five species of ficus. Trop. Anim. Health Prod., 36: 157-167.
43. Ogunbosoye, D.O., G.O. Tona and F.K. Otukoya, 2015. Evaluation of the nutritive value of selected browse plant species in the Southern Guinea Savannah of Nigeria for feeding to ruminant animals. Br. J. Applied Sci. Technol., 7: 3862-395.
44. Mecha, I. and T.A. Adegbola, 1980. Chemical Composition of Some Southern Nigeria Forage Eaten by Goats. In: Browse in Africa; the current state of knowledge, Lehouerou, H.N. (Ed.), International Livestock Centre for Africa (ILCA), Addis Ababa, Ethiopia, pp: 303-306.
45. Arigbede, O.M., J.A. Olanite and M.A. Bamikole, 2005. Intake, performance and digestibility of West African dwarf goats supplemented with graded levels of *Grevia pubescens* and *Panicum maximum*. Niger. J. Anim. Prod., 32: 293-300.
46. Devendra, C., 1997. Mixed farming and intensification of animal production systems in Asia. Outlook Agric., 26: 255-265.
47. Arigbede, O.M. and S.A. Tarawali, 1997. Preliminary evaluation of the biomass production, seasonal chemical composition and relative preference of some indigenous multi-purpose tree species, by goats in South Western Nigeria. Proceedings of the 2nd Annual Conference of Animal Science Association of Nigeria, September 16-17, 1997, Airport Hotel, Lagos, Nigeria, pp: 117-187.
48. Gohl, B., 1981. Tropical Feeds. FAO Animal Production and Health Series No. 12. Food and Agricultural Organization, Rome, Pages: 529.
49. Uchegbu, M.C., U. Herbert, I.P. Ogbuewu, C.H. Nwaodu, B.O. Esonu and A.B.I. Udedibie, 2011. Growth performance and economy of replacing maize with combinations of brewer's grain, jack bean and cassava root meal in broiler finisher rations. Online J. Anm. Feed Res., 1: 160-164.
50. Bakshi, M.P.S. and M. Wadhwa, 2004. Evaluation of forest tree leaves of semi-hilly arid region as livestock feed. Asian-Aust. J. Anim. Sci., 17: 777-783.
51. Ngele, M.B., D.J.U. Kalla, M. Abubakar, U.D. Dass and A.A. Amba, 2008. Enhancing crop residues for livestock feeding in the tropics. J. League Res. Niger., 10: 1-20.
52. Oduguwa, B.O., O.O. Oduguwa and E.A. Amore, 1999. Effect of Season on the Anti-Nutritive Factors of Some Foliage of Some Leguminous Trees. In: Enhancing Livestock Production in Nigeria. Proceedings of the 26th Annual Conference of Nigerian Society of Animal Production, Joseph, J.K., B. Awosanya, D.F. Apata, M.A. Belonwu, J.O. Attah and K.L. Ayorinda (Eds.), Nigerian Society of Animal Production, Nigeria, pp: 21-25.
53. Oji, U.I. and J.O. Isilebo, 2000. Nutrient characteristics of selected browse plants of humid tropics. Proceedings of the 25th Annual Conference of Nigerian Society for Animal Production, March 19-23, 2000, Umudike, Nigeria, pp: 54-56.
54. Gidado, O.G., A. Kibon, Z.A. Gwargwor, P. Mbaya and M.J. Baba, 2013. Assessment of antinutritive factors and nutrient composition of some selected browse plants use as livestock feeds in Taraba state. Int. J. Applied Sci. Eng., 1: 5-6.
55. Yitaye, A., T. Azage and Y.K. Mohammed, 2001. Chemical composition and nutritive values of major feed resources in three peasant associations of Awassa Woreda, Southern Ethiopia. Proceedings of the 8th Annual Conference of the Ethiopian Society of Animal Production (ESAP), August 24-26, 2000, Addis Ababa, Ethiopia, pp: 288-296.
56. Aderemi, F.A., O.O. Tewe and F.I. Ogundola, 1999. Enzymic supplementation of Cassava Root Chaff (CRC) and its utilization by pullet chicks. Trop. Anim. Prod. Investig., 2: 195-203.