Available online at www.elixirpublishers.com (Elixir International Journal)

Applied Chemistry

Elixir Appl. Chem. 88 (2015) 36223-36229

ISSN: 2229-712X

# Proximate and Mineral Composition of Five Underutilized Wild Plant Seeds: *Borassus aethiopum, Bombacopsis glabra, Entada africana, Entada gigas* and *Myrianthus arboreus*

Olabode Gbolahan[1,*] and Lajide Labunmi [2]

[1]Department of Chemistry, Ekiti State University, Ado-Ekiti, Ekiti State, Nigeria.

[2]Department of Chemistry, The Federal University of Technology, Akure, Ondo State, Nigeria.

**ARTICLE INFO**

**Article history:**

Received: 30 September 2015;

Received in revised form:

29 October 2015;

Accepted: 04 November 2015;

**Keywords**

Proximate analysis,
Mineral composition,
*Borassus aethiopum,*
*Bombacopsis glabra,*
*Entada africana,*
*Entadas gigas,*
*Myrianthus arboreus.*

**ABSTRACT**

In most developing tropical countries the food situation is worsening, predictions of future food needs based on the current rates of population increase and food production emphasize the need to explore the vast number of less familiar plant resources existing in the wild which could be good sources of nutrients. Proximate analysis and mineral composition of five wild seeds (*Borassus aethiopum, Bombacopsis glabra, Entada africana, Entadas gigas* and *Myrianthus arboreus )* were carried out. Proximate analysis showed moisture content ranged between 1.50% to 3.00%, ash 2.00% to 4.69%, fat was between 2.06% to 34.46%, fibre between 0.99% to 4.92%, Protein between 4.40% to 44.86% and carbohydrate between 34.78% to 80.93 %. Mineral analysis revealed that the seeds contained minerals such as Ni, K, Na, Ca, Mg, Zn, and Fe, in abundance that ranges between 4.30 mg/100g Cr in *E africana* to $98.50^{a}$ ±0.50 mg/100g Ni in *B. aethiopum.*



## Introduction

A lot of interests are needed to be focused on the possibilities of exploiting the vast number of less familiar plant resources existing in the wild which could be of value in dealing with the food problem. Unconventional crops could be good sources of inexpensive nutrients; vitamins, minerals, protein, carbohydrates and fats (Okigbo, 1977). Many wild legumes are known for inexpensive proteins, calorific value, essential amino acids, essential fatty acids, fiber and vitamins (Akande *et al*., 2010). Moreover, their dietary contribution is increased and so important because they are available during most seasons including strategic periods in the year when the conventional staples and vegetables are scarceand have higher nutritional values compared with levels found in cultivated fruits (Eromosele *et. Al*., 1991).

***Borassus aethiopum***

*B. aethiopum* belongs to the family Palmae, Sub Family Coryphoideae .It is the most impressive of the Palmyra palms and one of the most amazing of all fan palms; it grows a massive, smooth trunk to over 30 m (100 ft.) tall and swollen in the middle,topped by a large crown of enormous, grayish green leaves. It is called by different names such as African Palmyra palm, Colossal fan palm or Toddy palm and 'Agbon eye' in Yoruba language. Its seeds are the size of small coconuts. Although a typical palm of the dry African savanna, where it is sometimes found in large stands, it is highly adaptable and will succeed beautifully even in the wet tropics.(Tylr,2008)

***Bombacopsis glabra***

(English: American chestnut; France: noisetier de Cayenne, Yoruba: 'Yaga') is a member of the family Bombacaceae originated from Mexico which grows wild and now cultivated around villages in the West Africa region. The young leaves are eaten in Equatorial Africa. The seeds are oily and are eaten fresh, boiled, or toasted in Sierra Leone, Liberia and in Zaire (Burkill, 1985).

*Entada africana* called 'ogurobe' in Yoruba belongs to the family Fabaceae – Mimosoideae . E. africana grows in high rainfall savannah areas. Leaves of E. africana make good fodder. An infusion of the leaves at a concentration of 1:1000 kills Carassius auratus (goldfish) in 12 hours, the bark of the root and stem yields a long fibre used for cordage, commonly for roof binding and grass matting. Gum or resin of E. africana yields a low-quality gum. The bark contains tannin. The bark is said to have abortive effects while a root decoction is a stimulating agent and tonic. The plant is said to have antidote effects against various toxic agents because of its emetic properties. Healing and fever-reducing beverages are prepared from leaves, bark, roots and shoots. In northern Nigeria and northern Ghana, an infusion of the leaves or of the bark is taken as a tonic and for stomachache. The leaves also constitute a good wound dressing, preventingsuppuration.

***Entada gigas***

*E gigas* (English: Monkey Ladder of The Tropical Rain Forest, Sea heart of the ocean, Yoruba: Agbigbara) belongs to the family Fabaceae – Mimosoide. (Katende et al, 1995) E. gigas is the undisputed record for the longest bean pod. The seeds of monkey ladder have been fashioned into all sorts of trinkets and useful objects as ,snuffboxes, matchboxes and beautiful lockets, children's games, musical seedshaker (Berg and Hijman,1989).. Ground seeds were also taken internally for an incredible variety of remedies, including contraception, constipation, Reliever of painful inflammations, snake bites, and as an aphrodisiac in India. In Central America, species of E. have been used as a natural shampoo and laundry soap. In Norway, a bitter tea was

Tele:
E-mail addresses: olabode.gbolahan@yahoo.com

made from sea hearts to relieve pain during childbirth. In England, sea hearts were used as teething rings and as good luck charms for sailors embarking on a long ocean voyage.Sea hearts were also carried as an amulet to protect the owner from sickness and to ward off evil spirits. Sea hearts commonly wash ashore on islands of the Caribbean, and in Jamaica they are beautifully hand painted and sold as lucky pendants.

