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Nutritional Qualities and Amino Acid Profile of Velvet Tamarind (*Dalium guineense)* Pulp.

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A B S T R A C T

The proximate, functional properties, *In-vitro* multi enzyme protein digestibility and amino acid composition of velvet tamarind (*Dalium guineense)* pulps were evaluated. The ash, moisture, crude fat, crude fibre, crude protein and carbohydrate of the velvet tamarind (*Dalium guineense)* pulp were: 4.63%, 8.22%, 5.80%, 7.15%, 24.3% and 49.9% respectively. The water and oil absorption capacities were: 238% and 162% which makes the pulp exhibit a high water retention capacity. The least gelation concentration was 17.0% while the foaming capacity and stability were: 43.5% and 62.2% respectively. The *in-vitro* protein digestibility was 66%. Glutamic acid was the most concentrated amino acid with the value of 14.8 mg/g crude protein while histidine (2.12 mg/g crude protein) was the least concentrated amino acid. The % total essential amino acid with histidine was 34.2% while the % total essential amino acid with histidine was 60.8%. The calculated isoelectric point was 0.54 while the predicted protein efficiency ratio (P-PER*) was 2.62.

British Biomedical Bulletin

Introduction

Velvet tamarind (*Dalium guineense)* belongs to the genus *Dalium* and to the family of *leguminosae*. Legumes are good sources of protein and energy, for most grain legumes the protein content ranges generally between 20-40%[1-4]. Legumes are nutria-tionally useful for both human and animal consumption and also for improvement of soil fertility[5]. Velvet tamarind (*Dalium guineense)* grows as shrub in the savanna regions of West Africa and widely spread in Nigeria. At maturity stage, the fruit dries up while the pod becomes stiff, brittle and inside turns pasty and brown. It helps to alleviate protein malnutrition among old and the infants at a reduced price. When other protein - rich foods are scarce and expensive, it is highly affordable and available to rural and low income people. The aim of this work is to determine the proximate, functional properties, *In-vitro* protein digestibility and amino acid of velvet tamarind (*Dalium guineense)* pulp and to harness its nutritional potentials.

Materials and Methods

Velvet tamarind (*Dalium guineense*) pulps were bought at the central market in Ado-Ekiti, Southwest of Nigeria in Africa continent. The sweet brownish edible pulps were carefully separated from the seeds. The pulps were dried and then milled into powder using Kenwood blender and kept until analyses.

The proximate analysis of the sample for total ash, moisture, crude fibre and ether extract were carried out using the method described[6]. The nitrogen content was determined by micro-Kjedahl method described[7] and nitrogen content was converted to protein by multiplying by 6.25. Carbohydrate was calculated by method of difference. All determinations were done in triplicates. The method[8] was used to determine gelation property with slight modification. The water and oil absorption capacities of the sample were determined as described[9]. The emulsion capacity and stability were determined by the method[10] while foaming capacity and stability were determined by method[11]. The protein solubility as a function of pH was determined by method described[6]. The graph of protein solubility (%) against pH was plotted using the data obtained. The multi enzyme digestibility was determined using the method[12]. 50ml of an aqueous suspension of the sample (6.25mg sample per ml) in distilled water was adjusted to pH 8.0 with 0.1M HCl and / or NaOH, while stirring in a 37^0C water bath. The multi enzyme solution (1.6mg trypsin, 3.1mg chymotrypsin and 1.3mg peptidase per ml) was maintained in an ice bath and adjusted to pH 8.0 with 0.1M HCl/ or NaOH. 5ml of the protein multi enzyme solution was then added to the protein suspension and then stirred at 37^0C and a rapid decline in pH was observed. The pH drop was recorded automatically over a period of 10 to 15 minutes using a pH meter. The multi enzyme digestibility was calculated using the regression equation[12],

$$Y = 210.46 – 18.10x \text{ ------------ } (1)$$

Where Y is *in-vitro* digestibility (%) and x is pH of the sample suspension after 10 and 15 minutes digestion with the multi enzyme solution.

