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Full Length Research Paper

Prospects in the use of *Ficus polita* as a local ruminant feed

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The proximate as well as the mineral compositions of *Ficus polita* and some anti nutritional factors were determined in order to justify the local use of this plant as a feedstuff especially for ruminant animals and to establish the possible wide scale utilization of this plant in the feed industry. The proximate, mineral and phytonutrient compositions of the plant were determined using standard methods of analysis. The plant was found to contain reasonable amounts of both macro and micro minerals required by farm animals for healthy growth. The caloric value of *F. polita* was also compatible with those of most tubers, roots and green leaves of many plant feeding stuffs. Also, the anti nutritional factors of the plant were found to be low. Thus, this plant, if well studied, could be used as an alternative to the highly prized grains and legumes required in human nutrition.

Key words: *Ficus polita*, local, ruminant, feed.

INTRODUCTION

Nigeria possesses vast resources in livestock comprising cattle, goats, sheep, horses, donkeys and camels. Pigs, rabbits, fish and poultry are also kept to appreciable extents. Hence, the immense position of livestock farming in this country cannot be overemphasized. In the northern region alone, about 70% of the country's population of sheep and goats are found due to their high adaptation to the ecological constraints of this region (Aliyu, 2004).

However, like in any other tropical country, livestock production has been faced with the problem of meeting up with the competition between human needs and those of farm animals for the scarce conventional foodstuffs like the cereals, pulses and root crops. The high cost and sometimes unavailability of the conventional feeds all the year round coupled with the shortages in the foreign exchange and poor quality feeds have rendered livestock production an expensive venture in Nigeria (Parr et al., 1988). In addition, this country has been classified as one of the vulnerable countries in terms of food security considering some salient factors that militate against her adequate food production especially in recent years. Among these factors are early cessation of rains, lack of access to fertilizers and improved seeds as well as the poor timeliness of supply and distribution of other agricultural inputs (Jean, 2008). As a result of this, instead of Nigeria, as a country, to export most of these agricultural products to boost her international trade, it rather imports them. For instance, it was reported that in 2008, the country's import of cereals was as high as 30 million tones which only represented 25% of the total utilization of these commodities within the same period (Jean, 2008). This has therefore made the situation of these materials very critical in the country which led to rises in the prices of the locally available feedstuffs most especially that the concentrates containing animal proteins are usually imported. Thus, studies on alternative feedstuffs to the conventional carbohydrate and protein sources are very important. In recent years, studies have been conducted on the use of other non conventional feeding stuffs especially the non protein nitrogen (NPN) ruminant nutrition in order to replace the relatively more expensive plant protein supplements like groundnuts, *Cajanus cajan* and soya beans (Adegbola et al., 1985). The toxicity of this NPN at high concentrations could, nonetheless, be highly dangerous unless experienced hands are available to ensure the use of these supplements at safe levels. Due to the high poverty level among the local livestock farmers in the country, chaffs of cereals, crop residues, agro-industrial wastes, grasses

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and leaves of trees are being used to feed farm animals without minding their nutritional constituents or their toxicity because they are relatively cheap and readily available (Oluremi et al., 2007). The use of these non conventional sources to complement the conventional ones is however, affected by several factors ranging from low protein contents, high fibre content, amino acid imbalance to the presence of anti nutritional factors which generally have significant negative effects on livestock production as they interfere with the bioavailability of the mineral elements required for healthy growth of livestock (Oluremi et al., 2007). Very recently, the increasing cost of proteins of plant origin especially groundnut meal and soya bean meal, has led to extensive research in the use as well as the characterization of these plant supplements in order to augment livestock feeds production (Davis, 2004; Agu, 2006; Oluremi et al., 2007). The fig tree, which is also referred to as *Ficus polita* and called Durumi in Hausa, Jammeiz alazrak in Shuwa Arabic and Gbanchi bokun in Nupe, all in northern Nigeria, belongs to the family *Moraceae* (Keays, 1989). It grows to about 18 m high and is much branched with dense rounded crown upon which abscission can occur during wind or storms (Raghavendra, 1991). The stem of this plant is erect with a single trunk and smooth bark which secretes a milky juice that contains some waste products (Muller, 1977; Dutta, 1989). Its leaves are slender and tend to hang downwards which, close to the time of annual bud break, shed off their old ones which are soon replaced by the expanding buds hence, the plant is essentially evergreen (Raghavendra, 1991). This perennial plant is found grown mostly in towns and villages primarily to provide shade around the houses (Gibbon and Pain, 1985). It can grow on poor rocky soils and even poorer ones than these with its extensive rooting system (both tap root and aerial) being capable of exploiting these soils very efficiently (Gibbon and Pain, 1985). *F. polita* can also be propagated vegetatively; and considering its temperature requirement, its plantation can easily be established in most parts of the country. It is one of the tropical plants whose leaves and bark are cherished and consumed by ruminants (especially sheep and goats) as feeds. The leaves of this plant are therefore harvested and fed to these animals by peasant farmers in most rural settings of the northern Nigeria but not much has been found in literature regarding its nutrient quality in this part of the country as an alternative for ruminants' feed. In addition, the northern part of this country, being the major producer of most gains required for poultry feeds production, is highly prone to unfavourable pattern of rainfall characterized by prolonged dry spells. As a result, there is a dire need for the exploration of other alternative sources of feeding stuffs for the feed industry. Due to the reasons stated above earlier, this research was conducted on this plant.

