# Compositional Evaluation of Pulp and Seed of Blood Plum (Haematostaphis barteri), a Wild Tree Found in Taraba State, Nigeria

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**Abstract**
Traditional leafy vegetables represent inexpensive but high quality nutritional sources for the poor segment of the population especially in developing world like Nigeria, where malnutrition is wide spread. Blood plum (*Haematostaphis barteri)* is an under–utilized leafy vegetable belonging to the Anacardiacea family. A comparative study was carried out on proximate composition and amino acid profile of pulp and seed of *H. barteri*. The proximate composition values (%) for pulp and seed samples were found to be as follows: Moisture (3.56 and 2.75), ash (2.97 and 3.92), crude fat (17.76 and 29.68), crude protein (21.81 and 29.38), crude fibre (8.44 and 2.40), and carbohydrate (45.48 and 31.88). The calculated fatty acids and metabolizable energy were 14.21 and 23.74%; 1801.05 and 2139.58 kJ/100g, respectively. The high metabolizable energy values showed that the samples have an energy concentration more favourable than cereals, and which compare favourably well with those of legumes. The amino acid profiles revealed that pulp and seed samples of *H. barteri* contained nutritionally useful quantities of most of the essential amino acids. The total amino acids (TAA), total essential amino acids (TEAA) (with His), total sulphur amino acids (TSAA), and essential aromatic amino acids (EArAA) for the pulp and seed samples were 53.39 and 67.07; 26.49 and 34.28; 1.21 and 2.59; 2.70 and 3.37, respectively. However, supplementation of essential amino acid is required in a dietary formula based on *H. barteri* (pulp and seed), when comparing the EAAs in this report with the recommended FAO/WHO provisional pattern. The limiting EAAs in the pulp and seed of *H. barteri* were Leu and Lys, respectively.
**Keyword:** Proximate, amino acids, pulp, seed, *Haematostaphis barteri*

## 1. Introduction

An immense variety of fruits and seeds exists, many of which are known to be edible. In general, edible fruits appear to be under-utilized throughout the world and may in some areas even be diminished in use. These are inexpensive, high yielding, already part of the local diet and often easily available, but these have a low status frequently. Nutritionally, many edible leafy vegetables, fruits and seeds are excellent sources of carotene, folate, niacin, iron, vitamin C and calcium. These are of special importance in the prevention of avitaminosis A, a major cause of blindness in young children (Khan & Hamid, 1986).

African leafy vegetables, fruits and seeds are considered as valuable sources of nutrients (Nesamvuni *et al*., 2001) with some having important medicinal properties (Hilou *et al*., 2006). Indeed, these plants are valuable sources of nutrients especially in rural areas where they substantially contribute to proteins, minerals, vitamins, fibres and other nutrients which are usually in short supply in daily diets (Mohammed & Sharif, 2011). In view to their nutritive potential, leafy vegetables and their fruits contribute substantially to food security in sub-Saharan Africa where people's diets based on rice, potato and cassava are high in calories but deficient in essential micronutrients (Yiridoe & Anchirinah, 2005; Aremu *et al.*, 2006a). In these countries, chronic under-nutrition affects about 215 million people representing 43% of the population (FAO, 1996).

The fight against malnutrition and under-nourishment continues to be a basic goal of development and a variety of strategies are being applied. Strategies based on nutrient-rich foods like vegetables are considered essential (Susane, 1996). In Nigeria, most rural dwellers rely on leaves and fruits gathered from the wild as their main source of leafy vegetables and fruits. Throughout the year, these nonconventional vegetables, fruits and seeds play an important role in everyday cooking. Although, commonly eaten in rural areas, they are also consumed by urban people who buy from traders who also collect them from the wild. In addition, these vegetables supply calories and nutrient during the dry season when there is shortage of cultivated green vegetables and other food resources. The inclusion of these non–conventional vegetables and fruits in the diet of most rural communities therefore is critical to their survival.

Until recently, little attention has been given to the role of these wild and semi-wild vegetables and their fruits in Nigeria. Indeed, their nutritional contribution has not been widely exploited hence nutritional information on these species would be useful for the nutritional education of the public and to improve the nutritional status of the population.

