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Mineral Composition of Seed, Seed Hull, and Pod of African Locust Bean "*Parkia Biglobosa*"

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Abstract

The study was conducted to determine the mineral composition of different part of African locust bean (Parkia biglobosa) tree utilized by man and animal. The experiment was carried out at Federal University Wukari Teaching and Research Farm. The samples of different part of African locust bean (Parkia biglobosa) tree were collected within the Federal University environment. The different part collected were as follows: Seed, Pod, Seed hull, and each one serves as a treatment (T1...T3). Samples collected were oven dried and milled for laboratory analysis to determine the mineral composition using standard techniques. The following minerals were (Calcium (Ca), Phosphorus (P), Magnesium (Mg), Sodium (Na), Potassium (K), Zinc (Zn), Iron (Fe), Manganese (Mn), Selenium (Se), Sulphur (S) and Copper (Cu)). Data obtained were subjected to analysis of variance (ANOVA) using SPSS version 23.0.2018. The results of analysis showed that the mineral composition are; (P (0.28-0.36%), Ca (0.19-0.23%), K (0.35-0.72%), Na (0.19-0.22%), S (0.37-0.48%), Cu (13.57-21.47 mg/kg), Fe (118.80-138.07 mg/kg), Se (0.04-0.07 mg/kg), Mn (37.30-52.57 mg/kg), Zn (58.50-81.57 mg/kg)) showed that T1 (seed) had the highest values of all the mineral analysed except Mg (0.22-0.27%) followed by T3, Seed hull. The mineral composition was observed to have varied

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significantly (P<0.05) across the treatments which could be attributed to different parts of *Parkia biglobosa* examined. In conclusion, mineral composition of the African locust bean (*Parkia biglobosa*) tree parts, were lower than the tolerance level. Consequently, ruminant farmers can include seed hull, and pod in formulating ration for their livestock.

Keywords: Mineral, Composition, Seed, Seed Hull, Pod, African Locust Bean, Parkia Biglobosa

INTRODUCTION

Parkia biglobosa (African locust bean), is a genus of flowering plants of the Fabaceae family and is one of the many species of trees which serve as sources of food and medicinal purposes to the indigenous people of Africa. It is a perennial deciduous tree and provides shade for man. It is planted mainly for the food value of its fruit; as a source of mouth wash to relieve toothache, the bean husk (seed coat) are used with indigo dye to improve the luster of fabrics while the tree bark yields a red tannin for dying leather. The leaves are used to treat burns, haemorrhoids, and used as a local soap. The tree is also important in apiculture, being a good source of nectar and suitable for placement of hives. (Omafuvbe *et al*., 2000; and Teklehaimanot, 2015).

The tree *Parkia biglobosa* known as African locust bean is a source of livelihood for both human and livestock, and it is very important to rural population. It is also source revenue in the sub-Saharan region. When it comes to the processing of the seeds into a fermented product called dawdawa or iru a popular food seasoning that is rich in vitamin B2 and protein, thus, every part of the plant species is important and valuable as fodder or food (Abdou, *et al.,* 2019; Teklehaimanot, 2004). In medicines, *Parkia biglobosa* is used against bronchitis, pneumonia, diarrhea, violent colic, vomiting, sores and ulcers. The root of *Parkia biglobosa* when combined with leaves can be used in lotions for sore eyes, they treat diseases such as dental carries and conjunctivitis, cough, bronchitis, amoebiasis and pile (Millgo-kone *et al.,* 2006). In addition, popular diseases in the plant habitat like malaria and stomach disorders are also cure by the plant and more other illness. Moreover, poultry lice, trypanosomes and mouth ulcers of ruminants are also treated illness of farm animals by the plant. Apart the use of pods and husks as feed for livestock; it is also used in traditional ceremonies (Teklehaimanot, 2004; Alabi, *et al.,*2005).

The tree can be found mainly in Africa, especially in the following countries; Nigeria, Benin, Burkina Faso, Cameroon, Chad, Cote d Ivoire, Democratic Republic of Congo, Gambia, Guinea, Guinea-Bissau, Mali, Togo, and Uganda (Ouoba *et al.*, 2003; Campbell, 2010). The raw unfermented seeds of *Parkia biglobosa* are not edible but fermentation improves the nutritional quality and digestibility. The most valuable part of the Locust bean tree is the seed which is high in protein, carbohydrate, lipid and is a good source of fat and calcium (Achinewhu and Barbar, 1992).