***Myrianthus arboreus***

*M. arboreus* is called giant yellow mulberry, bush pineapple and corkwood in English, It is called 'Igi alade' in Yoruba. *M. arboreus* is a member of the family Cecropiaceae. It is a dioecious shrub or tree up to 14–20 m tall; bole short, up to 1 m in diameter, often with stilt roots; bark fairly smooth, thin, slash white; branches spreading. Flowers sessile, male flowers with 3–4 petals and 3–4 stamens; female flowers with 2–3-lobed perianth and superior, 1-celled ovary, stigma tongue-shaped. Fruit drupe-like, with fleshy perianth, yellow to orange-red, 1-seeded, closely arranged in an infructescence up to 10 (–15) cm in diameter. (Katende *et al*, 1995).

**Uses**

Sap from young leaves or terminal buds is applied topically to treat toothache or to the chest against bronchitis and to the throat against laryngitis or sore throat. *M. arboreus* is a useful analgesic in the treatment of muscular pains, fractures and hemorrhoids (Copp,2003).In Côte d'Ivoire pounded leaves are applied as an enema to treat pain in the back and loins. The wood is suitable for paper making. Its ashes are used in soap making in Guinea. Extracts of M. arboreus deter the termite *Reticulitermes lucifugus*. Bark extracts of *M. arboreus* showed antiplasmodial, antimycobacterial and antitrypanosomal effects in vitro, which supports some of its uses in traditional medicine, e.g. to treat malaria.(Burkill,1985). The focus of this present research was to investigate the proximate and mineral composition of five underutilized Wild Plant Seeds: *B. aethiopum, B. glabra, E. africana, E. gigas and M. arboreus*

**Materials and Methods**

**Proximate Analysis**

The proximate analysis of the sample for moisture, crude protein, crude fibre, crude fat and ash were carried out in tripilicates according to (AOAC,1990).Nitrogen was determined by the micro Kjeldah method as described by Pearson (1976) and percentage nitrogen was converted to crude protein by multiplying by 6.25.Carbohydrate was determined by Clegg Anthrone Method.

**Mineral Analysis**

Determination of mineral elements was done according to the method of (IITA, 1988). 1.0 g of the samples was digested in 5ml of the digestion mixture HClO4 and HNO3 (ratio 1:1) in the digestion flask. The heating (digestion) continued until the sample become clear, this was filtered into a 100cm3 flask and made up to mark with distilled water. The solutions were then taken for mineral analysis using BUCK 210 VGP Atomic Absorption Spectrometer Model to analyze Fe, Zn, Mn, Mg, Na, K, Ca, Ni, Cr, Pb and Cd . Na and K were determined by Model 405, Corning UK flame photometer. Phosphorus was determinate by Vanado-Molybdate colorimetric Method(Pearson ,1976) and Sulphur was determined by turbidimetric method.

**Results and Discussion**

**Proximate Composition**

The proximate composition of the five wild plant seeds reported in percentage of dry weight are shown in Table 1.The moisture content ranges from 1.50% to 3.00. %. The seeds moisture values are low compared to most tropical crop seeds as reported for *Triticum durum* whole meal flour 7.93% (Adeyeye and Aye, 2005), *Winged bean* 9.22% and *Pitonga cherries* 17.21% (Amoo *et al*., 2006). Too much of moisture in any sample has been proved to cause caking especially in flour and can also determine the Storage/Shelve life and the viability of microorganisms' growth (Adeyeye and Ayejuyo, 2000). The low moisture content in the seeds flour therefore suggests that they will have a long shelf life (Oyenuga, 1998) because low moisture content prevents microbial spoilage. Moisture content in *B. aethiopum* was the highest with 3.0% which was significantly higher than that of *E. africana, E. gigas* and *M. arboreus* with 2%, 2.67% and 2.50% respectively. The mean of this three sample were not significantly different from themselves but are significantly different compared with B .glabra 1.50%. The crude fats values for the seeds are 2.06%, 34.46%, 13.42%, 8.57% and 23.68. % for *B.aethiopum, B. glabra, E. africana, E.gigas* and *M.arboreus* respectively. There were significant differences between the crude fat content of the five samples with the highest being 34.46% in *B. glabra* this was significantly different from *M .arboreus* 23.68%, E. africana 13.42%, *E .gigas* 8.57% and 2.06% which was the least in *B. aethiopum.*

The value for *E. gigas* 8.57% is comparable to *African walnut* 8.9% (Falconer, 1990). *B. aethiopum* 2.06%,is very low compared A. walnut. The value for *B. glabra*, 34.46% is comparable to B. glabra, seed 34.8 %( Olaofe et al., 2006) but lower than C. edulis 43.8 % (Ige et al, 1994), Pumpkin seeds 47.7(Aisegbu, 1987). M. arboreus 23.68.b□□0.11% is higher than that of Winged been 17.51% and P cherries 15.62% (Amoo et al, 2006). E. africana 13.42% is compared to *Albizzia lebbeck* seed 13.40%(Adubiaro,2010).Fat is universally stored forms of energy in living organisms, it provides more than twice as much energy as carbohydrates and proteins. They are major structural elements of biological membranes as phospholipids and sterols (Nelson and Cox, 2008).The crude protein ranges between 4.40% and 44.86%. Protein content of *B aethiopum* 4.40% is very low compared to some tropical seeds, breadnut 19.25% (Oshodi *et al*, 1999) Benniseed 22.5% (Oshodi *et al*., 1999]. *E. gigas* 24.57% and *M. arboreus* 24.37% are comparable to Locust bean 24.1% (Adeyeye *et al*., 2004) and lower comparable to *Conophur nut* 29.09% (Eriyamremu and Adamson1994)) and melon *Colocynthis citrullus* 28.4% (Akande *et al*., 2010). The protein value of *B. glabra* 19.31% is higher than *B glabra* 16.56% (Olaofe *et al*., 2006) The protein value of *E africana* 44.86% is higher than *Albizzia lebbeck* 42% and Soybean 42% [Singh and Bhat ,2003] but is lower compared to cranberry beans [CBB] 51.1% (Aremu *et al*., 2006

