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COMPOSITIONAL EVALUATION OF YOUNG SHOOT OF DELEB PALM (*BORASSUS AETHIOPUM*, MART) AND WHITE YAM (*DIOSCOREA ROTUNDATA*) FLOURS

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Abstract
Proximate, mineral and amino acid compositions of young shoot of deleb palm (Borassus aethiopum, Mart) and white yam (Dioscorea rotundata) were studied using standard analytical techniques. The respective proximate composition values (g/100g sample) of B. aethiopum and D. rotundata were: Moisture content have (2.5), ash (3.0 and 4.1), crude fat (0.2 and 1.8), crude fibre (5.0 and 7.8), crude protein (1.0 and 3.3), and carbohydrate (87.2 and 78.3). The calculated metabolizable energy. for B. aethiopum and D. rotundata were 1507.11 kJ/100g and 1450 .93 kJ/100g, respectively. The metabolizable energy in this study showed that both samples have energy concentrations more favourable than cereals. The most abundant minerals in B. aethiopum and D. rotundata were Ca (275.6 and 346.9 mg/100g), Mg (126.3 and 219.6 mg/100g) and Na (78.0 and 170.5 mg/100g), respectively. Generally the two food samples were found to be good sources of essential minerals while harmful metals such as Pb, Cr and Cd were not at detecteble range of AAS. The levels of Na/K and Ca/P ratios were desirable compared with the recommended values. The amino acid analysis revealed that both samples contained nutritionally useful quantities of most of the essential amino acids with total essential amino acid (TEAA) (with His) were 46.49 and 45.44% for B. aethiopum and D. rotundata, respectively. The first limiting amino acid was methionine + Cystine (TSAA), calculated isoelectric point (pI) and predicted protein efficiency ratio (P-PER) for B. aethiopum and D. rotundata were (0.52 and 0.33), (4.03 and 3.78) and (2.17 and 2.60), respectively.

Keywords: Chemical composition, deleb palm, white yam, flour.

INTRODUCTION

Deleb palm *(Borassus aethiopum,* Mart) is an unbranched palm growing up to 8 m wide, young plants are covered with dry leaf stalks, showing gradually fading leaf scars, trees over 25 h old have a swelling of the trunk at 12-15 m above the ground . Back is pale grey in older palms and is more or less smooth leaves are very large, fan shaped, bluish-green, 1.5-3.0 m up to 3.5 m up long, including petiole which is marked with sharp black thorns, leaflets symmetric at the base. Flowers clustered in a branched spadix, 0.8-1.8 m long, female flowers with unbranched and shorter spadix, 1.3-2.6 m long. The fruit is a large drupe, diameter about 15 cm (Akinniyi *et al.*, 2011). Orange to brown when ripe,fibrous pulp contain tree woody kernels with an albmen that becomes hard when ripe. The Hausas of northern Nigeria call it "Giginya", Yorubas of western Nigeria call it "Agbon oludu", Igbos of eastern Nigerian call it "Ubiri", and Eggon of north central Nigeria call it "Agagga". The young germinating shoot of the plant is locally called "Muruchi" in Hausa, muruchi is only well known in northern Nigeria and it is found seasonally in the local markets. The people of northern Nigeria both young and old eat muruchi when boil as food.

Yam is primary agricultural and culturally important commodity in west Africa, where over 95 percent of world`s yam crop is harvested. Yams are still important for survival in this region. Some varieties of these tubers can be stored up to six months without refrigeration which makes them a valuable resource for the yearly period of food scarcity at the beginning of the wet season. Yam cultivars are also cropped in other humid tropical countries (Hsu *et al.*, 2002). Yam tubers can grow up to 1-5 m in length and weigh up to 70 kg and 3-6 m high. The vegetable has a rough skin which is difficult to peel, but which softens after heating. The skin varies in color from dark brown to light pink. The majority of the vegetable is composed of a much softer substance ranges in color from white or yellow to purple or pink in mature yams (FAO, 1988). Due to their abundance and importance to survival, the yam was highly regarded in Nigeria ceremonial culture and in part of many West African ceremonies. Locally, Hausa of northern Nigeria call it "Doya", Yoruba call it "Isu ewura", Igbo call it "Jiaga" and Eggon of north central Nigeria call it "Angiu".