Plants are known to contain high amounts of essential nutrients, vitamins, minerals, fatty acids and fibre (Gafar and Itodo, 2011). Plants also contain other chemical compounds such as saponins, tannins, oxalates, phytates, trypsin inhibitors and cyanogenic glycosides, which are known as secondary metabolites and are biologically active (Soetan and Oyewole, 2009). The latter groups of compounds are often regarded as anti-nutritional factors. Anti-nutrients may be defined as those substances, natural or synthetic, found in the human diet or animal feed that adversely affects the overall nutritional value by interfering with processes such as digestion, absorption and utilization of nutrients (e.g. vitamins and minerals) or affect the body's metabolic rate or exert direct toxic effects. The bioavailability of the essential nutrients could be reduced by the presence in these plants of the anti-nutritional factors. Mineral deficiencies, manifesting as different disease conditions such as goiter, rickets or one form of metabolic dysfunction or the other, may be a result of the interactions between the nutrient and anti-nutrient components of the diet of both animals and humans. It is therefore essential to evaluate the composition of different materials used in the diet to ascertain their nutritive values. This becomes essential as the high cost of animal protein has directed interest towards several leguminous seed proteins as potential sources of vegetable protein for human food and livestock feed (Esenwah and Ikenebomeh, 2008; Elemo *et al.*, 2002). The seeds on fermentation are used in cooking stew and soup. It has been reported that the husks and pods are good for livestock. The roots, barks, leaves, stems, flowers, fruits and seeds of *Parkia biglobosa* are all used medicinally to treat a range of ailments, including diarrhea ulcers, pneumonia, burns, coughs, etc (Sacande and Clethero, 2007).

MATERIALS AND METHODS

Experimental site:

The study was carried out in Teaching and Research Farm of Federal University Wukari Taraba state. Wukari lies between latitude 7˚51'N to 7˚85'N and longitude 9˚46'E to 9˚78'E of the Greenwich meridian. The mean annual rainfall value range from 1000 - 1500 mm. The onset of the raining season is usually around April while the offset period is October. The mean maximum temperature is experienced around April at about 40˚C while the mean minimum temperature occurs between the period of December and February at about 20˚C (Oyatayo *et al.*, 2015).

Samples collection and processing

The samples of the different parts of *Parkia biglobosa* were collected from within the Federal University Wukari Environment. The collected samples were oven dried at 65^0C and mill before taken for further laboratory analysis.

Analysis Site

The analysis was carried out at the Department of Animal Science, Ruminant Laboratory, Faculty of Agriculture University of Ibadan, Ibadan,

Parameters

Minerals analysed include: Calcium, phosphorus, magnesium, sulfur, potassium, sodium, zinc, manganese, copper and selenium were determined according to AOAC (2006).

Data analysis

Data collected were subjected to one-way analysis of variance (ANOVA) using SPSS (version 23.0.2018). The treatment means will be compared using the multiple Duncan Multiple range test (Duncan, 1951).

RESULTS AND DISCUSSION

Minerals composition of different parts of African bean (*Parkia biglobosa*) tree.

Table 1 shows the mineral composition of different parts of African locust bean (*Parkia biglobosa*) tree. The minerals such as phosphorus (P), calcium (Ca) magnesium (Mg), potassium (K), sodium (Na), copper (Cu), Sulphur (S) manganese (Mn), selenium (Se), iron (Fe) and zinc (Zn) varied significantly ($P<0.05$) across the treatments. The significant

differences were due to the different parts of African locust bean (*Parkia biglobosa)* tree such as seed, pod and seed hull. The ranged values of phosphorus (0.28 – 0.36%), Calcium (0.19 – 0.23%), Magnesium (0.22 – 0.27%), Potassium (0.35 – 0.72%), Sodium (0.19 – 0.22%), Sulphur (0.37– 0.48%), Copper (13.57– 21.47 mg/kg), Iron (118.60 – 138.07 mg/kg), Selenium (0.04 –0.07 mg/kg), Manganese (37.30 – 52.57 mg/kg) and Zinc (58.50 – 81.57 mg/kg).

Calcium (Ca) and phosphorus (P) are very important due to their roles in skeletal structure, metabolism and milk. The ranged values of Ca (0.19 – 0.23%) obtained in this study were below the ranged values (0.9 – 1.2%) of dietary Ca while P (0.28 – 0.36%) is within the range values (0.25- 0.35%) on dry matter basis (DM) recommended for dry cow (Robert, 2022).

Magnesium is essential for animals because it plays a vital role in various physiological functions, including muscle, nerve functions, energy metabolism, bone formation and maintaining normal heart routine. It also acts as a cofactor for many enzymes involved in this process. The ranged values (0.22–0.27%) of Mg obtained in this work fall within the reported value of 0.21% and 0.35% DM. Sulphur in the body is not associated with any mineral fractions but mainly with sulphur- containing amino acids. During fermentation, the microbes of the rumen can incorporate sulphur into the amino acids that form microbial protein (Amuda and Okunlola 2023). The results in table 1 showed that the sulphur content of the *Parkia biglobosa* parts ranged from 0.37 to 0.48%. The parts with the highest sulphur content was T_1 (Seed), while the parts with the lowest sulphur content was T_3 (pod). The sulphur obtained in this work would be enough to enhance the rate of protein synthesis in the rumen and supply nitrogen compounds to microbes.