MATERIALS AND METHODS

Sampling and samples preservation

The leaves and bark samples of the plant used in the study were obtained from six different locations around homes in Minna and its environs. Infected and dried leaves and barks were not sampled. After sampling, these were chopped using broken glass pieces and dried in the laboratory for two weeks away from direct sun rays.

The chopped dried samples were ground using porcelain pestle and mortar and subsequently stored separately in clean dried bottles with screw caps. Triplicate weights of the samples from each spot of the plant were taken and analyzed and the results obtained were given as averages of these values.

Laboratory analysis

The chemical parameters such as the crude protein (CP), total carbohydrates (TC), crude fibre (CF), moisture content, nitrogen free extract (NFE) and the ash contents (all of which constitute the proximate parameters of the sample), the micro and macro elements were determined using standard methods.

Determination of proximate parameters

The CP of the plant was determined using the Macro Kjeldhal digestion and distillation method (Harriss, 1970; AOAC, 2000) while the moisture content was quantified using the evaporation method (Julian, 1999; AOAC, 2000). The quantitative estimation of fat and ash contents of the sample were carried out using the Ministry of Agric Fish food (1973) and AOAC (2000) methods. For the total carbohydrates, the phenol-sulphuric acid colorimetric method (Craig, 2005) as well as the difference (Julian, 1999: Indrayan et al., 2005) method was employed. The values obtained by the difference method were not found to be much different from those of the colorimetric method. Hence, these carbohydrate values were used to estimate the nutritive values of the samples analyzed using the relation; nutritive value = 4 × % protein + 9 × % fat + 4× % carbohydrate (Indrayan et al., 2005).

Determination of macro and microelements

The minerals (the macro and the microelements) analyzed in this work were determined using atomic absorption spectrometry (AAS) and flame emission spectrophotometry (FESP) after digesting the sample with nitric acid- perchloric acid mixture (IITA, 1979).

Determination of anti nutritional factors

The anti nutritional phytoconstituents were also determined using various standard methods.

Determination of phytate

The phytate was determined using Reddy and Love method as reported by Umar et al. (2007). 4 g of the ground sample was soaked in 100 cm^3 of 2% HCl for 5 h and filtered. 25 cm^3 of the filterate was pipetted and 5 cm^3 of 0.5% ammonium thiocyanate solution was added and the mixture titrated with 0.01 $moldm^{-3}$ iron (III) chloride solution until a brownish yellow colour that persisted for 5 min was obtained.

Determination of oxalate

For oxalate estimation, the Munro and Bassir (1969), a modified method of Dye (1956) was used to obtain the total oxalate. 1 g of the ground sample was taken and extracted three times by warming and stirring with magnetic stirrer for 1 h in 20 cm^3 of 0.3 $moldm^{-3}$

Table 1. The proximate compositions (%) and nutritive values of the leaves and stem bark of *F. polita.*

Parameter	Moisture	Dry matter	Total ash	Organic matter	Crude fibre	Crude protein	Ether extract	N.F.E.	Carbohydrate	Nutritive value
Leaves	4.48 ± 0.43	95.55 ± 0.46	12.88 ± 1.45	86.47 ± 0.14	27.46 ± 0.28	11.40 ± 0.65	2.02 ± 0.20	42.21 ± 2.31	69.23 ± 2.02	341 ± 8.04
Stem bark	2.80 ± 0.18	97.21 ± 0.18	9.00 ± 0.06	90.02 ± 0.05	35.49 ± 0.29	6.16 ± 0.28	2.41 ± 0.14	36.51 ± 0.68	78.66 ± 0.34	360.99 ± 1.42

Values are in percentage.