 

*Haematostaphis barteri* (popularly known as blood plum) is a tree belonging to the Anacardiacea family. It is a perennial tree crop which normally grows wildly in the forest and usually among savannah. A tree of about 8 m high, 65 cm girth from Upper Volta, Nigeria, Cameroun and Sudan. It is a tree with a crooked bark, and spread branches. The bark is grey, rough slash brownish yielding a clear gum, the leaves are troupes at the end of the branch and are of OX-blood in colour. The leaves are glabrous 6-12 pairs same size, 1-3 inches (2.5, 7.5 cm), broad elongated elliptic or slightly wide below the middle blunt or rounded at the base (Nkafamiya *et al.*, 2010). The flower is produced during the dry season. The fruits grown in bunch, hanging in perils–smooth–red purple or deep drops nearly 2–5 cm long like the temperate plump. The pulp is thin and edible with a resinous taste (Tapsell *et al.,* 2006). It is known in Nigeria as "Ginin Kafiri" in Hausa language. The tree is found wild in Borno and Adamawa (Bokhari & Ahmed, 1979), and Taraba States of Nigeria.

Diet-related non communicable diseases like obesity, diabetes, hypertension, cardiovascular diseases are increasingly becoming public health problems in Nigeria. This is partly due to nutrition transition, which essentially has to do with changes in food consumption patterns associated with modernization, urbanization, economic development and market globalization (Nnam *et al.,* 2012). There is a shift away from the traditional foods towards overconsumption of processed foods high in saturated fats and sugar but low in fiber, vitamins, phytochemicals and minerals. Some traditional foods like fruits and seeds contain a lot of promoting bioactive substances. There is contrasting information on some nutritional status of some many fruits and seeds in the tropics (Aremu and Olaofe*,* 2007; Audu *et al.,* 2013).

Therefore, the present work involved the chemical investigation and evaluation of the proximate composition, metabolizable energy, amino acid profiles, isoelectric points, predicted protein efficiency ratios and amino acid scores of pulp and seed of *Haematostaphis barteri* grown in Zing local government of Taraba State, Nigeria.

## 2.1 Materials and Methods

## 2.2 Collection of samples

The fruits of blood plum (*Haematostaphis barteri*) were purchased from a local market in Zing local government area, Taraba State, Nigeria. The fruits were thoroughly sorted to remove the stones, and bad ones before washing with tap water. The clean fruits were then transported to the laboratory and proper identification was made by a Taxonomist in the Department of Biological Sciences, Federal University Wukari, Nigeria.

## 2.3 Preparation of samples

The clean fruit of *H. barteri* was dried in an Oven at $40^0$C for 5 days. The pulp was separated from the seed, and freely ground with Kenwood food blender. The seed was also carefully de–shelled using kitchen knife, and the kernel was dried in an Oven at $45^0$C for 72 h and ground into powder. Flours of the two samples were separately kept in the refrigerator at $–4^0$C prior use.

## 2.4 Proximate analysis

The moisture, ash, crude protein (N x 6.25), crude fat, crude fibre and carbohydrate (by difference) were determined in accordance with the methods of AOAC (1995). All proximate analyses of the sample flours were carried out in triplicate and reported in percentage. All chemicals were of Analar grade.

## 2.5 Amino analysis

Amino acid analysis was by Ion Exchange Chromatography (IEC) (FAO/WHO, 1991) using the Technico Sequential Multisample (TSM) Amino Acid Analyzer (Technicon Instruments Corporation, New York). The period of analysis was 76 min for each sample. The gas flow rate was 0.50 mLmin$^{-1}$ at 60$^o$C with reproducibility consistent within ±3%. The net height of each peak produced by the chart recorder of the TSM (each representing an amino acid) was measured and calculated. Amino acid values reported were the averages of two determinations. Nor–leucine was the internal standard. Tryptophan was not determined.

