# AMINO ACID COMPOSITION OF PULP AND SEED OF BAOBAB (*Adansonia digitata L.*)

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**Abstract:** Baobab (*Adansonia digitata L.)* is an underutilized tropical fruit tree of family *Bombacaceae* which is mostly found in Northern Nigeria. Proximate and amino acid compositions of pulp and seed of *Adansonia digitata L.* were investigated using standard analytical techniques. The respective proximate composition values (%) for the pulp and seed samples were: moisture (10.90 and 3.50), ash (4.20 and 2.80), crude fat (0.40 and 13.10), crude protein (3.20 and 19.20), crude fibre (5.80 and 15.30), and carbohydrate (72.50 and 46.10). The calculated fatty acids and metabolizable energy for the pulp and seed samples were 0.32 and 10.48%; 1352.70 and 1594.80 kJ/100g, respectively. The values of metabolizable energy in this study showed that both samples have energy concentrations comparable to some legumes. The amino acid profile revealed that pulp and seed samples of *Adansonia digitata L.* 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 98.24 and 106.64; 40.31 and 45.34; 2.52 and 3.93; 8.91 and 9.71, respectively. However, essential amino acid supplementation may be required in a dietary formula based on *Adansonia digitata L.* (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 *Adansonia digitata L.* is Threonine.

**Keyword:** Proximate, amino acids, pulp, seed, *Adansonia digitata* L.

## Introduction

In developing countries like Nigeria, the need for sustainable development and economic recovery is crucial particularly in the area of access to quality proteinous food and food security. Conversely, the commonly relied source of quality protein which is animal protein is grossly expensive and scarce (Adebowale & Adebowale, 2007). In view of the above, researchers have directed their efforts at exploring new and nonconventional sources of food that grow in the arid and semiarid land regions. Baobab trees are indigenous to these regions.Baobab (*Adansonia digitata*), locally called kuka (Hausa) andluru (Yoruba), which is another non-conventionalfeedstuff that is readily available and under-utilized butholds much agronomic potentials.It is a tropical fruit tree of family *Bombacaceae* which is mostly found in Northern Nigeria.The plant is of multipurpose, for food, beverage and medicine.

Every part of theplant (*Adansonia digitata L.*) is reported to be useful (Igboeli *et al.*, 1997; Gebauer *et al.*, 2002). The leaves, for instance, are usedin the preparation of soup. Seeds are used as athickening agent in soups, but they can be fermented as a flavouring agent, or roasted and eaten assnacks (Addy & Eteshola, 1984). The pulp is eithersucked or made into a drink while the bark is used inmaking ropes (Igboeli *et al.*, 1997). The different parts ofthe plant provide food, shelter, clothing and medicine aswell as material for hunting and fishing (Venter &Venter, 1996; Sidibe & Williams, 2002). Baobab treeprovides income and employment to rural and urbanhouseholds.

As a result of its high natural vitamin C content, baobab fruit pulp has a well-documented antioxidant capability (Vertuani *et al.*, 2002; Besco *et al.*, 2007; Lamien-Meda *et al.*, 2008; Blomhoff *et al.*, 2010; Brady, 2011). Antioxidants could help prevent oxidative stress related diseases such as cancer, aging, inflammation and cardiovascular diseases as they may eliminate free radicals which contribute to these chronic diseases (Kaur & Kapoor, 2001; Blomhoff *et al.*, 2010). The high vitamin C and antioxidant content of thefruit pulp may have a role to play in the extension ofshelf-life for foods and beverages, as well as cosmetics (Sidibe & Williams, 2002; Gruenwald & Galizia, 2005).

Most of the previous studies on the baobab fruit have focusedon the seed oil. Therefore, the purpose of this study isto determine the proximate and amino acidcomposition as well as to evaluatethe metabolizable energy, isoelectric point, predicted protein efficiency ratio and amino acid scores of baobab fruit pulp and seed grown in North Central Nigeria.

## Materials and Methods

### *Collection and preparation of samples*

The Baobab (*Adansonia digitata L.*)fruits were purchased from a local market in Gora village, Karu Local Government,Nasarawa State, Nigeria. The pulp was manually separated from the seeds using a knife. The seeds were ground in a hammer mill to pass through a 40 mesh screen, then placed in an airtight plastic jar and stored for further analysis.