The present result suggests that *E. africana, E. gigas* and *M. arboreus* are good sources of protein provided their amino acid compositions are relatively balanced. Since human diet are usually made up of mixture of many proteins which have important implications, it may therefore be possible to mix *E africana, E. gigas* and *M. arboreus* if they are having different biological value(BV) to obtain a protein mixture of higher BV to complement one another nutritionally (Osborne, 1996).

On the basis of the result in the table, all the seeds with the exception of *B. aethiopum* are good sources of protein as alternative sources of protein in livestock feeding and in man, especially in Nigeria where there is scarcity and the high cost of the conventionally protein providing food Average crude protein (4.73%), and they would serve as enzymatic catalyst, mediate cell responses, control growth and cell differentiation (Whitney and Rolfes, 2005). The protein content in the sample are significantly different with 44.86% been the highest in *E.aficana* which was significantly different from *E.gigas* and *M.arboreus*

which were 24.57% and 24.37% respectively. These also are significantly different from *B. glabra* (19.31%) and *B. aethiopum* (4.40%) which was the least. The ash content of the seeds ranged between 2.00% - 4.69%. The value for all the seeds are high compared to chestnut 1.67% (FAO, 2007). The value for *E gigas* 2.00% is favourably comparable to A. walnut 2.03% (Ekop and Eddy, 2009). *E africana* 2.67 %and *M arboreus* 3.33% are higher than A walnut 2.03% (Ekop and Eddy, 2009).*B. glabra* 4.17% and *B. aethiopum* 4.69% are comparable to sesame seed 4.41% (Udeala *et al*., 1980) and India almond seed 4.5% (Ekop and Eddy, 2009) but lower than cowpea 6.24% (Onuorah *et al*., 1989), *P cherries* 4.94% (Amoo *et al*., 2006) and locust bean 4.85% (Adeyeye *et a*l, 2004).The value of the ash in the seeds show that they have a reasonable quality of minerals element for building healthy body and proper functioning of body tissues as minerals are essential for the proper functioning of tissues and act as second messengers in some biochemical cascade mechanisms (Antia *et al*., 2006). They were significant difference among the samples *B. aethiopum* was the highest with 5.33%, this was significantly different from *B. glabra* (4.17%), this was significantly different from the remaining three samples *M.arboreus*,(3.33%) *E.africana*(2.67%) and *E.gigas*(2.00%) which were not significantly among themselves. The crude fibre ranged between 0.99%. - 4.92%. The value for B glabra 0.99% is lower compared to seed of African pear 1.81% [Ige *et al*, 1994], Breadnut 1.71%(Oshodi *et al*., 1999) and that of bitter gourd 1.28% (Anita *et al* ,2006). *M arboreus* 2.38% is lower compared to T. durum 2.46% (Adeyeye and Aye, 2005),but is higher compared to seed of African pear 1.81% [Ibanga and Oko, 2009], breadnut 1.71% (Oshodi *et al*., 1999) and African walnut 1.4% (Ekop and Eddy, 2009).B aethiopum 4.92% is lower than *B. glabra* 8.70% (Olaofe *et al*., 2006) and *Pitanga cherri* 9.70% (Amoo et al 2006).E gigas 1.83% is compared to African pear 1.81% [Ibanga and Oko, 2009]. The considerable amount of crude fibre in *B aethoipum* 4.92% seed implies that it can serve as a source of dietary fibre (Agostoni *et al*., 2001) and can be employed in the treatment of diabetes, obesity and gastrointestinal tract diseases because it will enhance easy movement of bolus in the large intestine. . It's also an indication that it contains a proportion of Cellulose, Hemicellulose and Lignin (Saldanha, 2003) .Others with low values can be complemented with seeds like P. *cherrie* 9.70% and winged bean 12.23% [Amoo et al., 2006]. Crude fibre in *B. aethiopum* is the highest. This is significantly different from *E. africana, E. gigas and M. arboreus* which were 2.27%, 1.83% and 2.38% which were not significantly different within themselves. The mean of these are in turn significantly different from 0.99% which was the least in *B. glabra*. The carbohydrate content that ranged between 80.93% in B aethiopum and 34.78% in E africana shows that the seeds will be good sources of Carbohydrates which contributes a high percentage of energy (readily accessible fuel) for physical performance and regulate nerve tissue(Whitney and Rolfes, 2005). There were significant differences between carbohydrate content of the five samples with the highest been 80.98% in *B.aethiopum* and the lowest value being 34.78% in *E. aficana*.