The amino acid profile was determined using the method described[13]. The sample was dried to constant weight, defatted using soxhlet extractor and hydrolysed in a sealed glass ampoule at $105^oC \pm 5^oC$ for 22 hours using 7ml of 6M HCl. The hydrolysate was evaporated in a rotary evaporator and loaded into the Technicon Sequential Multi sample Amino acid Analyser (TSM, Taryton, USA).

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Estimation of isoelectric point (PI)

The estimation of the isoelectric point (PI) for the mixture of amino acids was calculated using the equation below:

$$IPm = \sum IPiXi \quad \text{-----------------------(2)}$$

Where IPm is the isoelectric point of the i^{th} amino acid in the mixture and Xi is the mass or mole fraction of the i^{th} amino acid in the mixture[14].

Predicted protein efficiency ratio (P-PER*) was determined using one of the equations developed[15] as follows:

$$P\text{-}PER^* = -0.468 + 0.454(Leu) - 0.105(Tyr) \quad \text{-----------------------(3)}$$

Results and Discussion

The results of the proximate analysis of the sample are presented in Table 1. The velvet tamarind pulp had a low value of moisture content (8.22%). The moisture content was higher than those obtained for fluted pumpkin (5.0%)[16], *Prosopis africana* (3.0%)[17] and gourd seed (3.46%)[18]. The low moisture content of the sample may help to prevent microbial growth. The ash content was 4.63% with reasonable quality of essential minerals. The ash content was in close agreement with some legumes like the cream coat (4.30%) and dark red (3.90%) varieties of bambara groundnut, cranberry beans (4.60%)[19] and Kersting's groundnut (3.2%)[20], brown and white coat variety of cowpea (3.7% and 3.6% respectively) reported[21] but lower than those of kidney bean (5.68%)[22] and quinoa flour[23]. The fat content of the sample was close in agreement when compared to the values reported for African yam bean flour (5.48- 10.2%)[24] and pigeon pea (6.49 – 6.57%)[25] respectively but lower than those of kidney bean (14.4%)[22] and benniseed flour (44.3%)[18]. The value of crude fat obtained does not qualify the sample as oil rich food. The crude protein content (24.3%) was lower than that of calabash seeds (43.18%)[26], kidney bean (28.5%)[22] and Lima bean flour (26.2%)[27] but higher than those of *Moringa oleifera* leaves (3.03%)[28], kersting's groundnut (12.9%) and pigeon pea (22.7%) reported[20]. The crude fibre value (7.15%) was higher than those of calabash seeds (2.55%)[26], gourd seed (2.80%)[18] and kidney bean (2.68%)[22], walnut flour (3.03%)[29] and some varieties of melon seeds (2.00-2.60%) reported[18]. This will enhance the easy digestibility in the intestine.