Copper (Cu) plays metabolic roles and associated with protein and involved in the production of haemoglobin and assists in oxidation of food within cells. The ranged values (13.57 to 21.47 mg/kg) DM obtained from *Parkia biglobosa* parts can meet the required values by sheep (2- 6mg/kg) and 8-20mg/kg DM required by cattle (John, 2006), however, high level (15-20mglkgDM of Cu was reported to cause chronic toxicity in sheep while about four or five times will produce similar symptoms in cattle. Sodium is the principal cation in extracellular fluids. It regulates plasma volume and acid base balance, involve in the osmotic pressure of the body fluids, preserve normal irritability of muscles and cell permeability. The result obtained from this work showed that the seed had the highest

sodium (0.22%). This is in line with the requirement by dairy NRC (2001) for high producing cows (0.22%) while the pod had the lowest sodium (0.19%) synonymous to 0.18% recommended by the dairy NRC (1989). Zinc is a constituent of several important enzymes and also enhances the effective utilisation of vitamin A. The deficiencies of zinc in blood have be reported to be predisposing factor such as the occurrence of retention of placenta and repeat breeding in dairy cow and also reduced appetite and poor growth leading to general poor conditions. (Shectal *et al.,* 2004, Kumar, 2014). The observed range values (58.50 to 81.57 mg/kg DM) for zinc in this study can meet the requirements and even above (9-14mg/kgDM) for sheep and also above the requirements (20- 50mg/kgDM) for cattle (John, 2006).

Iron (Fe) is an important constituent of succinate dehydrogenase as well as a part of the haeme of haemoglobin (Hb), myoglobin and the cytochromes (Chandra, 1990). The results showed that the iron content of the *Parkia biglobosa* parts ranged from 118.60 to 138.07 mg/kg. The parts with the highest iron (138.07 mg/kg) was T_1 (Seed), while the parts with the lowest iron (118.60 mg/kg) was T_3(Pod). However, from the range values obtained in this work can meet the iron requirements of man and animals.

Manganese is an essential nutrient for dairy animals like other minerals. The maintenance requirement for absorbed manganese was set at 0.002 mg/kg of body weight (1.2 mg/day for an average Holstein cow), the growth requirement was set at 0.7 mg/kg of growth, pregnancy requirement was set at 0.3 mg/d, and the lactation requirement was set at 0.03 mg/kg of milk (NRC, 2001). Gestating cattle may need up to 50 mg of Mn/Kg of DM because it helps in skeletal cartilage and bone formation of fetus (Schefers, 2011) and this value is higher than 40 mg of Mn/Kg of DM recommended by NRC (1989). The results in table 1 showed that the manganese content of the *Parkia biglobosa* parts ranged from 37.30 to 52.57 mg/kg. The parts with the highest manganese (52.57 mg/kg) was T_1 (Seed), while the parts with the lowest Manganese (37.30 mg/kg) was T_3 (pod). The manganese obtained in this work would be enough to meet the requirements of gestating cattle. Selenium (Se) is an essential dietary trace element that plays an important role in the prevention of inflammation, cardiovascular diseases, infections, and cancer. Its optimal intake could potentially prevent various types of cancer and diseases like diabetes, age-related immunosuppression and even problems related to fertility (Milovanović *et al.,* 2014). The results in table 1 showed that the selenium content of the *Parkia biglobosa* parts ranged from (0.04 – 0.07 mg/kg). The parts with the highest Selenium content was T_1 (Seed), while the

parts with the lowest selenium content was T_3 (pod). Potassium (K) is an essential macro mineral nutrient. Within the body, potassium is the principal cation in intracellular fluid and participates in acid-base balance, regulation of osmotic pressure, conduction of nerve impulses, muscle contraction, cell membrane function and more. The results showed that the potassium content of the *Parkia biglobosa* parts ranged from (0.35-0.72%). The parts with the highest potassium (0.72%) was T_1 (Seed), while the parts with the lowest potassium (0.35%) was T_3 (pod) across the treatment. The potassium obtained in this work would be enough to meet the requirements of essential macro mineral of both man and animals.