### *Proximate analysis*

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

### *Amino acid analysis*

The amino acid analysis was by Ion Exchange Chromatography (IEC) (FAO/WHO, 1991) using the TechnicoSequential Multisample (TSM) Amino Acid Analyzer (Technicon Instruments Corporation, New York). Theperiod of analysis was 76 min for each sample. The gas flow rate was 0.50 mLmin$^{-1}$ at 60$^{o}$C with reproducibilityconsistent within ±3%. The net height of each peak produced by the chart recorder of the TSM (eachrepresenting an amino acid) was measured and calculated. Amino acid values reported were the averages of twodeterminations. Nor–leucine was the internal standard. Tryptophan was determined after alkali (NaOH) hydrolysis by the colorimetric method (Freidman & Finely, 1971).

***Determination of isoelectric point (pI), quality of dietary protein and predicted protein efficiencyratio (P–PER)***

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

$$\boldsymbol{plm} = \sum_{i=1}^{n=1} pliXi \ldots\ldots\ldots\ldots (1)$$

**Where:**

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

**pIi** = the isoelectric point of the ith amino acids in the mixture;

**Xi =** the mass or mole fraction of the amino acids in the mixture.

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

$$AAS = \frac{mgoraminoacidin\,1goftestprotein}{mgofaminoacidinreferenceprotein} \times \frac{100}{1} \ldots\ldots\ldots (2)$$

The predicted protein efficiency ratio (P–PER) of the seed sample was calculated from their amino acidcomposition based on the equation developed by Alsmeyer *et al.* (1974) as stated thus;

P–PER = –0.468 + 0.454(Leu) – 0.105(Tyr) …….. (3)

***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. crudefat x 0.8 = corresponding to fatty acids value (Paul & Southgate, 1978). The energy values were calculated byadding 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.

**Results and Discussion**

The proximate compositions of the pulp and seed of*Adansonia digitata*are presented in Table 1. The pulp and seed samples have 10.90% and 3.50% moisture, 4.20% and 2.80% ash, 0.40% and 13.10% crude fat, 3.20% and 19.20% crude protein, 5.80% and 15.30% crude fibre, and 75.50% and 46.10% carbohydrate respectively. The calculated fatty acids and metabolizable energy were 0.32 and 10.48%; 1352.70 and 1594.80 kJ/100g, respectively.

The moisture contents of pulp and seed of *Adansonia digitata* (Table 1) were all within the recommended dietary allowance (RDA) (3 – 10) (NRC, 1989). These contents are lower than that of pawpaw (88.89%) (Ugbogu & Ogodo, 2015), apple (78.24%) (Fasoyiro *et al.*, 2005), cucumber (41.97%) and soursop (10.97%) (Apiamu *et al.*, 2015) but higher when compared to the seed of *Maesobotry barteri* fruit (3.85%) (Ogbuagu & Agu, 2008), 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 & Ayejugo, 1994). Moderate moisture content of $\leq$ 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 are more minerals in the pulp (4.20%) than the seed (2.80%), the values of ash content are comparable to those reported for some leafy vegetable such as *Solanium nodiflorum* (ogumo) (2.67%) (Adeleke & Abiodun, 2010). Both the samples had ash content lower than the lowest RDA value of 6%.

Crude protein value of the seed (19.20%) is more than what was reported for some other leafy vegetable such as *Momordica balsamina* (11.29%), and *Lesianthera africiana* leaves (13.10 – 14.90%) (Asaolu *et al.*, 2012) and *M. barteri* (11.40 – 13.30%) (Ogbuagu & Agu, 2008). 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 *Adansonia digitata* (seed) is a good source of protein. This can also be confirm since the protein content of the seed obtained is 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 fat content of pulp and seed were 0.40 and 13.10%, respectively. The fat content of the seed sample obtained in this report is fairly high when compared with values reported in some other leafy vegetable such as bitter leaf (9.05%), Indian spinach (11.04%), bush – buck (3.51%) and scent leaf (4.02%) (Asaolu *et al.*, 2012) and *M. barteri* (7.06%) (Ogbuagu & Agu, 2008). 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.*, 2015b). 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 (5.80%) and seed (15.30%) samples of *A. digitata* exceed that of *T. triangulare* (2.40%), *T. occidentalis* (1.7%) and *C. argentea* (1.8%) (Akachukwu & Fawusi, 1995). Therefore, the consumption of *A. digitata* may be advantageous since high fibre 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 indicate that the oil may not be suitable for use in cooking (edibility), but could be useful for industrial purposes (Akintayo, 2004; Aremu *et al.*, 2006b), therefore oil obtained from baobab (*A. digitata*) fruit will be suitable for use in cooking because of it low acid value. The high metabolizable energy values obtained showed that the samples had energy concentration that compare fairly 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 and

