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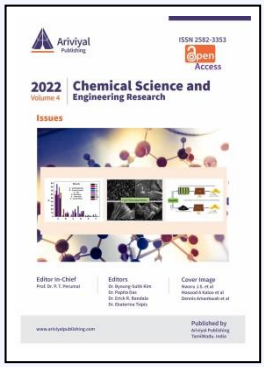

Evaluation of the Nutritive and Antioxidant Potentials of Velvet Tamarind (*Dialium Guineense*) Seed, Pulp and Shell

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Abstract: Velvet tamarind (*Dialium guineense*) is a wild fruit commonly grown and consumed in northern part of Nigeria. However, this study aimed at investigating the proximate, mineral, vitamin C and antioxidant potentials of velvet tamarind (seed, pulp and shell) using standard analytical procedures. The result of the proximate analysis showed that the pulp recorded highest percent crude protein (18.34%) and crude fat (4.92%) which also contributed to its highest calculated metabolizable energy (1536.43 KJ/100g) in the study while percentage moisture (7.67%) and carbohydrate (75.60%) were found to be highest in seed, and the shell were found to be highest in terms of crude fibre (10.47%) and ash contents (6.82%) respectively. The result of the mineral analysis revealed highest concentrations of Zn (6.30 ± 0.01 mg/100g), Ca (370.01 ± 0.08 mg/100g), and Mg (200.01 ± 0.04 mg/100g) in the pulp while highest concentrations of K (486.24 ± 2.10 mg/100g), Na (73.68 ± 0.03 mg/100g), and Fe (4.70 ± 0.01 mg/100g) were found in the seed. The vitamin C content was found to be highest in the seed (32 ± 0.05 mg/100) which also resulted to its higher antioxidant activity compared to the pulp and the shell. However, based on the results obtained, it could be inferred that velvet tamarind (shell, pulp and seed) are good sources of nutrients especially the pulp and the seed and could serve as natural antioxidant if incorporated in human diet.

Keywords: Velvet Tamarind; Proximate; Vitamin; Mineral; Antioxidant

1. Introduction

Several studies reveal that consumption of fruits and vegetables plays a vital role in human health due their nutritional and phytochemical constituents.[1-3] However, in tropical countries, wild fruits offer potential novel sources of macro and micro nutrients as well as health promoting phytochemicals for rural populations.[4] Among these wild fruits, velvet tamarind (*Dialium guineense*) remains a well-known nutritional health promoting food to local population.[5] Velvet tamarind (*Dialium guineense*) is a woody plant that grows in the rainforests of west Africa.[6] However, in Nigeria, it grows in the north central where it is commonly known as "tsamiyarbiri" in hausa language. The ripe fruits are available from January till may, but the peak period for the harvest is between March and April.[5] Furthermore, the fruits are used in medicinal remedies, as a source of vitamin C, as a flavour in snacks and can also be processed into beverages, soft drinks, alcoholic drinks, syrups/concentrate and jams.[7]

However, minerals are inorganic substances needed by both plants and animals to enhance their growth and development. Additionally, minerals are needed for the proper formation of blood and bones, maintenance of healthy nerve function, heartbeat regulation, reproduction and foetal development.[8,9] Furthermore, essential minerals such as calcium, magnesium and phosphorus helps in building of bones and teeth. Nerve signal which is vital for the brain and muscles also depend on calcium, magnesium, sodium and potassium ratio. While non-essential minerals such as selenium and zinc, help to boost the immune system in human body.[10]

Antioxidants are substances that are capable of hindering or minimizing the autoxidation process of some compounds or neutralizing free radicals in the body.[11] Thus, they are capable of protecting the cells from the damage caused by the free radicals which initiate chain reactions leading to membrane and other lipid per oxidation, DNA damage among others.[12] However, over the years, antioxidants have been used in both food processing and pharmaceutical industries as a preservative (to prevent oxidation), enhance flavor, aroma, color and for the treatment of various diseases such as cancer and coronary heart disease respectively.[13] Investigations had shown that most of the antioxidants incorporated in our foods and pharmaceutical products today, are synthetic and were reported to be unsafe on human health by some researchers.[14-16] However, considering the available literatures, widespread cultivation and critical investigation of *D. guineense* for nutritional importance, promotion of health and prevention against damages caused by free radicals are of significant importance in addressing food security and quality diet for both rural and urban population.