**Minerals**

Table 2 presents the mineral composition of the seed samples.The abundant minerals are Ni 48.92- 98.75mg/100g, Ca 53.76-95.50mg/100g, Fe 44.50 - 76.90mg/100g, Mg 36.00-69.76mg/100g, K 41.00- 68.30mg/100g and Zn 20.20 - 39.50mg/100g. This was in close agreement with the report of Jeanne *et al,* (2005) on mineral content of small Red kidney beans that reported Ca as the most abundant element. Ni values in the samples were significantly different 98.50mg/100g being the highest in *B. aethiopum*, which was significantly higher than 83.87mg/100g in *E. gigas*. This value was significantly higher than 64.42mg/100g in *E. africana*, this was higher than 51.50mg/100g in *B. glabra* which was also significantly higher than 48.92mg/100g in *M. arboreus* being the least K, 41.00-68.30mg/100g is also one of the abundant elements in the seed flour. This is in agreement with observations of Olaofe *et al*, (2008) , Oshodi *et al*., (1999) who reported K to be abundant mineral in Nigerian agricultural products .K is important in the synthesis of amino acids and proteins (Malik, 1982) The K content in *E. africana* (68.30mg/100g) was significantly higher than *E. gigas* (62.12mg/100g), this was significantly higher than those of other three species *B. aethiopum*(44.87 mg/100g) ,*B. glabra* (41.94 mg/100g), and *M. arboreus* (41.00mg/100g) which were not significantly different among themselves.The Na content of the seeds 35.76- 43.67mg/100g are high compared to that of sunflower 20.0mg/kg and pumpkin 30.00mg/100g (Reynolds,1995) and 24.80mg/100g for full fat fluted pumpkin (Lin *et al* 1994) generally, the Na levels of the Nigerian plants foods are less than K level Olaofe *et al*, (2008). Both Na and K are required to maintain osmotic balance of body fluid, the pH of the body, regulate muscle and nerve irritability, control glucose absorption (Fleck, 1976) and also enhance normal retention of protein during growth (NRC,1989).The Na:K in the body is of great concern in the prevention of high blood pressure. .The Na:K required for good health is less than one. The Na:K in the samples are *B. aethiopum* (0.80), *B. glabra* (0.87), *E .africana* (0.63),*E. gigas* (0.64) and *M. arboreus* (0.99)..Thus the samples have good Na:K ratio that would not promote high blood pressure (Niemal *et al*.,1992). The Na content in *M. arboreus* 39.14mg/100g was significantly higher than those of *E. africana* 43.67mg/100g and *E. gigas* 39.76mg/100g which were not different from one another. The mean of these two species were significantly higher than those of *B. aethiopum* 35.77mg/100g and *B. glabra* 35.76mg/100g which were not significantly different from one another.

The amount of Ca in the seeds ranged between 53.76 $^{c}\pm$1.75-95.50 $^{a}\pm$1.41mg/100g. The values are low compared to some legumes and cereals (490-601) mg/100g (Oshodi *et al*, 1999) and values reported for quinoa seed 874mg/100g (Ranhotra, *et al*,1988). The calcium content of *E. gigas* are comparable to African locust bean 94.3mg/100g (Adeyeye and Adejuyo, 2005) and kidney Bean seed 95.00mg/100g (Olaofe *et al*., 2006) P also assist Ca in many body reactions although it also has independent function, hence many moderate diet which are rich in animal proteins and P may promote the loss of Ca in the urine. This has lead to the concept of the Ca to P ratio. If the Ca/P ratio is low (low Ca, high P Intake) more than the normal amount of Ca may be lost in the urine, decreasing the Ca levels in bones. Food is considered 'good' if the Ca/P ratio is above one and 'poor' if the ratio is less than 0.5 (Nieman *et al*,.1992).The Ca/P ratio in the present study *E. gigas*(1.58),*M. arboreus*(1.33) are considered "good" because Ca/P ratio are above one. *B. aethiopum, B. glabra* and *E africana* which are 0.85,0.61 and 0.55 respectively are not poor because they are not less than 0.50 this suggests that the samples were good food in Ca/P ratio indicating that they would help to increase the absorption of Ca in the small intestine. The Ca values of the samples were significantly different with the highest Ca being 95.50 mg/100g obtained for *E. africana* and the lowest being 53.76mg/100g obtained for *B. glabra*.

**Table 1. Proximate Composiion of the Five Wild Seeds**

| Sample | Moisture (%) | Ash (%) | Fat (%) | Protein (%) | Carbohydrate (%) | Fibre % |
|---|---|---|---|---|---|---|
| *B.aethiopum* | $3.00^{a}\pm0.83$ | $5.33^{a}\pm0.67$ | $2.06^{e}\pm0.07$ | $4.40^{d}\pm0.28$ | $80.93^{a}\pm0.28$ | $4.92^{a}\pm0.01$ |
| *B. glabra* | $1.50^{c}\pm0.01$ | $4.17^{b}\pm0.17$ | $34.46^{a}\pm0.77$ | $19.31^{c}\pm0.06$ | $40.03^{d}\pm0.09$ | $0.99^{c}\pm0.01$ |
| *E.africana* | $2.00^{b}\pm0.49$ | $2.67^{c}\pm0.67$ | $13.42^{c}\pm0.19$ | $44.86^{a}\pm0.06$ | $34.78^{e}\pm0.48$ | $2.27^{b}\pm0.15$ |
| *E.gigas* | $2.67^{b}\pm0.28$ | $2.00^{c}\pm0.00$ | $8.57^{d}\pm0.88$ | $24.57^{b}\pm0.23$ | $60.33^{b}\pm1.15$ | $1.83^{b}\pm0.33$ |
| *M. arboreus* | $2.50^{b}\pm0.00$ | $3.33^{c}\pm0.00$ | $23.68^{b}\pm0.11$ | $24.37^{b}\pm0.04$ | $44.03^{c}\pm1.16$ | $2.38^{b}\pm0.04$ |

Results are mean of triplicates determinations. Means in each column follow by the same letter(s) are not significantly different by Duncan's Multiple Range Test.