The *in-vitro* protein digestibility of velvet tamarind pulp is depicted in Fig 1. A close look at the figure shows that *in-vitro* protein digestibility had high correlations with the pH drop at 10 and15minutes after enzyme addition. It was reported that heat treatment of legume proteins and protein-containing flours improves digestibility[30] and a similar observation was observed for cowpea flour[31]. Heating improves digestibility due to protein denaturation which results in opening of protein structure[8,9] and also destroys protease inhibitors[32]. From the current report, it was found that both digestion and heat treatment periods all contributed to high protein digestibility of sample. The lowest *in-vitro* protein digestibility was at pH 7.79 at 45minutes while the highest *In-vitro* protein digestibility was at pH 7.86 at 55minutes. The average value for *In-vitro* protein digestibility was 66%. This value was lower than those of *Afzelia africana* seed flour (71.5%) reported[33], raw heat-treated pigeon pea (77% and 84%)[34] and 78.44% African nutmeg[35]. It was found that the protein digestibility dropped rapidly as the time was increased during hydrolysis, similar to observation for African nutmeg[35]. The values for the functional properties of the velvet tamarind pulp are shown in Table 2. The water absorption capacity (238%) for the sample was higher than those of 160% African nutmeg[36], kidney bean (165%)[22], 130% soy flour[37], pigeon pea (138%)[38], benniseed (182.0%), pearl millet (115%) and quinoa(147%) reported[39]. This indicates that the pulp may be useful in the production of soups and gravies[40]. The oil absorption capacity (OAC) was 162%. The oil absorption capacity is an important functional food properties, since oil acts as a flavor retainer and improves the mouth feel of foods[41]. The value of OAC (162%) for velvet pulp was higher than those of kidney bean (117%)[22], fluted pumpkin (142.5%)[16], 108.13% conophor nut[42] and date palm flour (130.30%)[43] but lower than those of cowpea flour (281-321%)[44], dehulled African nutmeg (256%)[36], *Afzelia africana* (588.49%) [33], sun flower flour (207%)[37] and *Cucumeropsis edulis* (302%)[42]. The high value of OAC reported makes velvet tamarind better flavour retainer and improves the mouth feel of foods. The emulsion capacity (87.2%) was higher than those of dehulled African nutmeg (45.6%)[36], African yam bean (10.0-20.0%)[25] and *Afzelia africana* (35.25%)[33]. This suggests that may be useful as a food additive/extender, binder formulation and colloidal foods stabilization. The value for the least gelation concentration (Lgc) was 17.0%W/V. The least gelation concentration is the ability of protein to form gels and provide a structured matrix for holding water, flavors, sugars and food Ingredients and this is useful in food application and in new product development thereby providing an added dimension to food functionality[25,33]. This value was lower than full fat fluted pumpkin flour (36%W/V) reported[16] but higher than *Afzelia africana* (6.0%)[33], 12% pigeon pea[38], 8.0%W/V lima bean[2], 6.0%W/V kidney bean[22]. This high value of least gelation concentration precludes velvet tamarind as good gel forming material and useful for industrial baby food formulations. From figure 2, it was evident that the protein solubility of velvet tamarind (*Dialium guineense*) was pH dependent with minimum and maximum solubility at pH of 2 and 7 respectively. The observed pH of the minimum protein solubility (the isoelectric point of the protein) was similar to that of winged bean reported[8] but lower than that of pigeon pea reported[38]. It was observed that protein solubility dropped at pH of 11 and 12, this may be due to the exposition of some hydrophobic group at pH above 11 which may cause reduction in the solubility. The observed minimum solubility at pH of 2.0 and 7.0 was lower than pearl millet (pH 6.0)[39], white melon (pH 3.0)[18] and full fat fluted pumpkin (pH 4.0)[16]. The minimum solubility (pH 2.0) at acidic region indicates that it can be useful in the formulation of carbonated beverages and low –acid food at pH 7.0. The pattern of the curve was similar to that of full fat fluted pumpkin[16] and periwinkle[45].