Table 1: Mineral composition of different parts of African locust bean (*Parkia biglobosa*)

	TREATMENTS		
PRMTS	**T_1**	**T_2**	**T_3**
P(%)	0.36^{a}	0.31^{bc}	0.30^{cd}
Ca(%)	0.23^{a}	0.21^{bc}	0.21^{bc}
Mg(%)	0.25^{ab}	0.27^{a}	0.22^{b}
K(%)	0.72^{a}	0.37^{d}	0.36^{d}
Na(%)	0.22^{a}	0.20^{bc}	0.19^{c}
S (%)	0.48^{a}	0.38^{c}	0.37^{c}
Cu (mg/kg)	21.47^{a}	15.30^{d}	14.30^{e}
Fe (mg/kg)	138.07^{a}	126.47^{d}	119.47^{e}
Se (mg/kg)	0.07^{a}	0.05^{bc}	0.04^{c}
Mn (mg/kg)	52.57^{a}	41.77^{d}	38.67^{e}
Zn (mg/kg)	81.57^{a}	65.00^{d}	59.20^{e}

a, b, c, e, f = means on the same row with different superscripts are significantly ($P<0.05$) different.

T_1= *Parkia biglobosa* seed, T_2= *Parkia biglobosa* seed hull, T_3= *Parkia biglobosa* pod.

CONCLUSION

The mineral composition of Parkia biglobosa , analysed include: Calcium, phosphorus, magnesium, sulfur, potassium, sodium, zinc, manganese, copper and selenium. Minerals are structural components of body and play significant role in activities of enzyme, hormone, as constituents of body fluids and tissues, and as regulators of cell replication and differentiation. Mineral deficiencies, imbalances and toxicity of certain mineral elements may cause reproductive disorders as minerals play an important role in health and reproduction of the livestock.

However, these constituents are more concentrated in seed hull than the others. Some of the benefits derivable from this research as regards these showed that the presence of Calcium plays a very importance role in structural and physiological functions. Lactating cows must be provided with adequate amounts of Ca to maximize production and minimize health problems.

Phosphorus (P) It is the second most abundant mineral element in the body with 80 to 85% of P found in the teeth and bones. Phosphorus is involved in a number of metabolic reaction and energy transfer within the body. It is required for normal milk production, growth, and efficient use of feed and by the rumen microorganisms in the digestion of cellulose and synthesis of microbial protein.

Zinc is an essential component of over 200 enzyme systems involved in metabolism of carbohydrate, protein and nucleic acid metabolism, epithelial tissue integrity, cell repair and division, vitamin A and E transport and their utilization

Copper is a necessary component of number of enzymes including superoxide dismutase. Lysis oxidase and thioloxidase. Action of these enzymes is to scavenge free radicals and thus prevent tissue susceptibility to infections, increase structural strength of connective tissues and blood vessels, and increase strength of horn and hooves.

Manganese is an essential nutrient for dairy animals like other minerals. There is large variation in manganese (Mn) levels in feedstuffs while the presence of Magnesium is an active component of several enzyme systems in which thymine pyrophosphate is a cofactor. Oxidative phosphorylation is greatly reduced in the absence of magnesium.

Iron (Fe) Iron functions as haemoglobin in the transport of oxygen. In cellular respiration, it functions as essential component of enzymes involves in biological oxidation such as cytochromes c, C_1,

Sulphur (S) Sulfur is present in three amino acids which are cystine, cysteine and methionine. Connective tissue, skin, hair and nails are rich in sulfur. Also, thiamine and biotin (member of vitamin B complex) and coenzyme A contain sulfur in their molecules

Sodium (Na) Sodium is the principal cation in extracellular fluids. It regulates plasma volume and acid-base balance, involved in the maintenance of osmotic pressure of the body fluids, preserves normal irritability of muscles and cell permeability, activates nerve and muscle function and involved in Na/K-ATPase, maintenance of membrane potentials, transmission of nerve impulses and the absorptive processes of monosaccharides, amino acid, pyrimidines, and bile salts.

Potassium (K) is an essential macro mineral nutrient. Within the body, potassium is the principal cation in intracellular fluid and participates in acid-base balance, regulation of osmotic pressure, conduction of nerve impulses, muscle contraction, cell membrane function and more.

Selenium (Se) is a component of over 25 different proteins called selenoproteins. Selenoproteins are important in a wide array of physiological processes. Moreover, it is important in the synthesis of glutathione, critical detoxification and free radical neutralizing enzyme

This work therefore elucidates the presence of these minerals in these *Parkia biglobosa* tree parts. Concerning the mineral composition particularly, the minerals such as calcium, phosphorus, magnesium, potassium, sodium, Sulphur, Copper, Zinc, Manganese, selenium and iron resides mostly in the seed. These Minerals can meet the minerals requirement of man and animals with little or no mineral supplement.

Recommendation

The results of minerals composition indicate that the minerals reside mostly in seed. However, since seed is utilized by man the seed, seed hull and pod can be incorporated into ruminants feed, if processed to improve the quality by reducing Anti-Nutritional Effects (ANFs) levels to enhance the digestibility and utilization by ruminants.

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