Works have been reported on enabolic effect of androgens of the edible portion of the short of *Borassus aethiopum,* Mart (Akinniyi *et al.*, 2010. Medicinal values of the root extract of *B. aethiopum* was also been tested on albino rat (Sarma and Mahanta, 2000). This research therefore was aimed at evaluating the nutritional quality of *B. aethiopum*, Mart and *D. rotundata* by determining the proximate, mineral and amino acid compositions of these plant foods.

MATERIALS AND METHODS

Collection and Treatment of Samples

Young and mature shoot of deleb palm (*Borassus aethiopum*, Mart) and white yam (*Dioscorea rotundata*) were purchased from Nasarawa market in Nasarawa local government area of Nasarawa State, Nigeria. They were brought to the laboratory and rinsed with distilled water to remove any attached dirt. The shoot of *B. aethiopum*, Mart and *D. rotundata* were chopped into slice and oven dried at 45°C for 72 h. The two samples were ground into fine powder using Kenwood food blender and kept in polyethylene bags until prior to use.

Proximate Analyses

The proximate analyses of sample for moisture, crude fat, crude fibre and total ash were carried out in triplicate according to the methods of Association of Official Analytical Chemists (AOAC, 2000). Nitrogen was determined by the micro–Kjeldahl method and the percentage nitrogen converted to crude protein by multiplying by 6.25. The total carbohydrate content was determined by difference (AOAC, 2000).

Mineral Analysis

Sodium and potassium were determined using a flame photometer (Corning, UK, Model 405), other metals were determined by means of atomic absorption spectrophotometer (Buck Scientific Inc., Connecticut) while phosphorus was determined colorimetrically (AOAC, 2000). All the chemicals used were of analytical grade and obtained from British Drug House (BDH, London).

Amino Acid Analysis

Amino acid analysis was by Ion Exchange Chromatography (IEC) (Alsmeyer *et al.*, 1974) using the Technicon Sequential Multisample (TSM) amino acid analyzer (Technicon Instruments Corporation, Ney York). The period of analysis was 76 min for each sample. The gas flour rate was 0.50 mL/min at 60°C with reproducibility consistent within ± 3 min. The net height of each peak produced by the chart recorder of the TSM (each representing an amino acid) was measured and calculated. The amino acid values reported were the averages of two determinations. Nor–leucine was the internal standard. Tryptophan was not determined.

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

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

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

Where:

pIm = The isoelectric point of the mixture of amino acids.

pI$_i$ = Theisoelectric point of the ith amino acids in the mixture.

X$_i$ = 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 protein compared with needs expressed as a ratio. Amino acid score (AAS) was then estimated by applying the FAO/WHO (1991) formula:

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

The Predicted Protein Efficiency Ratio (P–PER) of the seed sample was calculated from their amino acid composition based on the equation (Alsmeyer *et al.*, 1974) as stated thus; P–PER = –0.468 + 0.454 (Leu) –0.105 (Tyr).