Aremu, 2011). The coefficient of variation (CV %) levels range from 8.21 in calculated metabolizable energy to 94.07 in crude fat.

**Table 1: Proximate composition (%)[a] *Adansonia digitata***

| Parameter | Pulp | Seed | Mean | SD | CV% |
|---|---|---|---|---|---|
| Moisture | 10.90 ± 0.20 | 3.50 ± 0.10 | 7.20 | 3.70 | 51.39 |
| Ash | 4.20 ± 0.20 | 2.80 ± 0.20 | 3.50 | 0.70 | 20.00 |
| Crude fat | 0.40 ± 0.10 | 13.10 ± 0.30 | 6.75 | 6.35 | 94.07 |
| Crude protein | 3.20 ± 0.30 | 19.20 ± 0.30 | 11.20 | 8.00 | 71.43 |
| Crude fibre | 5.80 ± 0.10 | 15.30 ± 0.50 | 10.55 | 4.75 | 45.02 |
| Carbohydrate[b] | 75.50 ± 0.30 | 46.10 ± 0.20 | 60.80 | 14.70 | 24.18 |
| Fatty acid[c] | 0.32 ± 0.08 | 10.48 ± 0.24 | 5.40 | 5.08 | 94.07 |
| Energy[d] | 1352.70 ± 2.10 | 1594.80 ± 3.50 | 1473.75 | 121.05 | 8.21 |

[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)

Table 2 shows the amino acid profile of the pulp and seed of *Adansonia digitata*. Eighteen amino acids were detected. The *Adansonia digitata* was a source of ten essential amino acids. Arginine and glutamic acid were the most abundantessential and non-essential amino acidswith values 6.30 and 12.23 g/100g crude protein (cp) (pulp) and 8.45 and 12.89 g/100g cp (seed) respectively. The sulphurcontaining amino acids, methionine and cystine were 1.21 and 1.31 g/100g cp (pulp), and 1.83 and 2.10 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 98.24 and 106.64; 40.31 and 45.34; 2.52 and 3.93; and 8.91 and 9.71, respectively.

**Table 2: Amino acid composition of *Adansonia digitata* (g/100g crude protein)**

| Amino acid | Pulp | Seed | Mean | SD | CV% |
|---|---|---|---|---|---|
| Lysine (Lys)[h] | 4.95 | 4.67 | 4.81 | 0.14 | 2.91 |
| Histidine (His)[h] | 2.14 | 2.72 | 2.43 | 0.29 | 11.93 |
| Arginine (Arg)[h] | 6.30 | 8.45 | 7.38 | 1.08 | 14.63 |
| Aspartic (Asp) | 9.21 | 11.36 | 10.29 | 1.08 | 10.50 |
| Threonine (Thr)[h] | 2.32 | 2.03 | 2.18 | 0.15 | 6.88 |
| Serine (Ser) | 7.01 | 6.91 | 6.96 | 0.05 | 0.72 |
| Glutamic acid (Glu) | 12.23 | 12.89 | 12.56 | 0.35 | 2.79 |
| Proline (Pro) | 7.94 | 6.83 | 7.39 | 0.56 | 7.58 |
| Glycine (Gly) | 6.39 | 6.41 | 6.40 | 0.01 | 0.00 |
| Alanine (Ala) | 5.06 | 5.79 | 5.43 | 0.37 | 6.81 |
| Cystine (Cys) | 1.31 | 2.10 | 1.71 | 0.40 | 23.39 |
| Valine (Val)[h] | 5.31 | 6.16 | 5.74 | 0.43 | 7.49 |
| Methionine (Met)[h] | 1.21 | 1.83 | 1.52 | 0.31 | 20.39 |
| Isoleucine (Ile)[h] | 3.68 | 3.42 | 3.55 | 0.13 | 3.66 |
| Leucine (Leu)[h] | 5.49 | 6.35 | 5.92 | 0.43 | 7.26 |
| Tyrosine (Tyr) | 8.78 | 9.01 | 8.90 | 0.12 | 1.35 |
| Tryptophan (Trp)[h] | 3.28 | 3.18 | 3.23 | 0.05 | 1.55 |
| Phenylalanine (Phe)[h] | 5.63 | 6.53 | 6.08 | 0.45 | 0.07 |
| Isoelectric point (pI) | 5.18 | 5.63 | 5.41 | 0.23 | 4.25 |
| P–PER | 1.10 | 1.47 | 1.29 | 0.19 | 14.73 |
| Leu/Ile | 1.49 | 1.86 | 1.68 | 0.19 | 11.31 |

