COMPARATIVE STUDIES ON THE PROXIMATE COMPOSITION, MINERAL AND ANTI-NUTRITIONAL FACTORS IN THE SEEDS AND LEAVES OF AFRICAN LOCUST BEAN (*Parkia biglobosa*)

Kehinde Olugboyega **Soetan**[1], Akinleye Stephen **Akinrinde,** Shehu Bolaji **Adisa**

[1]Department of Veterinary Physiology, Biochemistry and Pharmacology, Faculty of Veterinary Medicine, University of Ibadan, Ibadan, 20001, Nigeria.
Email: kehinde.soetan@gmail.com

Abstract
The seeds and leaves of African Locust Bean (Parkia biglobosa) were evaluated for their proximate analysis, minerals and anti-nutritional factors. Atomic absorption spectrometry was used in the determination of the levels of Ca, Mg,K, Na, Mn, Fe, Cu and Zn. Anti-nutritional Factors (ANFs), including Trypsin inhibitor, oxalates, phytates, tannins, saponins, hydrocyanic acid were also determined using appropriate techniques. The result showed that the seeds of P.biglobosa had significantly higher ($p<0.05$)crude protein (33.50%), crude fat (49.20%) and %dry matter (95.20%) contents compared to the leaves having crude protein(18.40%), crude fat (8.11%) and %dry matter (88.80%), while the leaves had significantly higher ($p<0.05$) contents of ash (13.60%), crude fibre(18.90%) and moisture (11.20%) as against the seeds havingash (4.81%), crude fibre(4.66%)and moisture (4.89%). The mineral content of the analyzed samples showed that the seeds were richer in Ca (0.703%), Mg (0.356%), K (0.211%), Na (86.729ppm), Mn (54.811ppm), Fe (69.828ppm), Cu (9.766ppm) and Zn (12.156ppm), while the leaves recorded higher Phosphorus level (79.833ppm) than the seeds. For the ANFs, the seeds recorded higher levels of trypsin inhibitor (0.059 ± 0.01), haemagglutinating units (46.00 ± 0.07) and tannins (0.51 ± 0.00) than the leaves, while the leaves recorded higher levels of oxalates (0.97 ± 0.00), phytates (2.16 ± 0.03), saponins (1.24 ± 0.00) and hydrogen cyanide (87.9 ± 0.56)than the seeds. The overall results are suggestive of higher nutritional quality of the seeds than the leaves due to higher mineral contents and lower presence of some anti-nutritional factors.

Keywords: *Parkia biglobosa*, proximate analysis, minerals, anti-nutritional contents.

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1.INTRODUCTION

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 African Locust bean tree, *Parkia biglobosa* is a perennial tree legume which belongs to the sub-family Mimosoidae and family Leguminosae. The trees are usually carefully preserved by the inhabitants of the area where they grow because they are valuable sources of reliable food, especially the seeds which serves as source of useful ingredients for consumption (Campbell-Platt, 1980). The seeds on fermentation are used in cooking stew and soup. It has been reported that the husks and pods are good for livestock (Douglas et al, 1951; Obizoba, 1998). The roots, barks, leaves, stems, flowers, fruits and seeds of *P. biglobosa* are all used medicinally to treat a range of ailments, including diarrhea ulcers, pneumonia, burns, coughs, etc (Sacande and Clethero, 2007).

Earlier investigations on the nutritive values of P. biglobosa seeds have been carried out by several workers (Fetuga et al, 1974; Odunfa, 1983; Alabi, 1993; Alabi et al, 2004). This study was designed to investigate the comparative nutritive and anti-nutritive properties of the seeds and leaves of *P. biglobosa*.

2.MATERIALS AND METHODS

2.1Collection and Preparation of Plant Materials

Fresh seeds and leaves of *P. biglobosa* were collected from Ajibode village in Ibadan, Oyo State, Nigeria. The samples were identified at the herbarium of the Department of Botany, University of Ibadan, Nigeria. The leaves were sun-dried and ground using a mechanical blender into fine powder. The seeds after ripening were removed from the pods, dried and grounded into powder.