However, till date, little or no information is documented regarding the full nutritional and antioxidant properties of this fruit (shell, pulp and seed). Therefore, this study is aimed at evaluating both the nutritional (proximate, minerals and vitamin C) and antioxidant properties of velvet tamarind fruit (shell, pulp and seed).

2. Experimental Section

2.1. Sampling and Sample Preparation

Sample of black velvet tamarind (*D. guineense*) fruit was purchased in Keffi market, Nasarawa state of North Central Nigeria, in the month of March 2021 during the pre-raining season. Stones and other large particles were removed from the sample and dried under the sun. It was separated into three portions using pestle, mortar and sieve. The first portion was the shell, second portions were the pulp and the third portion was the seed. The samples were ground into powdered form to provide a larger surface area for further analyses.

2.2. Proximate Analysis

The proximate compositions, including moisture, ash, crude fat, crude protein contents (N x 6.25), and crude fibre were determined using the method described by the Association of Official Analytic Chemists.[17] The carbohydrate was determined by difference. All the parameters in the samples were determined in triplicates and were expressed in percentage. The chemicals used were all analytical grade.

2.3. Determination of Minerals

Method of Okonkwo and Ozoude[18] was adopted with slight modifications, the sample (5 g) was weighed into a 250 cm^3 conical flask and digested with a mixture of concentrated Hydrochloric acid and Nitric acid in the ratio of 3: 1 (15 cm^3 : 5 cm^3) at the temperature of 200 – 250^oC in a fume cupboard. The samples were filtered after digestion, transferred into 100 cm^3 volumetric flask and made up to mark with distilled water and finally analysed using Atomic Absorption Spectrophotometer(ICE 3000 series) for Ca, Mg, Fe, and Zn while for Na and K, Flame Photometer(model 405, corning, U.K) was used.

2.4. Determination of Vitamin C

Method of Barak at et al.[19] was adopted with slight modifications. For this method, 5 g of the prepared sample was placed into 250 cm^3 volumetric flask followed by addition of 100 cm^3 of distilled water and allowed to dissolve for 30mins, and filtered. The filtrate (25 cm^3) was pipetted into a conical flask followed by addition of 1 cm^3 of freshly prepared 1% starch solution and titrated against standard iodine solution (0.05 M) until a blue black colour was observed which indicated the end-point.

2.5. Antioxidant Activity

The free-radical scavenging activities of the samples were evaluated using 2, 2-diphenyl-1-picrylhydrozyl radical (DPPH) in methanol by a slightly modified method of Re et al.[20] According to the method, 0.5 cm^3 of 1 mm of DPPH in methanol was prepared under darkness condition and 3 cm^3 of this solution was added to 1 cm^3 of various concentrations (0.1, 0.3, 0.5, 0.7 and 1.0 mg/cm^3) of the extracts. Vitamin C was used as a standard. The absorbance was taken after 30 minutes at 517nm and the radical scavenging activity was calculated as:

$$\boldsymbol{Inhibition}\ (\%) = \boldsymbol{A} - \frac{\boldsymbol{B} \times \boldsymbol{100}}{\boldsymbol{A}}$$

Where A = absorption of the blank sample without extract.
B = absorption of the extract.

2.6. Statistical Analysis

The energy values (KJ/100) were calculated by adding up (protein x 17 + fat x 37+ carbohydrate x 17) for each of the sample. Mean and errors of three determinations were calculated as standard deviation (SD) for the proximate composition.