RESULTS AND DISCUSSION

The results of proximate composition, calculated metabolisable energy and fatty acid values of the studied samples are presented in Table 1. The moisture values for *B. aethiopum* and *D. rotundata* were 2.5 g/100g each, which is slightly higher than the value of Prosopis africana flour 1.9 g/100g sample reported by Aremu *et al.* (2007a), slightly comparable to that of red kidney bean flour (2.4 g/100g) as reported by Audu and Aremu (2011); cowpea flour 4.0 g/100g (Aremu *et al.*, 2006a), but slightly lower than the values reported for white coat small cowpea, red specks coat scarlet runner bean, white coat scarlet runner bean which were 18.0, 17.4 and 16.2 g/100g, respectively as reported by Aremu *et al.* (2006b) and the values reported by Akinniyi *et al.* (2011) for the flours of wheat, barley, maize, rice, cassava(sweet), cocoyam and plantain (green) which were 13.4, 14.9, 13.0, 11.2, 56.7, 52.7 and 58.5 g/100g, respectively. The result of the analysis showed that moisture content of *B. aethiopum* is low compared to the value 5.4 g/100g flour sample for *B. aethiopum* as reported by Akinniyi *et al.* (2011). The low moisture content of *B. aethiopum* remains an asset in storage and preservation of the nutrients. Onyeike *et al.* (1995) observed that high moisture content could lead to food spoilage through increasing microbial action. The ash content of the samples were 3.0 g/100g sample for *B. aethiopum* and 4.1 g/100g sample for *D. rotundata* which are comparable to that of red kidney bean seed flour 4.4 g/100g as reported by Audu and Aremu (2011) and 4.4 g/100g for Prosopis africana (Aremu *et al.*, 2007a). Thus higher than the values reported by Akinniyi *et al.* (2011) for flours of wheat, barley, maize, *B. aethiopum*, cassava cocoyam, sweet potato and yam which were 1.70, 2.50, 1.20, 1.18, 1.10, 1.30, 0.70 and 0.90 g/100g sample, respectively. The ether extracts (crude fat) of the samples were 0.2 g/100g sample for *B. aethiopum* and 1.8 g/100g sample for *D. rotundata*, the values are highly lower compared with 15.8 g/100g kidney bean flour reported by Audu and Aremu (2011) and the value reported for soybean 19.5 g/100g (Temple *et al.* 1991). Crude fibre values of the samples were 5.0 g/100g sample for *B. aethiopum* and 7.8 g/100g sample for *D. rotundata*. These values are higher than the value reported for cream coat bambara groundnut, 2.1 g/100g (Aremu *et al.*, 2008); red kidney bean seed flour, 3.6 g/100g (Audu and Aremu, 2011); wheat, barley and maize flours which were 1.9, 4.4 and 2.2 g/100g, respectively (Akinniyi *et al.*, 2011). The result indicates that *D. rotundata* has higher fibre content than *B. aethiopum*. Fibre has useful role in providing roughage that aids digestion (Eva, 1983). Dietary fibre reduces the risks of cardiovascular diseases. Reports have shown that increase in fibre consumption might have contributed to reduction in the incidence of certain diseases such as diabetes, coronary heart disease, colon cancer and various digestive disorder (Augustin *et al.*,1978). Fibre consumption also soften stools and lowers plasma cholesterol level in the body (Norman and Joseph, 1995).

The crude protein values of the samples in (Table 1) are all lower in comparison with the values of 11.1 g/100g for bambara groundnut, 12.0 g/100g for kersting`s groundnut and 51.1 g/100g for scarlet runner bean as reported by Aremu *et al.* (2006); 61.4 g/100g for soybean (Salunkhe *et al.*, 1985); 78.0-80.1 g/100g for chickpea as reported by Sa`nchez-Vioque *et al.* (1998). The values are comparable with protein concentrates of wheat flour (1.9 g/100g), barley flour (1.5 g/100g), rice flour (1.8 g/100g) and *B. aethiopum* flour (1.5 g/100g) (Akinniyi *et al.*, 2011). The carbohydrate contents were 87.2 g/100g for *B. aethiopum* and 78.3 g/100g for *D. rotundata* . The reports of Alinnor and Akalezi (2010) on the carbohydrate contents of white cocoyam and sweet potato were 57.8 g/100g and 76.9 g/100g, respectively. The result of the analysis showed that carbohydrate contents of *B. aethiopum* and *D. rotundata* are higher compared to values reported for white cocoyam and sweet potato. Carbohydrate supplies energy to cells such as brain, muscles and blood. It contribute to fat metabolism and spare proteins as an energy source and act as mild natural laxative for human beings and generally add to the bulk of the diet (Gordon, 2000; Gaman and Sherrington, 1996). *B. aethiopum* can therefore serve as an alternative source of carbohydrate for the consumers. The calculated metabolizable energy values were: *B. aethiopum* (1507.11 kJ/100g) and *D. rotundata* (1450.93 kJ/100g). The high energy value of *B. aethiopum* may be attributed to high carbohydrate contents. The calculated fatty acid of *B. aethiopum* (0.2 g/100g) and *D. rotundata* (1.4 g/100g).

Table 1: Mean proximate composition (g/100g sample)[a] of *B.aethiopum* and *D. rotundata*

Parameter	*B. aethiopum*	*D. rotundata*
Moisture	2.5±1.20	2.5±0.50
Ash	3.0±0.25	4.1±2.2
Crude fat	0.2±0.00	1.8±0.01
Crude fibre	5.0±2.01	7.8±1.10
Crude protein	1.0±0.02	3.3±1.02
Carbohydrate	87.2±2.15	78.3±3.01
[b]Energy (kJ $100g^{-1}$)	1507.11	1450.93
[c]Fatty acid	0.2	1.4

[a]Each value represents the mean ± standard deviation of three replicate determinations; [b]Calculated fatty acids (0.8 x crude fat); [c]Calculated metabolisable energy (kJ $100g^{-1}$) (protein x 17 + fat x 37+ carbohydrate x 17).