2.2 Determination of Proximate Analysis and Mineral Content

The proximate analysis of the air-dried seeds was determined by standard methods (AOAC, 1999). These include the determination of crude protein, crude fat, crudefibre, ash, gross energy, moisture content, dry matter and the nitrogen free extract. The minerals analysed include sodium, potassium, calcium, phosphorus, magnesium, Iron, manganese, copper and zinc. The sodium and potassium contents were determined by flamephotometry (Jenway Limited, Donmow Essex, UK) and phosphorus was determinedby the vanado-molybdate method (AOAC, 1995). Calcium, magnesium, iron, manganese, copper and zinc were determined after wet digestion with a mixture of nitric,sulphuric andperchloric acid using atomic absorption spectrophotometer (Buck Scientific,EastNorwalk,CT,USA).

2.3 Analysis of Anti-nutritional Factors

Trypsin inhibitor activity of the samples was determined by the method of Liener (1979) . Hemagglutinin levels were determined by the method of Jaffe *et al*, (1979). Phytates were determined by the method of Maga (1983). Tannins were determined by the method of Dawra *et al* (1988), while saponin levels were determined using the procedure of Brunner (1984). Hydrogen cyanide levels were determined using the procedure of Bradburry *et al* (1999). Total oxalates were determined according to the procedure of Fasset (1996). Full details of the methodology are reported in Soetan (2012)

2.4 Statistical Analysis

The analyses were done in triplicates. The data obtained were expressed as mean±standard error of the means (mean + SEM). Significant differences between meanswere determined by the student t-test (Bailey, 1992).The value of $p<0.05$ was regarded as significant for statistical comparison in all cases.GraphPad Prism, Version 5.0, San Diego, CA was the statistical package used.

3.RESULTS

The proximate composition of the seeds and leaves of *P. biglobosa*are presented in Table 1. The leaves of the plant had significantly higher ($p<0.05$) contents of moisture, crude fibre and ash, while the seeds had significantly higher ($p<0.05$) protein, fat and dry matter compare to the leaves. The mineral composition of the seeds and leaves, shown in Table 2, indicates that the seeds had higher contents of Ca, Mg, K, Na, Mn, Fe, Cu and Zn. The leaves, however, had a higher content of Phosphorus, compared to the seeds.

Table 1: Proximate composition of the seeds and leaves of *P. biglobosa*

Parameter [%]	Seed	Leaf
Crude protein	33.50±0.12*	18.40±0.25
Ash	4.81±0.04*	13.6±0.02
Crude Fibre	4.66±0.01*	18.9±0.01
Fat	49.2±0.04*	8.11±0.02
Dry Matter	95.2±0.02*	88.80±0.01
Moisture	4.81±0.02*	11.2±0.01

Results are shown as mean±standard error of mean.
*indicates significant difference in means at p<0.05.

Table 2: Mineral composition of the seeds and leaves of *P. biglobosa*

Parameter	Seed	Leaf
%Ca	0.703	0.346
%Mg	0.356	0.184
%K	0.211	0.123
ppm P	47.392	79.833
ppm Na	86.729	21.446
ppm Mn	54.811	17.981
ppm Fe	69.828	26.334
ppm Cu	9.766	2.256
ppm Zn	12.156	5.529

Results are shown as mean±standard error of mean

Table 3 shows the different levels of some anti-nutritional factors in the seeds and leaves of *P. biglobosa*. The leaves contained significantly higher levels (p<0.05) of oxalates, saponins and phytates compared to the seeds, while levels of hemagglutinin and tannins were significantly higher (p<0.05) in the seeds than in the leaves. While the leaves contained significantly high levels (p<0.05) of hydrogen cyanide, this anti-nutritional factor was barely detectable in the seeds.

4.DISCUSSIONS

The high cost of animal protein is directing interest towards several leguminous seeds which can serve as potential sources of vegetable protein and other nutrients for human foods and livestock feeds (Bailey, 1992).

Table 3: Levels of some anti-nutritional factors in the seeds and leaves of *P. biglobosa*

Parameter	Seed	Leaf
Trypsin Inhibitor (U/mg)	0.059±0.01	0.0395±0.00
Hemagglutinin (U/mg)	46.00±0.07*	17.9±0.14
Oxalate (mg/g)	0.47±0.01*	0.97±0.00
Phytate (mg/g)	1.30±0.03*	2.16±0.03
Tannin (mg/g)	0.51±0.00*	0.21±0.00
Saponin (mg/g)	0.92±0.00*	1.24±0.00
HCN (mg/g)	0.00±0.00*	87.9±0.56

Results are shown as mean±Standard error of mean
*indicates significant difference in means at p<0.05

The high prevalence of mineral deficiencies in the society has also stimulated interest in investigating rich sources of essential minerals, such as in legumes. However, the overall nutritional value of a component of diet must be considered with respect to its relative contents of both nutrient and anti-nutrients. Anti-nutritional factors can cause poor availability and/or utilization of nutrients, producing effects which include reduction in food intake, neurological effects and even death (Osagie, 1998).