**Table 2. Composition of Minerals (mg/100g)**

| Sample | K | Na | Ca | Mg | Zn | Fe | Cr | Pb | Cd | Ni | Mn |
|---|---|---|---|---|---|---|---|---|---|---|---|
| *B. aethiopum* | 44.87 | 35.77 | 74.76 | 36.00 | 20.26 | 76.90 | 14.50 | N.D | 4.26 | 98.50 | 8.00 |
| *B. glabra* | 41.00 | 35.76 | 53.76 | 69.76 | 39.50 | 58.26 | 7.00 | N.D | 2.26 | 51.50 | 5.50 |
| *E. africana* | 68.30 | 43.67 | 95.50 | 63.26 | 20.76 | 44.56 | 4.30 | N.D | 2.76 | 64.42 | 15.00 |
| *E. gigas* | 62.12 | 39.76 | 95.25 | 65.00 | 27.66 | 67.26 | 5.60 | N.D | 4.50 | 83.87 | 9.76 |
| *M. arborcus* | 41.94 | 39.14 | 91.76 | 48.76 | 35.76 | 44.50 | 32.67 | N.D | 1.76 | 48.92 | 6.26 |

Results are mean of triplicate determinations. Means in each column follow by the same letter(s) are not significantly different by Duncan's Multiple Range Test. N.D=Not Detected.

The Fe content was between 44.50-76.90mg/100g. This shows that the seeds are very rich in Fe. The Fe content contents of these seeds flour are higher than that of African pear 6.41mg/100g (Ibanga and Okon, 2009), *T. durum* 4.93mg/100g (Adeyeye and Ayejuyo, 2005). Fe is very important for the formation of haemoglobin and normal functioning of the central nervous system. (Kabata, 1992). Fe is also essential for chlorophyll formation and for the synthesis of proteins contained in the chloroplasts. (Kabata, 1992).The Fe content in the samples was significantly different. The highest value 76.90mg/100g in *B. aethiopum* was significantly higher than 67.26mg/100g in *E. gigas* which was significantly higher than 58.26mg/100g obtained in *B. glabra* this was higher than those of the remaining two species *E. africana* 44.56mg/100g and *M. arboreus* 41.50mg/100g.The value of Mg in the seeds 36.00 $^{b}\pm$4.00-69.76 $^{a}\pm$1.75 mg/100g is close to kidney bean seed 72.90mg/100g(Olaofe *et al*,2006*)* but lower than the values in pearl millet 105.0mg/100g, Quinoa seed 232.00mg/100 reported by Oshodi *et al* (1999), Chickpea seed, 176.00mg/100g (Tarek, 2002). But the values are higher than *Mucuna* species (59.80-50.00) mg/100g. High amount of Mg, K and Ca (as macro elements) may help to lower the blood pressure (Ranhortra *et al*., 1998). Several clinical studies have shown Mg, k and Ca to be effective pressure lowering agents (Osborne *et al*, 1996) hence consumption of these flour may help achieve this purpose. There were significant differences in the Mg values. The values obtained for *B. glabra* (69.76mg/100g), *E. africana* ( 63.26mg/100g )and *E. gigas* (65.00mg/100g) were not significantly different among themselves. These were however significantly higher than 48.76mg/100g and 36.00mg/100g for *M. arboreus* and *B. aethiopum* respectively which were not significantly different among themselves. The Zn content 20.26$^{c}\pm$4.00-39.50 $^{a}\pm$9.50 mg/100mg and Mn content 5.50 $^{c}\pm$4.00-15.00 $^{a}\pm$2.50mg/100mg suggests that the micronutrients would be effective in certain enzyme systems. For example, Zn and Mn function in enzyme systems which are necessary for important reactions in plant metabolism. Mo and Mn are essential for certain nitrogen transformations in microorganisms as well as in plants. Zn is thought to be concerned in the formation of some growth hormones and in the reproduction process of certain plants. There were significant differences in the Zn content of the samples. The highest was 39.50mg/100g *in B. glabra* while the least was 20.26mg/100g in *B. aethiopum.* There were significant differences in the Mn values. *E. africana* 15.00mg/100g was the highest; it was significantly higher than 9.76mg/100g and 8.00mg/100g which were not significantly different from one another. Their means were significantly different from 6.26mg/100g in *M. arboreus* which was also significantly higher than 5.50mg/100g in *B. glabra* which was the least. The less abundant are Mn 15.0-5.5mg/100g, Cr 14.50-2.67mg/100g and Cd4.50-1.76mg/100g.It is interesting to note that Pb is not detected in any of the samples, this is good because Pb is not required since it is nutritionally deleterious. There were significant differences in the Mn values. *E. africana* 15.00mg/100g was the highest; it was significantly higher than 9.76mg/100g and 8.00mg/100g which were not significantly different from one another. Their means were significantly different from 6.26mg/100g in *M. arboreus* which was also significantly higher than 5.50mg/100g in *B. glabra* which was the least. The highest Cr content 14.50mg/100g was obtained in *B. aethiopum* which was significantly higher, compared to 7.00mg/100g in *B. glabra*, 5.60mg/100g in *E. gigas*, and 4.30mg/100g in *E. africana* which were not significantly different among themselves but were significantly higher than the least value , 2.67mg/100g obtained in *M. arboreus*. The Cd values were significantly different. *E.gigas* 4.50mg/100g being the highest was significantly higher than 4.26mg/100g in *B. aethiopum* this was higher than 2.76 mg/100g in *E. africana* which was also higher than 2.26 mg/100g in *B.glabra* and the least value being 1.76mg/100g in *M. arboreus*.