## 2.6 Evaluation of isoelectric point (pI), quality of dietary protein and predicted protein efficiency ratio (P–PER)

The predicted isoelectric point was evaluated according to Olaofe & Akintayo (2000):

$$pIm = \sum_{i=1}^{n=1} pI_i X_i$$

**Where:**

**pIm =** the isoelectric point of the mixture of amino acids;

**pI$_i$** = the isoelectric point of the i$^{th}$ amino acids in the mixture;

**X$_i$ =** the mass or mole fraction of the amino acids in the mixture.

Quality of the dietary protein was measured by finding the ratio of available amino acids in the sample protein compared with the needs expressed as a ratio. Amino acid score (AAS) was then estimated by applying the FAO/WHO (1991) formula:

$$AAS = \frac{mg\ or\ amino\ acid\ in\ 1\ g\ of\ test\ protein}{mg\ of\ amino\ acid\ in\ reference\ protein} \ x\ \frac{100}{1}$$

The predicted protein efficiency ratio (P–PER) of the seed sample was calculated from their amino acid composition based on the equation developed by Alsmeyer *et al.* (1974) as stated thus; P–PER = –0.468 + 0.454 (Leu) –0.105 (Tyr).

## 2.7 Statistical analysis of the samples

The fatty acid values were obtained by multiplying crude fat value of each sample with a factor of 0.8 (i.e. crude fat x 0.8 = corresponding to fatty acids value (Paul and Southgate, 1978). The energy values were calculated by adding up the carbohydrate x 17kJ, crude protein x 17kJ and crude fat x 37kJ for each of the samples (Kilgore, 1987). Errors of three determinations were computed as standard deviation (SD) for the proximate composition. The grand mean, SD and coefficient variation (CV%) were also determined.

## 3. Results

The proximate compositions of the pulp and seed of *Haematostaphis barteri* are presented in Table 1. The pulp and seed samples have 3.56% and 2.75% moisture, 2.97% and 3.92% ash, 17.76% and 29.68% crude fat, 21.89% and 29.38% crude protein, 8.44% and 2.40% crude fibre, and 45.48% and 31.88% carbohydrate (by difference), respectively. Also the respective calculated fatty acids and metabolizable energy were 14.21 and 23.74%; 1801.05 and 2139.58 kJ/100g.

**Table 1: Proximate compositions (%)[a] of pulp and seed of *Haematostaphis barteri***

| Parameter | Pulp | Seed | Mean | SD | CV% |
|---|---|---|---|---|---|
| Moisture | 3.56 ± 0.09 | 2.75 ± 0.35 | 3.16 | 0.4 | 12.82 |
| Ash | 2.97 ± 0.12 | 3.92 ± 0.13 | 3.45 | 0.48 | 13.78 |
| Crude fat | 17.76 ± 0.34 | 29.68 ± 0.62 | 23.72 | 5.96 | 25.13 |
| Crude protein | 21.81 ± 0.18 | 29.38 ± 1.03 | 25.60 | 3.76 | 14.79 |
| Crude fibre | 8.44 ± 0.24 | 2.40 ± 0.21 | 5.42 | 3.02 | 44.72 |
| Carbohydrate[b] | 45.48 ± 0.38 | 31.88 ± 1.63 | 38.68 | 6.80 | 17.58 |
| Fatty acid[c] | 14.21 ± 0.15 | 23.74 ± 0.65 | 18.98 | 4.78 | 25.11 |
| Energy[d] | 1801.05 ± 2.15 | 2139.58 ± 4.55 | 1970.32 | 169.27 | 8.59 |

[a]Mean values ± standard deviations of triplicate determinations
[b]Carbohydrate percent calculated as the (100 – total of other components)
[c]Calculated fatty acid (0.8 x crude fat)
[d]Calculated metabolizable energy (kJ/100g) (protein x 17 + fat x 37 + carbohydrate x 17)

The amino acid profiles of the pulp and seed of *Haematostaphis barteri* are shown in Table 2. Seventeen amino acids were detected. The *H. barteri* was a source of nine essential amino acids. Arginine and glutamic acid were the most abundant essential and non-essential amino acids with values 4.66 and 7.73 g/100g crude protein (cp) (pulp) and 7.59 and 9.85 g/100g cp (seed), respectively. The sulphur containing amino acids, methionine and cystine were 0.55 and 0.66 g/100g cp (pulp), and 1.20 and 1.39 g/100g cp (seed), respectively.

Table 3 depicts the essential, non-essential, acidic, neutral and sulphur containing amino acids. Total amino acids (TAA), total essential amino acids (TEAA) with His, total sulphur amino acid (TSAA), and essential aromatic amino acid (EArAA) of pulp and seed samples were 53.39 and 67.07; 26.49 and 34.28; 1.21 and 2.59; and 2.70 and 3.37, respectively.