HCl each time. The combined extract was made up to 100 cm^3 in a volumetric flask with distilled water. 5 cm^3 of this was taken and made alkaline with 1.0 cm^3 5 $moldm^{-3}$ ammonium hydroxide. Drops of glacial ethanoic acid were added after 3 drops of phenolphthalein indicator were added until a colourless solution was obtained. 1.0 cm^3 of 5% $CaCl_2$ was then added; the mixture was allowed to stand for 3 h and finally centrifuged at 3000 rpm for 15 min. The supernatant was discarded and the precipitate was washed with hot water. The precipitate was then dissolved in 2.0 cm^3 warm 1.5 $moldm^{-3}$ H_2SO_4 in a water bath. This was then titrated with a freshly prepared 0.01 $moldm^{-3}$ $KMnO_4$ initially at ordinary temperature until the first pink colour appeared throughout the solution. This was allowed to stand until it became colourless and warmed afterwards for further titration until a pink colour which persisted for at least 30 s was obtained. The obtained values were used to calculate the oxalate content of the samples.

Determination of saponin

The saponin of the samples was gravimetrically determined using the AOAC (1984) method. 5 g of the dry ground sample was weighed into a thimble and transferred into a soxhlet extractor chamber and about 300 cm^3 of acetone was used to exhaustively extract lipids and interfering pigments in the samples for 3 h. Afterwards, a pre-weighed round bottomed flask containing 300 cm^3 of methanol was used to exhaustively extract the saponin for 3 h. The methanol was distilled off and collected for further use and the flask reweighed. The difference between the final and the initial weights of the flask was taken as the weight of the extracted saponin.

Determination of Tannins

Tannin was estimated using the AOAC (1984) method. 1.0 g of dry ground sample was weighed into a conical flask and 100 cm^3 of distilled water added and the mixture boiled gently for 1 h on a hot plate. This was filtered through a No. 44 Whatman filter paper into 100 cm^3 volumetric flask and made up to the mark.

For colour development, 10 cm^3 of the extract above was pipette into 100 cm^3 volumetric flask containing 50 cm^3 of distilled water. 5.0 cm^3 Folin-Denis reagent and 10 cm^3 saturated Na_2CO_3 solution were added and then made up to the mark. The mixture was thoroughly shaken and allowed to stand for 30 min in a water bath (25°C). Optical density was measured at 700 nm using a spectrophotometer and compared on a standard tannic acid plot.

Determination of cyanide content

The cyanide content of the samples was determined using the method described by Gopal and Ranjhan (1980). 8.0 g of the sample was placed in 800 cm^3 Kjeldahl flask and about 200 cm^3 distilled water and 5 cm^3 of chloroform were added and steam distilled into 100 cm^3 test tube containing 5 cm^3 2% KOH. About 70 cm^3 of the distillate was collected into a beaker making sure that the tip of the delivery tube was immersed into the collecting solution. This was made up to 300 cm^3; a few crystals of potassium iodide were added and titrated to faint opalescence with a 0.1 $moldm^{-3}$ $AgNO_3$ solution. The cyanide content of the samples was estimated from the obtained titre values.

RESULTS AND DISCUSSION

The higher total ash content of the leaves compared to the level in the bark is a good indication that the former would be richer in mineral content than the latter as indicated in Table 1. This is expected since the actively growing parts of plants are usually associated with more mineral elements than the older parts (Keays, 1989). The ash content obtained in this study is higher than that reported for Makmur rice straw (Vadiveloo, 1995). The ash content of the bark which was found to be lower than that of the leaves was similar to the value obtained for beet pulp (Arosemena et al., 1994). The dry matter content of the bark was expectedly higher than that of the leaves giving an indication of lower mineral contents of the bark. The crude fibre of the bark was also much higher than that of the leaves but slightly lower than the value obtained for maize silage (Givens and Cotyn, 1994). The value obtained for the leaves of this plant (27.46 ± 0.28%) was found to be lower than the value for the palm kernel meal (30.50%) but higher than that of the copra meal (15.40%) as reported by Burhanudin and Dingle (2003) but the obtained value for the bark (35.49 ± 0.29%) was higher than those of the copra and palm kernel meals (Table 1). The higher fibre content of the bark makes it a less important feed than the leaves which are the parts of the plant being employed in feeding farm animals. The crude protein of the leaves was about twice that of the bark but this was lower than that reported on the rice bran (Arosemena et al., 1994). However, this value (for the leaves) is higher than the values reported for unpeeled Chinese yam, peeled water yam, rice grain with hull and maize (Oyenuga, 1968). This low protein content of the plant can, however,