**Sulphate and Phosphate Contents**

The sulphate concentration ranged between 3,590ppm in *E. gigas and 7*,900ppm in *E. africana*. Sulphur in form of sulphate is found in all the samples. Sulphur is found in every living cell. It's part of the molecules that form the amino acids (protein building blocks) methionine, cysteine, and taurine, which are essential for health. It's a constituent of vitamin B1 and biotin, the antioxidant glutathione, the anticoagulant heparin, and coenzyme A, which drives energy production in cells. Sulphur is an integral part of the biological cement that forms skin, hair, nails, and the cartilage that shapes nose and pads joints. Sulphate content in the five samples showed significant difference. *E. africana* 7,900ppm was the highest and was significantly higher than 5,375ppm in *B. aethiopum*; this was also significantly different from 4,680ppm and 4,460ppm in *B. glabra* and *M. arboreus* which were not significantly different between each

other . The least value was 3,590ppm in *E. gigas* which was significantly different from the means of *B. glabra* and *M. arboreus.* Phosphate concentration was between 865ppm *B. aethiopum* and 3,550ppm in *B. glabra* indicating that the samples are good sources of phosphorus. Phosphorus is importance to the health of body in general and bones and teeth in particular. Phosphorus is found in bones, teeth, nucleic acids (DNA and RNA), in the energy carriers (such as ATP), lipids, proteins and enzymes. Phosphorus is an essential mineral for human and animal life .It is fundamental to growth maintenance and repair of all body tissues and is necessary (along with calcium and magnesium) for proper growth and formation of bones. In addition, the body utilizes phosphorus in protein synthesis, carbohydrate metabolism, enzyme activation and as a component of nucleic acids (DNA) and (RNA) (NAS, 1997). Publication by the National Academy of Sciences updated the Dietary Reference Intakes (also referred to as the Recommended Dietary Allowances) for phosphorus to 500, 700 and 275mg per day for children, adults, and infants, respectively. It long has been known the intake of appropriate levels of calcium is important to maintain proper bone mass, since bone mineral (hydroxyapatite) is a form of calcium phosphate (Heaney and Shapiro, 2003). Calcium is known to bind quantitatively to phosphorus during digestion, therefore inhibiting the absorption of a portion of the phosphorus. For diets that contain more phosphorus than calcium. The dietary calcium will not block the absorption of enough phosphorus to negatively impact bone growth. However, when high doses of extra calcium from non-phosphate sources are given (i.e. carbonate, gluconate, lactate, citrate, or other organic salts), a significant interference can occur with the absorption of the phosphorus from food sources. Heaney concluded that the prudent course would be to ensure a total calcium intake (food plus supplement) of at least 1500mg/day and to use a phosphate salt at least for those with low dairy and meat intakes( Heaney, 2002). Mono calcium phosphate (MCP) and dicalcium phosphate dihydrate act as leavening agents in baked goods. MCP is also useful as a dough conditioner and can be used to strengthen the gel formation in instant pudding products. Tri calcium phosphate is extremely useful in dry powder mixes, to prevent the adsorption of moisture and allow the powders to flow properly. When these phosphates are used as functional food ingredients, they also provide the added benefit of calcium and phosphorus fortification, which readily can be noted by consumers as they read the food labels. There were significant differences in the phosphate content of the samples. The highest phosphate content was 3,550ppm in *B. glabra*. This was higher than 2,610ppm and 2,410ppm in *M. arboreus* and *E. gigas* respectively which had no significant difference between one another but are significantly different from 1,905ppm in *E. africana* which was also significantly different from 865ppm in *B. aethiopum* which was the least.

**Table 3. Phosphate and Sulphate concentration in the seeds sample**

| Samples | Phosphate (ppm) | Sulphate (ppm) |
|---|---|---|
| *Borassus aethiopum* | $865^{d}\pm0.51$ | $5,375^{b}\pm2.28$ |
| *Bombacopsis glabra* | $3,550^{a}\pm3.25$ | $4,680^{c}\pm2.25$ |
| *Entada africana* | $1,905^{c}\pm2.20$ | $7,900^{a}\pm4.25$ |
| *Entada gigas* | $2,410^{b}\pm2.12$ | $3,590^{d}\pm2.32$ |
| *Myriathus arboreus* | $2,610^{b}\pm2.22$ | $4,460^{c}\pm3.25$ |

Results are mean of triplicate determinations. Means in each column follow by the same letter(s) are not significantly different by Duncan's Multiple Range Tests.

**Conclusion**

*E. africana, E. gigas, M. arboreus,* and *B. glabra* are good sources of protein and they could be used as source of protein supplement thereby reducing the net effect of protein deficiency diseases such as marasmus, kwashiorkor and mental deficiency (retardness ). *B. glabra and M. arboreus* are rich in lipids which can be further explored for domestic uses and industrial purposes. The high level of crude fibre in *B. aethiopum* (4.92%), *M. arboreus* (2.38%) and *E. africana* (2.27%) indicate that they would be good diet supplement that would aid easy digestion.

The result obtained from this research work suggest that *E. africana, E. gigas, M. arboreus* and *B. glabra* are good sources of protein and minerals with *B. glabra and M. arboreus* which are as well rich in lipid. *B. aethiopum* which is rich in crude fibre (4.92%) could serves as food supplement.

**Reference**

Ademoroti CMA, (1996): Standard methods for water and effluents analysis, Mareh Prints and Consultancy,47,Jona Akpoborie Streets,Benin. 60-62.

Adeyeye, E.I. and Aye, P. A. (2005): Chemical composition and the effect of salt on the food properties of Triticum durum wholemeal flour. Pak. J.Nutrition (4)3:187-196.

Adeyeye, E.I. and Ayejuyo, O.O. (2000): Chemical composition of Cola Gluminate and Garcinia kola seeds grown in Nigeria. J. Food Sci., 45: 223-230.