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

The results of amino acid composition of pulp and seed samples of *A. digitata* are shown in Table 2. Glutamic acid (Glu) was the most highly concentrated (12.23 – 12.89 g/100g crude protein, cp) non – essential amino acid in the samples followed by aspartic (9.21 – 11.36 g/100g crude protein, cp). However, the value of Glu obtained in this report is comparable to that obtained from the protein concentrate of some Nigerian plant foods; *Luffa cylindrical* kernet (13.0 g/100g cp) (Olaofe *et al.*, 2008), *Prosopic Africana* flour (13.3 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.*, 2015a). But the values are higher than the reported Glu content of some Nigerian legumes; liman bean (7.45 g/100g cp), pigeon pea (8.40 g/100g cp) and African yam 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) and *H. barteri* pulp (7.73 g/100g cp) and seed (9.85 g/100g cp) (Aremu *et al.*, 2015b). It is observed that glutamic and aspartic acids (together make up 21.44 and 24.25 g/100g cp) are the most abundant amino acids in the pulp and seed samples respectively. 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.*, 2015a, b) had similar observation. Arginine constituted the highest single essential amino acid (EAA) in both the pulp and seed samples (6.30 – 8.45 g/100g cp). Arg is an essential amino acid for children growth (Aremu *et al.*, 2006e).

The least amino acid was methionine (1.21 and 1.83 g/100g cp) in pulp and seed respectively. The calculated isoelectric point (pI) were 5.18 (pulp) and 5.63 (seed) samples. 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 (1.47) is higher than the reported P – PER values of *Lathynis sativus L.* (1.03) (Salunkhe & Kadam, 1989), but lower than those reported by Audu & Aremu (2011) (2.5), Aremu *et al.* (2007a) (2.3), Aremu *et al.* (2015a) (2.77) and Aremu *et al.* (2015b) (1.95) for red kidney bean, *Prosopis Africans*, tiger nut and *H. barteri* seed respectively. 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 (1.49 – 1.86) were low.

The nutritive value of a protein depends primarily on the capacity to satisfy the needs for nitrogen and essential amino acids (Pellet & 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 (40.31 g/100g cp) and seed (45.34 g/100g cp) represent 41.03 and 42.53% respectively. Histidine is important for the synthesis of red and white blood cells. It is a precursor for histamine which is good for sexual arousal and improved blood flow (Khan

& Bassey, 2015, Omoyeni*et al.,* 2015). High dosage of histidine however increases stress and anxiety (Cox & Nelson, 2011). The TEAA contents with His (%) 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 2.52 – 3.93 g/100g cp are lower than the 5.8 g/100g cp recommended for infants (FAO/WHO/UNU, 1985). The % Cystine in TSAA ranged from (51.98 - 53.44), this is in agreement to the reported value for *Parkia biglobossa* seeds (44.4%) (Adeyeye, 2006). It has also been reported that most animal proteins are low in cystein and hence% Cystine in TSAA ratios, for instance, 21.0%, 38.8% and 35.5% were reported for *Limicolaria sp*, *A.archantina* and *A.marginata* respectively (Adeyeye & Afolabi, 2004). Cysteine has a positive effect on mineral absorption, especially Zinc (Mendoza, 2002). The values of essential aromatic acids (EArAA) (8.92 – 9.71 g/100g cp) are within 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 *A. digitata* 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 41.03 and 42.52% for the pulp and seed samples respectively. These are lower than the reported values 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 concentrate (49.7%) (Aremu *et al.,*2008), some selected spices (47.30 – 49.95%) (Aremu *et al.,* 2011), tiger nut (48.31%) (Aremu *et al.,* 2015a) and *H. barteri* (51.10%) (Aremu *et al.,* 2015b).