Table 2. Some mineral compositions (%) of the leaves and stem bark of *F. polita.*

Parameter	Potassium	Sodium	Magnesium	Calcium	Iron
Leaves	1.24 ± 0.08	0.21 ± 0.04	0.42 ± 0.04	0.020 ± 0.004	0.323 ± 0.016
Stem bark	0.54 ± 0.04	0.08 ± 0.01	0.18 ± 0.01	0.026 ± 0.007	0.312 ± 0.022

Values are in percentage.

Table 3. Some phytonutrient compositions (%) of the leaves and stem bark of *F. polita.*

Parameter	Cyanide	Saponins	Tannins	Oxalates	Phytates
Leaves	0.043 ± 0.009	7.94 ± 0.41	0.416 ± 0.051	0.0837 ± 0.0084	2.06 ± 0.10
Stem bark	0.029 ± 0.006	12.51 ± 0.06	3.891 ± 0.122	0.0759 ± 0.085	1.74 ± 0.3

Values are in percentage.

be improved by the use of lysine and sulphur amino acids (cysteine and methionine) supplementation. The ether extract of the bark was higher than that obtained for the leaves. This is probably due to the presence of more esters in this part of the plant than the leaves.

The evaluation of macro minerals and trace elements in food samples is an important exercise from the nutritional and toxicological point of view. This is because some of these metals have long term effects on human health when accumulated in target organs (Campanela et al., 1998).

Both sodium and potassium take part in ionic balance of the human body and maintain tissue excitability. Sodium salts are very soluble in aqueous phase therefore; the metal plays an important role in the transport of metabolites while potassium is a diuretic metal (Indrayan et al., 2005). The potassium content of the leaves (1.24 ± 0.08%) and stem bark (0.54 ± 0.04%) of *F. polita* as indicated in Table 2 above were greater than the values obtained for cowpea testa (0.17%) but lower than the 1.52% for the cowpea seeds (Markakis and Akpapunam, 1981).

A large proportion of bones, human blood and extra-cellular fluid are made up of calcium. This metal therefore plays an important role in the normal functioning of cardiac muscles, blood coagulation, milk clotting and regulation of cell permeability. It also plays an important part in the nerve impulse transmission and in the mechanism of neuromuscular system (Indrayan et al., 2005). The calcium content of the two parts of this plant were compatible with those of sweet potato (0.025%), water yam (0.01%) and soya beans (0.02%) but far greater than that of maize (0.006%) as given by Oyenuga (1968).

Magnesium is required in the plasma and extracellular fluid where it plays a vital role in the maintenance of osmotic equilibrium. It is also required in many enzyme catalyzed reactions. Insufficient supply of this element causes abnormal irritability of the muscles and convulsion while excess of it is associated with the depression of the central nervous system (Indrayan et al., 2005). The magnesium content of the leaves and bark of *F. polita*, (0.42 ± 0.04% and 0.18 ± 0.01%, respectively), showed that the leaves had a higher value than soya beans (0.23%), the millet (0.18%), guinea corn (0.23%), rice (0.119%) and even wheat (0.17%), while the bark had a magnesium content compatible with these feed supplements as given by Oyenuga (1968).

Iron is a mineral that has always been associated by legends with strength and vitality (Alex, 2008). When present in small amounts, iron is essential for the formation of haemoglobin. It is the metal that combines with oxygen and transports it through the blood to all parts of the body and any person who suffers from the deficiency of this metal is anaemic with such symptoms as tiredness, lack of stamina, headaches, breathlessness and loss of appetite (Niederau et al., 1996). Among the good sources of iron are the vegetables like broccoli and bok choy which can provide from 1 - 10% of human's iron requirement. Both the bark and the leaves of this plant were found to have higher iron contents (0.312 ± 0.022 and 0.323 ± 0.016%, respectively), as stated in Table 2 as either the cowpea testa or the seeds (0.07 or 0.01%) as reported by Markakis and Akpapunam (1981).