**Table 2: Amino acid profiles of pulp and seed of *H. barteri* (g/100g crude protein)**

| Amino acid | Pulp | Seed | Mean | SD | CV% |
|---|---|---|---|---|---|
| Lysine (Lys)[y] | 3.19 | 3.59 | 3.39 | 0.20 | 5.90 |
| Histidine (His)[y] | 1.45 | 2.24 | 1.85 | 0.40 | 21.35 |
| Arginine (Arg)[y] | 4.66 | 7.59 | 6.13 | 1.47 | 23.90 |
| Aspartic (Asp) | 6.33 | 7.01 | 6.67 | 0.34 | 5.010 |
| Threonine (Thr)[y] | 3.20 | 2.98 | 3.09 | 0.11 | 3.56 |
| Serine (Ser) | 2.33 | 2.77 | 2.55 | 0.22 | 8.63 |
| Glutamic acid (Glu) | 7.73 | 9.85 | 8.79 | 1.06 | 12.06 |
| Proline (Pro) | 3.15 | 2.24 | 2.70 | 0.46 | 16.85 |
| Glycine (Gly) | 3.00 | 3.94 | 3.47 | 0.47 | 13.54 |
| Alanine (Ala) | 2.43 | 3.23 | 2.83 | 0.40 | 14.13 |
| Cystine (Cys) | 0.66 | 1.39 | 1.03 | 0.37 | 35.44 |
| Valine (Val)[y] | 3.17 | 4.55 | 3.86 | 0.69 | 17.88 |
| Methionine (Met)[y] | 0.55 | 1.20 | 0.88 | 0.33 | 36.94 |
| Isoleucine (Ile)[y] | 3.23 | 2.89 | 3.06 | 0.17 | 55.56 |
| Leucine (Leu)[y] | 4.34 | 5.87 | 5.11 | 0.78 | 14.97 |
| Tyrosine (Tyr) | 1.27 | 2.38 | 1.83 | 0.56 | 30.33 |
| Phenylalanine (Phe)[y] | 2.70 | 3.37 | 3.04 | 0.34 | 11.30 |
| Isoelectric point (pI) | 3.01 | 3.86 | 3.44 | 0.43 | 12.36 |
| P–PER | 1.37 | 1.95 | 1.66 | 0.29 | 17.47 |
| Leu/Ile | 1.34 | 2.03 | 1.69 | 0.35 | 20.42 |

[y]Essential amino acid; **P–PER** = Predicted protein efficiency ratio

**Table 3: Concentrations of essential, non–essential, acid, neutral, sulphur, aromatic, etc. (g/100g crude protein) of *H. barteri***

| Amino acid description | Pulp | Seed |
|---|---|---|
| Total amino acid (TAA) | 53.39 | 67.09 |
| Total non–essential amino acid (TNAA) | 26.90 | 32.81 |
| % TNAA | 50.38 | 48.90 |
| Total essential amino acid (TEAA) | | |
| With histidine | 26.49 | 34.28 |
| Without histidine | 25.04 | 32.04 |
| % TEAA | | |
| With histidine | 49.62 | 51.10 |
| Without histidine | 46.90 | 47.76 |
| Essential alphatic amino acid (EAAA) | 13.94 | 16.29 |
| Essential aromatic amino acid (EArAA) | 2.70 | 3.37 |
| Total neutral amino acid (TNAA) | 21.70 | 26.23 |
| % TNAA | 40.64 | 39.10 |
| Total acidic amino acid (TAAA) | 14.06 | 16.86 |
| % TAAA | 26.33 | 25.13 |
| Total basic amino acid (TBAA) | 9.30 | 13.42 |
| % TBAA | 17.42 | 20.00 |
| Total sulphur amino acid (TSAA) | 1.21 | 2.59 |
| % cystine in TSAA | 54.55 | 53.67 |

Results of essential amino acid scores based on the provisional amino acid scoring pattern (FAO/WHO, 1991) standards are shown in Table 4. Trytophan was not determined. The EAAC of Ile, Leu, Lys, Met + Cys (TSAA), Phe + Tyr, Thr and Val were 3.23, 4.34, 3.19, 1.21, 3.97, 3.20 and 3.17 (pulp), and 2.89, 5.87, 3.59, 2.59, 5.75, 2.98 and 4.55 (seed), respectively.