The amino acid profile velvet tamarind (*Dalium guineense)* is shown in Table 3. Glutamic acid was the most concentrated in the sample with the value of 14.8 mg/g crude protein, while phenylalanine (4.0mg/g crude protein) was the least concentrated amino acid. The value of glutamic acid was comparable with those of African catfish (14.6 mg/g), snake fish (14.5 mg/g) and tilapia fish (14.3 mg/g) reported[46]. It was in good agreement with the statement of other workers that glutamic acid was the most abundant amino acid[21,28,33,34,47]. The value obtained for glutamic acid was higher than those of *Moringa oleifera* stem (13.8 mg/g)[28] and *Luffa cylindrical* (13.0 mg/g)[48] but lower than those of periwinkle (134.8 mg/g)[45], kidney bean (134.1)[22] and faba beans (19.8 mg/g)[49]. The methionine value (4.30mg/g) was lower than those of soy beans (13.0 mg/g)[50], kidney bean[22] and cooked walnut (15.9 mg/g)[29] but higher than *Oryctes rhinoceros* (1.93 mg/g) [51] and pigeon pea (3.2 mg/g)[34]. Methionine is an essential amino acid and is needed for the synthesis of choline, choline forms lecithin and other phospholipids in the body. When diet is low in protein, insufficient choline may be formed and this may cause accumulation of fat in the liver. Cysteine can spare part of the requirement for methionine[52]. Table4 also shows the total amino acid (TAA) in sample to be 102 mg/g crude protein. The value was lower than those values obtained for dehulled African yam bean (917.48mg/g protein) reported[53], *Afzelia africana* (796.6 mg/g)[33] and faba beans[49] but higher than those leaves (76.4 mg/g), stem (65.4 mg/g) and root (70.9 mg/g) for *Moringe oleifera*[28]. Both histidine and arginine are particularly essential for children [52,54,55]. The current result shows that the sample is a good source of both amino acids. The total non-essential amino acid (TNEAA) (61.7mg/g protein) was higher than the total essential amino acid (TEAA) 34.7mg/g with histidine and 32.56mg/g without histidine. The values of TEAA with and without histidine were lower than that of raw pearl millet with histidine (224 mg/g) and without histidine (219 mg/g) reported[47]. This result was also found to be lower than the TEAA value for cow's milk: 490mg/g protein (with histidine but no tryptophan), (463.50mg/g) (without histidine and tryptophan), egg: 495mg/g (with histidine but no tryptophan) and 473.00 mg/g (no histidine no tryptophan), and beef: 467mg/g (with histidine and no tryptophan) and 433mg/g (no histidine, no tryptophan)[52].

The percentage of TNEAA is 60.76 while the percentage of TEAA is 34.15 (with histidine). The percentages EAA and TAA were lower than those of egg (50%)[56], beach pea protein isolate (43.8-44.4%)[57], pearl millet (48.6-51.1%)[47] and pigeon pea (43.6%)[34]. Tryptophan was not determined.

The percentage of total neutral amino acid (%TNAA) in the sample (59.6) and because of this high value, it indicates that it would form the bulk of the amino acid. The percentage of % TNAA 59.6> % TAAA 24.3 > %TBAA18.1 > %TSAA 10.0 > %TArAA 9.00. The % TAAA (24.3) was greater than the %TBAA (18.1) indicating that the protein is probably acidic in nature and similar to statement made by[48] for *Luffa cylindrical* seeds. The value of TArAA (9.00 mg/g) is higher than that of *Luffa cylindrical* seeds (3.25 mg/g) reported[48] but lower than the range suggested for the ideal infant protein (6.8 – 11.8 mg/g)[52] indicating that the sample when used as the weaning baby food, would be complemented with ArAA rich foods particularly when velvet tamarind is used. The value of phenylalamine (14.04 mg/g) was lower than those of *oryctes rhinoceros* (4.60 mg/g)[51], *Moringa oleifera* leaves and root (4.60 and 4.84 mg/g)[28] but compared favourably with that of *Moringa oleifera* stem (4.06 mg/g)[46]. Phenylalanine is known to be most predominant anti-sickling agent in pigeon pea extract[34,58], the studied sample extract would likely be able to perform this function since it contains a reasonable amount of phenylalanine.