Table 2: Mean mineral composition (mg/100g sample) of *B. aethiopum* and *D. rotundata*

Mineral	*B. aethiopum*	*D. rotundata*
Na	78.0	170.5
K	59.0	92.0
Ca	275.6	346.9
Mg	126.3	219.6
P	ND	7.5
Fe	3.4	31.2
Cu	ND	3.6
Pb	ND	ND
Cr	ND	ND
Cd	ND	ND
Mn	5.4	38.7
Zn	2.1	10.1
Na/K	1.3	1.9
Ca/P	-	46.3
Ca/Mg	2.2	1.6

Na/K = Sodium to potassium ratio; **Ca/P** = Calcium to phosphorus ratio; **Ca/Mg** = Calcium to magnesium ratio; **ND** = Not detected.

The result presented in Table 2 showed the mineral composition of *B. aethiopum* and *D. rotundata* flours. Lead, chromium and cadmium were not detected. The least concentrated minerals were zinc 2.1 mg/100g and copper 3.6 mg/100 g, while the abundant minerals in the studied samples of *B. aethiopum* and *D. rotundata* flours were calcium 275.6 - 346.9 mg/100g, magnesium 126.3 - 219.6 mg/100g, sodium 78.0 and 170.5 mg/100g, respectively. Sodium is an important mineral that assist in the regulation of body fluid and in the maintenance of electric potential in the body tissue. The world health organization (WHO) recommended intake of sodium per day is 500 mg for adult and 400 mg for children WHO (1973). The result indicates that sodium content of *B. aethiopum* and *D. rotundata* were below WHO recommended standard. This study shows that potassium composition of *B. aethiopum* and *D. rotundata* were 59.0 mg/100g and 92.5 mg/100g, respectively. Potassium is important in the regulation of heart beat, neurotransmission and water balance of the body. Calcium is an important mineral required for bone formation and neurological function of the body.

calcium in conjunction with phosphorus, magnesium, vitamin A, C and D, chlorine and protein are all involved in bone formation (Fleck, 1976). Calcium is also important in blood clotting, muscle contraction and in certain enzymes in metabolic processes (Adeyeye and Fagbohun, 2005). The recommended daily intake of calcium by WHO is 800 mg for both adult and children. The study indicates that *B. aethiopum* and *D. rotundata* values were below WHO standard. *B. aethiopun* and *D. rotundata* have magnesium composition ranged from 126.3 mg/100g to 219.6 mg/100g, respectively. Magnesium plays essential role in calcium metabolism in bones and also involve in prevention of circulatory diseases. It helps in regulating blood pressure and insulin releases (Onyiriuka *et al.*, 1997; Umar *et al.*, 2005).Magnesium is also an activator of many enzyme systems and maintains the electrical potentials in nerves (Shills, 1973). Recommended dietary allowance (RDA) for magnesium in adult is 350 mg/day, while children is 170 mg/day. The result revealed that the values obtained from *B. aethiopum* and *D. rotundata* were below the recommended values. Therefore, *B. aethiopum* and D. rotundata cannot be regarded as a rich source of magnesium. D. rotundata has 7.5 mg/100g composition of phosphorus, recommended dietary allowance for phosphorus in both adult and children is 800 mg/day, the value of phosphorus in D. rotundata is far below recommended standard. The iron compositions were 3.4 mg/100g for *B. aethiopum* and 31.2 mg/100g for *B. aethiopum* and *D. rotundata*. The recommended dietary allowance of iron in adult and children is 10 mg/day, while female adult is 15 mg/day. Iron is required for blood formation and it is important for normal functioning of the central nervous system (Adeyeye and Fagbohon, 2005). It also facilitates the oxidation of carbohydrates, proteins and fats. The copper contents of *D. rotundata* is 3.6 mg/100g, copper is required in the body for enzyme production and biological electron transport. The result also shows that *B. aethiopum* and *D. rotundata* have zinc composition 2.1 mg/100g and 10.1 mg/100g, respectively. Zinc is an essential micronutrient associated with number of enzymes, especially those associated with synthesis of ribonucleic acid (Guil-guerrero *et al.*, 1998). Zinc deficiency limits the rate of recovery for protein energy in malnourished children (Hambridge, 1986). The ratio of sodium to potassium in the body is of great concern for prevention of high blood pressure. Na/K ratio less than one is recommended, the ratios of Na/K were greater than one in *B. aethiopum* and *D. rotundata*. Therefore, the two samples would promote high blood pressure. The result of the analysis indicates that Ca/P ratio of *D. rotundata* was 46.3 mg/100 g. If the Ca/P ratio is low (low calcium, high phosphorus intake), more than the normal amount of the calcium may be lost in the urine. Food is consider "good" if Ca/P ratio is above one and "poor" if the ratio is less than 0.5, while Ca/P ratio above two helps to increase the absorption of calcium in the small intestine. This study indicates that *B. aethiopum* and *D. rotundata* are both good source of calcium and phosphorus. The ratio of calcium to magnesium in *B. aethiopum* and *D. rotundata* were high with values 2.2 mg/100g and 1.6 mg/100g, respectively, above the recommended value of 1.00 mg NRC (1989).