**Table 4: Amino acid scores of pulp and seed of *H. barteri* based on FAO/WHO standards**

| EAA | PAAESP g/100g protein | Pulp | | Seed | |
|---|---|---|---|---|---|
| | | EAAC | AAS | EAAC | AAS |
| Ile | 4.0 | 3.23 | 0.81 | 2.89 | 0.72 |
| Leu | 7.0 | 4.34 | 0.62 | 5.87 | 0.84 |
| Lys | 5.5 | 3.19 | 0.58 | 3.59 | 0.65 |
| Met + Cys (TSAA) | 3.5 | 1.21 | 0.35 | 2.59 | 0.74 |
| Phe + Tyr | 6.0 | 3.97 | 0.66 | 5.75 | 0.96 |
| Thr | 4.0 | 3.20 | 0.80 | 2.98 | 0.75 |
| Try | 1.0 | nd | na | nd | na |
| Val | 5.0 | 3.17 | 0.63 | 4.55 | 0.91 |
| **Total** | **36.0** | **22.01** | **4.45** | **28.22** | **5.57** |

**nd** = not determined; **na** = not applicable

## 4. Discussion

### 4.1 Proximate Composition

The moisture contents of pulp and seed of *Haematostaphis barteri* (Table 1) were all within the recommended dietary allowance (RDA) (3 – 10) (NRC, 1989). These contents are higher when compared with some legumes; kersting's groundnut (1.7 ± 0.12%) and cranberry bean (1.7 ± 0.51%) (Aremu *et al.,* 2006a). High moisture content in food is important to act as a solvent to aid in all biochemical reactions and physiological activities during digestion. However, foods with high moisture contents are prone to easy microbial spoilage and subsequent short shelf life (Uriah & Izuagbe, 1990; Adeyeye & Ayejuyo, 1994; Aremu *et al.,* 2007). Moderate moisture content of ≤ 12% is preferred for shelf stability of food on long storage (Ijeomah *et al.,* 2012). Ash content is a measure of mineral content of food. The results indicate that there were more minerals in the seed (3.92%) than the pulp (2.97%); the values of ash content are comparable to those reported for some leafy vegetable such as *Solanium nodiflorum* (ogumo) (2.67%) (Adeleke & Abiodun, 2010) and *Basella albs L.* (Indian spinach). Both the samples had ash content lower than the lowest RDA value of 6%.

Crude fat content of pulp and seed were 17.76 and 29.68%, respectively. This qualify *Haematostaphis barteri* as an oil-rich vegetable, since it is comparable with soybean (22.8 – 23.5%) (Elias *et al.,* 1976; Salunkhe *et al.,* 1985) and pumpkin (Asiegbu, 1989; Fagbemi & Oshodi, 1991) grown in Nigeria. The fat content obtained in this report were fairly high when compared with values reported in some leafy vegetables such as bitter leaf (9.05%), Indian spinach (11.04%), bush – buck (3.51%), scent leaf (4.02%), amaranthus hybrids (14.02%) (Asaolu *et al.,* 2012); *Ocimum bassillium, Ocimum vivide* and *Piper guineens* (Udosen, 1995). Crude protein values (21.81 – 29.38%) are more than what was reported for some leafy vegetables such as *Momordica balsamina* (11.29%), *Moringa oleifera* (20.72), *Lesianthera africiana* leaves (13.10 – 14.90%) and *Leptadenia hastate* (19.10) (Asaolu *et al.,* 2012). Plant foods that provide more than 12% of their calorific value from protein have been shown to be good sources of protein (Ali, 2009). This shows that *H. barteri* is a good source of protein. This can also be confirmed since the protein contents obtained are comparable to those of protein – rich foods such as cowpea (24.13%) (Arewande & Borokini, 2010), pigeon pea (21.53%) (Oboh *et al.,* 2010), bambara groundnut (24.44%) (Agunbiade *et al.,* 2011), and kersting's groundnut (12.90%) (Aremu *et al.,* 2006a). Crude fibre is a significant component in the body. It increases stool bulk and decreases the time that waste materials spend in the gastrointestinal tracks (Aremu *et al.,* 2015). Crude fibre in the diet consists mostly of the plant polysaccharides that cannot be digested by human dietary enzymes such as cellulose, hemicelluloses and some materials that make up the cell wall (Southland, 1975). The fibre content values obtained in the pulp (8.44%) and seed (2.40%) samples of *H. barteri* exceed that of *T. triangulare* (2.40%), *T. occidentalis* (1.7%) and *C. argentea* (1.8%) (Akachukwu & Fawusi, 1995). Therefore, the consumption of *H. barteri* may be advantageous since high fibres content of foods help in digestion, prevention of colon cancer and in the treatment of diseases such as obesity, diabetes and gastrointestinal disorders (Saldanha, 1995; UICC/WHO, 2005).