From the results of this study, the seeds of *P. biglobosa* had higher protein, fat and dry matter compare to the leaves.Higher levels of crude protein obtained in this study for the seeds (33.5%) is in accordance with previous reports by Okpala (31.60%) (Okpala, 1990); Alabi, (35.0%) (Alabi,1993); Obizoba (34.3%) (Obizoba, 1998) and Alabi *et al* (34.02%) (Alabi et al, 2004). Consumers of the seeds therefore would obtain higher protein value than the leaves or the seeds would rather, therefore be used as a protein source than the leaves. African locust bean has been known to be rich in protein and may thus be used to add protein to a protein-deficient diet (Odunfa, 1983; Ikenebomeh and Kok, 1984; Dike and Odunfa, 2003).

The leaves of the plant had higher contents of moisture, crude fibre and ash. The higher fibre content of the leaves suggest that they would be more effective as agents to control constipation as foods that contain high fibre are known to expand the inside walls of the colon, easing the passage of waste. On the contrary, high fibre diets in the nutrition of infants can lead to irritation of the gut mucosa (Bello et al, 2008). As such, incorporation of seeds or leaves of *P. biglobosa* in the diet will be determined by the age of animals and humans being fed.

The results obtained in this study showed that the seeds of *P. biglobosa* contain higher levels of minerals compared to the leaves. These values compare favorably with those reported by (Okpala, 1990). The levels of Ca, Mg, K, Na, Mn, Fe, Cu and Zn were either double or almost double of those found in the leaves. Calcium is an important mineral required for bone formation and neurological function of the body. Sodium is an important mineral that assist in the regulation of body fluid and in the maintenance of electric potential in the body tissue. Zinc is an essential micronutrient associated with number of enzymes, especially those associated with synthesis of ribonucleic acid (Guil-Guerrero et al, 1998). Iron is required for blood formation and it is important for normal functioning of the central nervous system (Adeyeye and Fagbohun, 2005). It also facilitates the oxidation of carbohydrate, protein and fats. Magnesium plays essential role in calcium metabolism in bones and also involve in prevention of circulatory diseases. It helps in regulating blood pressure and insulin releases (Onyiriuka et al, 1997; Umar et al, 2005). Copper is required in the body for enzyme production and biological electron transport. The seeds with their higher contents of these minerals, would therefore, appear to offer better nutritional value than the leaves.

In this study, the leaves contained higher levels of oxalates and phytates compared to the seeds, while levels of trypsin inhibitor, hemagglutinin, tannins and saponins were higher in the seeds than in the leaves.Levels of hydrogen cyanide were rather high in the leaves.Oxalates have a negative effect on mineral availability (Onyeike and Omubo-Dede, 2002) as they interfere with absorption of divalent minerals, particularly calcium by forming insoluble salts with them (Guil and Isasa, 1997). Phytates can bind some essential mineral nutrients in the digestive tract and can lead to mineral deficiencies (Bello et al, 2008). The phytate and oxalate contents in this study (1.30 and 0.47mg/g, respectively in the seeds and 2.16 and 0.97mg/g, respectively in the leaves) may not pose any health hazard, asphytate levels of about 10-60mg/g consumed over a long period of time is the level that reportedly causes the negative effects (Thompson, 1993). The implication of low levels of phytates and oxalates is that the seeds and leaves would contain available nutrients for absorption in the body.

The considerably high level of cyanide in the leaves of *P. biglobosa* calls for immense caution. Consumption of high levels of cyanide is associated with a serious neurological disease known as Tropical Ataxic Neuropathy (TAN) (Hassan and Umar, 2004). It is interesting from this study that while the leaves contain such high levels of cyanide, they are barely detectable in the seeds. Levels of tannins and saponins were quite low in the seeds and leaves and may not pose any significant nutritional health problems.

5.CONCLUSIONS

It can be concluded from the results of this study that the seeds of *P. biglobosa* appear to have the potential to offer better nutritional value than the leaves. Higher content of protein and minerals in the seeds, combined with relative low levels of anti-nutrients, and especially the almost undetectable levels of hydrogen cyanide, would seem to place the seeds above the leaves with regards to their nutritional values.

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