3. Results and Discussions

3.1. Proximate Compositions

Table 1 shows the result of the proximate compositions of the velvet tamarind samples (Seed, Pulp and Shell). The result revealed that moisture contents fell within the range of 5.43% to 7.67%. However, moisture content is the measure of the amount of water found in a substance at a given time, it is an index of perishability and storability.[21] From the values obtained (Table 1), velvet tamarind seed had the highest percent moisture content (7.67 ± 0.01) while the Shell had the lowest (5.43 ± 0.01). This indicates that the shell will be less prone to microbial attacks and can be stored for a longer time without spoilage. The moisture content of any food material is of significance to its shelf life, packaging and general acceptability.[22]

Ash content signifies the level of minerals present in a sample. Thus, the higher the ash content, the higher mineral content vice-versa. The results of the analysis obtained shows that the shell had 6.82% which is higher than both the Pulp (4.14%) and the seed (6.17%). This implies that higher amount of mineral contents could be present in the shell compared to the seed and the pulp. Proteins plays a vital role in human diet in terms of growth and warn out tissues in human body.[23] This study shows that the crude protein value of the pulp was found to be 18.34% which is much higher than the shell (5.69%) and the seed (5.25%) respectively. These values indicate that the pulp is a better protein supplier compared to the shell and the seed. The crude fat obtained from this study shows that the Pulp had the highest percent crude fat (4.92%) when compared to the Seed (2.18%) and Shell (1.20%). However, these values are also in close agreement with the ones reported by Achoba et al.[24] on the nutritional composition of velvet tamarind (seed and pulp) 5.4% and 2.6% respectively. Fibre plays a vital role in providing roughages that aid digestion and also helps to lower the risk of cardiovascular diseases.[25] The values of the crude fibre fell within the range of 3.13% to 10.47% with the shell having the highest value and the Seed having the lowest value. However, the values for the seed and the pulp appeared to be lower than the 7.15% obtained by Ogungbenle and Ebadan[7] in his research on the nutritional qualities

Table 1. Proximate Composition of Velvet Tamarind (Seed Pulp and Shell)

Parameter (%)	Velvet Tamarind Seed	Velvet Tamarind Pulp	Velvet Tamarind Shell
Moisture	7.67± 0.01	6.80± 0.04	5.43± 0.11
Ash	6.17± 0.21	4.14± 0.05	6.82± 0.06
Protein	5.25± 0.04	18.34± 0.01	5.69± 0.09
Crude fat	2.18± 0.01	4.92± 0.010	1.20± 0.02
Crude Fibre	3.13± 0.02	4.47± 0.01	10.47± 0.04
Carbohydrate	75.60± 0.61	61.33± 0.23	70.39± 0.81
[a]Energy(KJ/100)	1455.11	1536.43	1337.76

Data are presented as mean ± standard deviation of triplicate determinations:

[a] Calculated metabolizable energy(KJ/100) (protein x 17 + fat x 37+ carbohydrate x 17)

Table 2. Mineral Composition of Velvet Tamarind (Seed, Pulp and Shell)

Minerals (mg/100g)	Velvet Tamarind Seed	Velvet Tamarind Pulp	Velvet Tamarind Shell
Zn	6.30 ± 0.01	5.09± 0.02	0.25 ± 0.01
Ca	370.01 ± 0.08	172.4±0.04	64.7± 0.01
Mg	200.01 ± 0.04	122.92 ± 0.11	12.08 ± 0.06
Fe	2.90 ± 0.02	4.70± 0.01	1.70 ± 0.01
Na	43.3 ± 0.01	73.68± 0.03	7.01 ± 0.07
k	171.00±0.03	486.24±2.10	18.30±0.02
[a]Na/K	0.25	0.39	0.38

[a]Na/K : Sodium to Potassium ratio

and amino acid profile of velvet tamarind (*Dalium guineense*) Pulp except for the shell (10.47%). This implies that the shell will enhance easy digestibility more than the pulp and the seed.