The carbohydrate values revealed in Table 1 are high compared to the carbohydrate level of 8.0% in *T. occidentalis* (FAO, 1986). High fatty acid value in oil indicates that the oil may not be suitable for use in cooking (edibility), but however, be useful for industrial purposes (Akintayo, 2004; Aremu *et al.,* 2006b). The high metabolizable energy values obtained showed that the sample had energy concentration more favourable than cereals (Paul & Southgate, 1978; Adeyeye & Aye, 1998) and tubers (Aremu *et al.,* 2015). However, the values compare favourable well with those reported for some legumes such as bambara groundnut (1691.3 kJ/100g), kersting's groundnut (1692.9 kJ/100g) cranberry beans (1651.7 kJ/100g) (Aremu *et al.,* 2006a), red kidney bean (1678.4 kJ/100g) (Audu & Aremu, 2011). The coefficient of variation (CV%) levels were relatively close ranging from 8.59 in calculated metabolizable energy to 25.13 in crude fat.

### 4.2 Amino acid composition

The results of amino acid profiles of pulp and seed samples of H. barteri are shown in Table 2. Glutamic acid was the most highly concentrated (7.73 – 9.85 g/100g crude protein, cp) non – essential amino acid in the samples. However, the values obtained in this report is lower than Glu content of protein concentrate of some Nigerian plant foods; *Luffa cylindrical* kernel (13.0 g/100g cp) (Olaofe *et al.,* 2007), *Prosopis Africana* flour (13.3 7.73 – 9.85 g/100g cp) (Aremu *et al.,* 2007a), *Anarcadium occidentale* protein (13.6 g/100g cp) (Aremu *et al.,* 2007b), soybean (16.25 g/100g cp) (Odumodu, 2010) and *Cyperus esculentus* (19.7 g/100g cp) (Aremu *et al.,* 2015). But the values are comparable to the reported Glu content of some Nigerian legumes; lima bean (7.45 g/100g cp), pigeon pea (8.40 g/100g cp) and African yan bean (7.45 g/100g cp) reported by Oshodi *et al.* (1998); *H. barteri* leaves (9.52 g/100g cp) and *H. cannabinus* (11.11 g/100g cp) reported by Kabmarawa *et al.* (2009). It is observed that glutamic and aspartic acids (together make up 14.06 g/100g cp) are the most abundant amino acids in the pulp sample. Some workers (Kuri *et al.,* 1991; Olaofe *et al.,* 1994; Oshodi *et al.,* 1998; Adeyeye, 2004; Aremu *et al.,* 2006c, 2006d; Kubmarawa *et al.,* 2009; Odumodu, 2010; Aremu *et al.,* 2015) had similar observation. Arginine constituted the highest single essential amino acid (EAA) in both the pulp and seed samples (4.66 – 7.59 g/100g cp). Arg is an essential amino acid for children growth (Aremu *et al.,* 2006e).

The least amino acid was methionine (0.55 and 1.20 g/100g cp) in pulp and seed, respectively. Tryptohan (Try) could not be determined in the samples. The calculated isoelectric point (pI) was 3.86 in the seed sample. This is useful in predicting the pI for protein in order to enhance the quick precipitation of protein isolate from biological samples (Olaofe & Akintayo, 2000). The predicted protein efficiency ratio (P – PER) is one of the quality parameters used for protein evaluation (FAO/WHO, 1991). The P – PER in this report for seed sample (1.95) is higher than the reported P – PER values of *Lathyrus sativus L.* (1.03) (Salunkhe & Kadam, 1989), but lower than those reported by Audu & Aremu (2011) (2.5), Aremu *et al.* (2007a) (2.3) and Aremu *et al.* (2015) (2.77), for red kidney bean, *Prosopis Africans* and tiger nut respectively. However, the P – PER value obtained in this study is in close agreement with that of *Phaseolus coccineus* (1.91) (Aremu *et al.,* 2008). Chemical, biochemical and pathological observations in experiments conducted in human and laboratory animals showed that high leucine in the diet impairs the metabolism of tryptophan and niacin, and it is responsible for niacin deficiency in sorghum eaters (Ghafoorunisa & Narasinga, 1973). High leucine is also a factor contributing to the pellagragenic properties of maize (Belvady & Gopalem, 1969). These studies suggest that the leucine/isoleucine balance is more important than dietary excess of leucine alone. The Leu/Ile ratios in the samples (1.34 – 2.03) were low. The seed sample of *H. barteri* has the highest concentrations of all the amino acids except for Thr, Pro and Ile which differs from the pulp by 6.88%, 28.89% and 10.53%, respectively. The level of CV% ranged from 3.56 in Thr to 55.56 in Ile.