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

| Amino acid description | Pulp | Seed |
|---|---|---|
| Total amino acid (TAA) | 98.24 | 106.64 |
| Total non–essential amino acid (TNAA) | 57.93 | 61.30 |
| % TNAA | 64.01 | 57.48 |
| Total essential amino acid (TEAA) | | |
| With histidine | 40.31 | 45.34 |
| Without histidine | 38.17 | 42.62 |
| % TEAA | | |
| With histidine | 41.03 | 42.52 |
| Without histidine | 38.85 | 36.43 |
| Essential alphatic amino acid (EAAA) | 16.80 | 17.96 |
| Essential aromatic amino acid (EArAA) | 8.91 | 9.71 |
| Total neutral amino acid (TNAA) | 63.41 | 66.55 |
| % TNAA | 64.55 | 62.41 |
| Total acidic amino acid (TAAA) | 21.44 | 24.25 |
| % TAAA | 21.82 | 22.74 |
| Total basic amino acid (TBAA) | 13.39 | 15.84 |
| % TBAA | 13.63 | 14.85 |
| Total sulphur amino acid (TSAA) | 2.52 | 3.93 |
| % cystine in TSAA | 51.98 | 53.44 |

**Table 4: Amino acid scores of *Adansonia digitata* based on FAO/WHO standards**

| EAA | PAAESP g/100g protein | Pulp | | Seed | |
|---|---|---|---|---|---|
| | | EAAC | AAS | EAAC | AAS |
| Ile | 4.0 | 3.68 | 0.92 | 3.42 | 0.86 |
| Leu | 7.0 | 5.49 | 0.78 | 6.35 | 0.91 |
| Lys | 5.5 | 4.95 | 0.90 | 4.67 | 0.85 |
| Met + Cys (TSAA) | 3.5 | 2.52 | 0.72 | 3.93 | 1.12 |
| Phe + Tyr | 6.0 | 14.41 | 2.40 | 15.54 | 2.59 |
| Thr | 4.0 | 2.32 | 0.58 | 2.03 | 0.51 |
| Trp | 1.0 | 3.28 | 3.28 | 3.18 | 3.18 |
| Val | 5.0 | 5.31 | 1.06 | 6.16 | 1.23 |
| **Total** | **36.0** | **41.96** | **10.64** | **45.28** | **11.25** |

**EAA** = Essential Amino Acid; **PAAESP** = Provisional Amino Acid (Egg) Scoring Pattern; **EAAC** = Essential Amino Acid Composition; **AAS** = Amino Acid Score

Results of essential amino acid scores based on the provisional amino acid scoring pattern (FAO/WHO, 1991) standards are shown in Table 4. The EAAC of Ile, Leu, Lys, Met + Cys (TSAA), Phe + Tyr, Thr, Trp and Val were 3.68, 5.49, 4.95, 2.52, 14.41, 2.32, 3.28 and 5.31 (pulp), and 3.42, 6.35, 4.67, 3.93, 15.54, 2.03, 3.18 and 6.16 (seed) respectively.The essential amino acids contents in this report with the exception of Try were lower than the FAO/WHO (1991) recommended pattern. Thus by implication, dietary formula based on the pulp and seed samples of *A. digitata* 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). In this study, Thr is the first limiting amino acids (LAA) for both pulp and seed samples, while Met and Lys were the second LAA for the pulp and seed samples respectively.

## Conclusion

The proximate and amino acid composition of pulp and seed ofbaobab found in Northern Nigeria had been documented. The seed sample had the highest total amino acids value (106.64 g/100gcp) while the pulp the protein value (98.24 g/100gcp). Both samples were found to be rich sources of essential amino acids, and the results compared well with other reported values for other plants. The results further showed that if the baobab fruitis consumed in sufficient amount, it could contribute to meeting human nutritional needs and helps to combat diseases associated with malnutrition. It is therefore recommended for consumption both as fruit and food supplements especially when animal proteins becomes expensive since they are relatively cheap sources of protein.

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