Adeyeye, E.I., Ajibade, E.A. and Temola A.F. (2004): Trace metals in Soil and Plants from Fadama farms in Ekiti State, Nigeria. Bull Chemical Society of Ethiopia, 2005 19(1), 23-34.

Adeyeye, E.I and Ayejuyo,O.O., (2005): Proximate, mineral and phytate profile of some selected spices found in Nigeria. Pak. J.Sci Res; 48: 14- 22.

Aiseigbu, J.E.(1987):Some biochemical evaluation of fluted pumpkin seeds.J.Sci. Food Agric.40:155

Adubiaro H.O. (2010): Chemical and Spectroscopic analysis of the seed flours and oil of Adasonia digitata (Baobab), *Albizzia lebbeck and Daniella olivieri* Ph.d thesis (UNAD).Pg. 45-50.

Agostoni, C., Carratu, B., Boniglia, C., Riva, E., and Sanzini, E. (2001): Free amino acid content in standard infant formulas: Comparison with human milk. J. Am. College Nutr., 19: 434-438.

Aisegbu,J.E. (1987): Some biochemical evaluation of fluted pumpkin seeds .J.Sci.FoodAgric 40: 151-155.

Akande, F.B., Adejumo O.A, Adamade, C.A. and Bodunde A.O.J (2010): Processing of locust bean fruits: Challenges and prospects. Afr. J.Agric. Res. 5(17):2268-2271.

Akande, K.E., U.D. Doma, H.O. Agu and H.M. Adamu, (2010): Major anti-nutrients found in plant protein sources: Their effect on nutrition. Pak. J. Nut. 9: 827- 832.

Amoo, I.A, Adebayo, O.T. and Oyeleye, A.O.(2006): Chemical evaluation of winged beans, Psophocarpus tetragonolobus, Pitanga cherries, Eugenia uniflora and orchid fruit. Orchid fruit myristica. African J.FoodAgric.Nutr.Develop.Vol.6:24-31.

Anazonwu-Bello, J. N. (1981): Indigenous foods and nutritional adequacy. Symposium on development of indigenous technology. Enugu, Nigeria, Ministry of Science and Technology.

Anderson, A.B. (1989): Land-use strategies for successful extractive economies. Paper presented at the symposium on extractive economies in tropical forests. "A Course of Action". Washington, D.C., National Wildlife Federation.

Andrew, G. and Ebert A.C (2005): Phosphorus: the forgotten, essential ingredient: phosphates enhance the nutritional benefits of food by adding phosphorus, an essential mineral.

Antia, B.S., E.J. Akpan, P.A. Okon and I.U. Umoren, (2006): Nutritive and anti-nutritive evaluation of sweet potatoes (Ipomoea batatas) leaves. Pak. J. Nut., 5: 166-168.

AOAC, (1990): Official Methods of Analysis.15th Edn., Association of Official Analytical Chemists. Washington D.C., USA.

AOAC, (1995): Official Methods of Analysis.15th Edn. Vol. 67 Association of Official Analytical Chemists. Washington D.C., USA.

Aremu, M.O., Olaofe, O. and Akintayo, E.T. (2006): A comparative study on the chemical amino acid composition of some Nigerian under-utilized legume flours Pak. J. nutrition, 5(1): 34-38.

Ekop, A.S. and Eddy,N.O.,(2009): Comparative studies of proximate composition of African walnut seed and Indian almond seed.Global J.Pure and Appl.Sci. 33-38.

Ejiofor, M.A.N., Onwubuke, S.N. & Okafor, J.C. 1987. Developing improved methods of processing and utilization of kernels of Irvingia gabonensis (var. gabonensis and var. excelsa). United Kingdom, Int. Tree Crops Journal, 4.

Ejiofor, M.A.N., Obiajulu, O.R. and Okafor, J.C. 1988. Diversifying utilities of African breadfruit (Treculia africana Decne. subsp. africana) as food and feed. United Kingdom, Int. Tree Crops Journal, 5.

Eriyamremu, G.E. and Adamson, I. (1994): "Early Changes in Energy Metabolism in Rats Exposed to an Acute Level of Deoxycholate and Fed a Nigerian-Like Diet". Ann. Nutr. Metab. 38:174-183.

Eromosele, I.C.,Eromosele, O., Kuzhkuzha, D.M. (1991): Evaluation of mineral elements and ascorbic acid contents in fruits of some wild plants. Plant food Hum. Nutr. 41: 53-57.

Fleck ,H.A.,(1976): Introduction to nutrition, Macmillian Publising Company.Inc..New York.pp 45-46.

Heaney, M.D., (2002): The Calcium Phosphate Connection in Alternative Therapies in women's Health, October 2002.

Heaney, M.D. and Shapiro, R.P. (2003):Bone, 2003.32:532

Ige, M.M; Ogunsuwa, A.O and Oke O.L. (1994): Functional ppt; of the protein of some Nigerian oil seeds: Conophor seeds and three varieties of Melon seeds. Food Chem. 32: 822- 825.

IITA, (1988): Selected method for soil and plant analysis( Mannal Series No.1). International Institute for Tropical Agriculture, Ibadan, Nigeria, PP 55-56.

Jeanne,A.A., Meckes, M., Ramirez, R., Tores, J. and Luna-Herrera, J. (2005): Activity against multidrug-resistant Mycobacterium tuberculosis in Mexican plants used to treat respiratory diseases. Phytother Res., 17(8): 903-908.