Table 3 shows the amino acid profile of *B. aethiopum* and *D. rotundata* flours. Glutamic acid and aspartic acid are the most concentrated amino acid in both samples with glutamic acid with concentration 12.04 g/100g to 10.00 g/100g crude protein (cp) and aspartic acid with concentration 9.69 - 10.51 g/100g cp in both sample of *B. aethiopum* and *D. rotundata* flours, while leucine was the most concentrated essential amino acid, with concentration of 6.44 g/100g cp for *B. aethiopum* and 7.35 g/100g cp for *D. rotundata* as expected in food samples. The values obtained are in close agreement with observed values of legumes and nuts (Aremu *et al.*, 2011; Audu and Aremu, 2011; Akintayo *et al.*, 2002; Kuri *et al.*, 1991; Oshodi *et al.*, 1998; Aremu *et al.*,2006b; Adeyeye, 2004). Tryptophan was denatured on application of heat and hence was not detected. Arginine had the highest value in *B. aethiopum* with concentration of 5.02 g/100g cp compared to the concentration of 4.83 g/100g for *D. rotundata*. Cystine had concentration less than one in both *B. aethiopum* and *D. rotundata* flours. The values of leucine, arginine, phenylalanine and lysine are respectively high and hence, this food samples can be prescribed as good sources of essential amino acid. Cystine which is not an essential amino acid can be incorporated by the body because of its low concentration. The calculated isoelectric point (pI) varied between 3.78 for *D. rotundata* to 4.03 for *B. aethiopum*. This is useful in predicting the pI for protein in order to enhance a quick precipitation of protein isolate from biological samples (Olaofe and 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 values in this report are higher than P-PER reported for flour of some legumes (Salunkhe *et al.*, 1989); cowpea (1.21), pigeon pea (1.83) and *Lathyrus sativus* (1.03). However, the protein concentrates of both samples satisfied the FAO requirement (FAO/WHO/UNU, 1985). The nutritive value of a protein depends primarily on the capacity to satisfy the needs for nitrogen and essential amino acids (Oshodi *et al.*, 1998). The total essential amino acids (TEAA) values with histidine were 32.95 g/100g for *B. aethiopum and* 30.47 g/100g for *D. rotundata*. The values without histidine were 30.76 g/100g for *B. aethiopum* and 28.45 g/100g for *D. rotundata* was presented in (Table 4). These values are comparable with values obtained from legume flours of bambara groundnut, kersting's groundnut and scarlet runner bean which were 32.5, 32.7 and 31.8 g/100g cp, respectively (Aremu *et al.*, 2006a). Both of the two samples are to be considered as good sources of the required essential amino acids.

The observed values of *B. aethiopum* (15.95 g/100g cp) and *D. rotundata* (14.90 g/100g cp) for essential aliphatic amino acids (EAAA) which constitute the hydrophobic region protein indicate that *B. aethiopum* has better emulsification properties than *D. rotundata*. Their essential aromatic amino acid scores (EArAA) were low. The ranges of percentage total neutral, acidic and basic amino acids were 52.98 – 54.53%, 30.58-30.66% and 14.88-16.35%, respectively.

Total acidic amino acid (TAAA) which was found to be greater than the percentage of total basic amino acids (TBAA) in the samples indicating that the protein is probably acidic in nature (Aremu *et al*, 2006b).