The nutritive value of a protein depends primarily on the capacity to satisfy the needs for nitrogen and essential amino acids (Pellet and Young, 1980). Table 3 depicts the essential, non – essential, acidic, neutral and sulphur containing amino acids. The total essential amino acids (TEAA) with His of pulp (26.49 g/100g cp) and seed (34.28 g/100g cp) represent 49.62 and 51.10% respectively. This is comparable with values obtained for selected oil seeds *Prosopis africana* protein concentrate (31.9 g/100g cp) (Aremu *et al.,* 2007a) and *Anarcadium occidentale* protein concentrate (35.3 g/100g cp) (Aremu *et al.,* 2007b). However, it is less than that of some Nigeria legume protein concentrates; lima bean (44.88 g/100g cp), pigeon pea (48.11 g/100g cp), and African yam bean (48.28 g/100g cp) reported by Oshodi *et al.* (1998) and tiger nut (41.21 g/100g cp) by Aremu *et al.* (2015). Nevertheless, the TEAA contents (%) in this report are well above the 39% considered to be adequate for ideal protein food for infants, 26% for children and 11% for adults (FAO/WHO/UNU, 1985). The concentrations of total sulphur amino acids (TSAA) which range from 1.21 – 2.59 g/100g cp are lower than the 5.8 g/100g cp recommended for infants (FAO/WHO/UNU, 1985). The values of essential aromatic acids (EArAA) (2.70 – 3.37 g/100g cp) are also lower than the ideal range suggested for infant protein (6.8 – 11.8 g/100g cp) (FAO/WHO/UNU, 1985). The total acidic amino acid (TAAA) is found to be greater than the total basic amino acid (TBAA) in both the pulp and seed samples, indicating that *H. barteri* protein is probably acidic in nature (Aremu *et al.,* 2012). The percentage ratios of TEAA with His to TAA (total amino acids) in the samples were 49.69 and 51.10% for the pulp and seed samples, respectively. These values are comparable to that of egg (50%) (FAO/WHO, 1991), scarlet runner bean (48.31%) (Aremu *et al.,* 2006d), *Anarcadium occidentale* (47.19%) (Aremu *et al.,* 2007b), *Vigna subterranean* L. Verdc protein concentrate (49.7%) (Aremu *et al.,* 2008), some selected spices (47.30 – 49.95%) (Aremu *et al.,* 2011) and tiger nut (48.31%) (Aremu *et al.,* 2015).

The essential amino acids contents in this report were lower than the FAO/WHO (1991) recommended pattern. Thus by implication, dietary formula based on the pulp and seed samples of *H. barteri* will require essential amino acid supplementation. It has been reported that EAAs most often acting in a limiting capacity are Met (and Cys), Lys and Try (FAO/WHO/UNU, 1985). Try was not determined. In this study, Leu and Lys are the first and second limiting amino acids (LAA) for pulp, while Lys and Leu serves as the first and second LAA for seed sample, respectively.

 

## 5. Conclusion

The studies conducted on the proximate composition and amino acid profile of pulp and seed of *H. barteri* revealed that the crude fat and crude protein contents are favourably comparable to that of oil and protein rich foods respectively, such as soybean, cowpea and bambara groundnut. Amino acid analysis indicates that the samples contained nutritionally useful quantities of most of the essential amino acids, but dietary formula based on the samples may require some essential amino acids supplementation.

## 6. Acknowledgements

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## 7.0 References

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