Kabata,A. and Pendias ,H.(1992):Trace Elements in Soil and Plants ,2nd ed.,CRC Press:Boca Randon Florida.pg 1-10

Lin, M.J.Y; Humbert, E.S; Sosulski, F.W, (1995): Certain functional properties of Sunflower meal products. J. Food Sci. 39: 368-370.

Malik, N.K. (1982): Gravimetric determination of tannins and their correlations with chemical and protein precipitation methods. J. Sci. Food Agric., 61: 161-165.

N.A.S., (1997): National Academy of Sciences Publication. National Academy Press,Washinton D.C Pg 78-79

Nelson, D.L. and M.M. Cox, (2008): Lehninger Principles of Biochemistry. 5th Edn., W.H. Freeman and Company. Madison Avenue, New York, pp: 343.

Nieman,D.C.,Butterworth,D.E. and Nieman,C.N,(1992): Nutrition, WMC.Brown Publiser, Dubugue,USA PP 540:31

NRC, (1989): National Research Council. Reccommended Dietary Allowance,National Academy Press,Washinton D.C

Odukoya.O.O. and Ajayi, S.O. (1987):Trace Heavy metals in Nigerian fishes II.Nig.J.Nutritional Sci. 8(1),41-45

Okafor, J.C. (1975a): Edible indigenous woody plants in the rural economy of the Nigeria forest zone. In: Okali, D.U.U. (Editor). The Nigerian rainforest ecosystem. Proceedings of the MAB Workshop on the Nigerian Rainforest Ecosystem, University of Ibadan, Nigeria. pp.262–300.

Okafor, J.C. (1977): Agroforestry aspects. Appendix No. 2 of Caldecott et al. 1989. Cross River National Park, Oban Division: Plan for developing the park and its support zone. Godalming. UK, WWF.

Okafor, J.C. (1979): Edible indigenous woody plants in the rural economy of the Nigerian forest zone. In D.U.U. Okali, ed. The Nigerian rainforest ecosystem, Proc. of M.A.B. Workshop on the Nigerian Rainforest Ecosystem. Nigeria, University of Ibadan.

Okafor, J.C. (1980a): Trees for food and fodder in the savanna areas of Nigeria. Int. Tree Crops Journal, 1.

Okafor, J.C. 1980b. Edible indigenous woody plants in the rural economy of the Nigerian forest zone. Forest Ecol. Management, 3.

Okafor, J.C. 1981a. Woody plants of nutritional importance in traditional farming systems of the Nigerian humid tropics. Ph.D. thesis. Ibadan, Nigeria, University of Ibadan.

Okafor, J.C. and Okolo, H.C. (1983b): Potentialities of some indigenous fruit trees of Nigeria. Proc. 5th Annual Conference, Nigeria Forestry Association.

Okafor, J.C. (1987): Identification and conservation of plants used in traditional medicines. Lead lecture presented at the International Workshop on Evaluation of Traditional M Medicine. Nigeria University, Nsukka.

Okafor, J.C. 1989a. Agroforestry aspects. Appendix No. 2 of Caldecott et al. 1989. Cross River National Park, Oban Division: Plan for developing the park and its support zone. Godalming. UK, WWF

Okafor, J.C. (1989c): Tropical plants in health-care delivery. Guest lecture delivered to Pharmacognosy Society of Nigeria. University of Nigeria, Nsukka.

Okafor, J.C. (1997): Conservation and use of traditional vegetables from woody forest species in southeastern Nigeria. In: Guarino, L. (Editor). Traditional African vegetables. Proceedings of the IPGRI international workshop on genetic resources of traditional vegetables in Africa: conservation and use, 29–31.

Olaofe, O., Famurewa, J.A.V. and Ekuagbere, A.O. (2006): Chemical and functional properties of kidney bean seed (Phaseolus vulgaris) flour.Proceedings,Chem.Soc. of Nig.104-108.

Olaofe, O., Okiribiti, B.Y., and Aremu, M.O. (2008): Electronic Journal of Enviromental, Agricultural and Food Chemistry ISSN:1579-4377.Pg 3444-3452.

Osborne,C.G.,Mctyre,R.B.,Duck,J.,silverstein,B.,Winberg,M.S.a nd Salkeld,A.A(1996): Evidence for the relationship of calcium to blood pressure.Nutr.Rev. 54:365-381.

Oshodi, A.A., H.N. Ogungbenle and M.C. Oladimeji, (1999): Chemical composition, nutritionally valuable minerals and functional properties of benni seed (Sesamum radiation). Peal millet (Pennisetum typhoides) and guninoa (Chenopodium quinoa) flours. Int. J. food Sci. Nutrition, 50: 325-331.

Oyenuga V.A.,(1998):Nigerian Food and Feeding stuffs.Their Chemistry and Nutritive value.University Press,Ibadan.pp 99.Ranhotra,G.S,Gelroth,J.A,Leinen,S.O.,Vmas,M.AandLoreiz,

K.J.(1988): Nutritional Profile of some edible plants from Mexico.J. Food Comp. and Analysis. 11:298-304.

Reynolds, T. (1995): Comparative chromatographic patterns of leaf exudate components from shrubby aloes. Botanical. J. Linnean Soc. 102: 273-285.

Tarek, A.E. (2002):Nutritive composition and nutritional factors of chickpeas Cicerarietinum undergoing different cooking methods and germination .Plant Food for Human Nutri. 57:83-92

Udeala, O.K., Oneyechi, J.O. and Agu, S.I. (1980): Preliminary evaluation of dike fat, a new tablet lubricant. J. Pharm Pharmacol.. 32: 6-9. Whitney, E.N. and S.R. Rolfes, (2005): Understanding Nutrition. 10th Edn., Thomson/Wadsworth Publishing Company, Belmont, CA., pp: 132-1