The calculated isoelectric (PI) was 0.54. This value was lower than 3.66 for *Luffa cylindrical*[48]. This value is useful in predicting Pl for proteins in order to enhance a quick precipitation of protein isolate from a biological sample. The quality of dietary protein can be measured as the ratio of available amino acid in the food or diet compared with needs[56,59,60]. The predicted protein efficiency ratio (P-PER) is the gain in weight per gram of ingested protein[46]. P-PER is one of the parameters used for protein evaluation (FAO/WHO, 1991). The result of P-PER obtained for sample (2.62) as shown in Table 4 was higher than those of *Luffa cylindrical* (1.49)[48], ogi samples (millet, 1.62; sorghum, 0.27) reported[61], *Phaseolus coccineus* (1.91)[62] and 1.32-1.66 pearl millet[47]. This indicates that velvet tamarind (*Dalium guineense)* will be good complement of ogi samples and the quality of the protein is much better than *Luffa cylindrical*. It is also interesting that the sample satisfied the Food and Agricultural Organization requirement for essential amino acids[56]. The experimentally determined PER usually ranged from 0.0 for a very poor protein to a maximum possible of just over 4.0[55]. It could be deduced that the quality of velvet tamarind is fairly good based on the P-PER scale[55].

Conclusion

The velvet tamarind (*Dalium guineense* is a valuable source of nutrients and has high water retention ability. It contains considerable amount of the essential amino acid useful for both infants and adults. It is therefore recommended as good source of quality food for human consumption.

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Table 1. Proximate composition (%) of velvet tamarind (*Dalium guineense*) pulp

Component	(%)
Moisture	8.22
Ash	4.63
Crude Fat	5.80
CrudeProtein	24.3
Crude Fibre	7.15
Carbohydrate (by difference)	49.9

Table 2. Functional properties (%) of velvet tamarind (*Dalium guineense*) pulp

Functional properties	%
Water Absorption capacity	238
Oil Absorption Capacity	162
Foaming capacity	43.5
Foaming Stability	62.2
Emulsion capacity	87.2
Emulsion Stability	86.7
Least Gelation Concentration (W/V)	17.0

Table 3. Amino acid profile of velvet tamarind (*Dalium guineense*) pulp

Amino acid	Concentration (mg/g crude protein)
Glycine	4.63
Alanine	3.82
Serine	4.43
Proline	5.41
Valine*	5.17
Threonine*	4.23
Isoleucine*	5.64
Leucine*	7.98
Aspartic acid	9.86
Lysine*	6.39
Methionine*	4.30
Glutamic acid	14.8
Phenyl alanine*	4.04
Histidine*	2.12
Arginine*	7.81
Tyrosine	5.11
Cysteine	5.83

Table 4. Essential, non-essential, acidic, basic, neutral, total sulphur and total aromatic amino acids (mg/g crude protein) of velvet tamarind (*Dalium guineense*) pulp

Amino acids	
Total amino acid (TAA)	102
Total non-essential aminoacid (TNEAA)	61.7
% TNEAA	60.7
Total essential amino acid (TEAA) with histidine	34.7
% TEAA with histidine	34.2
Total Essential amino acid (TEAA) without histidine	32.6
% TEAA without histidine	32.1
Total acidic amino acid (TAAA)	24.7
% TAAA	24.3
Total Neutral amino acid (TNAA)	60.6
% TNAA	59.6
Total basic amino acid (TBAA)	18.4
% of TBAA	18.1
Total Sulphur amino acid (TSAA)	10.1
% TSAA	10.0
Total aromatic amino acid (TArAA)	9.15
% TArAA	9.00
P-PER*	2.62
Calculated Iso-electric point	0.54