Tannin, which gives rise to a dry, pickery, astringent sensation in the mouth, was found to be 0.416 ± 0.051% in the leaves while the stem bark had 3.891 ± 0.122% as shown above in Table 3. This value in the bark which was higher than that of the leaves was still found to be higher than the 1.2% commonly found in cereals and legumes which have been reported to have depressed the growth of non ruminants (Oluremi et al., 2007). This level however, especially in the bark, is adequate for the ruminants which need higher tannins (2 - 3%) to reduce the wasteful protein degradation in the rumen by the formation of a protein tannin complex. The saponins contents of the leaves and the bark of the plant were 7.94 ± 0.41 and 12.51 ± 0.06%, respectively. This bitter phytonutrient reduces the palatability of livestock feeds and also increases excretion of cholesterol. It also inhibits growth in some farm animals like swine and poultry. The saponins levels in the two parts of the plant which are highly relished by the ruminants are however, quite higher than the 3% reported to be the anti nutritional factor responsible for the death of several cattle when grazed on high saponins containing plants (Oluremi et al., 2007). On the basis of this one may be tempted to assume that this plant may be hazardous to livestock but in reality, it has not been locally noticed that the plant is dangerous to farm animals especially the ruminants.

The oxalate contents of the leaves and stem bark of the plant were 0.0837 ± 0.0084% and 0.0759 ± 0.085%, respectively. This chemical substance in foods and feeds decreases the availability of dietary essential minerals such as calcium and at high concentrations can cause death due to its corrosive effects. In small amounts therefore, it has been reported to be responsible for a variety of pathological disorders like pyridoxine deficiency and calcium oxalate stones (Oluremi et al., 2007). The levels of oxalate obtained for these parts of the plant though were higher than the 0.033 and 0.048% range reported for the peels of some varieties of oranges, these values are low compared to those of beet roots and cocoa found to be respectively 0.275 and 0.7% (Oluremi et al., 2007).

Cyanides, in plants, are generally estimated as hydrocyanic acid although hydrocyanic acid does not occur free in plants. It exists in combined forms as sugars called the cyanogenic glycosides. The knowledge of the cyanogenic glycosides content of food materials is very vital because cyanide is an effective cytochrome oxidase inhibitor which interferes with aerobic respiratory system. This phytonutrient is so potent that even a small quantity as low as 0.05 g/kg body weight of an adult can be lethal (Gregory, 2005). It is, however, lost during soaking and cooking (Kay et al., 1977). The cyanide contents of the two parts of the plant analyzed (0.043 ± 0.009 and 0.029 ± 0.006%, respectively, for the leaves and the stem bark) were quite lower than that reported for the bitter variety of cassava (0.084%) but the leaves had a slightly higher content than the sweet variety (0.036%) but were close to the 0.031% for garri (Ikediobi and Fashagbu, 1985).

Conclusion

The levels of most chemical parameters determined were considered safe especially if proper handling and treatments are done to the plant before being fed to the farm animals. It is, therefore, the recommendation of this work that this plant should be tried as a feed for livestock keeping and further work be carried out to establish its safe use and the ease with which its plantation can be established.

REFERENCES

Agu PN (2006). Nutritional Evaluation of sweet orange(*Citrus sinensis*) Peel as a Feed Resource in Broiler production (Unpublished) M.Sc. Thesis. Department of Animal Production, University of Agriculture, Makurdi, Benue State, Nigeria.

Akpapunam MA Markakis P (1981). Protein supplementation of cowpeas with sesame and water-melon seeds. J. Food Sci. 49: 4060-4064.

AOAC (1984). Official Methods of Analysis (14th edition). Association of Official Analytical Chemists. Washington D.C.

AOAC (2000). Methods of Analysis by Association of Official Analytical Chemists. Washington D.C., USA.

Arosemena A, Depeters EJ, Fadel JC (1994). Extent of variability in nutrient composition within selected by product feedstuffs, Animal .Feed .Sci. Technol. 54: 108-110.