Carbohydrate supplies energy to the cells of the brains, muscles and blood. It contributes 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.[26] From the result obtained, it shows that *D.guineense* seed has higher carbohydrate (75.60%) than the shell (70.39%) and the Pulp (61.33%). The high carbohydrate of the seed shows that it is a very good source of energy. The result also revealed that the calculated metabolizable energy in the samples is in the order of: pulp > seed > shell. However, the high amount of the calculated metabolizable energy (1536.43 KJ/100g) obtained in the pulp compared to the seed and the shell is due to the presence of high percentage of other components or nutrients (protein and fat) in the shell which also provide energy.

3.2. Mineral Compositions

Table 2 shows the results of the mineral compositions of the velvet tamarind (shell, pulp and seed). Highest Ca content of 370.01 ± 0.08 mg/100g was found in the seed whereas lowest content was determined in the shell (64.7 ± 0.01 mg/100g). Thus, Calcium provides skeletal structure of the bones and teeth as well as prevention of colon cancer and the reduction of obesity.[27] The samples could be considered as good sources of calcium in a diet since the values are moderately high when compared with the values obtained from coconut and deleb palm nut.[28] Magnesium concentrations fell within the range of 12.08 ± 0.06 to 200.01 ± 0.04 mg/100g. Magnesium is extremely important for health because it is needed for many biochemical reactions in the body and is partially responsible for countless aspects of good and sound health.[29] The recommended dietary allowance for magnesium in adult is 350 mg/day while in children is 170 mg/ day.[30] This indicates that the values obtained in this study were below the recommended standard except for the seed which is higher than the recommended value for children. Therefore, they cannot be regarded are rich sources of magnesium especially for adult. According to literature, Iron combines with protein and more than 90% of it, is present in animal body.[31] From this study, iron concentrations ranged from 1.7 ± 0.01 to 4.7 ± 0.01 mg/100g. However, this is in close agreement with 0.2 mg/Kg in *Cocos nucifera* nut reported by Jibrin et al.[29]

Table 2 shows the result of the mineral compositions of the velvet tamarind (shell, pulp and seed). Also from Table 2, the concentrations of Zn fell within the range of 0.25 ± 0.02 to 6.30 ± 0.01 mg/100g in which the seed is comparatively higher than the Shell (0.25 ± 0.01 mg/100g) and the Pulp (5.09 ± 0.02 mg/100g). Though, the values are relatively low in all the samples when compared with 10.1 mg/100g in *D. rotundata* obtained by Aremu et al.[26] on the compositional evaluation of young shoot of deleb palm(*Borassus aethipum*) and white yam(*Diescorea rotundata*).This suggests that the samples are not rich sources of Zn. The concentrations of Ca were found to be highest in seed (372. *D. guineense* Pulp in the study was found to be highest in Na concentration (73.68 ± 0.03 mg/100g) and the least (7.01 ± 0.07 mg/100g) in the Shell. Sodium plays an important role in the transmission of nerve impulses and in the absorption of sugar and amino acids from the digestive tract.[32] The values obtained were found to be lower than the recommended dietary allowance in take for both adult (500 mg/day) and children(400 mg/day). This study also reveals that concentrations of K in all the samples ranged from 18.30 ± 0.02 to 486.24 ± 2.10 mg/100g. Potassium plays an important role in the nerve muscle excitability and is also concerned in the metabolism of carbohydrates by effecting intake of glucose into the cells. It facilitates the uptake of natural amino acids by the cell.[33] However, the values obtained for K were found to be the highest in all the analysed minerals. This suggests that the samples are relatively good sources of K. Studies revealed that the ratio of sodium to potassium (Na/K) plays a vital role in the regulation and