Table 3: Amino acid composition (g/100g crude protein) of *B.aethiopum and D. rotundata* Flours

Amino Acid	*B. aethiopum*	*D. rotundata*
Lysine (Lys)[a]	4.38	3.13
Histidine (His)[a]	2.19	2.02
Arginine (Arg)[a]	5.02	4.83
Aspartic acid (Asp)	9.69	10.51
Threonine (Thr)[a]	2.39	2.01
Serine (Ser)	3.01	3.26
Glutamic acid (Glu)	12.04	10.00
Proline (Pro)	2.65	2.54
Glycine (Gly)	3.24	2.91
Alanine (Ala)	3.80	4.10
Cystine (Cys)	0.79	0.73
Valine (Val)[a]	3.82	3.16
Methionine (Met)[a]	1.02	0.78
Isoleucine (Ile)[a]	3.30	2.38
Leucine (Leu)[a]	6.44	7.35
Tyrosine (Tyr)	2.70	4.39
Phenylalanine (Phe)[a]	4.39	4.81
(pI)[b]	4.03	3.78
(P-PER)[c]	2.17	2.60

[a] = Essential amino acids; [b] = Calculated isoelectric point (pI); [c] = Predicted protein efficiency ratio (P-PER).

Table 4: Classification of Amino Acid Composition (g/100g) of *B. aethiopum and D. rotundata* Flours

Parameter	*B. aethiopum*	*D. rotundata*
Total amino acid (TAA)	70.87	67.06
Total non-essential amino acid (TNEAA)	37.92	36.59
% TNEAA	53.51	54.56
Total essential amino acid (TEAA)		
With histidine	32.95	30.47
Without histidine	30.76	28.45
%TEAA		
With histidine	46.49	45.44
Without histidine	43.40	42.42
Essential alphatic amino acid (EAAA)	15.95	14.90
Essential aromatic amino acid (EArAA)	4.39	4.81
Total neutral amino acid (TNAA)	37.55	36.57
% TNAA	52.98	54.53
Total acidic amino acid (TAAA)	21.73	20.58
% TAAA	30.66	30.58
Total basic amino acid (TBAA)	11.59	9.98
% TBAA	16.35	14.88
Total sulphur amino acid (TSAA)	1.81	1.51
% Cystine in TSAA	43.65	48.34

Table 5: Amino acid scores of *B. aethiopum and D. rotundata*

EAA	PAAESP (g/100g protein)	*B. aethiopum* EAAC	*B. aethiopum* AAS	*D. rotundata* EAAC	*D. rotundata* AAS
Ile	4.0	3.30	0.83	2.38	0.60
Leu	7.0	6.44	0.92	7.35	1.05
Lys	5.5	4.39	0.80	3.13	0.57
Met +Cys (TSAA)	3.5	1.81	0.52	1.51	0.33
Phe + Tyr	6.0	7.09	1.18	7.35	1.23
Thr	4.0	2.39	0.60	2.01	0.50
Try	1.0	ND	ND	ND	ND
Val	5.0	3.82	0.76	3.16	0.63
Total	36.0	29.24	5.61	26.89	4.91

EAA = Essential Amino Acid; **PAAESP** = Provitional Amino Ecid (Egg) Scoring Pattern; **EAAC** = Essential Amino Acid Composition (see Table 3); **AAS** = Amino Acid Score; **ND** = Not Determined; [a]**Source:** Belchant *et al.* (1975).

Table 5 shows the amino acid scores of the samples as revealed that the first limiting amino acid in *B. aethiopum* and *D. rotundata* was Met + Cys (0.52 and 0.33). Most of the essential amino acids in both samples are lower than the FAO/WHO (1991) recommended pattern. Thus by implication, dietary formula based on these rare food sample varieties will require some amino acids supplements such as metheonine, cysteine, valine, thrionine and lysine. It has been reported that EAAS most often acting in a limited capacity are methionine and cystine. In this study, metheonine + cystine and threonine were the first and second limited amino acids, respectively in both samples.

CONCLUSION

The study revealed that young shoot of deleb palm (*Borassus aethiopum,* Mart) and white yam (*Dioscorea rotundata*) flours were not rich in protein but rich in some essential minerals such as sodium, calcium and magnesium. Although the flours of both samples contained some nutritionally useful quantities of the essential amino acids but dietary formula based on the samples may require all the essential amino acids except Phe + Tyr for *B. aethiopium* and Leu; Phe + Tyr for *D. rotundata.*

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