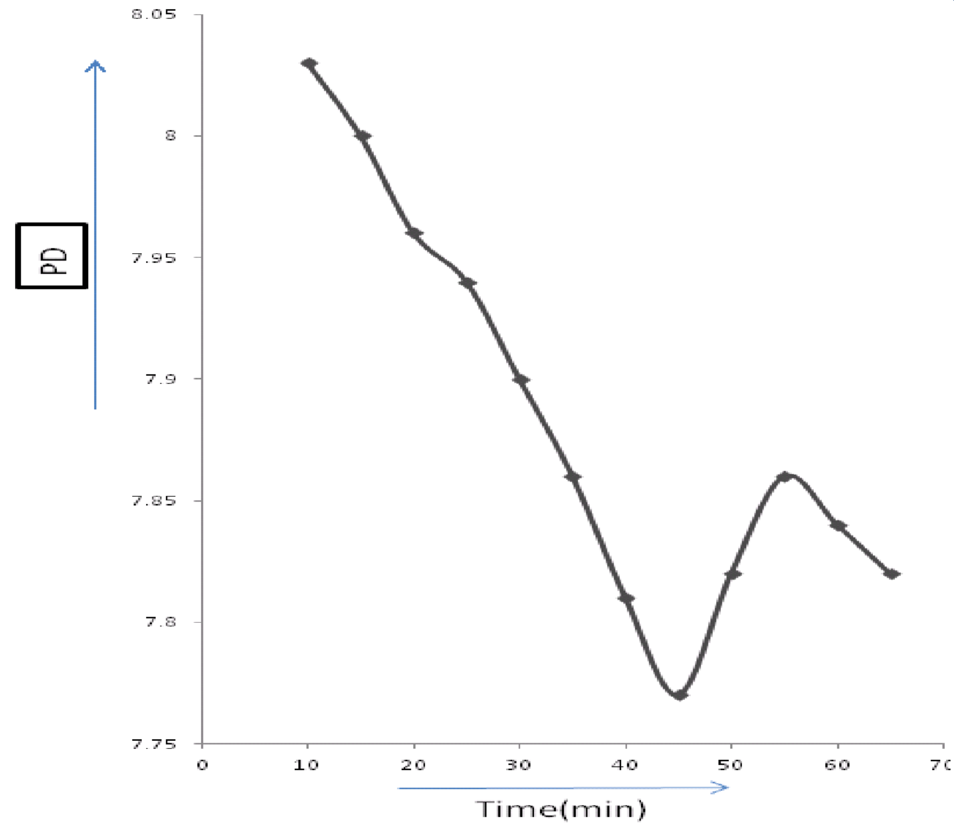

Figure 1. The graph of protein digestibility against time

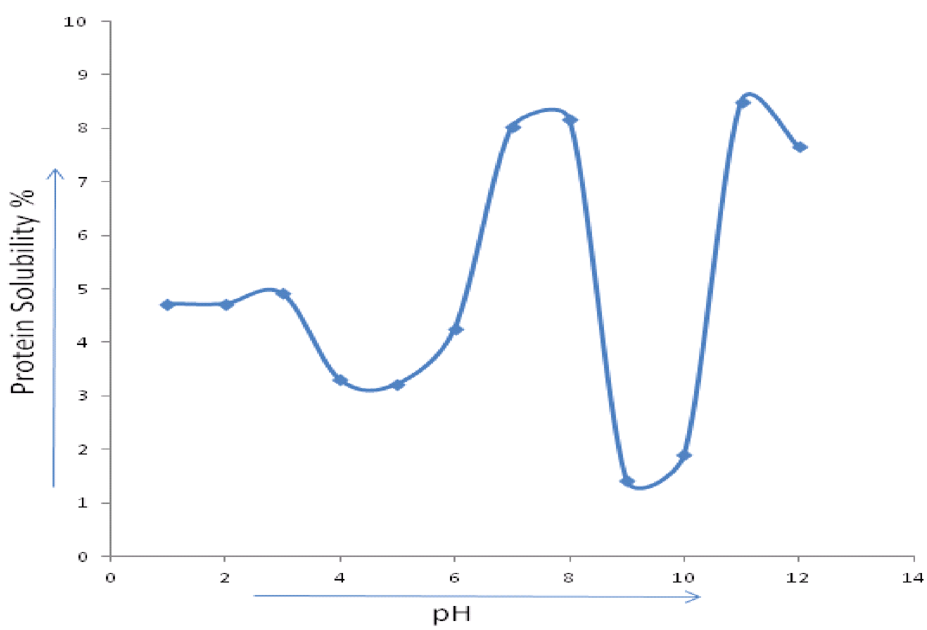

Figure 2. The graph of protein solubility against pH