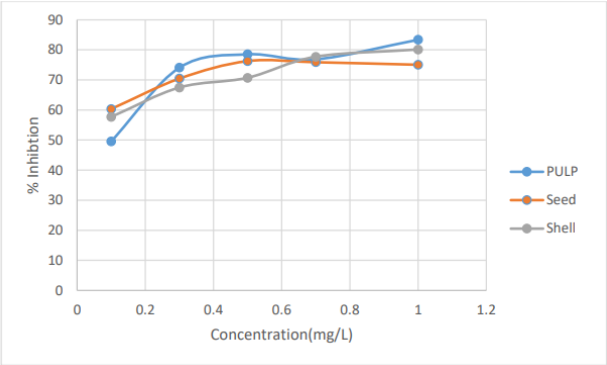

Fig. 1. DPPH Radical Scavenging Activities of the Extracts

Table 3. Vitamin C Composition of Velvet Tamarind (Seed, Pulp and Shell)

Sample	Vitamin C(mg/100g)
Velvet Tamarind(Seed)	32 ± 0.05
Velvet Tamarind(Pulp)	30 ± 0.01
Velvet Tamarind(Shell)	18.6 ± 0.03

prevention of high blood pressure.[34] Thus, the recommended ratio is less than one. However, the values obtained from this study revealed that all the samples are within the recommended ratio. Therefore, this suggests that the samples may be suitable for the prevention of high blood pressure when consumed.

3.3. Vitamin C Compositions

Table 3 shows the results for vitamin C contents of the velvet tamarind shell, pulp and seed samples. The vitamin C contents fell within the range of 18.6 ± 0.03 to 32 ± 0.05 mg/100g in which the seed was found to be the highest while the shell recorded least vitamin C content. However, vitamin C is a powerful antioxidant that assists the body in contesting viral infection, bacterial infection and toxicity.[35] Deficiency of Vitamin C causes Bruising, Bleeding, Skin and hair loss. The symptoms are all related to diminished levels of Collagen in bones, blood vessels and connective tissues.[36] The values obtained from this study are higher than 8.88 mg/100g in Cocos nucifera and 6.71 mg/100g in Borassus aethiopum reported by Jibrin et al.[29] but in close agreement with 33.33 ± 0.10 mg/100g reported by Ogungbenle[7] on analytical and nutritional evaluation of velvet tamarind (Dialium guineense) Pulps. This suggests that all the samples are good sources of vitamin C and could also serve as natural antioxidants.

3.4. Antioxidant Activity

Ingestion of natural antioxidants has been associated with reduce risk of cancer and many chronic disease.[37] The DPPH assay provides an easy way to determine the antioxidant activity of most plant extracts. Fig. 1 depicts the % inhibition of the DPPH free radicals against the concentrations of the extracts. From the study, the % inhibition of the DPPH free radicals were found to be 27.70, 52.10, 57.46, 76.02 and 81.20% for the seed, 30.59, 40.46, 58.54, 70.86 and 79.38% for the pulp and 17.34,37.46, 46.38, 60.90 and 70.06 for the shell. The results also indicates that maximum % inhibitions of the DPPH free radicals for the shell, seed, and pulp are in ascending order of; shell < pulp < seed. However, it was observed from the results that the % inhibition of the DPPH free radicals was concentration dependant of the extracts. This implies that increase in concentration of the extract increases the % inhibition of the DPPH free radicals. Also from the results, highest % inhibitions of the DPPH free radicals were found in velvet tamarind seed. This is also justifiable as highest amount of vitamin C content was recorded in velvet tamarind seed among the samples which is a strong antioxidant. Moreover, other phytochemical components could also be responsible.

4. Conclusions

In conclusion, the proximate analysis showed highest percent protein and fat in pulp which contributed to its highest calculated metabolizable energy while percentage moisture and carbohydrate were found to be highest in the seed and the shell were found to be highest in terms of crude fibre and ash content. The results for the mineral analysis revealed highest concentrations of Zn, Ca, and Mg in the seed while highest concentrations of K, Na, and Fe were found in the seed. The vitamin C content was found to be highest in the seed which also resulted to its higher antioxidant activity compared to the pulp and the shell. However, based on the results obtained, it could be inferred that velvet tamarind (shell, pulp and seed) are good sources of nutrients especially the pulp and the seed, and could also serve as a source of natural antioxidant if incorporated in human diet.

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Conflicts of Interest

The authors declare no conflict of interest.

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