Burhanudin S, Dingle J (2003). Use of enzymes to improve the nutritional value of palm kernel meal and copra meal. Proc. Queensland, Poultry .Sci. Symposium, Australia.11 (14): 1-15.

Campanela L, Cresentini G, Avino P, Moauro A (1998). Determination of macro minerals and trace elements in the alga *Spirulina platensis*. FDP Sciences, Wiley-VCH.

Craig DS (2005). Methods of measuring the main Classes of Substances present in Fish and Fish products. Wikipedia, the free encyclopedia.

Davis S (2004). Tangerine peels may lower Cholesterol. J. Agric. Food Chem. 110: 1107-1119.

Dye WB (1956). Determination of oxalate. Weeds. 4: 55-58.

Gibbon D, Pain A (1985). Crops of the Drier Regions of the Tropics. Longman, England. pp. 70-71.

Givens DI, Cotyn BG (1994). A Comparism of Neutral Detergent-Cellulose method with other laboratory methods for predicting the digestibility *in vivo* of maize silages from three European countries, Anim. Feed Sci. Technol. 54: 59.

Gopal K, Ranjhan SK (1980). Laboratory Manual of Nutrition Research. Printed by Typodraphers India at Rashtravani Printers, Mayapuri, Phase 1, New Delhi. A-49 (1): 134-138.

Gregory IO (2005). Food Analysis and Instrumentation Theory and Practice. Published by Naphthali Prints, A division of HG Support Nigeria Ltd, 6 Adeniyi Jones Close, Surulere, Lagos, Nigeria. pp. 140-148

Harris LE (1970). Nutrition research techniques for domestic and wild animals. Utah State University, Logan Utah, USA. 1: 2501-2504.

IITA (1979). Selected Methods for Soil and Plant Analysis. International Institute of Tropical Agriculture, Oyo Road. P. M. B. 5320, Ibadan, Nigeria.

Ikediobi CO, Fashagbu E (1985). A Method for Cyanide Assay in Cassava Products using the Barbiturate/ Pyridine Reagent, *Nig. J. Biochem.* 2. pp .102-105.

Indrayan AK, Sharma S, Durgapal D, Kumar N, Kumar M (2005). Determination of nutritive and analysis of mineral elements for some medicinal valued plants from Uttaranchal, Curr. Sci. 89. (7): 1252-1255.

Jean S (2008). FAO; Food and Agricultural Organization. FAO Global Information and Early Warning System on Food and Agriculture World Food programme. A special Report on the markets, prices food situation and prospects for Benin, Niger and Nigeria.

Julian M (1999). Food Emulsions: Principles, Practice and Techniques CRC press Boca Raton, FL.

Kay T, Ogunsola VA, Eka OU (1977). The prevention of beany taste development and the elimination of bitter taste in preparing soya bean food in rural community in Nigeria. Samaru. Agric. Newsletter. 9: 11-16.

Keays RWJ (1989). Trees of Nigeria. Clarendon Press, Oxford. pp. 288-289.

Munro A, Bassir O (1969). Oxalate in Nigerian Vegetables, West .Afr. J. Biol. Appl. Chem. 12(1):4-18.

Niederau C, Fischer R, Purschel A, Stremmel W, Haussinger D, Strohmenyer G (1996). Long term survival in patients with hereditary haemochromatitis Gastroenterology. 110; 1101- 1119.

Oluremi OIA, Ngi J, Andrew I (2007). Phytonutrients in citrus fruit peel meal and nutritional implication for livestock production. Livestock Research for Rural Development 19(7): 345-346.

Oyenuga YA (1968). Nigeria's Foods and Feeding-Stuffs. Their Chemistry and Nutritive Values. Ibadan University. Press. pp. 9-15

Raghavendra AS (1991). Physiology of Trees. John Willy and Sons Inc.

New York. pp. 285-289.
Adegbola TA, Opara AC, Tabansi P (1985). Urea as a Partial Replacement for Groundnut meal in the Diet of Sheep, J. Anim.. Prod, Res. 5(2): 175-188.
Umar HA, Adamu R, Dahiru D, Nadro MS (2007). Levels of antinutritional factors in some wild edible fruits of Northern Nigeria. Afr J. Biotechnol. 6 (16):1935-1938.
Vadiveloo J (1995). Factors contributing to varietal differences in the nutritive value of rice straw, Anim. Feed. Sci. Technol. 54: 48.